HRVA - NAVI MUMBAI

SOCIAL VULNERABILITY ANALYSIS

APRIL 2017

VOLUME I–MAIN REPORT

JAMSETJI TATA SCHOOL OF DISASTER STUDIES

TATA INSTITUTE OF SOCIAL SCIENCES

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HRVA Navi Mumbai

Social Vulnerability Analysis

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VOLUME I – MAIN REPORT

Jamsetji Tata School of Disaster Studies
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Abbreviations

CDMP - City Disaster Management Plans

CDP - City Development Plans

DM – Disaster Management

CIDCO - City and Industrial Development Corporation

DRR – Disaster Risk Reduction

FSI – Floor Space Index

GIS – Geographical information System

GoM - Government of Maharashtra

H/H – Household

HRVA - Hazard Risk and Vulnerability Assessment

IFRC - International Federation of Red Cross

MoU – Memorandum of Understanding

NMMC – Navi Mumbai Municipal Corporation

NTDA - New Town Development Authority

PAR - Pressure and Release Model

SC/ ST – Scheduled Caste/Scheduled Tribe

SoVI – Social Vulnerability Index

TISS-JTSDS – Tata Institute of Social Science – Jamsetji Tata School for Disaster Studies

TTC – Trans Thane Creek

UNDP - United Nations Development Programme

UNISDR - United Nations Office for Disaster Risk Reduction

Glossary

Note: All definitions are based on the 2009 UNISDR Terminology on Disaster Risk Reduction

Building Codes

A set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage.

Capacity

The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.

Capacity Development

The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.

Climate Change

(a) The Inter-Governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use".

(b) The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Critical Facilities

The primary physical structures, technical facilities and systems which are socially, economically or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency.

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Disaster Risk

The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

Disaster Risk Management

The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster Risk Reduction

The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Emergency Services

The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.

Exposure

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Mitigation

The lessening or limitation of the adverse impacts of hazards and related disasters.

Land-use Planning

The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses

Natural Hazard

Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Non-structural Measures

Any measure not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education.

Preparedness

The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.

Prevention

The outright avoidance of adverse impacts of hazards and related disasters.

Resilience

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Risk

The combination of the probability of an event and its negative consequences.

Risk Assessment

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.

Risk Management

The systematic approach and practice of managing uncertainty to minimize potential harm and loss.

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

Executive Summary

The necessity of conducting a Hazard Risk Vulnerability Assessment (HRVA) arises from the need to anticipate the potential risks, so as to be in a position to minimize the damage and ensure speedy recovery after a disaster. It is an important step towards enhancing resilience. This study focuses on social vulnerability in the city of Navi Mumbai. The study is based on data from Census 2011 and analysis is done at three levels i.e. at the Ward level, Node level and the City level. The Census 2011 outlined 89 wards in Navi Mumbai. A ward is the smallest unit of analysis on which comparable data is available for the entire city. A certain number of Municipal wards together form Nodes and there were 8 such nodes in NMMC as of 2011.

Several methodologies are used worldwide for multi hazard risk assessment, and vulnerability analysis. However, to apply them directly in the Indian context seems difficult due to various challenges such as, lack of availability or easy access to time series and spatial data and so on. Accepting these limitations, a methodology was devised to create indices and assign ranks to the Census wards and nodes in assessing their social vulnerability. In constructing the methodology, certain factors became important such as, available data sources, type of data available at the disaggregated level, maps and format of maps available (example AutoCAD, GIS). In this report the endeavour has also been to present the analysis in a visual format, so that decision making may be facilitated around reduction of vulnerability planning for disaster preparedness and to enhance disaster resilience.

By definition, a disaster is an unexpected event. However, based on the review of the past NMMC-City Disaster Management Plan and through discussions with officials from the corporation and local authorities, a number of likely events viz. floods and water logging, fires, building collapse and landslides were identified. These were the key hazards along which social vulnerability analysis for NMMC was carried out and mapped.

Further, indicators of vulnerability were identified and vetted by experts. While identifying each indicator, care was taken to understand why the indicator is selected and how it affects the vulnerability of people (i.e. whether the indicator is directly or indirectly proportionate to social vulnerability). In accordance with extant practice, the indicators have been re-grouped on the basis of their characteristics/sources of vulnerability.

Following the methodology suggested by Patnaik and Narain (2009), the indicators have been divided into 2 main categories and 5 sub-categories. The two main categories are **social and physical vulnerabilities**. The Social Vulnerability Indicators have been further divided into; Demographic, Marginalised Population, Economic status and Social Security. Similarly, within Physical Vulnerability Indicators, two sub-categories, namely; Housing and Physical Infrastructure have been considered. These are indicators on which Census data is available.

Values for the above indicators for all 89 wards were tabulated and normalised (based on whether they were directly or indirectly proportionate to the vulnerability). This method of normalization, that takes into account the functional relationship between the variable and vulnerability, was most important in the construction of the Social Vulnerability Indices (SoVI). The normalised values were then ranked. In case of directly proportionate indicators, highest normalized value has been given highest rank (i.e. rank 89 in this case) which indicates

highest vulnerability and vice versa. Since the city administration functions at the municipal ward level, the indices for wards have been aggregated at the node level.

The outcome of the scientific analysis was then scrutinised individually at the ground level through field visits and discussions with Ward officers. Simultaneously, a set of maps were created to further understand the vulnerability spatially. These outcomes are expected to help ward level and node level actions, as well as departmental/sectoral plans and identify concerted intervention.

While doing the analysis, certain geographic, demographic and cultural characteristics were noticed that may have a major impact on the vulnerability of Navi Mumbai. It was observed that the spatial distribution of vulnerability decreases as one moves towards south i.e. from Digha to Belapur. This is because of the development pattern. When CIDCO undertook the development of Navi Mumbai, Vashi and Belapur were the first nodes to be developed. Belapur was developed as a central business district and Vashi as a residential and commercial sector. Thus a well-developed area emerged in the southern part of Navi Mumbai which is less vulnerable. Later, as the city grew, more and more areas were included within NMMC's jurisdiction. However, the development of Vashi and Belapur had spurred developmental activities in the surrounding hinterland. As a result, when CIDCO undertook planning, most of the nearby areas already had haphazard development, which became a part of the city. This increased social vulnerability. Due to presence of several stakeholders - CIDCO, MIDC, NMMC in Navi Mumbai, jurisdiction has emerged as a vital point of concern. Through discussions, it was noted that the city is still working in a "crisis management" mode rather than moving on to working systematically on prevention and resilience building.

The vulnerability analysis showed interesting outcomes which have been flagged in the report at appropriate junction. The final outcome of the vulnerability assessment has also been mapped so as to spatially understand the distribution of vulnerability. The Report is presented in 3 volumes–

Volume I: Main Report

Volume II: Appendix and

Volume III: Book of Maps.

Disasters present challenges at different levels (the community, city and even the region) and hence, different actions are required to meet these challenges at each level. Actions that are directed at reducing vulnerability at the city level (such as addressing systemic issues of water logging and drainage, improving coordination, and enhancing technical capacity of each of the city agencies) should be implemented in conjunction with actions at the ward and community level. Local communities should be empowered to address their infrastructural needs through local initiatives and ward committees. NMMC needs to emphasize mainstreaming DRR in all aspects of development and plan systematically to take proactive steps to reduce vulnerability. Section 5.10 of the Main Report (Volume I) on observations and recommendations offers 20 points which are summarised here:

1. **Coordinated functioning**

- Navi Mumbai has land that is managed by NMMC, CIDCO and MIDC for overall functioning of the city. These bodies have certain responsibilities and areas to cater to. There is some overlap and inadvertent intrusion into each other's jurisdiction, which creates complications and neglect. It would be useful if arrangements for coordinated functioning for disaster risk reduction and resilience building (mitigation, preparedness and response) are developed carefully. This will help avoid duplication and desertion during disaster events.
- Periodic joint meetings and exercises would foster greater coordination and role clarification.

2. **Shifting Boundaries and cascading impacts**

- Navi Mumbai is divided into 89 electoral wards (Census 2011), but these ward boundaries are dynamic and change based on the population density. It is recommended that the ward officers within nodes familiarise themselves about issues in the neighbouring wards. This would help when a vulnerable area is shifted from one ward to another due to administrative or other reasons. Since events or conditions in the neighbouring ward may impact each ward, recognition of mutual vulnerabilities would result in better preparedness and coordination.

3. **Fire fighters** are the first responders. Therefore, a robust team complemented by state of art equipment is recommended. Fire stations need to be upgraded to avoid over-stretching. Alternate arrangements like Mini fire stations or Mobile Fire Motor Cycle can be explored to deal with hutments, narrow roads and congested areas. Periodic table top exercises and mock drills, involving all fire agencies will ensure better coordination and familiarization. Standing Fire Advisory Council (SFAC) periodically updates the norms based on latest experience and observations. Fire department needs to refer to the SFAC recommendations on a regular basis and implement changes on priority. NMMC needs to promulgate stringent rules for old buildings to avoid building collapse and related injuries and deaths.
4. **Disaster Management Cell** needs to have adequate facilities such as, decision support and telecommunications capabilities that provide flexibility, sustainability, security, survivability and interoperability during emergencies. Currently the room where the DM cell is housed needs suitable physical alteration for better operation. Upgraded communication system with trained and sufficient manpower is also recommended. Communication equipment (such as SAT phones, Wireless Set, HAM Radios) with trained personnel may be considered. Hazard based Standard Operating Procedures (SOPs) should be prepared. All departments need to participate in periodic hazard based exercises for better preparedness. The outcome of these exercises should be used to amend SOPs and feed into periodic updates of Disaster Management Plans. Emergency Operation Centres (EOCs) at the ward level will be an added asset. If not, Control rooms or equivalent entities may be set up in all wards.
5. **Systematic Training:** Periodic training on various aspects of disaster management should be conducted for all government officials and elected representatives. Printing and dissemination of relevant material would help. Currently there are only pre monsoon preparatory meetings that take place to discuss communication and response strategies. Multi stakeholder table-top exercises would help.

6. **Community Preparedness:** Awareness generation campaigns on DRR- (preparedness and prevention), should be organised periodically and systematically. Preparedness and trainings sessions need to be conducted periodically in the wards, localities and schools to raise the level of awareness. Mock drills and social audits should be conducted with participation of the community with coordinated action from various departments.

A vulnerability analysis is dynamic and needs to be updated periodically. NMMC would need to take ownership of HRVA process which will help internalise the idea of mainstreaming DRR. The present study has created a baseline analysis as per the Census 2011 data. NMMC should undertake updation of the HRVA in-house along with the ward administration. This would require some training.

NMMC is a multi-hazard prone region with natural disasters like earthquakes, floods, landslides, besides other disasters including industrial and road accidents, fires etc. Human activities disturbing the ecological balance can directly result in disastrous events or exacerbate a natural hazard. With projected increase in the frequency and intensity of extreme events globally and in India, cyclones, droughts, and floods, disaster management and investments in disaster risk reduction will need greater attention even in the planned city of Navi Mumbai.

1. Introduction

Navi Mumbai was envisaged as a counter magnet to the ever densifying island city of Mumbai, on the west coast of India. The city was planned on the concept of polycentric nodal development with principles of walk to work, environment sustainability and planned sectors with mixed land-use. Planned by CIDCO, the 108.63 sq.km regions was converted to a Municipal Corporation and thus Navi Mumbai Municipal Corporation (NMMC) was established on 1st January 1992 and its current population stands at 1120547 or 1.1 million (Census 2011).

Despite being a planned region, several concerns have surfaced in recent years. Like most cities in India, Navi Mumbai Municipal Corporation (NMMC) area is facing new and ever increasing vulnerabilities. Disasters in urban India are on the rise and with the current pace of urbanisation, the cities and its dwellers are facing new challenges and exposure to hazards. It is argued by many that most of these disasters are development induced rather than natural. For example, landslides in urban areas are more a result of people building and living in unsafe area and deforestation rather than excess rainfall or tectonic movement. Similarly, flooding in urban areas is mostly water logging due to poor planning and encroachment of the natural drainage systems and ad hoc development which does not respect the contours of the region.

Though the city of Navi Mumbai has achieved its goal of creating polycentric nodes of liveable areas with amenities and commercial facilities at walkable distance, it has in its development process created certain vulnerabilities. Due to the development activities and pollution, the protective mangrove edge has been lost in certain areas, thus exposing the city to the open seas. The natural contour of the city has been disrupted and certain low lying pockets have been created which are left with no drain off passages. Mining activities in Airoli has also left the slopes in precarious situations and in recent years there have been incidences of landslides, which have been further augmented by haphazard development on the slopes. Increase in FSI and recent development trends of high rise buildings and shopping malls with centralised air conditioning systems or standalone ACs with no proper outlet has increased vulnerability to fires.

Thus, Navi Mumbai is an interesting case of increased vulnerability due to changing demographics and developmental pattern which can potentially cause an increase in the frequency of disasters. The city's immediate needs are to ensure coordination and convergence of its developmental works, disaster resilience building and DRR efforts.

It was in this context that the Navi Mumbai Municipal Corporation decided to take stock and review its City Disaster Management Plan prepared in 2007 with few updations in the recent years. This review was carried by TISS-JTSDS with support from UNDP and NMMC. A few highlights and issues identified in the study that preceded this one:

- The present Disaster Management Plan discusses the city as a whole and does not capture vulnerabilities at the micro level such as wards and localities.
- The plan discusses the various risks and vulnerabilities within the city, however a detailed HRVA is missing. The updated CDMP should capture ward level issues and

vulnerabilities through Ward HRVAs and also work towards creation of maps for ease of visual identification and appropriate planning, coordination and decision making in the event of a disaster.

- Maps are an essential and integral part of any CDMP as they form the base for any mitigation plans and response work. These are completely missing in the CDMP

- It has been observed that the development plan and disaster management plan are two different documents with no connect with each other. The concept of disaster management is shifting from response and rehabilitation to building resilience and disaster risk reduction. Thus the city development plans (CDP) and city disaster management plans (CDMP), should also reflect the same.

- Importance needs to be given to cross cutting issues like updating and testing, capacity building and financing of disaster mitigation, preparedness and prevention.

- Departments involved in capacity building should be part of the CDMP with a list and details of personnel with the specific skill sets required by them. Tie ups need to be developed with institutes that could help in the training and capacity building programs including table-top exercises.

It was decided by NMMC-UNDP to undertake HRVA studies. JTSDS-TISS was approached to undertake the social vulnerability assessment.

1.1. Scope of this Study

To examine social vulnerabilities present in Navi Mumbai in the context of various disasters.

- To identify the coping capacities/climate change adaptation of the community. This will help in planning for mitigation and preparedness techniques to reduce the impact of disasters in future.

- On the basis of the above a consolidated risk and vulnerability index will be prepared for the city. This will help identify areas/communities, which are more vulnerable to different hazards.

2. Hazard, Risk Vulnerability Assessment: A Note

2.1. Mainstreaming Disaster Risk Reduction into Urban Planning

The after effects of natural calamities are usually worse in developing countries as compared to the more developed ones. This is because of poor environment safeguarding measures and the presence of large number of marginalized communities. With rapid growth, India's urban centres, face new disaster risks and vulnerabilities. Weak institutional frameworks and gross social inequalities make the urban centres of the country particularly susceptible to the adverse impacts of disasters. In order to minimize the after effects of a disaster (like forced eviction, life loss etc.), it is necessary to include preventive measures in the planning process of the city. In other words it is important to mainstream disaster risk reduction into planning processes.

Evidence from the post hazard situations clearly indicates that the severity, damage and negative economic impacts of disaster events have increased in recent times. This can be attributed to the increasing vulnerabilities of individuals, communities and regions, especially due to poor living conditions, weak or non-existent land use planning, increasing poverty, absence of safe living spaces, low levels of literacy and weak warning systems.

Climate change has added another level of complexity to the mire of existing vulnerabilities. Since the late 1990s, several studies have pointed out the need to 'mainstream' disaster risk reduction in development planning to address hazard risk in India. Many disasters can be avoided, or at least made less destructive, by reducing the risks that people face. Disaster risk reduction has been effective in many countries around the world, contributing to saving lives and protecting livelihoods. Several Indian states and cities have developed Disaster Management (DM) Plans during the last two decades. However most of them are response plans. Disasters such as cyclones, floods, earthquakes and landslides have made it clear that robust DM plans need to be developed through a systematic Hazard Risk and Vulnerability Assessment (HRVA) analysis would meaningfully help reduce disaster risks.

Hazard Risk and Vulnerability Assessment (HRVA) has the potential to instruct the planning and response authorities to prepare for emergencies and helps avoid future disasters. It should therefore form a critical part of the disaster risk reduction program.

2.2. What is HRVA and why is it necessary?

In a DM Plan, considering hazards alone may lead to a skewed set of priorities for action. It is equally important to consider the severity of possible impacts from the hazard as well as the frequency or likelihood of a hazard event occurring. The combination of severity and likelihood is termed as the level of risk (Provincial Emergency Program, 2004). In determining the severity of a hazard event, a community's vulnerability must also be examined. Here vulnerability would define the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

The objective of hazard, risk and vulnerability analysis (HRVA) is to help a community/local authority and other administrating bodies, make risk-based choices to address vulnerabilities, mitigate hazards and prepare for response and recovery from hazard events (Winrock, 2012). *Risk-based* means based on informed choices of alternate unwanted outcomes. In other words, to make risk reduction choices based on the acceptability of consequences and the frequency of hazards.

The primary objective of undertaking a HRVA is to anticipate the potential problems, how they can be prevented and if not, identifying possible solutions to help save lives, protect property, assets, reduce damage and facilitate a speedy recovery. Undertaking HRVA helps policy makers, administrators and also the community to prepare for hazard events which may be beyond the capacity of a society to prevent. Ideally, HRVA should examine future projections around population, their mobility, planned developments and emerging risks.

However, this exercise is more extensive and long drawn. The NMMC is doing a social vulnerability assessment for the first time therefore this may be viewed as a baseline study that would help them work further on future HRVAs. Ideally the HRVA must be conducted periodically as an internal exercise by departments rather than by consultants.

Thus, HRVA can be defined as follows:

A HRVA examines the hazards that may impact a community and the risk that each hazard event poses to the community as a whole and to vulnerable elements of the community (Whistler, 2012)

Thus, the **objective of undertaking a HRVA is primarily to anticipate the potential problems and possible solutions to help to save lives, protect property, assets, reduce damage and facilitate a speedy recovery.** It is worthwhile to mention that HRVA is an important step towards becoming disaster resilient and is not an end in itself. Apart from the central government, the state governments, district authorities and even the local level governance institutions (like municipalities and village panchayats) should undertake hazard risk and vulnerability analysis based on their respective locations vis-à-vis hazards. The level at which the HRVA is undertaken, must therefore be articulated. HRVA is thus one of the important and integral components of actions that help disaster risk reduction.

Currently several methodologies are being used worldwide for multi hazard risk assessment, vulnerability, capacity assessment and risk analysis for development of effective strategies for disaster risk reduction. However, while considering them for application in the Indian context it is marred by several issues, constraints and challenges. These are:

- Limited agencies working on HRVA, who can guide and advice development practitioners in selection, development and implementation of such methodologies, suitable to the local context.

- Lack of availability of time series and spatial database on various socio-economic, environmental and infrastructural parameters along with demographic details in the public domain/ public access that dissuades action research in this field.

- Hazard mapping and development of probability matrix of various hazard events necessitates use of advanced software like GIS, remote sensing and high resolution satellite imageries, which often has cost implications and require a certain level of technical expertise for its application.
- Lack of historical legacy in the form of learnings that can be drawn from application of these methodologies in the context of various hazards in India.
- Limited number of research agencies working in the field of development and application of new methodologies.
- Limited work on practical application of methodologies used worldwide in various hazard situations to assess its suitability and adaptation to Indian context. (Winrock, 2012)
- Absence of community based GIS practices and reluctance on part of the technocrats to share data and relevant maps and satellite images, necessary for the risk analysis and vulnerability mapping.

2.2.1. Defining Hazard and Hazard Assessment

UNISDR defines Hazard as a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro- meteorological and biological) and / or induced by human process (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity and probability.

2.2.2. Defining Vulnerability and Vulnerability Assessment

What is vulnerability? How does one define it? Many organizations and individuals have defined vulnerability in different contexts.

Vulnerability is a key concept in understanding the impact of a disaster. Question such as why an earthquake of equal magnitude in the US and in Chile has different impact is best understood through the concept of vulnerability. Addressing pre-existing vulnerabilities is therefore essential to reduce damage caused by a disaster.

Among social scientists, Blaikie et al. (1994) defines vulnerability as “characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of natural hazards”.

Adger (2000) provides an alternative definition: “the presence or lack of ability to withstand shocks and stresses to livelihood”.

UNISDR (2009) in its list of standard definition suggest that vulnerability as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. It further elaborates that there are many aspects of vulnerability like physical, social, economic and environmental.

According to IFRC vulnerability in the context of disasters as "Vulnerability can be defined as the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard. The concept is relative and dynamic." Further, to determine people's vulnerability, two questions need to be asked:

- **To what** threat or hazard **are they vulnerable**?
- **What makes them vulnerable** to that threat or hazard?

Thus vulnerability is also defined as a set of conditions and processes resulting from physical, social, economic and environmental factors, which increase the susceptibility of a community to the impact of hazards. There are different ways of classifying vulnerability types with reference to a specific settlement or geographical site, the key categories or types or factors of vulnerability are:

- **Physical vulnerability** assessments include the variables directly or indirectly related to the location and nature of the built environment. In case of natural hazards physical factors have direct impact on the structures and further define the vulnerability of the physical structures. It is determined by the aspects such as population density levels, remoteness of a settlement, the site, layout of a settlement, design and materials used for critical infrastructure and for housing.

- **Economic vulnerability** is function of financial accessibility of individuals and communities, extent of debt and the degree of access to credit, loans and insurance. Having inadequate access to critical and basic infrastructure, including communication networks, utilities and supplies, transportation, water, sewage and health care facilities, increase people's exposure to risk and economic vulnerability as they would have to incur a high cost to procure these.

- The discussion of **ecological aspects of vulnerability** covers a wide portfolio of issues in the inter-acting social, physical, economic and ecological aspects of sustainable development as it relates to disaster risk reduction. The key aspects of ecological vulnerability are the extent of natural resource depletion, the state of resource degradation, loss of resilience of the ecological systems, loss of biodiversity, exposure to toxic and hazardous pollutants.

- **Social Vulnerability** is defined as "the exposure of groups of individuals to stress as a result of the impacts of hazards and related extremes". It is linked to the level of development in terms of human development indicators and well-being of individuals, communities and society. Instead, social vulnerability is most often described using the individual characteristics of people (age, race, health, income, type of dwelling unit, employment). It includes variables measuring levels of literacy, morbidity, mortality and disability rates, public health services, population density, livelihood activities and

poverty. At a more advance level Social Vulnerability should also include the existence of peace and security, access to basic human rights, governance, social and gender. From the perspective of an individual, social vulnerability is based on traditional values, traditional knowledge, social networking of relatives and friends, customs and ideological beliefs and how these interface with overall collective organizational systems of a given society. In conducting a HRVA, this study will explore vulnerability of people in Navi Mumbai which is discussed in greater detail in the next section.

2.2.3. The concept of Risk

Understanding the interaction of hazards, exposure and vulnerability is crucial to effective disaster prevention. Risk assessments are therefore fundamental to UNDP's work on disaster risk reduction (DRR) and recovery.

UNDP defines risk as the probability of harmful consequences — casualties, damaged property, lost livelihoods, disrupted economic activity, and damage to the environment — resulting from interactions between natural or human-induced hazards and vulnerable conditions. Thus, risk assessment is the process to determine the nature and extent of such risk, by analysing hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.

A comprehensive risk assessment not only evaluates the magnitude and likelihood of potential losses but also provides full understanding of the causes and impact of those losses. Risk assessment, therefore, is an integral part of decision and policy-making processes and requires close collaboration among various parts of society

2.3. Concept and Models of Social Vulnerability

Of the above discussed types vulnerability (refer section 3.2.2), this project primarily deals with social vulnerability assessment/analysis.

In an age of unprecedented natural and man-made disasters, regions especially prone to these disasters are taking various measures to mitigate potential threats. This is more so in coastal settlements/cities that are experiencing the effects of environmental degradation as a result of increased urbanization, upward shifts in population, and climate change.

For most of the twentieth century, disaster management focused on the physical vulnerabilities, emphasizing role of infrastructure and technology. Socially created vulnerabilities were largely ignored, mainly due to the difficulty in quantifying them. Social vulnerability is partially the product of social inequalities—those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond. However, it also includes place inequalities—those characteristics of communities and the built environment, such as the level of urbanization, growth rates, and economic vitality, that contribute to the social vulnerability of places. Thus the physical and social interact.

The concept of social vulnerability within the disaster management context was introduced in the 1970s when researchers recognized that vulnerability also involves socioeconomic factors that affect community resilience (Juntunen 2005).

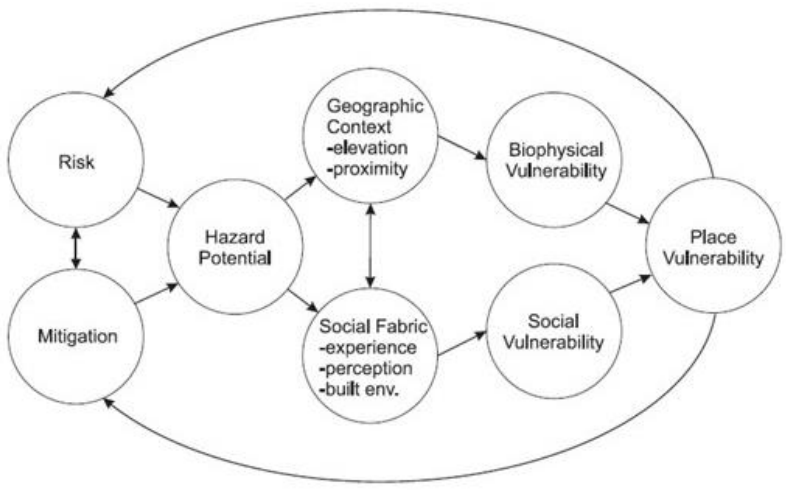
Exploring the manner in which hazards may affect the population at large is vital, but understanding how and where particularly socially vulnerable communities may be affected can help allocate resources more effectively during the phases of mitigation, preparedness, response, and recovery.

The hazards and vulnerability literature reveals that categories of people living in a hazard affected area are not affected equally. For example, evidence indicates that the poor are more vulnerable at all stages—before, during, and after—of a catastrophic event. The findings are similar for racial and ethnic minorities; children, elders, or disabled people; and residents of certain types of housing, particularly high-rise apartments or mobile homes. Furthermore, such vulnerability factors often occur in combination.

Clearly, if social vulnerability of a region and its people is to be measured, it is not an easy and straight forward task. Few of the models of social vulnerability assessment have been reviewed. However, for the project, the Hazards-of-place Model of Vulnerability best conceptualises the adopted approach for this study. This, has been discussed below and other reviewed models are part of Appendix 1.

Hazards-Of-Place model of vulnerability (Cutter, 1996; Cutter, Mitchell, and Scott, 2000; Heinz Centre for Science, Economics, and the Environment, 2002) examines the components of social vulnerability. In this conceptualization, risk (an objective measure of the likelihood of a hazard event) interacts with mitigation (measures to lessen risks or reduce their impact) to produce the hazard potential. The hazard potential is either moderated or enhanced by a geographic filter (site and situation of the place, proximity) as well as the social fabric of the place. **The social fabric includes community experience with hazards, and community's ability to respond to, cope with, recover from, and adapt to hazards, which in turn are influenced by economic, demographic, and housing characteristics. The social and biophysical vulnerabilities interact to produce the overall place vulnerability.**

Figure 2-1 The Hazards-of-place Model of Vulnerability



This models not only considers the social indicators but also indicators of biophysical vulnerabilities and hence are more comprehensive and adaptable.

The Appendix 1, 2 and 3 presents a brief review and summary of methodologies for assessing social vulnerability.

3. Introduction to the City – Navi Mumbai

3.1. History

Mumbai Metropolitan Regional Planning Board recommended considering a twin city across the creek from Mumbai to be developed as a counter magnet to the city. Navi Mumbai was expected to de-congest Mumbai in respect of both population and activities by shifting of industrial, market and office activities in a way that the new city will be sustainable physically, economically and environmentally.

The Navi Mumbai project began in 1971 with the formation of City and Industrial Development Corporation (CIDCO). CIDCO was set up by Government of Maharashtra (GoM) as public limited company under Indian Companies Act and is wholly owned by the GoM. In March 1971, CIDCO was designated as the New Town Development Authority (NTDA) for Navi Mumbai.

Navi Mumbai project area spread over approx. 343.7 sq. km. and contained 95 villages of Thane and Raigad Districts. The area covered under the project had about 17,000 hectares of private land and an equal area of forest and government land. Most of the land was marshy and barren. Although 95 gaonthans were within the project area, care was taken to exclude them from acquisition and thereby retain their homes.

Polycentric pattern i.e. nodal development ensured balanced land and even distribution of residential areas, job centres, wholesale markets, non-polluting industry and population density. Today, Navi Mumbai is endowed with an entire gamut of infrastructure.

As per the TOR, the area to be considered for the analysis is defined by the Navi Mumbai Municipal Boundary. The data recorded by MRSAC (Maharashtra Remote Sensing Application Centre) the land use pattern of the city consists of built up area, agricultural land, forests, wastelands, water bodies, roads, and so on. NMMC's jurisdiction is spread across 108.63 sq. km. and does not include area under MIDC. Majority of the NMMC area (56.16%) is built up area which is spread across 61 sq. km. This comprises residential, commercial, industrial, administrative constructions and infrastructure such as crematoriums, water supply, sewage disposal, roads, and railways. Wetlands are an important feature of the city with 13.46 sq. km. area under lakes, mangroves, wetlands, creeks, mudflats and manmade water bodies. Further within the Municipal Boundary are 8 wards details of which are as given below:

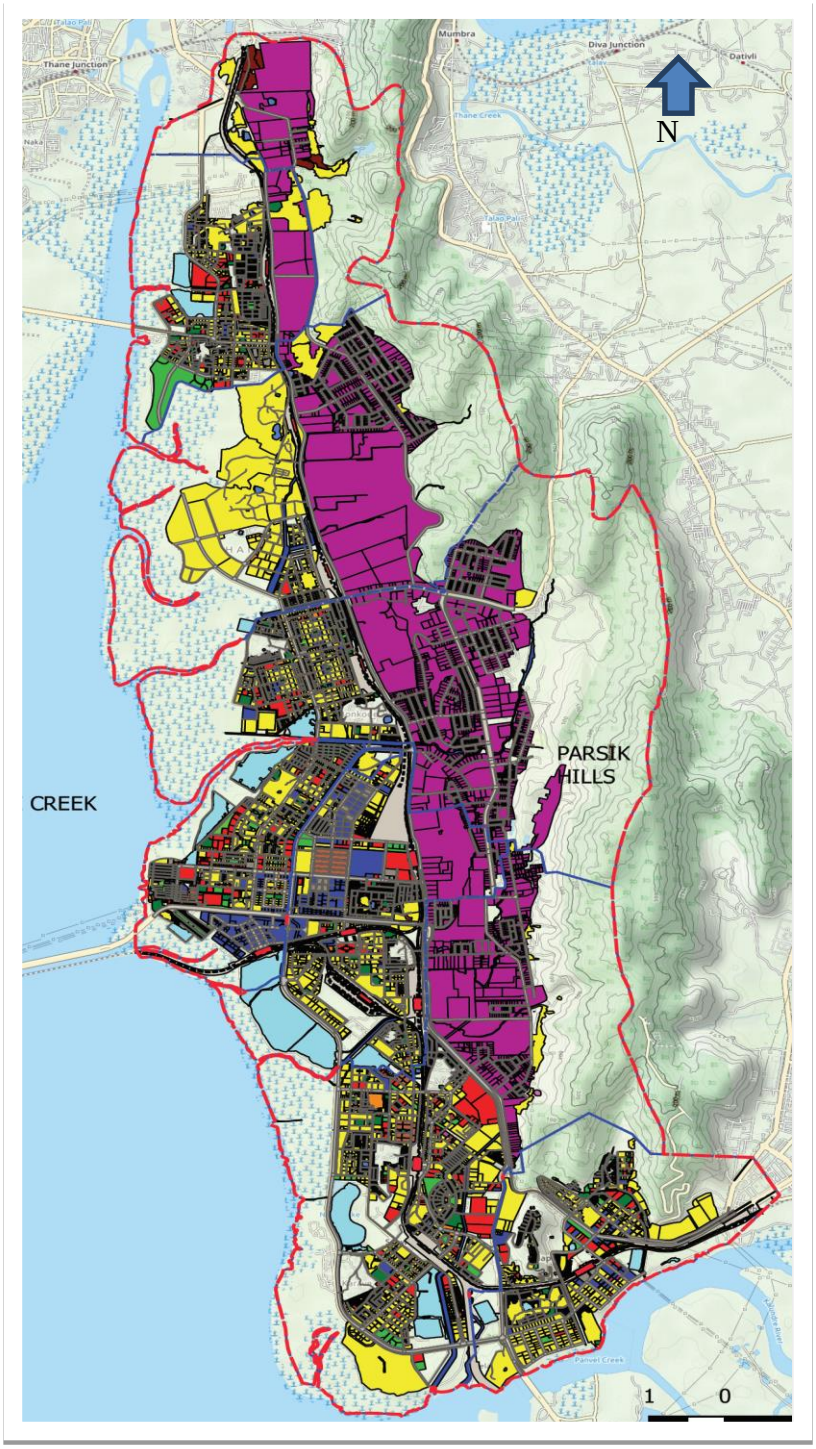
Table 3-1 NMMC –Land Use

Sr. No	*Name*	*Urban area*	*Industrial*	*Park/ forest*	*Village area*	*Marshy area*	*Total*
1	*CBD Belapur*	*16.50*	*0.00*	*0.00*	*0.00*	*8.00*	*24.50*
2	*Nerul*	*3.75*	*4.00*	*4.15*	*0.00*	*3.00*	*14.90*
3	*Vashi*	*4.75*	*0.00*	*0.00*	*0.00*	*3.75*	*8.50*
4	*Turbhe*	*7.25*	*3.10*	*4.00*	*0.00*	*1.50*	*15.85*
5	*Koparkhairane*	*7.75*	*7.00*	*9.75*	*0.00*	*7.75*	*32.25*

Sr. No	*Name*	*Urban area*	*Industrial*	*Park/ forest*	*Village area*	*Marshy area*	*Total*
6	*Ghansoli*	*7.25*	*6.75*	*4.50*	*0.00*	*4.00*	*22.50*
7	*Airoli*	*4.60*	*0.75*	*0.40*	*0.00*	*2.00*	*7.5*
8	*Digha*	*0.75*	*4.00*	*3.75*	*0.00*	*0.75*	*9.25*
9	*Total*	*52.6*	*25.6*	*26.55*	*0*	*23*	*135.25*

Source: Navi Mumbai Municipal Corporation, Fire Hazards Response and Mitigation Plan 2010

Figure 3-1 NMMC Region



When Navi Mumbai was created in the 1970s, CIDCO was the only authority that looked after the development and maintenance of the city. CIDCO prepared a developmental plan for Navi Mumbai covering 95 villages. For the first ten years of the project CIDCO acted as the planning and administrative body, and as the developer and builder for the project. Taxes on property, land, commercial and water were payable to CIDCO. The 14 nodes which CIDCO created were: Airoli, Ghansoli, Koparkhairane, Vashi, Sanpada, Nerul, CBD Belapur, Kharghar, Kamothe, New Panvel, Kalamboli, Ulwe, Pushpak and Dronagiri. Each of the nodes is divided into smaller groups called sectors.

Initially only Vashi, Nerul and CBD Belapur were developed by CIDCO. But after the arrival of the harbour railway line extension in the 1990s, there was an increase in population. CIDCO shifted its development plan to nodes like Kharghar, Kamothe, New Panvel, and Koparkhairane. In its new development plan, CIDCO land was allocated to builders for housing. CIDCO only provided basic infrastructure like roads, water and electricity, therefore the nodes were developed mostly by private builders according to the CIDCO plan.

On 17 December 1991, Navi Mumbai Municipal Corporation (NMMC) was constituted by the state government for maintaining some of the developed nodes of Navi Mumbai. Local self-government started on 1 January 1992. NMMC was handed eight of the 14 nodes of the Navi Mumbai project area for its jurisdiction. However, CIDCO, as a planning authority, has rights on the open plots in the remaining five nodes.

The eight nodes maintained by NMMC are:

1. Digha,
2. Airoli,
3. Ghansoli,
4. Koparkhairane,
5. Vashi,
6. Turbhe,
7. Nerul, and
8. Belapur.

The newly developed nodes of Navi Mumbai on the south side like Kharghar, Kamothe, New Panvel and Kalamboli are still maintained by CIDCO. All these nodes are beyond CBD Belapur and come under the Raigad district.

3.2. Topography:

The overall trend is west ward dipping and Parsik hills, part of Sahyadri hill ranges is present across the eastern border of the city. The Region is part of Deccan traps which are largely basalts (Source: www.nmmconline.com.) Due to this rock type and the proximity to the coast a very unique soil pattern is observed here which is predominantly sand along with alluvial and loamy soils.

3.3. Demographics

The population as per 2006 Census was 9,25,346, in 2011 Census recorded 11,20,547. The Rate of growth of population is high and the population density is rapidly increasing due to the high influx of migrant population who came in to avail job opportunities in both Mumbai and Navi Mumbai. The projected population for 2021 and 2031 is 1.8 million and 2.38 million respectively. The population density as per 2011 Census is 8934, per square km. This congestion is a cause of concern and Navi Mumbai must plan ahead to ensure that infrastructure such as roads, water, drainage, waste management, transportation all keep pace with the rising density. Else it can be a major source of vulnerability.

3.4. Climate

Navi Mumbai receives rain from south-west monsoons, which commence usually in the first fortnight of June and last till the 1st week of October. Pre-monsoon showers are received in April/May. Occasionally, north-east monsoon showers occur in the month of October and November.

In Navi Mumbai city the average maximum temperature is 32 degree Celsius, while the average minimum temperature is 27 degree Celsius. The average total annual rainfall is 2529.66[1] mm. The details about climates and rainfall Navi Mumbai are recorded at various rain gauge stations of Navi Mumbai Disaster Management Department at Vashi, Koparkhairane and Airoli.

3.5. Transport and Communication Network

Navi Mumbai Municipal Corporation has 6 main entry and exit points - CBD Belapur, Uran, Vashi, Shil, Mulund and Vitava. The main road stretches are the Thane Belapur Highway from Vitava to Turbhe and Panvel - Sion Highway leading to NH4 and NH 17. Similarly there are two parallel roads, one from Digha to Uran and MIDC industrial area and another parallel road runs from Vitava to Belapur and is called Palm Beach road.

3.5.1. Surface Transport

Railways and Road Transport are the two main modes of surface transport. Railways provide mass transport through the Harbour- Railway from Vashi to Belapur and the Central Railway from Vashi to Thane. MSRTC, BEST and NMMT buses ply within NMMC limits and also up to Panvel, Thane, and Mulund which are outside NMMC limits. There are total 2 bus depots and 11 Terminus in NMMC area. A total 226 buses of NMMT ply over 26 routes covering a distance of 60,000 kms daily. The daily foot fall recorded for NMMT is 1.5 lakhs and an equal number of commuters use the services provided by BEST, MSRTC and Railway. In all 6.00 lakhs people travel in and out of various parts of Navi Mumbai.

[1] ESR 29.07.2015.pdf

3.5.2. Outstation Travel

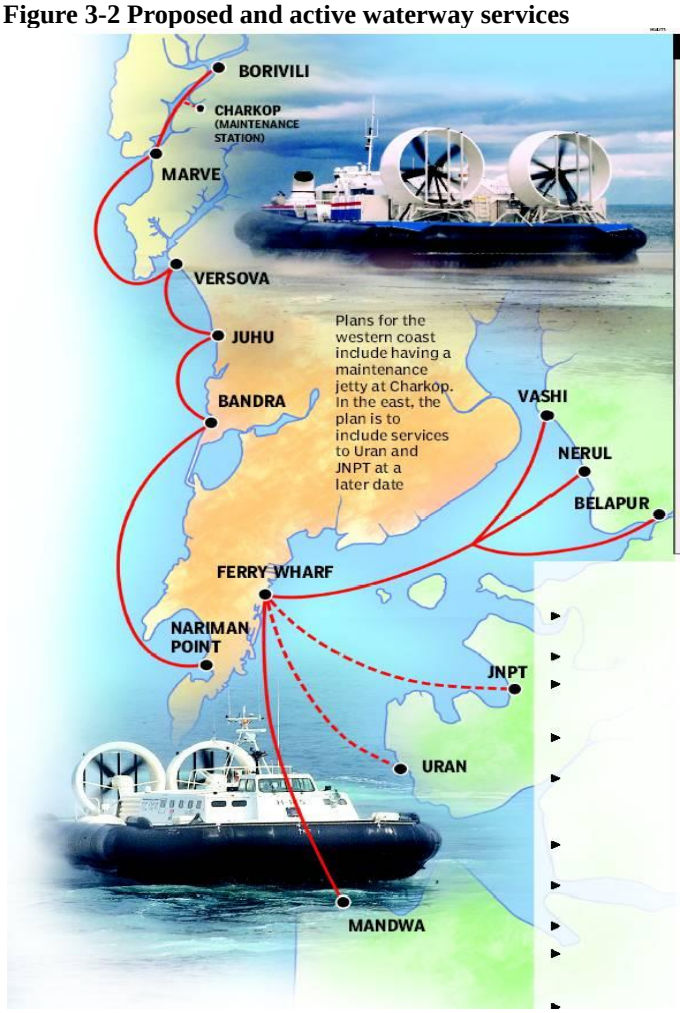
For outstation travel, Harbour Railways operate from Belapur and Vashi. MSRTC operates buses from Vashi and CBD Belapur depots. In addition, there are many private transporters who operate luxury and semi-luxury buses to outstation locations. All buses going south of Mumbai city pass through NMMC.

3.5.3. Waterways

As per a report in the Times of India, April 28, 2010, the Mumbai Metropolitan Region Development Authority was to invite tenders soon for the Eastern Waterways project. MMRDA had proposed two water transport services on the eastern waterfront - the first between Ferry Wharf and Vashi, Nerul and Belapur and the second one a roll-on, roll-off (RoRo) ferry service to carry both people and vehicles between Ferry Wharf and Mandva Jetty near Alibaugh. The passenger service would supplement the saturated suburban railway system on the eastern side of the city. Shown below is the proposed route.

The hovercraft services and ferry services had started operating in 2013 during the non-monsoon period from Gateway of India in South Mumbai to CBD Belapur, but has been inactive for the past few years.

Figure 3-2 Proposed and active waterway services



Source: Times of India, 2013

3.5.4. Air Travel

The nearest international airport is at Mumbai Sahara, which, on an average has 4 million passengers alighting and departing in a day.

The nearest domestic airport is located at Mumbai Santacruz which on an average has 4.2 million passengers alighting and departing in a day. Similarly a new International Airport is proposed at Kharghar.

The map below shows various transport and communication routes within and outside Navi Mumbai.

Figure 3-3 Transport and communication routes within and outside Navi Mumbai

Source: http://apexrealty.co.in

4. Methodology for Social Vulnerability Analysis

4.1. The Study Area: Nodes and wards

This is the first and foremost step in the process of analysing vulnerabilities. The area to be considered for NMMC – HRVA will be the NMMC municipal limits. This shall be larger realm of analysis.

For the purpose of detailed analysis the area is divided into smaller zones. The demarcation of these zones are based on the lowest/smallest level at which data is available. Detailed primary data collection was ruled out since this study was to be concluded within one year.

Through secondary data collection and discussions with NMMC, the Census ward 2011 was considered as the unit of micro analysis as Primary Census Abstract and House Listing data is available for these units.

According to 2011 Census, there are 89 electoral wards in NMMC. These are considered for micro analysis and have been summarised at the municipal ward level which are 8 in number. Given below is the list of Municipal wards and the census wards within them.

Table 4-1 NMMC – Nodes and Electoral Wards

Municipal Nodes	*Electoral Ward No (Census 2011)*	*No. of Electoral Wards*
Digha	*1,2,3,4,5*	*5*
Airoli	*6,7,8,9,10,11,12,13,14,15,16,17*	*12*
Ghansoli	*18, 19, 20, 21, 25, 26*	*6*
Koparkhairane	*22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 40*	*16*
Vashi	*39, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56*	*14*
Belapur	*79, 81, 82, 83, 84, 85, 86, 87, 88, 89*	*10*
Nerul	*62, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 80*	*15*
Turbhe	*41, 42, 43, 57, 58, 59, 60, 61, 63, 64, 65*	*11*

During our meetings for data collection with Ward Officers, it was observed that officers are typically concerned with their own area and are generally oblivious to the adjoin areas. However, ward boundaries are subject to change. Here we refer to wards as per 2011 census. (Currently the number of wards has increased from 89 to 111)

4.2. Identifying the Potential Disasters for HRVA

While by definition, a disaster is an unexpected event, based on the review of the past NMMC-City Disaster Management Plan and through discussions with the officials from the corporation and local authorities, only the following disasters were identified for inclusion in the HRVA study:

- Fire
- Floods and water logging
- Building Collapse and landslides

These were identified based on the observation and experiences during the last decade within the city. Due to rapid urbanization, there have been several alternations in the natural drainage of the city. As a consequence, certain areas are frequently flooded. Also with development, the city now has a very large number of high rise buildings with central AC systems and a number of fire incidences have been reported. Besides that the industrial area cuts through the length of the city. With development taking place along the slope and around old mining sites (as in the case of Digha), the risk of building collapse and landslides have increased. These have been considered for HRVA analysis.

4.3. Mapping Hazard Risks: A Review

The data on past hazards has been considered. Assessment of hazard and their prediction is a complex scientific exercise and beyond the scope of this study which focuses largely on social

vulnerability. However, the idea of a hazard occurrence and mapping has been used to inform vulnerability assessment.

History of hazard occurrence, frequency, extent and spread of damage, intensity and magnitude was studied. The institutional capacity to mitigate and resist is discussed.

4.4. Social Vulnerability Assessment – Indicators and Indices

Based on the identified indicators, the Social vulnerability Index is calculated for all 89 electoral wards and further aggregated at the 8 node levels.

For calculating Social vulnerability index, literature review and discussion with experts was done. Later, Patnaik and Narain suggested methodology was adopted to calculate the same. The details of the methodology are given below:

STEP 1: IDENTIFYING AND ANALYSING VULNERABILITY INDICATORS

Based on the literature review, availability of Census data, initial data collection and data sets from NMMC, the broad indicators for various disasters were developed (**Table 4-2 Vulnerability Indicators and its Rationale**.)The scope of the study is "To examine **social vulnerabilities** present in Navi Mumbai in the context of various disasters." In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, certain physical vulnerability indicators based on the data available in the Census and that which can be extracted from the maps were also considered. Overlaying social and physical vulnerabilities provide a more realistic picture of the existing situation. Ideally, social vulnerability must be overlaid with physical vulnerabilities based on risk mapping carried out for floods, earthquakes, fires etc. However, this is the first and limited exercise of locating social vulnerabilities in NMMC.

Indicators of vulnerability are many. However, since primary data was not to be collected, the indicators selected are only those which are provided by Census 2011 and are available from maps provided by NMMC. This certainly does not mean that this is the exhaustive set of indicators of vulnerability.

While identifying each indicator, care was taken to explain why the indicator was to be taken and how it affects the vulnerability of the people i.e. directly or indirectly proportionate to the vulnerability. Given below is the list of 22 indicators with the rationale for its selection in HRVA study.

Table 4-2 Vulnerability Indicators and its Rationale

Sr No	***Indicator***	***Used for***	***Rationale for selection***
1	*Dilapidated housing (structures within the ward)*	*Fire, flood, building collapse and landslide*	*Dilapidated houses pose a threat to those living in them during fires, floods and landslide, thus it is an important indicator of vulnerability.* *The Census 2011, gives ward wise number of house in good, liveable and dilapidated condition. This has been used as an indicator of physical vulnerability. Here 'good' and 'liveable' are considered to be safe for residing and thus inversely related to vulnerability, whereas dilapidated is not deemed fit to reside and thus increases vulnerability.* *The Census does not gives details of number of people residing in these houses, thus percentage of dilapidated houses in each ward is considered as an indicator of vulnerability.*
2	*Vulnerable roof (structures within the ward)*	*Fire, flood, building collapse and landslide*	*In the Census 2011, houses have been classified as per the roofing material. This information has been used to gauge its vulnerability to disasters.* *Handmade tiles, machine made tiles, Burnt bricks, Slate, Concrete roof are deemed fit for hazardous situation and thus decrease vulnerability.* *On the other hand, Grass/Thatch/Bamboo/ Wood/Mud, Plastic/polythene, G.I/Metal/Asbestos Sheets, increase vulnerability and thus the aggregate of these have been used an indicator of vulnerable roof.*
3	*Vulnerable walls (structures within the ward)*	*Fire, flood, building collapse and landslide*	*Material of the walls of houses that people live in adds or reduces vulnerability. In the Census 2011, its classification is done as below.* *Stone packed with mortar, Burnt brick, Concrete - these are less vulnerable in disaster situation.* *Grass/ Thatch/ Bamboo etc., Plastic/ Polythene, Mud/ Unburnt brick, Wood, Stone not packed with mortar, G.I./ Metal/Asbestos sheets, Any other – all these materials are unsafe thus increasing the vulnerability of people living in them*
4	*Vulnerable floor (structures within the ward)*	*Fire, flood, building collapse and landslide*	*Flooring of houses has also been categorized as safe and unsafe thus adding or reducing vulnerability.* *Burnt Brick, Stone, Cement Mosaic/ Floor tiles, are deemed as safe thus reducing vulnerability and Mud/ Wood/ Bamboo, Any other material is deemed unsafe thus increasing vulnerability of people living in them*
5	*Proximity of the wards to water body (location of wards)*	*Flood*	*Being a coastal city, the western part of the city opens into the Thane creek and thus a large number of small and large creeks are part of the city's fabric. With time some have been lost due to reclamation and contour changes and others are have been reduced to being nallahs. This has increased the vulnerability to flooding. Thus wards have been classified into most vulnerable, medium vulnerable and least vulnerable based on*

Sr No	***Indicator***	***Used for***	***Rationale for selection***
			their location and topography. This is thus an important indicator for vulnerability to flooding.
6	*Proximity to sloping or quarrying site (location and topography of wards)*	*Building collapse and landslide*	*On the eastern edge of the city are the Parsik Hills and on the west is the Thane creek. Owing to its geography, the city slopes from the east towards the west. On the eastern edge, large settlements have developed on slopes. The vulnerability is further augmented by the fact quarrying activity along the hills. Thus the area is vulnerable to landslides and building collapse. Based on the location and topography of the ward, the wards are classified as most vulnerable and medium vulnerable.*
7	*Unsafe source of drinking water*	*Flood*	*Having treated tap water connection reduces social vulnerability during floods whereas, water from untreated source, covered well, uncovered well, hand pump, tube well/boreholes, spring, river/ canal tank/ pond/ lake, other sources, increases vulnerability to ill health*
8	*Water source out of premises*	*Fire, flood*	*Having a connection to tap-water within the premise ensures safe drinking water. This is significant for good health and for avoiding diseases. This is also important in disaster situation and also supply during fire breakouts, thus reducing vulnerability. However, a source away from the house would increase vulnerability.* *Thus percentage of houses with water source outside its premise are considered vulnerable and used as an indicator of vulnerability.*
9	*Unsafe Source of light*	*Fire, flood, building collapse and landslide*	*Electricity and solar power are safer option than kerosene and oil being used for lighting and thus the categorizations.* *Use of solar power and electricity reduces vulnerability to fire and Kerosene, and oil is deemed unsafe thus increasing the vulnerability.*
10	*No access to latrine*	*Flood*	*Absence of latrines increases exposure and vulnerability, more so to diseases in the case of floods*
11	*Unsafe Drainage*	*Flood, building collapse and landslide*	*Closed drainage helps in reducing contamination and water logging thus reducing vulnerability. Also, open drainage increases cases of seepage and could induce landslides or weaken structures. Thus percentage of houses connected to open drains increases vulnerability.*
12	*Population density*	*Flood, building collapse and landslide*	*Density gives a sense of the quality of development and in case of a disaster it gives the number of people likely to be affected. Thus greater the density more the vulnerability.*
13	*Percentage of female population*	*Flood, building collapse and landslide*	*Rescue operations, relief, recovery, etc. has to be appropriate for women. Their special needs need consideration, which must be taken into account during the preparedness phase. Women may not be in a position to swim or move in the water logged*

Sr No	*Indicator*	*Used for*	*Rationale for selection*
			area during the floods especially in saris and it may not be culturally appropriate to expect all women to wear jeans and salwars in order to facilitate mobility.
14	*Percentage of illiterate population*	*Flood, building collapse and landslide*	*Higher the literacy rates implies higher awareness. Thus it reduces the vulnerability, as literate people are assumed to take rational decisions. Illiterate people tend to take decisions based on traditions which may be irrational. Rational decisions will prevent the post disaster chaos. And vice versa, lower literacy rates indicated lower awareness. Thus it increases vulnerability.*
15	*Large families*	*Flood, building collapse and landslide*	*Large households usually depict families with large numbers of dependents and often have limited finances to outsource care for dependents, and thus must juggle work responsibilities and care for family members. This affects the resilience to and recovery from hazards.* *1-4 members – smaller H/H size* *More than 5 members – Large Households*
16	*Percentage of SC & ST population*	*Flood, building collapse and landslide*	*Discrimination based on caste restricts the access to resources of particular caste groups. More attention must be paid to ensure equal opportunities to SC/ ST population in an area. They may be living in physically excluded locations and the rescue or relief may miss them. They may also be forced to live in low lying areas with inherent vulnerability.*
17	*Population below 6 years*	*Flood, building collapse and landslide*	*Population below the age of six is highly vulnerable in disaster situation, thus is an indicator of vulnerability. Higher the population of children more is the vulnerability.*
18	*Area of hutments in each ward*	*Flood, building collapse and landslide*	*As per the map given by the TP department of NMMC, the area of land used by hutments and slums in each ward is calculated. This is used as an indicator of pockets where marginalised (EWS) population reside and thus larger the area covered, more the vulnerability.*
19	*Percentage of marginal workers*	*Flood, building collapse and landslide*	*Those workers who had not worked for the major part of the reference period (i.e. less than 6 months) are termed as Marginal Workers in the Census. Households with marginal workers could be economically weaker and hence more vulnerable to disasters.*
20	*Percentage of non-workers*	*Flood, building collapse and landslide*	*Larger the non-working population greater the vulnerability as the number of non-earning member and thus the number of dependents will increase. Their ability to access other resources also shrinks, making them more vulnerable.*

Sr No	*Indicator*	*Used for*	*Rationale for selection*
21	*House ownership status*	*Flood, building collapse and landslide*	*People who have their own house have a larger resource base and they can rebuild the house post disaster. Whereas people living in rented house just own the assets inside the house. If these are destroyed they are left with nothing. This adds to their vulnerability.* *People who rent do so because they are either transient or do not have the financial resources for home ownership. They often lack access to information about financial aid during recovery. In the most extreme cases, tenants lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford.*
22	*Availing banking services*	*Flood, building collapse and landslide*	*Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts are less vulnerable than households without bank accounts.*

STEP 2: REGROUPING THE INDICATORS

The available literature on resilience and vulnerability discusses the need to regroup the indicators based on their characteristics. Here the identified indicators are regrouped based on their characteristics/source of vulnerability.

Following the methodology suggested by Patnaik and Narain (2009), the indicators were divided into two main categories and 5 sub-categories.

1. **Physical Vulnerability Indicators**

This refers to the built environment which includes housing and critical facilities. These variable/indicators play an important role not only in emergency situation but also are an indicator of the overall wellbeing and quality of urban development, which in itself is as indicator of resilience and vulnerability.

Within Physical Vulnerability Indicators, two sub categories have been created.

- **Housing**
  - Here all indicators pertaining to the structure of the dwelling unit have been considered. For example, roof, flooring and wall material and overall condition of the house.
- **Physical infrastructure**
  - Here all external physical infrastructure facilities have been considered which service the house. For example water supply, cooking fuel, power supply, drainage, toilets facility etc.

2. **Social Vulnerability Indicators**

This refers to the social indicators of the built environment. It covers aspects of demography, economic status, social security and marginalized population. These indicators cover the human and social dimension of the unit of analysis i.e. the electoral wards.

Within Social Vulnerability Indicators, four categories have been created.

- **Demographic**

Indicators like density, sex ratio, literacy rates and household size give the basic demographic pattern of the ward and have thus been considered under this head.

- **Marginalised Population**

When discussing vulnerability, the stress is on identifying the "most vulnerable of the vulnerable", thus this has been considered as a separate category for analysis. The SC/ST population is covered under this section.

- **Economic status**

Here indicators of the livelihood have been considered as an indicator of vulnerability.

- **Social Security**

Being socially secure is a vital indicator of resilience and the vice versa of vulnerability. Thus analysing the factors which denote social security have been considered in this section. Indicators like property ownership and access to bank accounts have been considered as indicators.

Table 4-3 Regrouping Vulnerability Indicators

PHYSICAL VULNERABILITY INDICATORS		***SOCIAL VULNERABILITY INDICATORS***			
Housing	***Physical Infrastructure***	***Demographic***	***Marginalised Population***	***Economic Status***	***Social Security***
Dilapidated housing	*Unsafe source of drinking water*	*Population density*	*Percentage of SC & ST population*	*Percentage of marginal workers*	*House ownership status*
Vulnerable roof	*Water source out of premises*	*Percentage of female population*	*Population below 6 years*	*Percentage of non-workers*	*Availing banking services*
Vulnerable wall	*Unsafe source of light*	*Percentage of illiterate population*	*Area of hutments in each ward*		
Vulnerable floor	*No access to latrine*	*Large families*			
Proximity to water body	*Unsafe Drainage*				

PHYSICAL VULNERABILITY INDICATORS		***SOCIAL VULNERABILITY INDICATORS***			
Housing	***Physical Infrastructure***	***Demographic***	***Marginalised Population***	***Economic Status***	***Social Security***
Proximity to sloping or quarrying site					

STEP 3: NORMALIZING THE DATA AND CALCULATING THE VULNERABILITY INDEX FOR EACH SUB-GROUP

In the earlier stage the indicators were analysed for their relationship with vulnerability i.e. whether they contribute to increasing or decreasing vulnerability. Identifying whether they are directly and indirectly proportionate to vulnerability is important.

Here it is assumed that if the indicator is **directly proportionate to vulnerability, it contributes in increasing the vulnerability**. Similarly, if the indicator is **inversely proportionate to vulnerability, then the indicator contributes in increasing the resilience.**

Once this is done the values of these indicators are normalised, using the following formulas:

In case of directly proportional relation:

The normalised value of "Indicator 1" for "Ward 3" will be:

$$\text{Normalised } X_{13} = \frac{X_{13} - (\text{minimum value of indicator 1})}{\text{maximum value of indicator 1} - \text{minimum value of indicator 1}}$$

Similarly, in case of indirectly proportional relation:

The normalised value of "Indicator 4" for "Ward 2" will be:

$$\text{Normalised } X_{42} = \frac{(\text{maximum value of indicator 4}) - X_{42}}{\text{maximum value of indicator 4} - \text{minimum value of indicator 4}}$$

This method of normalization that takes into account the functional relationship between the variable and vulnerability is important in the construction of the indices.

After the values are normalised, they are ranked. In case of directly proportionate indicators, highest normalized value is given highest rank (i.e. rank 89 in this case) which indicates highest vulnerability. Whereas, in case of indirectly proportionate indicators, lowest normalised value is given highest rank to indicate highest vulnerability.

For ranking, the fractional ranking method is used i.e. if two or more wards have the same normalised value, the rank is the average of their ordinal ranks.

For example, suppose you have the data set 1.0, 1.0, 2.0, 3.0, 3.0, 4.0, 5.0, 5.0, 5.0.

The ordinal ranks are 1, 2, 3, 4, 5, 6, 7, 8 and 9.

For v = 1.0, the fractional rank is the average of the ordinal ranks: (1 + 2) / 2 = 1.5. In a similar manner, for v = 5.0, the fractional rank is (7 + 8 + 9) / 3 = 8.0.

Thus the fractional ranks are: 1.5, 1.5, 3.0, 4.5, 4.5, 6.0, 8.0, 8.0, and 8.0

Once each indicator is ranked, the ranks are averaged to get the vulnerability index. The averaging is done based on subcategories so that the vulnerability for each subgroup is calculated. These are then further aggregated to get the physical, social and aggregate vulnerability.

STEP 4: AGGREGATING VULNERABILITY INDEX ACROSS ALL SOURCES OF VULNERABILITY

To calculate the vulnerability index across the sectors (listed below), a separate methodology has been suggested.

1. Vulnerability index for physical indicators,
2. Vulnerability index for social indicators and
3. Aggregate vulnerability index.

To calculate the vulnerability index the following formula is used:

$$\text{Vulnerability Index} = \left[\sum_{i=1}^{n} (\text{Average Index}_i)^{\alpha} \right]^{1/\alpha} / n$$

STEP 5: AGGREGATING THE VULNERABILITY AND RESILIENCE INDEX FOR 8 Nodes

As mentioned in the earlier section, there are 8 Nodes in the city which have 89 electoral wards.

Since the city administration functions at the municipal ward level, the indices have been aggregated at the node level. This was also done using the methodology in Step 4.

STEP 6: MAPPING THE INDICES

The final outcome of the vulnerability assessment has been mapped so as to spatially understand the distribution of vulnerability.

5. Social Vulnerability Assessment: Nodes and Wards

This section deals with the analysis of the existing hazards in the city. The unit of analysis are the 8 nodes; Digha, Airoli, Ghansoli, Koparkhairane, Vashi, Turbhe, Nerul and Belapur.

The study reviews HRVA reports of several cities of India such Varanasi, Thiruvananthapuram, Nashik, Nainital, Bhubaneshwar, Vijaywada and Vishakhapatnam. Most of these provide a chapter on socio-economic profile. However, this report goes beyond presenting the statistical profile and also analysis the social vulnerability by over-laying 3 hazards (fire, floods and water logging, and landslides and building collapse) and providing a node level social vulnerability index.

The section below outlines the social vulnerability of NMMC in detail and provides extracts of the node level social vulnerability. In the appendix, chapters have been included given complete analysis at the node level. Given below is the structure of the analysis.

- **Location**

The location of each node has been discussed with respect to its surrounding. Since disasters do not follow boundaries and also the node boundaries are dynamic, it is important to see what is in the vicinity of the node being discussed. Thus, the geographical location of each node vis-à-vis NMMC is covered here.

- **Node composition for analysis**

Since the nodes are dynamic, and the analysis is based on the 2011 census. This section discusses the census wards which have been included in the node for analysis. It also gives map showing the ward boundaries and numbers. Latest data available at the micro level is that of Census 2011, wherein the city was divided into 89 smaller wards. These 89 wards are the smallest unit of analysis. It is seen that each node encompasses a certain number of census wards.

- **Land use**

Under this sub heading the existing land use pattern has been studied. Navi Mumbai Municipal Corporation Fire Hazards Response and Mitigation Plan, 2010 was used as data source. Land use mentioned here does not include land use under MIDC jurisdiction.

- **Population Density**

This section discusses in detail the population density and its effect on the ward / node / city.

- **Vulnerable Population**
    - As mentioned earlier, certain section of society add to the vulnerability of any given area either because of their dependency on the community or due to the social fabric. They do have an impact on the resilience of the community. Female population, children below 6 years of age, Scheduled Caste and Scheduled Tribes, Illiterate population and the distribution of working and non-working population along with marginal worker have been part of the data sets analysed under this section.

- Slums and its population

  Data for slums has been collated from three sources; Census 2011, list of slums with number of households and population data; list of slums provided by NMMC and slums and encroachments as shown in Auto Cad drawings given by the Town Planning Department, NMMC. The slums and encroachment as shown in the maps have been referred to as hutments hereafter. It is quite possible that the data from Census and from maps do not match, because within slums there are small pockets which are known by various names and the map most probably captures those.

- **Vulnerable Housing**

Under this section Census 2011 housing data has been collated to analyse information regarding the built environment.

- **Level of services**

Under this section parameters which are indicative of the availability of basic services and amenities have been covered. Safe drinking water, access to source of drinking water, access to latrine, condition of drainage system, availability of electric supply and medium of cooking fuel are the parameters analysed

- **Social Infrastructure**

This section also discusses the social infrastructure within the ward. Where the existence of schools, medical facilitates, fire stations and condition of roads have been studied. Maps have been attached for reference.

- **Social Security**

This indicator covers the house ownership status and the number of people availing banking facilities.

- **Vulnerable areas and Past Incidences**
  - Contour analysis and low lying areas

The low lying areas and comments on the existing topography from secondary sources is highlighted here. Due to the absence of contour data, the analysis is based on discussions with various stakeholders and a general understanding of the topography.

  - This section discusses past incidences in the node and relief and rehabilitation efforts taken at that point of time. It also discusses issues of disaster management and any resilience building activities if undertaken.

- **Social Vulnerability Assessment**

As mentioned earlier, based on the NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, only the following disasters were identified for inclusion in the HRVA study:

  - Fire
  - Floods and water logging

- Building Collapse and landslides

Census 2011 data, Maps provided by NMMC, Discussions with NMMC officials and field visit became a guide and each hazard was analysed as given below:

- **Fire**
  - Present Situation
  - Past Fire incidences
  - Existing infrastructure for fire management
  - Indicators identified
  - Social Vulnerability Index
- **Flooding and Water Logging**
  - Present Situation
  - Rainfall in the region
  - Existing infrastructure for flood management
  - Indicators identified
  - Social Vulnerability Index
- **Building Collapse and Landslides**
  - Present Situation
  - Existing infrastructure for landslide and building collapse management
  - Indicators identified
  - Social Vulnerability Index

This was overlapped with the social and physical vulnerability parameters for the 89 wards of NMMC. This involved collation of data sets for 89 wards based on the inputs of Census 2011 and NMMC were prepared, the analysis was done at three levels

1. Electoral ward (89 wards)
2. Node level (8 nodes)
3. City Level (NMMC)

The census data along with the data provided by NMMC was collated. The vulnerability and risk towards each hazard in detail was analysed for each ward. These wards were then regrouped for each node based on the data provided by Census 2011. Wards in each node were compared and the most vulnerable ward against each vulnerability parameter was identified. The thus prepared comprehensive data set for each node was analysed for each social and physical vulnerability parameter and the detailed analysis is placed in the NMMC chapter. The detailed chapter for each node is placed in Vol II - Appendix of this document whereas a precise giving general idea has been placed below the NMMC chapter.

5.1. NMMC

5.1.1. Location and composition

Navi Mumbai was developed by CIDCO on recommendation of Mumbai Metropolitan Regional Planning Board for decongesting and depressurising Mumbai. Main idea was to develop a city that will provide better residential options along with scope for industrial, market and office activities and should be sustainable in physical, economic and environmental terms. On 17 December 1991, Navi Mumbai Municipal Corporation (NMMC) was created by the state government to maintain some of the developed nodes of Navi Mumbai.

Located on eastern main land of Thane creek, Navi Mumbai (latitude of 20^{o} North and 73^{o} East) is a part of the Konkan coast line and is located in the centre of MMR (Mumbai Metropolitan Region). It has the Parsik hill ranges to its right, Thane and Panvel region covers the North and South zone. Jurisdiction of NMMC is divided into eight nodes starting with Digha in north and Nerul Belapur in south. (See Map no A1)

5.1.2. Node composition for analysis

As per Census 2011 data, the 8 nodes of NMMC are Digha, Airoli, Ghansoli, Koparkhairane, Turbhe, Vashi, Nerul and Belapur, which are further divided into 89 smaller wards (table no 5.1 below). Census data therefore is available node-wise and ward-wise which has been used.

Table 5-1 Nodes and ward distribution in NMMC

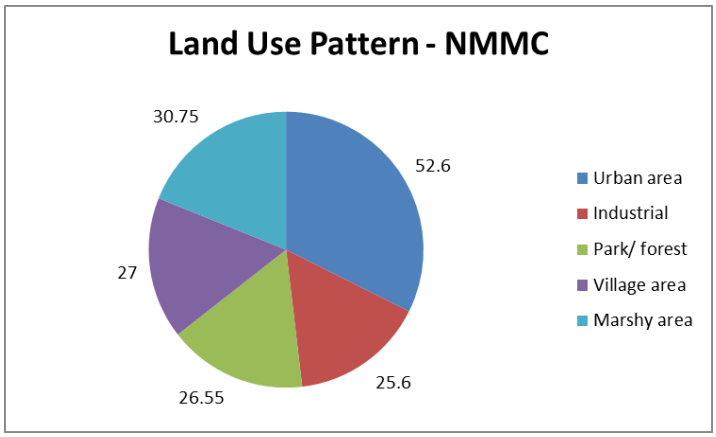
Nodes	*Census Wards*	*Total Wards*
Digha	*1,2,3,4,5*	*5*
Airoli	*6,7,8,9,10,11,12,13,14,15,16,17*	*12*
Ghansoli	*18, 19, 20, 21, 25, 26*	*6*
Koparkhairane	*22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 40*	*16*
Vashi	*39, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56*	*14*
Turbhe	*41, 42, 43, 57, 58, 59, 60, 61, 63, 64, 65*	*11*
Nerul	*62, 66,67, 68, 69, 70, 71, 71, 72, 73, 74, 75, 76, 77, 78, 80*	*15*
Belapur	*79, 81, 82, 83, 84, 85, 86, 87, 88, 89*	*10*

5.1.3. Land use[2]

NMMC is spread over 135.25 sq. km. area of which 50.79% area is used for urban commercial, industrial, administrative use and also for infrastructure such as crematorium, water supply and sewage disposal, roads, railways. According to the data 19.92 sq. km. area is undeveloped. There is forest area of 26.55 sq. km., 0.52 sq. km. garden area, and 0.52 sq. km. lake area and 34.2 km creek length (See Map no B2)

[2] Navi Mumbai Municipal Corporation Fire Hazards Response and Mitigation Plan, 2010.

Figure 5-1 Land Use Pattern - NMMC



5.1.4. Population Density

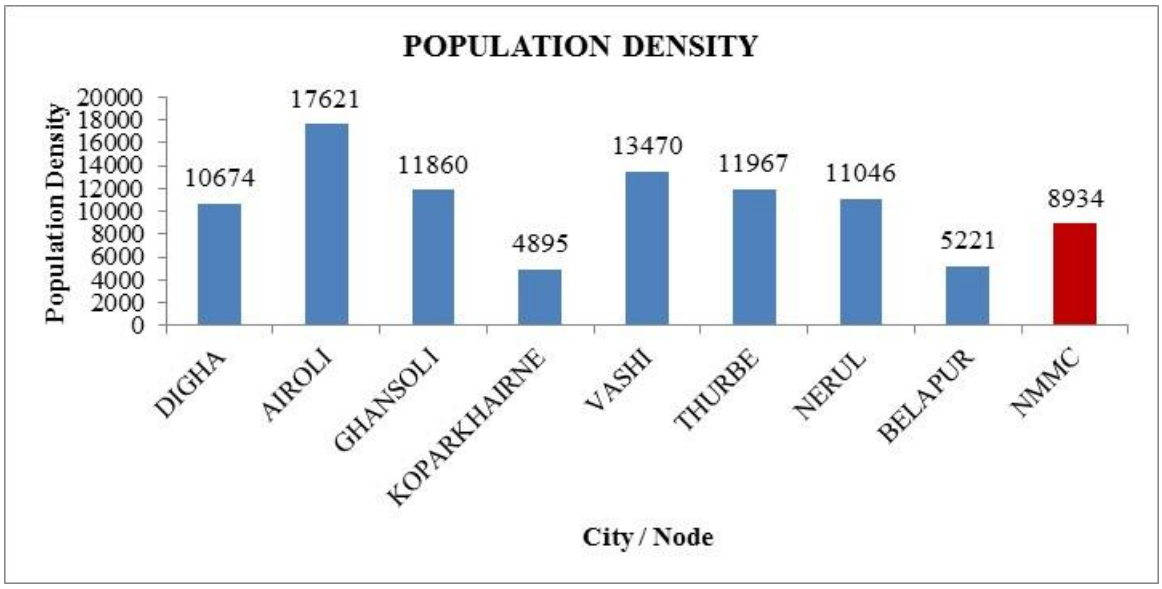
For disaster management and planning data on population growth and distribution is important as it provides an estimate of people likely to be affected in case of any event. Changing demographics and socioeconomic characteristics of the population has direct impact on the capacity of the society and can either lessen or escalate the threat due to any hazard. Population growth and distribution especially increased population density and urbanization, increases vulnerability to disasters.[3] Any city which is densely populated results in congestion and if escape routes are limited, or space for routing or plying emergency vehicles is limited, it could potentially render the infrastructure unsafe and compounded with social and economic characteristic of the community, it provides indicator of city's vulnerability.

The chart below (Figure 5.2) compares the population density (the number of people per unit of area in square kilometre) of various nodes vis-à-vis NMMC. It is evident that Airoli is most densely populated when compared to other nodes. Digha, Ghansoli, Vashi, Turbhe and Nerul also have a population density higher than average NMMC population density.

This indicates that NMMC caters to very large population and without adequate preparedness, overall vulnerability of the area and its population may increase.

[3] Charles Perrow, The Next Catastrophe (Princeton, NJ: Princeton University Press, 2007).

Figure 5-2 Population Density (Census 2011)



5.1.5. Vulnerable population

While population growth and distribution are important factors in producing vulnerability, who likely is to be affected by the disaster is an equally important consideration for working systematically on preparedness and disaster risk reduction. The social and economic characteristics of a group may limit its members' abilities to protect themselves from harm. Elderly, Female population, children below 6 years of age, illiterate people, people who have no or scarce income are more susceptible in the event of a disaster. They get adversely affected by an event and are less likely to recover, unless special provisions are made. A community is considered more resilient if it has lesser number of vulnerable individuals.

5.1.6. Female population

Table 5-2 Female Population NMMC (Census 2011)

VULNERABLE FEMALE POPULATION						
Node	***Tot_P***	***Tot_M***	***% ToT_M (wrt NMMC)***	***Tot_F***	***%Tot_F (wrt Ward)***	***%Tot_F (wrt NMMC)***
DIGHA	*59995*	*33213*	*5.44*	*26782*	*44.64*	*5.25*
AIROLI	*160538*	*86461*	*14.17*	*74077*	*46.14*	*14.51*
GHANSOLI	*132880*	*74685*	*12.24*	*58195*	*43.80*	*11.40*
KOPARKHAIRANE	*180161*	*102052*	*16.73*	*78109*	*43.36*	*15.30*
VASHI	*139371*	*73444*	*12.04*	*65927*	*47.30*	*12.91*
TURBHE	*137864*	*76534*	*12.55*	*61330*	*44.49*	*12.01*
NERUL	*168647*	*89992*	*14.75*	*78655*	*46.64*	*15.41*
BELAPUR	*141091*	*73679*	*12.08*	*67412*	*47.78*	*13.21*
NMMC	***1120547***	***610060***		***510487***	*45.56*	

Figure 5-3 Distribution of Female Population in NMMC nodes (Census 2011)

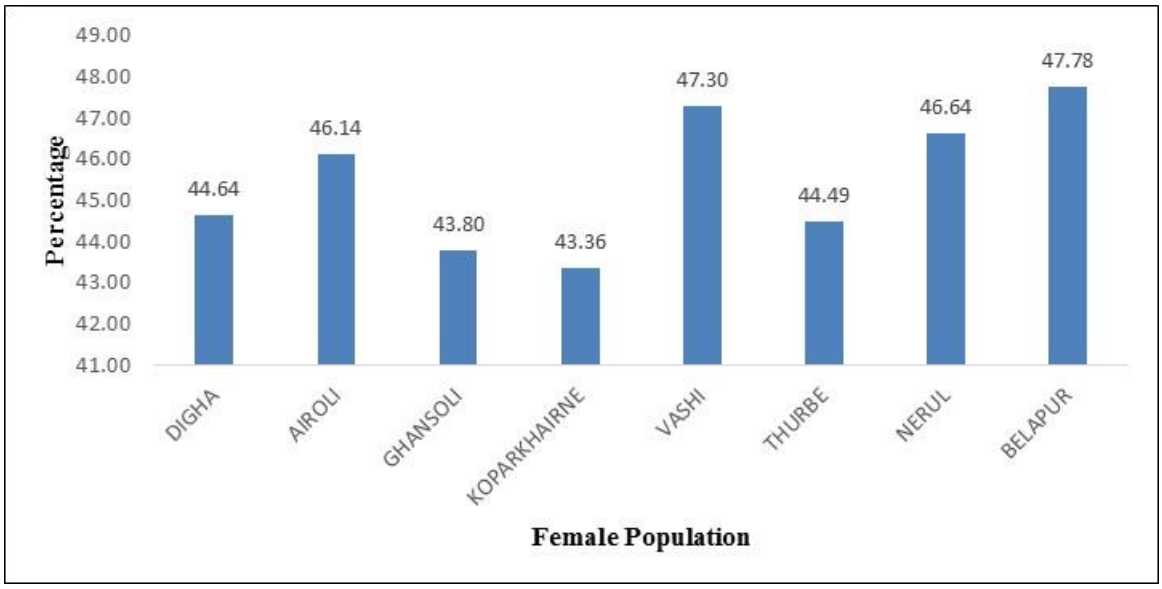
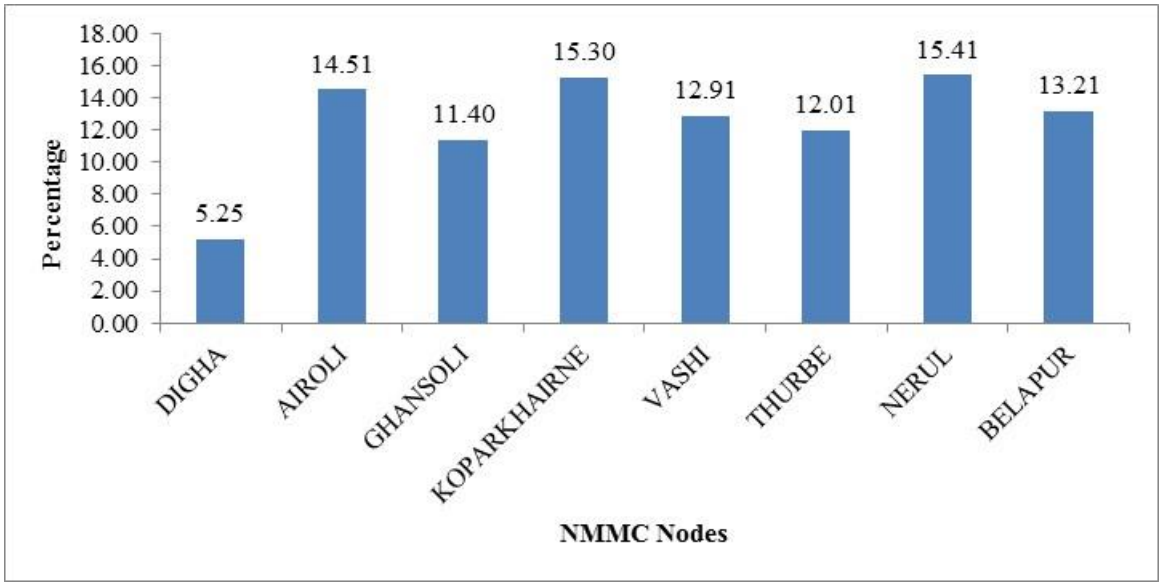


Figure 5-4 Distribution of Female population in each node of NMMC (Census 2011)



Census 2011 gives the Sex ratio of India as 943:1000 whereas in NMMC the ratio is 837:1000. Thus female constitute almost 45% of the NMMC population. This percentage of female population is indeed a positive feature but in any emergency situations communities perpetuate social patterns of discrimination, and these entrenched patterns cause certain groups of people to suffer more than others (Singh, 2009). The impact gets manifested due to the gender inequalities in society. In general, women in India tend to have more limited access to assets — physical, financial, human, social, and natural capital such as land, credit, decision-making bodies, agricultural inputs, technology, extension and training services which could potentially enhance their capacity to adapt. Thus a society with higher female population must pay attention to its women who would be more vulnerable to any hazard. In NMMC all the nodes have almost equal percentage of female thus pointing to the need to pay greater attention to gender sensitive development programmes.

15% of the total city female population resides in Koparkhairane and Belapur nodes whereas Digha has 5% of the total city female population.

5.1.7. Population 0-6 Years

Other factors that affect vulnerability include age and disability. Young children cannot protect themselves during disasters and are dependent upon elders for basic needs. Since they lack the necessary resources, knowledge, or life experiences to effectively cope with the situation, they need special care and attention in DM plans. The importance of age as a factor of vulnerability can be significant in situations where physical fitness is necessary for survival. Any event which leads to stress or loss in elders has major physical and psychological impact on children. Thus administration must provide for special support to communities with more children in the age group of 0-6 years who tend to be more vulnerable in any disastrous situation.

Table 5-3 Population distribution of children below 6 years of age (Census 2011)

POPULATION UNDER 6 YEARS OF AGE				
Node	***Tot_ Population***	***P_06***	***%P-06 wrt Node***	***%P_06 wrt NMMC***
DIGHA	*59995*	*8285*	*13.81*	*6.39*
AIROLI	*160538*	*18508*	*11.53*	*14.28*
GHANSOLI	*132880*	*18774*	*14.13*	*14.49*
KOPARKHAIRANE	*180161*	*20745*	*11.51*	*16.01*
VASHI	*139371*	*13214*	*9.48*	*10.20*
TURBHE	*137864*	*16762*	*12.16*	*12.93*
NERUL	*168647*	*18075*	*10.72*	*13.95*
BELAPUR	*141091*	*15228*	*10.79*	*11.75*
NMMC	***1120547***	***129591***	***11.56***	

Figure 5-5 Percentage of children below 6 years in each node (Census 2011)

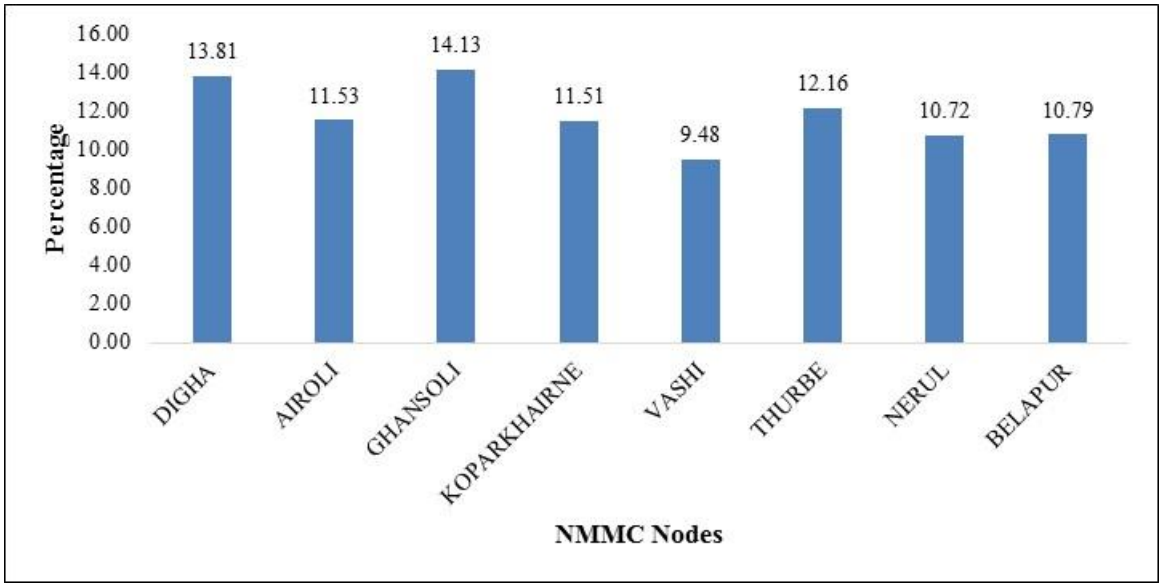
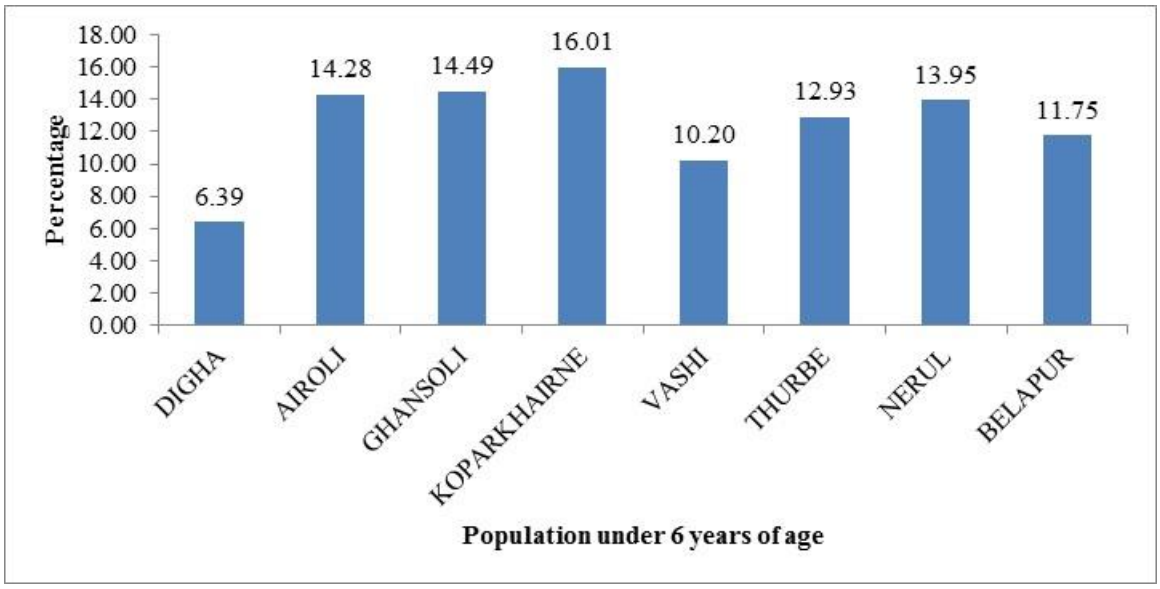


Figure 5-6 Population distribution of children below 6 years of age (Census 2011)



Children below 6 years of age constitute 12% of the population residing in NMMC. Koparkhairane has the highest percentage of population below 6 years of age whereas Digha has the lowest amongst all nodes. Calculation of percentage of children population below 6 years per node indicates that each node has approximately 10% - 14% of the population under this category. The DM plan should have special provision for such vulnerable groups which is devised along with local people.

5.1.8. SC and ST populations

Another category of vulnerable population in India on which data is available are Scheduled Caste and Tribes. Dalits are more vulnerable to natural and human- made disasters because of their marginal social standing and discrimination as well as their habitation in marginal spaces segregated from mainstream settlements. This often results in Dalits living in highly vulnerable places prone to all kinds of disasters. According to the Arjun Sen Gupta Committee report[4], Dalits constitute 81% of India's vulnerable population. Social inequality arising out of social identity overwhelms all other inequalities, especially regional and gender. And this is in relation to the parameters of basic human development and capability such as chronic poverty, health, housing and basic education (see Kannan 2008).

In NMMC percentage of SC population is 8.93 and that of ST is 1.69 both lower than the national average which is 17% and 9% respectively, however the distribution of this population varies in all the nodes. When the population in a particular node is analysed, Ghansoli emerges as a node with highest percentage of SC and ST population and Digha (node) has the second highest percentage. Both these nodes have higher percentage of people staying in unorganised and informal settlements (refer Table 5.4, Figure 5.8 and 5.9) clearly indicating the increase in vulnerability.

[4] http://www.ncdhr.org.in/daaa-1/daaa-publication/NCDHR%20Climate%20Change%20.pdf

Table 5-4 Vulnerable SC ST Population in NMMC Nodes (Census 2011)

VULNERABLE POPULATION SC ST							
City/ Node	***Total Population***	***P_SC***	***% P_ SC (% Ward)***	***% P_ SC (% NMMC)***	***P_ST***	***% P_ST (% Ward)***	***% P_ST (% NMMC)***
DIGHA	*59995*	*8393*	*13.99*	*8.39*	*1214*	*2.02*	*6.42*
AIROLI	*160538*	*15848*	*9.87*	*15.84*	*2779*	*1.73*	*14.69*
GHANSOLI	*132880*	*17632*	*13.27*	*17.62*	*2912*	*2.19*	*15.40*
KOPARKHAIRANE	*180161*	*11543*	*6.41*	*11.54*	*3496*	*1.94*	*18.48*
VASHI	*139371*	*7487*	*5.37*	*7.48*	*1382*	*0.99*	*7.31*
THURBE	*137864*	*14678*	*10.65*	*14.67*	*1845*	*1.34*	*9.76*
NERUL	*168647*	*14034*	*8.32*	*14.02*	*3130*	*1.86*	*16.55*
BELAPUR	*120645*	*10452*	*8.66*	*10.45*	*2155*	*1.79*	*11.39*
NMMC	***1120547***	***100067***	***8.93***		***18913***	***1.69***	

Figure 5-7 Node wise percentage of ST population (Census 2011)

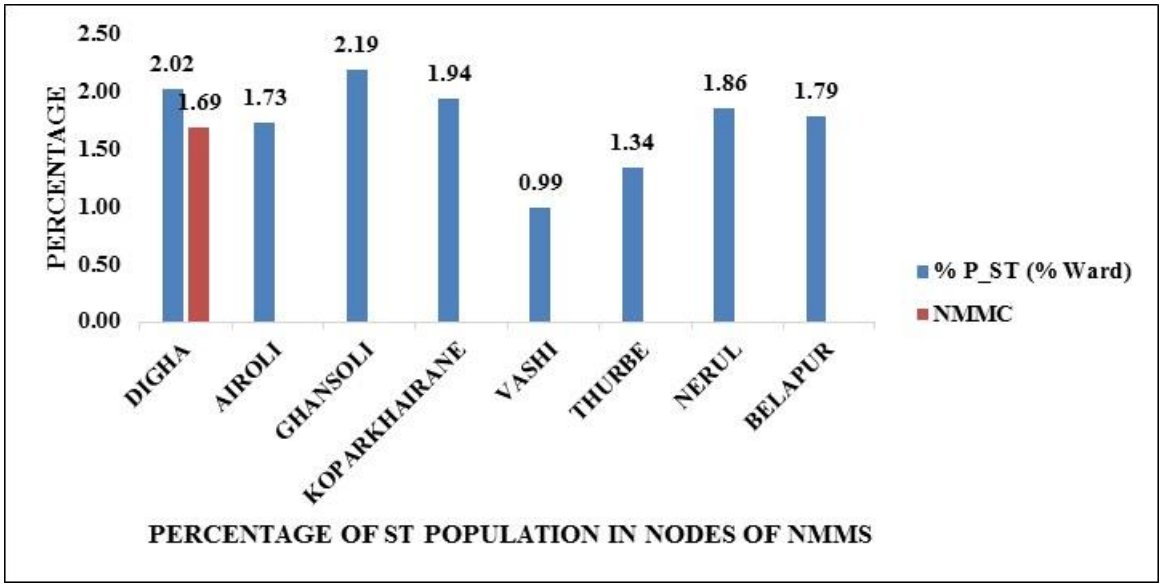


Figure 5-8 Node wise percentage of SC population (Census 2011)

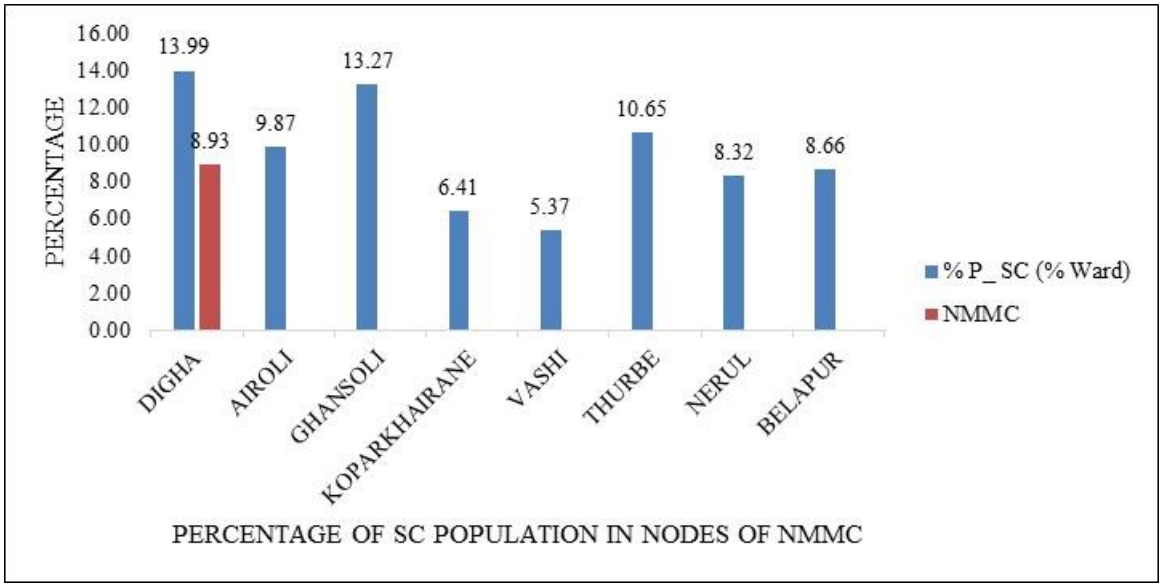


Figure 5.9 indicates that four nodes have SC population higher than city average; two nodes have almost same percentage whereas two have slightly less percentage of SC population. Analysis indicates that six nodes have ST population higher than city average and two nodes have slightly less percentage of ST population.

When the distribution of SC and ST population is combined as a category and analysed in the city (refer fig 9 & 10), node Ghansoli appears to have higher percentage of both SC and ST Citizens and Koparkhairane has highest percentage of ST population amongst all nodes. Experience suggest that the social and economic marginalization of certain racial and ethnic groups, including real estate discrimination, renders these populations more vulnerable at all stages of disaster (Morrow 1999).

Figure 5-9 SC population distribution in NMMC nodes (Census 2011)

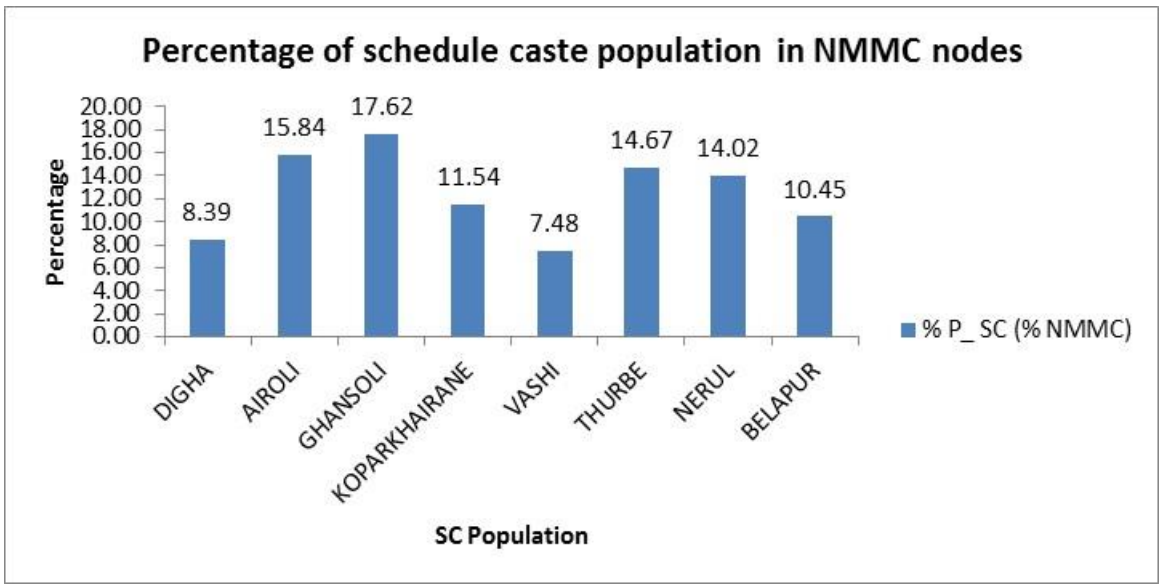
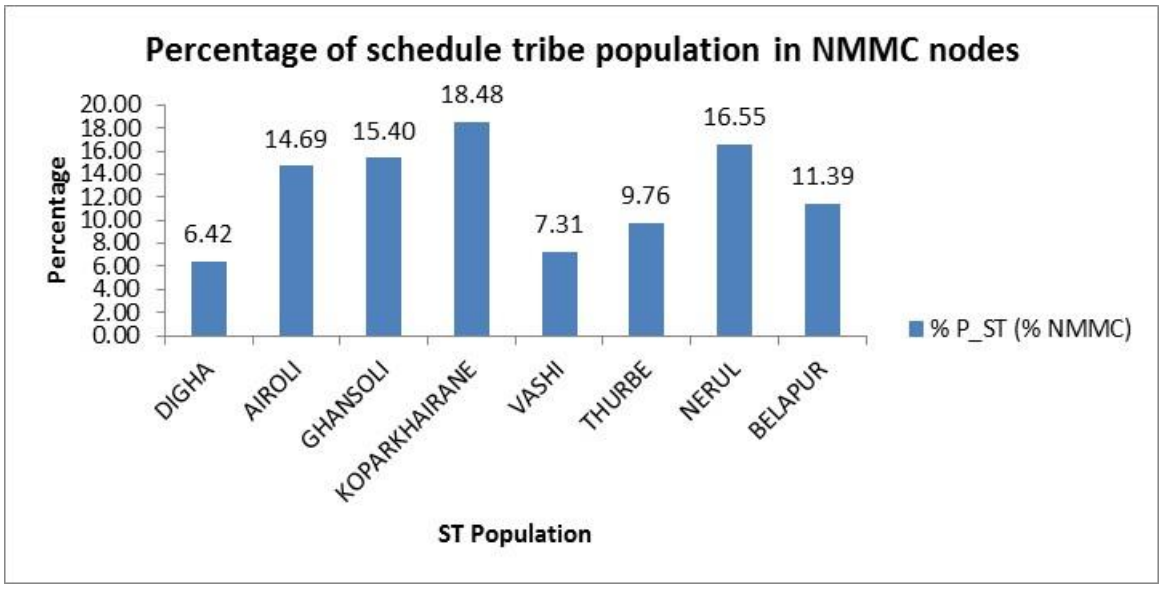


Figure 5-10 ST population distribution in NMMC nodes (Census 2011)



5.1.9. Illiterate population

Education is associated with both income and poverty. People with higher levels of education are more likely to have access to and act upon varied hazard information from preparation to recovery (Tierney 2006). For people with less education, the practical and bureaucratic hurdles to cope with and recover from disaster prove increasingly difficult to surmount (Morrow 1999). Higher literacy rate implies higher awareness. Thus it reduces the vulnerability, as literate people are assumed to take rational decisions. Illiterate people tend to take decisions based on traditions which may be irrational. Rational decisions will prevent the post disaster chaos. And vice versa, lower literacy rates imply lower awareness, which potentially increases vulnerability.

In NMMC, 20% population falls under the category of illiterates. When all the nodes are analysed individually, there is not much variation in percentage of population falling under this category when compared with the city average. However, Digha, Ghansoli and Turbhe have higher percentage than the city average. When the distribution of illiterate population in NMMC is analysed, it emerges that 15% of illiterate population of the city resides in Koparkhairane and Turbhe. From the perspective of city's education department, these nodes need special focus if the vulnerability of people to disaster is to be reduced.

Table 5-5 Distribution of illiterate population in nodes of NMMC (Census 2011)

ILLITERACY				
Node	***Total Population***	***P_Ill***	***% P_Ill wrt Node***	***% P_Ill wrt NMMC***
DIGHA	*59995*	*16494*	*27.49*	*7.10*
AIROLI	*160538*	*32768*	*20.41*	*14.10*
GHANSOLI	*132880*	*32331*	*24.33*	*13.91*
KOPARKHAIRANE	*180161*	*36302*	*20.15*	*15.62*
VASHI	*139371*	*22512*	*16.15*	*9.69*
TURBHE	*137864*	*36112*	*26.19*	*15.54*
NERUL	*168647*	*30942*	*18.35*	*13.31*
BELAPUR	*141091*	*24969*	*17.70*	*10.74*
NMMC	***1120547***	***232430***	***20.74***	

Figure 5-11 Distribution of illiterate population in NMMC (Census 2011)

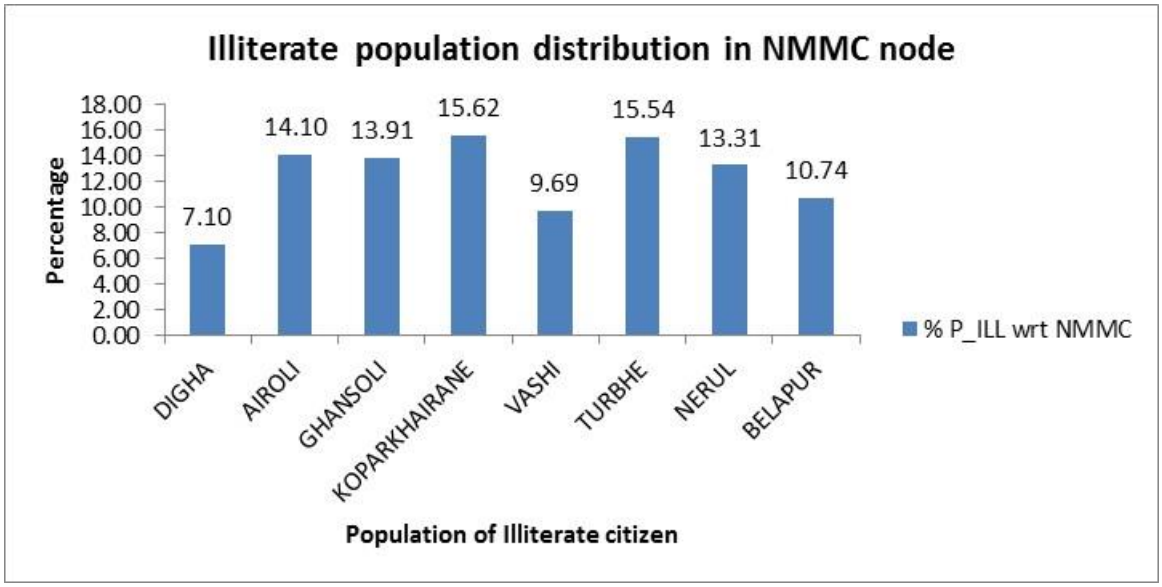
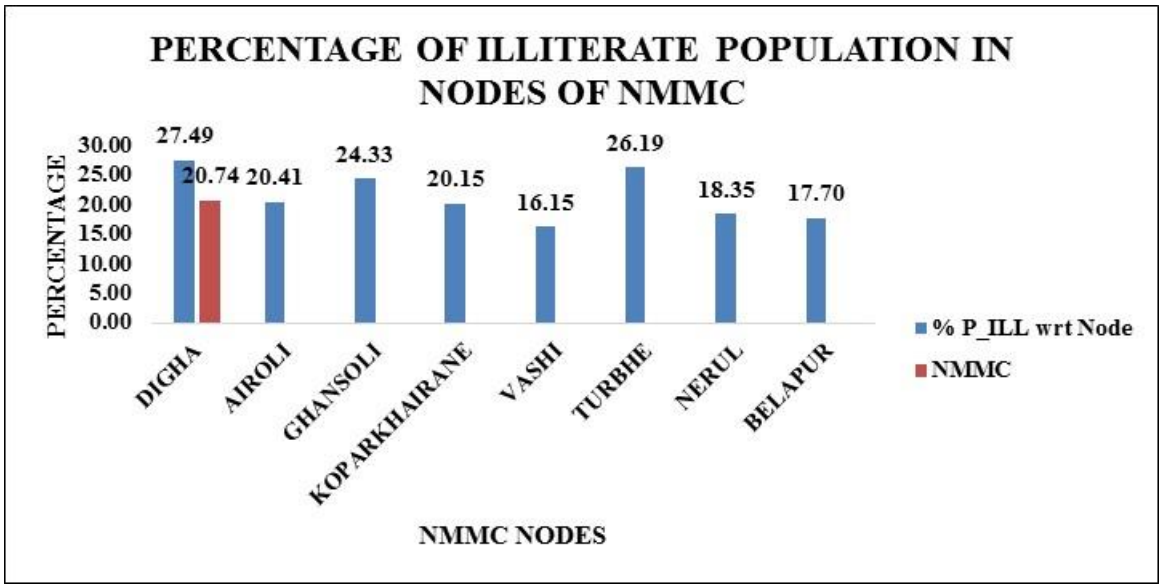


Figure 5-12 Node wise percentage of illiterate population



5.1.10. Non workers and marginal workers - Dependents

As per the Census, those workers who had worked for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers. Those workers who had not worked for the major part of the reference period (i.e. less than 6 months) are termed as Marginal Workers. A person who did not at all work during the reference period was treated as non-worker.

Households with marginal workers could be economically weaker and hence more vulnerable to disasters. Larger the non-working population greater the vulnerability as their economic status is likely to be lower and also the number of dependents in society will increase. Economically disadvantaged populations are disproportionately affected by disasters. Their ability to access other resources also shrinks, making them more vulnerable. The poor are less

likely to have income or assets needed to prepare for a possible disaster or to recover after a disaster (Morrow 1999; Cutter et al. 2003). Moreover, unemployed persons do not have employee benefits plans that provide income and health cost assistance in the event of personal injury or death (Brodie et al. 2006)

Table 5-6 NMMC Employment status by nodes (Census 2011)

WORKING POPULATION : DEPENDENTS													
Node	***Total Population***	***Tot_ Work_P***	***% Tot_Work P (Node)***	***% Tot_Work P (NMMC)***	***Main Work_P***	***% Main Work_P (Node)***	***% Main Work_P (NMMC)***	***Marg Work_P***	***%Marg Work_P (Node)***	***%Marg Work_P (NMMC)***	***Non_ Work_P***	***%Non_ Work_P (Node)***	***%Non_ Work_P (NMMC)***
DIGHA	*59995*	*23291*	*38.82*	*5.11*	*20869*	*34.78*	*4.98*	*2422*	*4.04*	*6.72*	*36704*	*61.18*	*6.29*
AIROLI	*160538*	*62826*	*39.13*	*13.79*	*57893*	*36.06*	*13.80*	*4933*	*3.07*	*13.70*	*97712*	*60.87*	*16.74*
GHANSOLI	*132880*	*54716*	*41.18*	*12.01*	*51367*	*38.66*	*12.25*	*3349*	*2.52*	*9.30*	*78164*	*58.82*	*13.39*
KOPARKHAIRNE	*180161*	*76033*	*42.20*	*16.69*	*71653*	*39.77*	*17.08*	*4380*	*2.43*	*12.16*	*104128*	*57.80*	*17.83*
VASHI	*139371*	*58181*	*41.75*	*12.77*	*52967*	*38.00*	*12.63*	*5214*	*3.74*	*14.48*	*81190*	*58.25*	*13.91*
TURBHE	*137864*	*57293*	*41.56*	*12.58*	*52773*	*38.28*	*12.58*	*4520*	*3.28*	*12.55*	*80571*	*58.44*	*13.80*
NERUL	*168647*	*66581*	*39.48*	*14.62*	*60584*	*35.92*	*14.44*	*5997*	*3.56*	*16.65*	*102066*	*60.52*	*17.48*
BELAPUR	*141091*	*56564*	*40.09*	*12.42*	*51363*	*36.40*	*12.24*	*5201*	*3.69*	*14.44*	*84527*	*59.91*	*14.48*
NMMC	***1120547***	***455485***	***40.65***		***419469***	***37.43***		***36016***	***3.21***		***583872***	***52.11***	

Table 5.6 reveals that in all the nodes of NMMC the ratio of working population to Non-working population is 40:60 which implies that a large population is dependent upon others thus increasing the vulnerability should a disaster occur.

When NMMC is analysed amongst all the nodes, Koparkhairane and Nerul have maximum percentage of non-working city's population (15%) but they also have 17% and 15% of city's working population respectively.

When the working population is further categorized under main and marginal population, Nerul has highest percentage of marginal workers in NMMC.

Figure 5-13 Distribution of working and non-working population (Census 2011)

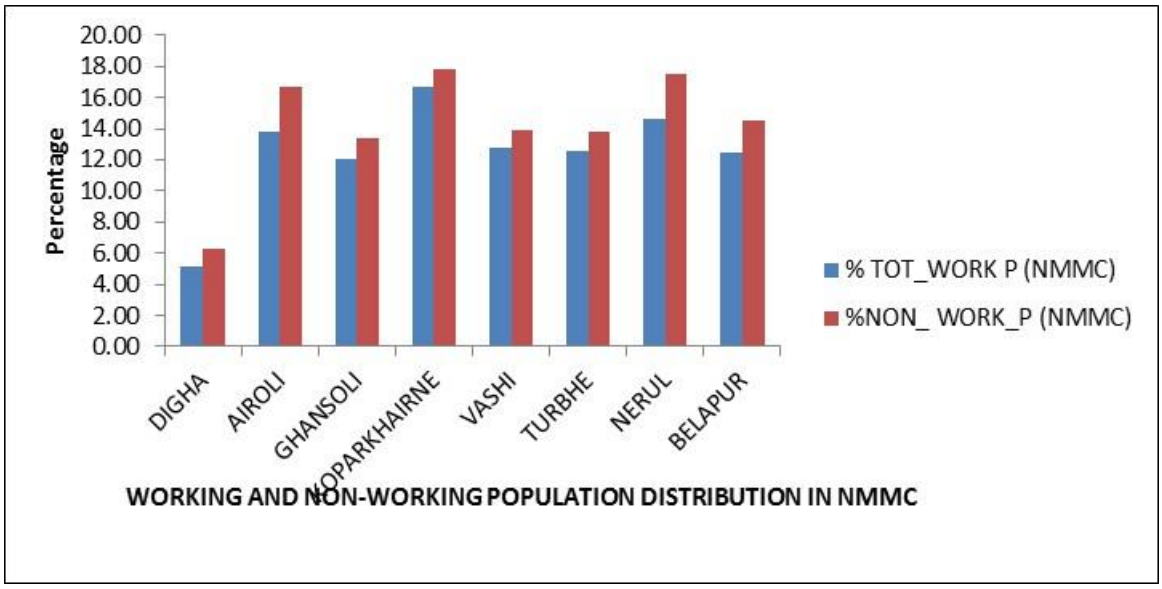
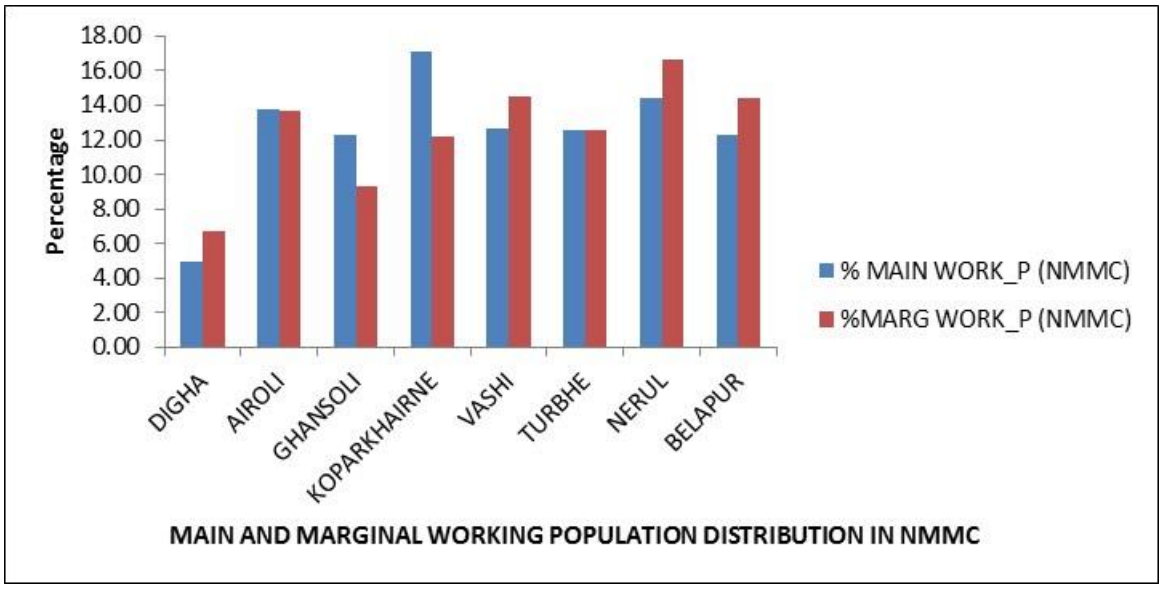


Figure 5-14 Distribution of main and marginal working population (Census 2011)



5.1.11. Vulnerable Housing

The condition of the housing stock in a city reveals the living condition of people. Proximity of Navi Mumbai to Koyna Region Source Zone, Panvel Flexure Source Zone, West Coast Fault and Chiplun Fault[5] increases vulnerability of unsafe constructions. Construction material used for wall, roof and floor (captured in Census data) indicate the vulnerability of those houses to any disaster event. Any house which shows signs of decay or those breaking down and require major repairs and are far from being in condition that can be restored or repaired ,are considered as dilapidated[6].

[5] www.nmmc.gov.in Earthquake Hazard Risk Vulnerability Analysis (HRVA) of Navi Mumbai, IITB

[6] Censusmp.nic.in – Housing condition and material used.

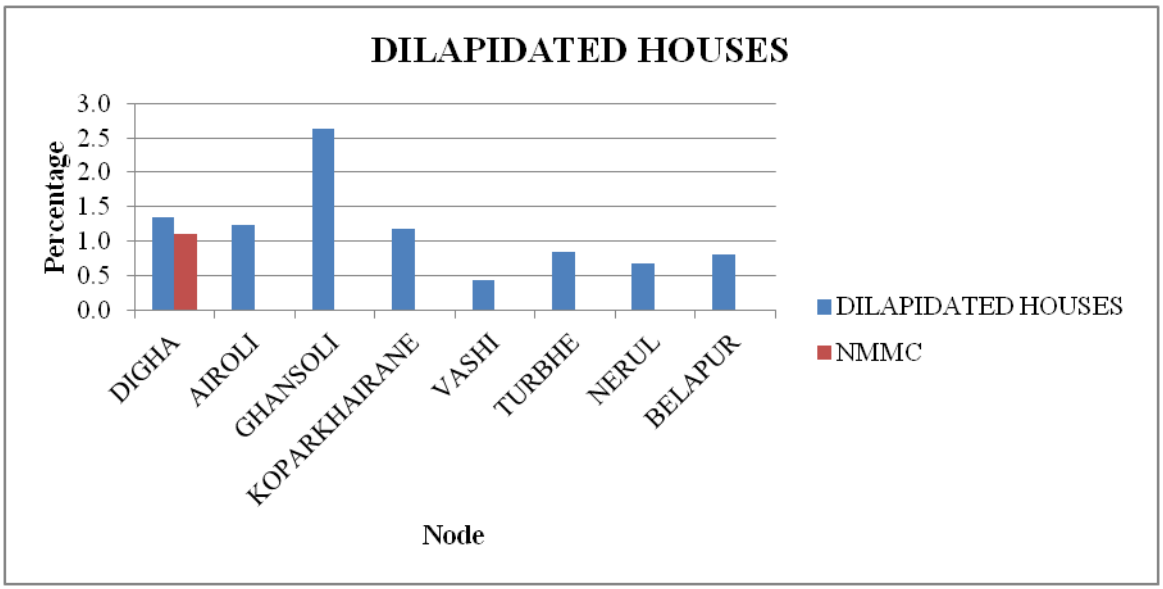
Table 5-7 Vulnerability indicator - Housing (Census 2011)

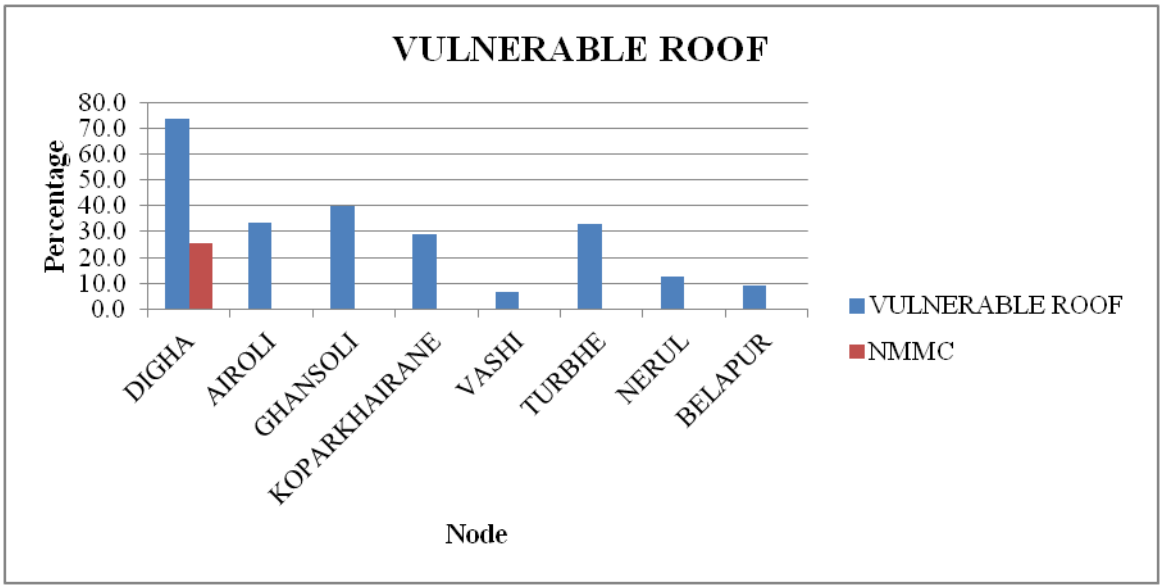
VULNERABILITY INDICATOR- HOUSING				
Node	***Dilapidated Houses***	***Vulnerable Roof***	***Vulnerable Wall***	***Vulnerable Floor***
DIGHA	*1.3*	*73.5*	*15.5*	*2.2*
AIROLI	*1.2*	*33.3*	*8.5*	*1.8*
GHANSOLI	*2.6*	*39.7*	*10.4*	*3.9*
KOPARKHAIRANE	*1.2*	*29.1*	*6.7*	*2.2*
VASHI	*0.4*	*6.9*	*3.3*	*2.0*
TURBHE	*0.8*	*33.2*	*7.8*	*2.3*
NERUL	*0.7*	*12.6*	*3.5*	*1.1*
BELAPUR	*0.8*	*9.2*	*5.2*	*2.6*
NMMC	***1.1***	***25.4***	***6.9***	***2.3***

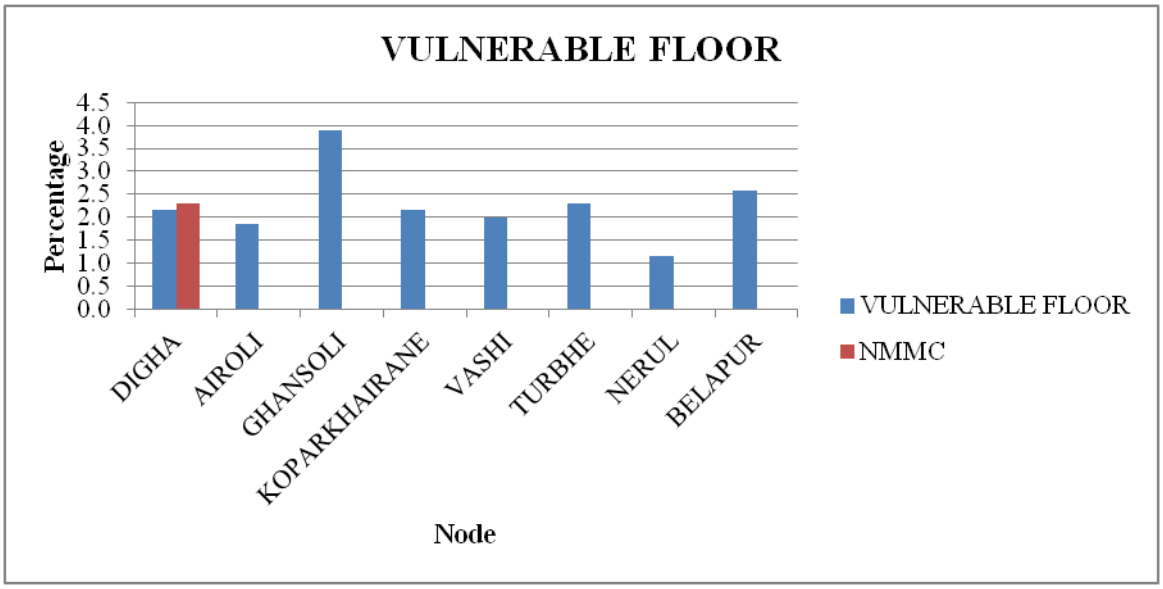
The **Table 5-7 Vulnerability indicator - Housing** above and **Figure 5-15 Vulnerable Housing – NMMC** below indicate that in node Digha the housing material has been compromised as it has highly vulnerable building stock. Visual survey of the node indicated that majority of building stock is non-engineered and follows a very congested pattern thus increasing the vulnerability. High percentage of building stock in Airoli, Ghansoli, Koparkhairane and Turbhe uses roof material that can be classified as vulnerable based on the definition of vulnerable roof Census 2011. The ward officers of the city need to carefully examine and develop an approach to prevent collapse by investing on repairs and strengthening of structures.

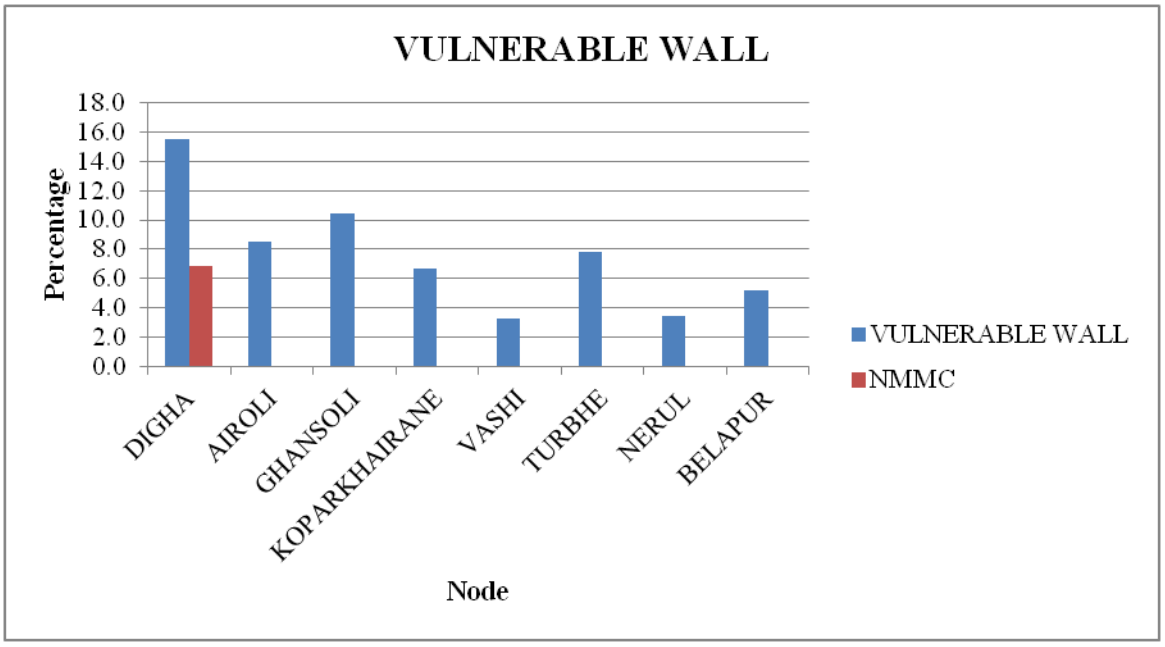
Proximity to Panvel flexure, variation in rain pattern, usage of flood plain for construction of houses further increases the vulnerability of people in NMMC.

Figure 5-15 Vulnerable Housing – NMMC (Census 2011)









5.1.12. Level of services

1 Physical Infrastructure

The quality of life of persons depends, among other factors, upon the amenities and assets available to them. Though remarkable achievements have been made in extending basic amenities in NMMC, there still are large areas of deprivation, which requires urgent attention.

Under this section, parameters which are indicative of the access and availability of basic services and amenities are covered. Safe drinking water is water that is free from disease causing organisms, toxic chemicals, colour, smell and unpleasant taste (Census 2011). Access to improved source of drinking water is a basic indicator of human development. Access to latrine and covered and proper drainage system are other services, which if not available can make the community highly vulnerable to diseases and compromise health. Non availability

and poor accessibility of basic amenities indicate high level of vulnerability in a disaster event. Improvement in public health infrastructure is an urgent need in such cases.

Each community must be provided with all the amenities along with electric supply. Absence or fewer facilities are indicator of vulnerability.

Figure 5-16 Percentage of households with unsafe drinking water (Census 2011)

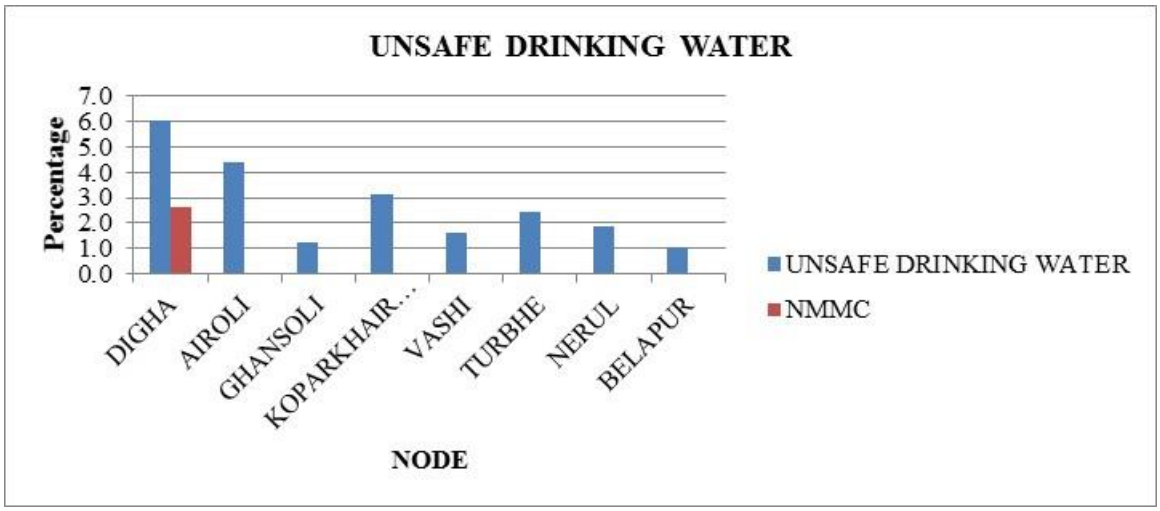


Figure 5-17 Percentage of households with water source out of living premises (Census 2011)

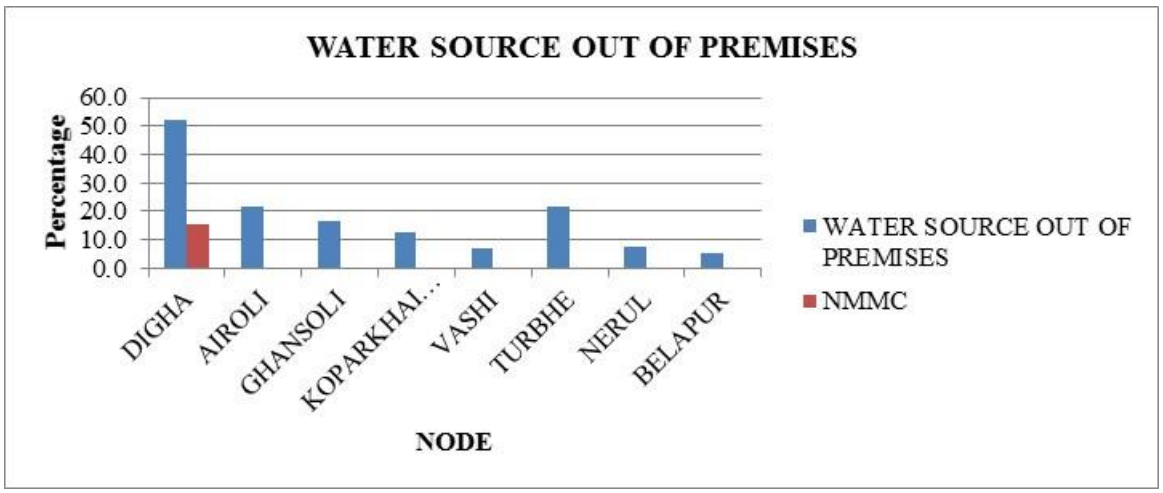


Figure 5-18 Percentage of households with unsafe source of light (Census 2011)

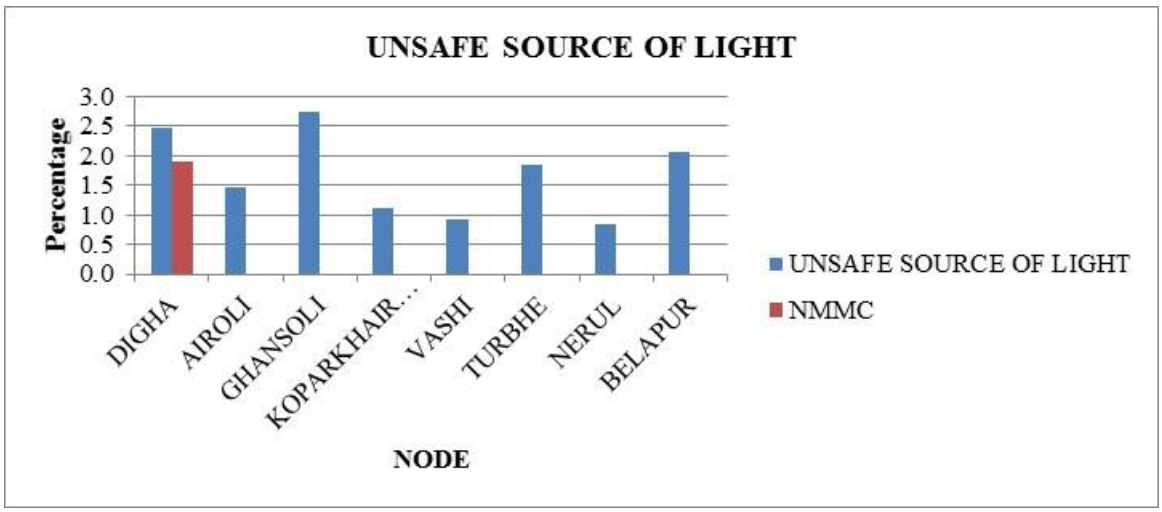


Figure 5-19 Percentage of households with no access to Latrine (Census 2011)

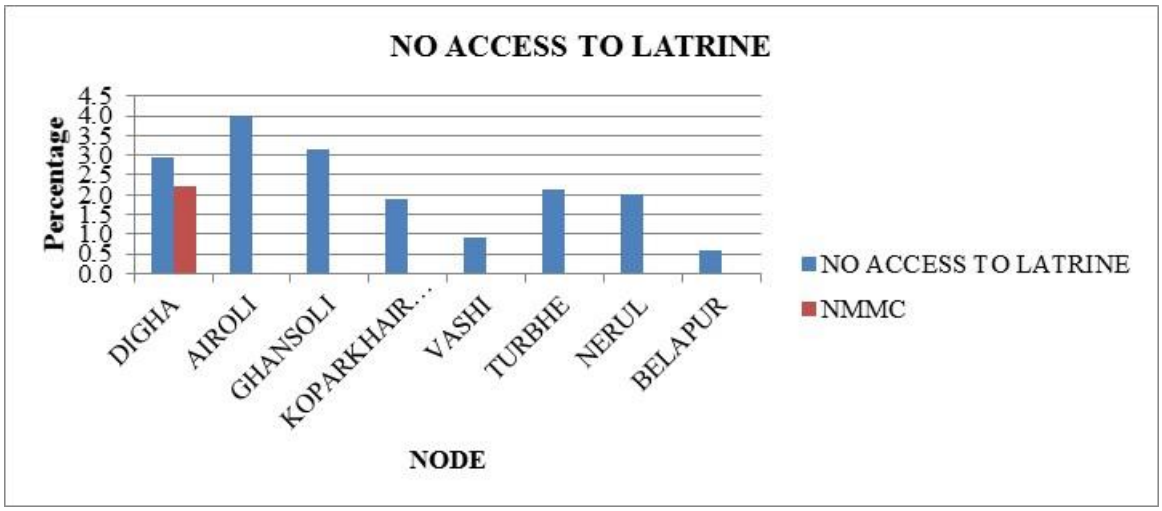


Figure 5-20 Percentage of households with unsafe cooking fuel (Census 2011)

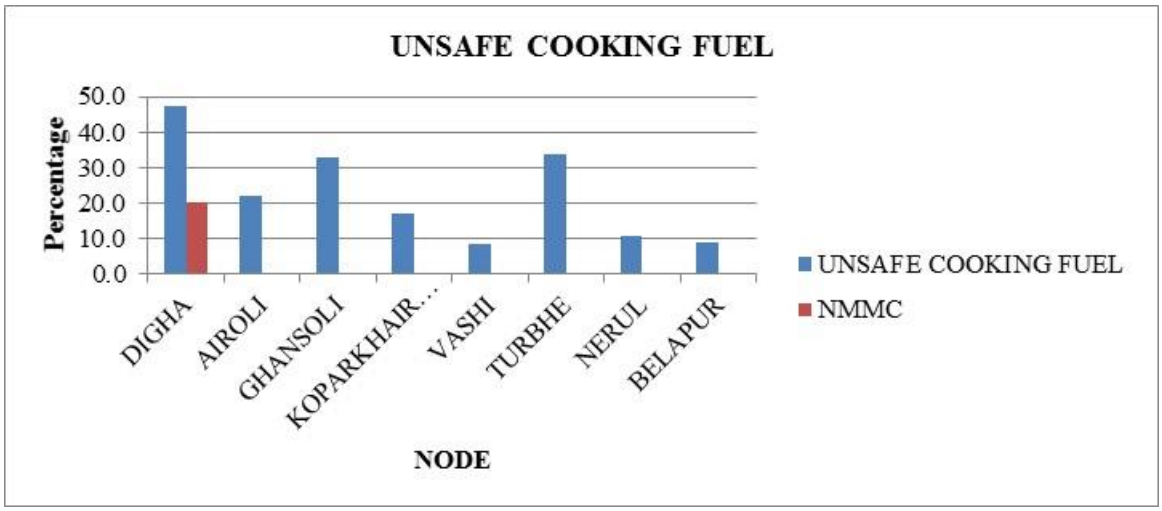


Figure 5-21 Percentage of households with unsafe drainage (Census 2011)

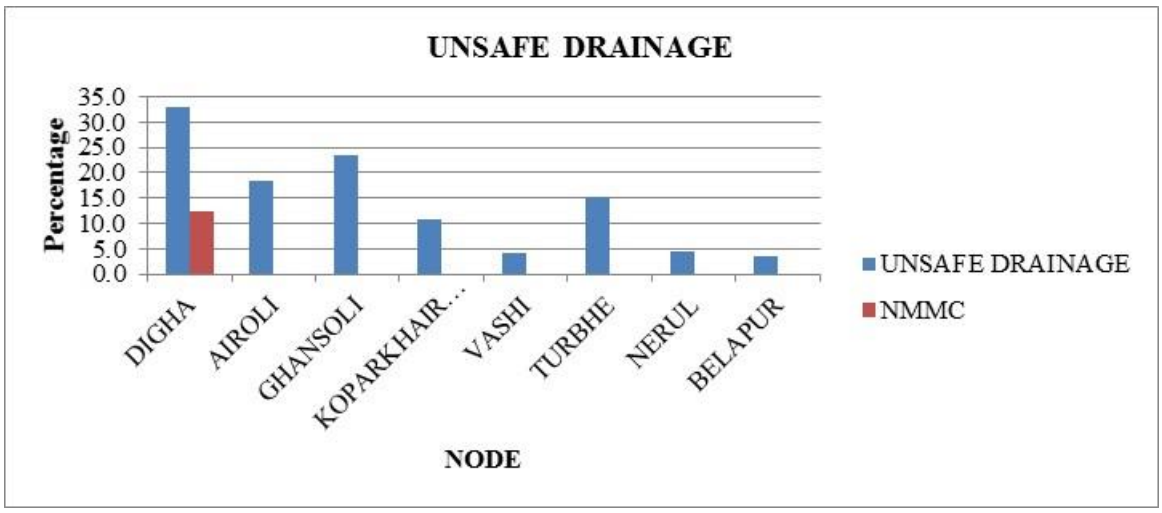


Table 5-8 Physical Infrastructure Vulnerability – NMMC (Census 2011)

PHYSICAL INFRASTRUCTURE VULNERABILITY						
Node	***Unsafe Drinking Water***	***Water Source Out Of Premises***	***Unsafe Source Of Light***	***No Access To Latrine***	***Unsafe Drainage***	***Unsafe Cooking Fuel***
DIGHA	*6.1*	*52.1*	*2.5*	*3.0*	*32.9*	*47.5*
AIROLI	*4.4*	*21.4*	*1.5*	*4.0*	*18.4*	*22.2*
GHANSOLI	*1.2*	*16.6*	*2.7*	*3.2*	*23.6*	*32.8*
KOPARKHAIRANE	*3.1*	*12.9*	*1.1*	*1.9*	*10.7*	*17.1*
VASHI	*1.6*	*7.0*	*0.9*	*0.9*	*4.1*	*8.3*
TURBHE	*2.4*	*21.7*	*1.8*	*2.1*	*15.1*	*33.8*
NERUL	*1.9*	*7.3*	*0.9*	*2.0*	*4.5*	*10.8*
BELAPUR	*1.0*	*5.5*	*2.1*	*0.6*	*3.7*	*8.6*
NMMC	***2.6***	***15.3***	***1.9***	***2.2***	***12.5***	***20.3***

Highlights (from the census 2011, and data collected for NMMC) on amenities and assets available to each household in NMMC are as follows:

- As many as 41,181 (15.3%) households have to fetch drinking water from sources which are at least 500 meters away in case of towns. Node Digha has more than 50% and Airoli and Turbhe have more than 20% of the household under this category.
- Electricity as the source of lighting is available to 2,69,311 (98%) households. Node Digha has more than 50% household without proper source of light and node Airoli and Turbhe have more than 20% of the household under this category.
- 20% of household in NMMC use Unsafe source of fuel for cooking, Nodes Digha, Ghansoli, Airoli and Turbhe have high percentage of houses with unsafe source of cooking fuel

- 2.6% of household in NMMC have unsafe source of drinking water but Digha, Airoli and Ghansoli have larger percentage of households with unsafe water source.
- 2.2% of household in NMMC have no access to latrine but Digha, Airoli and Ghansoli have larger percentage of household with unsafe water source.
- 12.5% of household in NMMC have unsafe drainage but Digha, Airoli and Ghansoli have larger percentage of household with unsafe water source.

All these indicators clearly bring out node Digha, Airoli and Ghansoli as highly vulnerable when the physical vulnerability indicators are mapped and analysed.

2 Social infrastructure

The status of social infrastructure is analysed in terms of its location with respect to the location and accessibility from the nearest fire station. This has been discussed in detail for each node in the appendix. However, for an overview, Map D1, E1, F1, G1, H, I and J1 can be referred to in the Book of Maps.

3 Social Security

Financially strong community can handle any calamity in a better way. They are not totally dependent upon the help from the government; they can survive or manage during the initial days till external help / support is available. It is also assumed that if people are availing banking services, they have some financial backup which can be used to cope with aftereffects of any disastrous event.

People who have their own house can be categorized under population with some possessions. A registered house helps in claims in the aftermath of a disaster which damages the structure. People who live in rented premises do so because they are either transient or do not have the financial resources town a house. They often lack access to information about financial aid during recovery. In the most extreme cases, tenants lack decent shelter options when lodging becomes uninhabitable or too costly to afford.

Similarly presence of banks and access suggests economic inclusion. People deposit savings which can be accessed during emergency situation. Any community having higher percentage of population falling in this category increases the overall capacity to cope with disaster. Further having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts are less vulnerable than households without bank accounts.

Figure 5-22 Percentage of residents in self-owned houses (Census 2011)

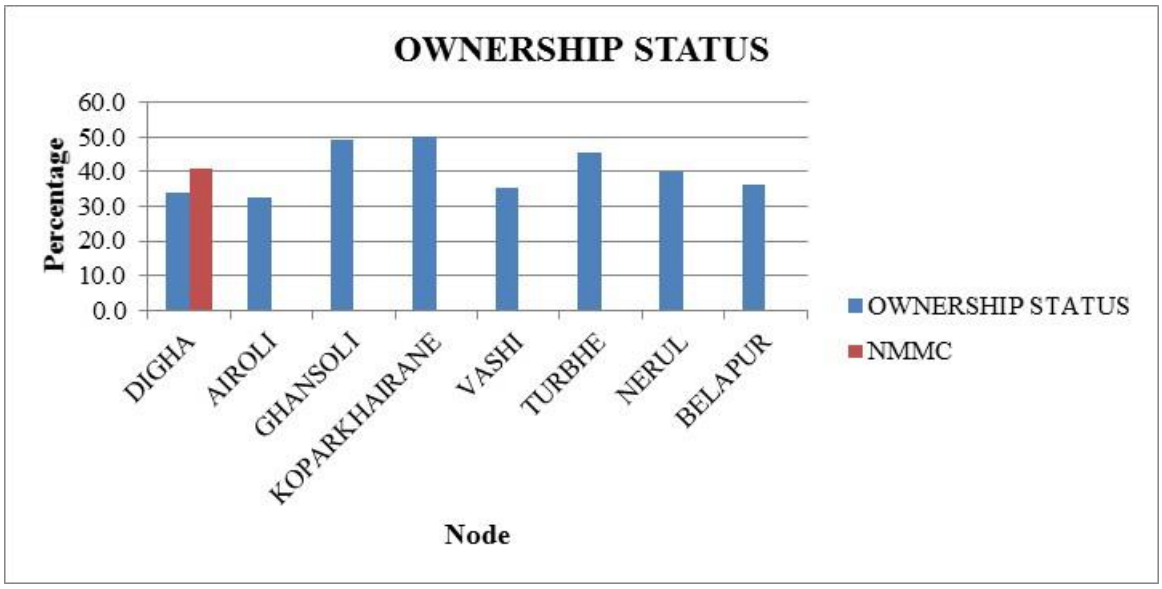


Figure 5-23 Percentage of people availing banking services (Census 2011)

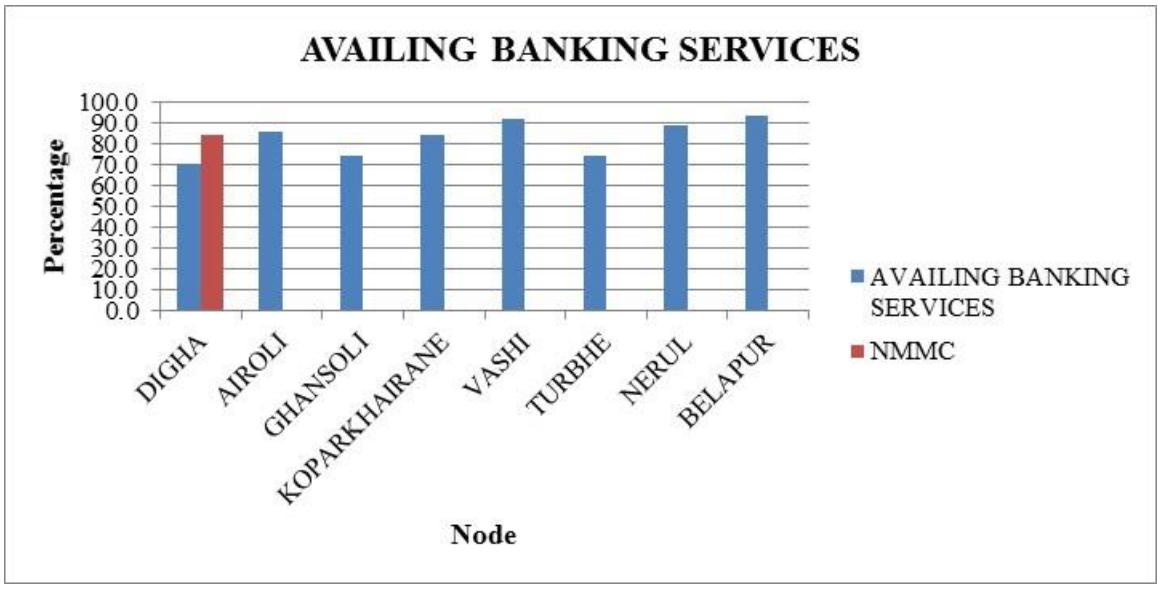


Table 5-9 Social Security

SOCIAL SECURITY		
Node	***Ownership Status***	***Availing Banking Services***
DIGHA	*33.9*	*70.7*
AIROLI	*32.6*	*86.3*
GHANSOLI	*49.4*	*74.1*
KOPARKHAIRANE	*50.1*	*84.9*
VASHI	*35.3*	*92.2*
TURBHE	*45.5*	*74.6*
NERUL	*40.1*	*89.5*
BELAPUR	*36.2*	*93.8*
NMMC	***40.8***	***84.6***

From the table above it is visible that Ghansoli and Koparkhairane have nearly 50% of the people residing in self-owned houses. All the other nodes have less than 50% percent of people residing in self-owned houses indicating majority of people are living in rented accommodation. In case of any disaster event, people who have their own house might be compensated for their loss. Whereas people living in rented house just own the assets inside the house and in case the assets are not insured, the losses incurred are more.

The reason behind lesser population in self-owned houses can be due to immigration, which means it may have people belonging to some other part of the country but are here for the purpose of work or education, if these are destroyed all the assets owned are lost moreover, they often lack access to information about financial aid during recovery. In the most extreme cases, tenants lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford.

The other reason could be that the real estate costs of this area is too high for working people to invest leaving renting as the only option. In both the situations, any disaster event can result in major loss to the current residents of the area.

At least 30% of population residing in all the nodes of NMMC do not utilise banking facilities. This is a major gap and financial inclusion should be an important agenda to reduce vulnerabilities. Digha, Ghansoli and Turbhe are nodes with less than 80% population availing banking services.

5.1.13. Social Vulnerability Assessment, Hazard Vulnerability: A Review

This section focuses on 3 main hazard and reviews how specific indicators reflect vulnerabilities of each node. The detailed node wise analysis is given in Vol II - Appendix. Current arrangements for these hazard risks are also discussed and their status reviewed.

1 Fire

The subject of Fire Services in the State of Maharashtra comes under the purview of Urban Local Bodies. Therefore, the provisions exist in the Bombay Municipal Corporation Act, 1888; Maharashtra Provincial Municipal Corporation Act, 1949; and the Maharashtra Regional Town and Industrial Township Planning Act 1966. In addition to this, as per the directives of the State Government, other Special Planning Authorities like MIDC & CIDCO also manage Fire Services for their areas.

As mentioned in chapter 3 of this report, NMMC, CIDCO and MIDC are the three major Authorities of Navi Mumbai responsible for landuse planning, infrastructural services and development planning through various departments. NMMC has four fire stations (Vashi, Airoli, Nerul and CBD Belapur) and MIDC has three fire stations (Koparkhairane, Rabale and Nerul) in Navi Mumbai. CIDCO also has four fire stations in the neighbourhood (Kharghar, New Panvel, Kalamboli and Uran.) Coordination among them is extremely important, in case of fire or accident.

Norms and rules for setting up of Fire stations in States / UTs

1. As per GR 30 August 2009, Maharashtra Government Agni Surakhsha Abhiyan, the standards for staff and equipment requirements are:

    - The fires stations within the city are subdivided into two categories, i.e. FS 1 and 2
    - FS1: is usually the head quarter and should have 4 fire engines, 1 jeep and 1 car
    - FS2: 3 fire engines, 1 jeep and 1 car
    - There should be one fire station for every 10.5 sq.km.
    - For every fire engine there should be 1 Station Officer, 1 Assistant Station Officer, 3 Leading firemen, 6 Driver, Operators and 21 Firemen.
    - Station officer and Assistant Station officer should be on 24 hours duty in shifts. They should be provided residential facilities within or close to the station premise.
2. Standing Fire Advisory Council recommends:

    - The desired number of fire stations as per the laid down norms should be put in place in a phased manner as part of an integrated Fire Services Modernisation and Revamping Plan to be evolved by each State / UT based upon HRVA of fire incidents.
    - Establishment of Fire Stations in the Country based on the response time which is 5 to 7 minutes in Urban areas and 20 minutes in Rural areas.

These SFAC recommendations are advisory in nature and States/ UTs have the discretion to make necessary changes as deemed appropriate for their specific disasters.

Existing infrastructure for fire management with NMMC Fire Department

- There are four fire stations in NMMC (at CBD Belapur, Vashi, Airoli, Nerul and). A new Fire station at Koparkhairane is in the pipeline. Of these the Vashi fire station is a FS1 station and is the Headquarters for NMMC Fire Brigade. All other stations are of FS 2 category.

To manage fires the following equipment is available with the fire department.

Detail	***Number***	***Specification***	***Remark***
Fire engines	*5*		*Can be used only on roads wider than 4.5m*
Mini fire engine	*4*		*Can be used on roads with minimum width of 3m*
Rescue tenders	*2*		*Mini and regular*
Water tanks	*2*	*8000 lit each*	
Ambulance	*3*		
Jeep	*5*		
Bronto sky lifts (hydraulic platform)		*3; 32m, 52m and 68m*	
Manpower	*140*		*officers + staff* ***(Note: This staff is also used to combat other disasters like floods, building collapse, industrial accidents, gas leaks etc.)***

- Other than the above, 1 rescue vehicle and additional water douser of 12000 lit capacity have been ordered.

Present Situation

Fire hazard is one of the major threats that needs attention in NMMC in terms of preparedness and response planning. Having an industrial zone within its jurisdiction only adds to the vulnerability of NMMC and its residents.

Development of Navi Mumbai as a counter magnet to Mumbai started in the late 1980 and in January 1992, Navi Mumbai Municipal Corporation came into existence. In the early years of its development huge government establishments were developed here along with their residential facility. These residential facilities are now nearly more than 20 years old and currently there is a large stock of old building. Lack of proper maintenance and age render these buildings highly vulnerable to frequent fire incidences and building collapse. Apart from that the city has a large number of high rise commercial developments. Most of these do comply with the fire safety norms in letter and spirit. Frequent cases of fire due to electric short circuits, AC failure, UPS system failure and electric cable failure have been reported. The maximum numbers of cases reported are in Vashi.

The city is spatially divided into two zones vertically with the Thane-Belapur Road, running north to south dividing the city into two. The western zone is predominantly residential and commercial, whereas the eastern zone is industrial.

The Maharashtra Industrial Development Corporation (MIDC) established an industrial estate at Thane Belapur Road, Navi Mumbai in 1963 and is also known as TTC (Trans-Thane Creek) MIDC Estate. The industrial estate is located along the Thane Belapur Road towards eastern side of road. It covers a total area of 27 sq. km. There are about 2200 industrial units of various category engaged in the manufacture of chemicals, dyes, dye-intermediates, Bulk drugs, pharmaceuticals, Textile auxiliaries, Pesticides, Petrochemicals, Textile processors, and Engineering units.*(Source: Action Plan for Industrial Cluster : Navi Mumbai, 2010)*

The table 5-10 gives the classification of industries as per the Ministry of Environment & Forests, GoI based on the amount of pollution caused.

Table 5-10 Number of industries under pollution categories of MoEF

Type of Industries	***No. of Industries in MIDC***
Highly Polluting Industries (Under CREP -17 categories).	*23*
Red Category Industries (54 categories)	*548*
Orange and Green Category Industries	*1478*
TOTAL	*2049*

The table reveals that the city has nearly 548 (28%) of highly polluting and red category industries. To further add to this vulnerability is the wind direction. Except during the monsoons, when wind direction is south west, the city has winds blowing from the north east. Thus due to wind pollutants are spread across the city. This is an important factor during fires and especially during gas leakages, which is an impending threat.

From a long term planning perspective, there is an urgent need to comprehensively examine the issue of fire risks and pollution.

Past Fire incidences

There have been 8 major fire calls (listed below) and 240 minor calls within the city in the year 2014-2015. These have mostly been in commercial areas and due to short circuits, UPS and AC failure.

Table 5-11 NMMC past fire incidences

Sr. No	*Location*	*Responding fire station*	*Building type*	*Reason*	*Loss to life*	*Loss to property*
1	*CBD*	*CBD*	*Commercial*	*Defective electric circuit*	*Nil*	*20 lakhs*
2	*Turbhe*	*Vashi*	*Commercial*	*Diwali Crackers/Diya*	*Nil*	*4-5 Crores*
3	*Turbhe*	*Vashi*	*Commercial*	*Short Circuit*	*Nil*	*20-30 Lakhs*
4	*Vashi*	*Vashi*	*Commercial*	*Short Circuit*	*Nil*	*1-1.5 Crores*
5	*Vashi*	*Vashi*	*Commercial*	*Short Circuit*	*Nil*	*50-60 Lakhs*
6	*Nerul*	*Nerul*	*Residential*	*Gas cylinder burst*	*2*	*House and surrounding area affected*
7	*CBD*	*CBD*	*Commercial*	*UPS Failure and short circuit*	*Nil*	*Property affected*
8	*Vashi*	*Vashi*	*Commercial*	*Short Circuit*	*Nil*	

Other than in the NMMC residential and commercial area, the fire brigade also responds to fires in the TTC industrial area along with the TBIA-Fire and Emergency Response Station Khairne MIDC, Navi Mumbai. It has been noted that the number of fire calls, oils spills and gas leakages handled within the TTC area are greater than that in the NMMC residential and commercial area. The details of the incidences managed by NMMC Fire Brigade are mentioned below. On an average NMMC Fire Brigade helps manage around 10 major fire calls and 15 minor fire calls each year. Other than these, NMMC Fire Brigade also responds to calls pertaining to rescue (man and animal), accidents and gas or oil leaks.

The issues of jurisdiction:

When discussions were held with officials from NMMC and the Fire Department, issues of jurisdiction were highlighted. The developmental and infrastructure control of the industrial area lies with MIDC and thus they are also responsible for safety and disaster response. However since the MIDC area is part of Navi Mumbai, during emergencies, lack of clear SOPs chances of confusion in response are quite high. It is thus expected that the TBIA-Fire and Emergency Response Station Khairne MIDC, Navi Mumbai together should be the disaster response team. The TBIA-Fire and Emergency Response Station Khairne MIDC due to its restricted capacity cannot handle large fire incidences and is hence dependent on the NMMC Fire Brigade.

First responders Vs building permission:

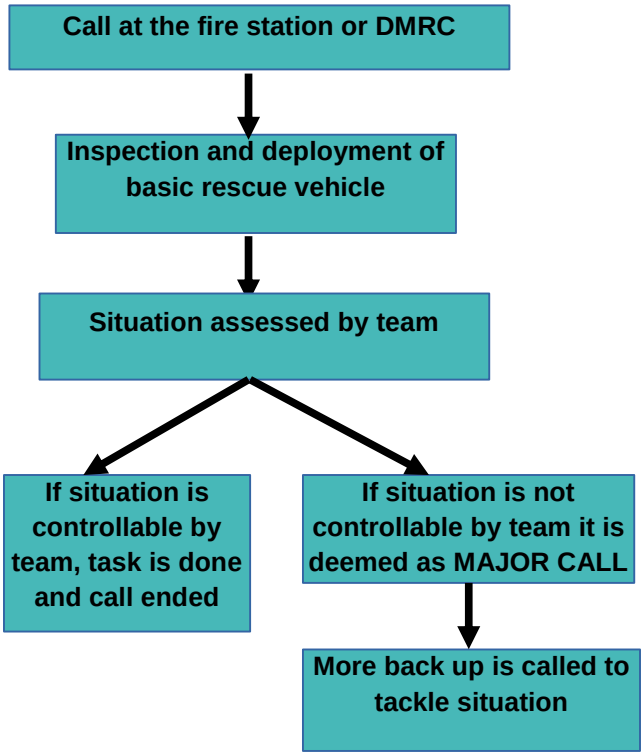
Another issue highlighted was that since MIDC is the developmental authority within TTC, building permissions are given by MIDC. Further at the time of construction of new industries or buildings, all fire related permissions, charges etc. are collected by the MIDC Fire Department, however as mentioned earlier in case of a fire even minor fires, NMMC Fire Brigade is summoned. In the last 5 years, MIDC has had 42 major fires and all of these have been tackled by NMMC Fire Brigade. The NMMC fire brigade feels that it is thus over burdened with additional duties. Also during major fires and gas leaks, MIDC has a silo approach to sharing information on type of gas leak and chemical within the affected industry. This makes combating the fire and gas leaks more challenging.

Table 5-12 Fire call history 2010 - 2015

Year	***Category***	***Number of cases***
2010	*Major fire call*	*16*
	Minor fire call	*15*
	Accident call	*3*
	Gas leak call	*2*
	Rescue Call	*5*
	Total	*41*
2011	*Major fire call*	*11*
	Minor fire call	*6*
	Accident call	*1*
	Gas leak call	*1*
	Rescue Call	*6*
	Total	*25*
2012	*Major fire call*	*4*
	Minor fire call	*17*
	Stand by	*1*
	Oil leak call	*1*
	Rescue Call	*1*
	Total	*24*
2013	*Major fire call*	*3*
	Minor fire call	*14*
	Oil leak call	*1*
	Rescue Call	*7*
	Total	*25*
2014	*Major fire call*	*5*

Year	*Category*	*Number of cases*
	Minor fire call	*19*
	Gas leak call	*1*
	Rescue Call	*7*
	Accident call	*1*
	Total	*33*
2015 (till March)	*Major fire call*	*3*
	Minor fire call	*4*
	Stand by	*1*
	Total	*8*

The protocol followed in case of a disaster is as follows:



(NOTE: If further assistance is required after major call, DM department sends message to relevant authorities like BMC Fire Brigade, NDRF, POLICE etc.)

Observation

- Based on the available resources and the standards and recommendations stated above, in NMMC Fire Stations are:
  - Grossly under staffed [Total staff recommended – 475, actual staff – only 140).
  - Fire Stations required – 8 (total area 108 sq.km – MIDC 24 sq.km = 84 sq.km, I FS @10.5 sq.km)

- These fire stations also extend support to MIDC area which is the industrial belt and includes many chemical industries.
- The span of work area varies from high rises to highly congested areas.

Social Vulnerability Index

Table 5-13 Social Vulnerability Index - Fire (NMMC)

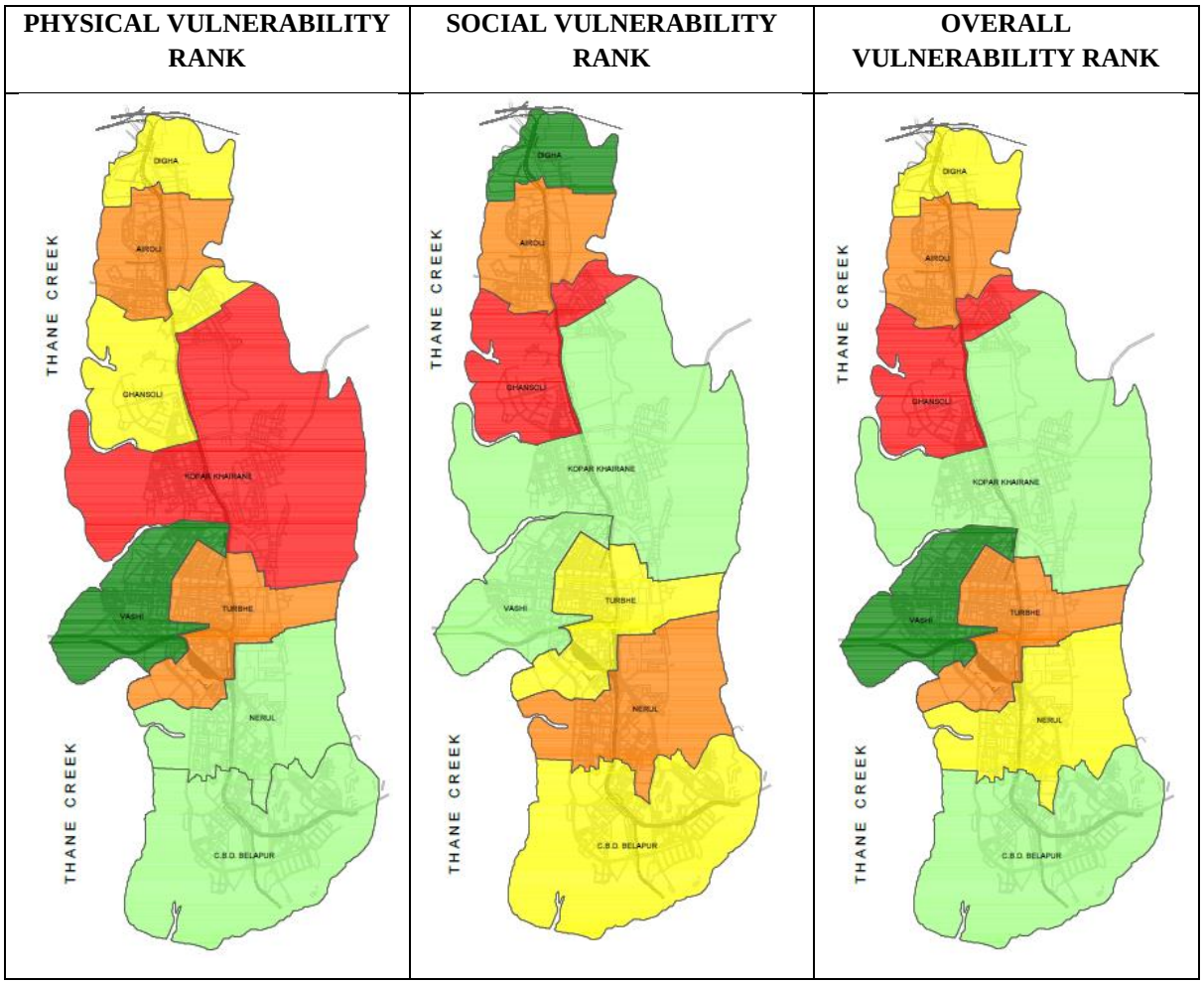
Sr. No	*Census Ward 2011*	*Physical Vul*	*Physical Vul Rank*	*Social Vul*	*Social Vul Rank*	*OVERALL SoVI*	*OVERALL RANK*
1	*DIGHA NODE*	*83.63*	*4*	*20.03*	*1*	*13.27*	*5*
2	*AIROLI NODE*	*87.34*	*6*	*23.69*	*6*	*13.34*	*6*
3	*GHANSOLI NODE*	*83.88*	*5*	*24.38*	*8*	*14.20*	*8*
4	*KOPARKHAIRNE NODE*	*103.77*	*7*	*22.58*	*3*	*12.35*	*3*
5	*VASHI NODE*	*62.89*	*1*	*21.13*	*2*	*12.10*	*1*
6	*TURBHE NODE*	*106.83*	*8*	*23.53*	*5*	*13.86*	*7*
7	*NERUL NODE*	*69.95*	*2*	*24.29*	*7*	*12.86*	*4*
8	*BELAPUR NODE*	*76.39*	*3*	*22.75*	*4*	*12.30*	*2*

Of the 8 nodes of Navi Mumbai, Ghansoli is most vulnerable to fire and fall in the high vulnerability bracket. Vulnerability in this node is largely influenced by the economic vulnerability and large number of marginal population.

When seen at the nodal level, Vashi ranks 1st out of 8 in terms of overall vulnerability towards fire and it is the least vulnerable wards in terms fire vulnerability.

The spatial distribution of the vulnerability can be seen in the figure below.

Figure 5-24 Fire risk at node level



2 Flooding and Water Logging

Present Situation

Navi Mumbai is bound by the Parsik Hills and part of the Sahyadri Range on the east and the Thane Creek on the west, hence the entire region naturally slopes from the east to the west. Thus the entire region is the catchment area. The creeks form sub-catchment areas which drain of the rain water. The western edge of the city was originally below mean sea level and thus was reclaimed to develop NMMC.

To safe guard the city from flooding, along the western edge holding ponds were created between the mainland and the sea. These ponds are based on the concept of Dutch Dykes. This method involves construction of bunds rising above the highest waterline to block entry of tidewater in the area proposed to be reclaimed. These have been especially designed and installed with unidirectional flap gates along the bund wall. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff. For disposal of rainwater, total 11 holding ponds have been constructed in Belapur, Vashi, Turbhe, Koparkhairane and Airoli nodes (ESR 2015).

Since the holding ponds lie between the creek and the land, there is movement of water in and out of the holding pond owing to the tidal currents. The tidal currents bring with them mangrove

propagators in the holding ponds. The growth of mangroves in the holding ponds has caused siltation thereby decreasing the holding capacity of these ponds. Further it has been noticed that construction debris is also being illegally dumped in the ponds which has further reduce their capacity. In lieu of this situation, the city has been witnessing flooding and water logging during high tides and monsoons.

The city faces a major issue in clearing and de-silting the holding ponds. Since the ponds have now been encroached by mangroves, permission has to be sought from the court to do so. In 2013, an action plan has been submitted to the Bombay High Court for clearance, however the decision on it is yet pending. As a result the city has become extremely vulnerable to flooding.

Other than the issue of holding ponds, in the process of development, low lying pockets have been created in the city. There are certain points in the city which get regularly flooded. Since it is slums which usually develop on such low lying area they are the worst affected. The NMMC-DMP 2007 lists the following areas as being vulnerable:

Table 5-14 Node wise flooding points in NMMC

Sr. No	*Ward/node Name*	*No of flooding points*	*No. of slums affected*
1	*Belapur*	*13*	*5*
2	*Nerul*	*6*	*4*
3	*Vashi*	*Nil*	*Nil*
4	*Turbhe*	*7*	*4*
5	*Koparkhairane*	*15*	*9*
6	*Ghansoli*	*23*	*16*
7	*Airoli*	*5*	*5*
8	*Digha*	*6*	*6*
9	*TOTAL*	*75*	*49*

Most of these flooding points listed above have a localized impact, but with a combination of heavy precipitation and high tide, these areas have a tendency to disrupt the traffic and paralyze city life.

Other than the above there are few underground section of the harbour railway line which get flooded. These are at Belapur, Nerul, Sanpada, Koparkhairane, Ghansoli, Airoli and Digha. In such cases the entire city is paralyzed as railways are the most used mode of transport in the city. Past incidences within each ward have been discussed in detail in the previous section.

Thus summarizing, flooding and water logging in the NMMC region is attributed to three issues:

i. Accumulation of water in the low lying areas
ii. Overflow and obstruction to nallahs and storm water drains due to siltation and debris

iii. Failure of the holding ponds.

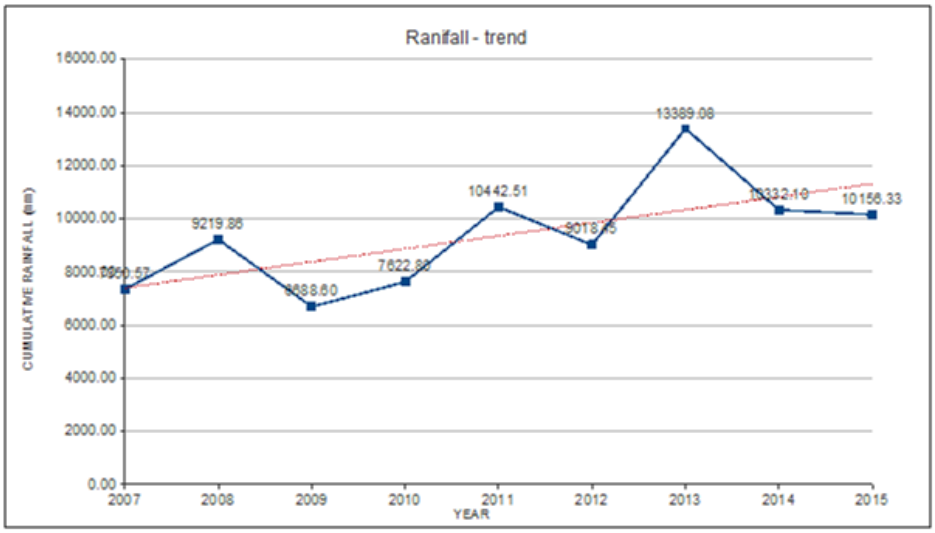
Rainfall in the region

An analysis of the past 9 year rainfall record shows a trend line of increasing precipitation in the area. In 2007 the cumulative rainfall of five months was 7350.57 mm and that in 2015 it was 10156.33 mm, thus an overall increase of around 38%. This trend is also seen in the plotted trend line below. Thus it is an indicator to the city that it needs to upgrade the drainage system to cater to the future requirement.

Table 5-15 NMMC Rainfall data for 2007 - 2015

Year		Months						TOTAL
		June	July	August	September	October	November	
2007	Cumulative	2637.47	1852.20	1932.70	928.20	0.00		7350.57
	Average	29.13	19.92	20.78	82.00	0.00		30.37
	Highest	332.70	199.40	93.20	10.31	0.00		332.70
2008	Cumulative	2483.10	2663.10	2596.26	1424.30	53.10		9219.86
	Average	20.69	21.48	20.94	11.87	0.43		15.08
	Highest	126.00	178.60	134.10	81.30	15.00		178.60
2009	Cumulative	403.80	3758.80	557.40	1166.90	801.70		6688.60
	Average	3.37	30.31	4.50	9.72	6.47		10.87
	Highest	44.80	216.20	32.30	104.40	99.80		216.20
2010	Cumulative	190.60	3517.60	2640.00	978.50	105.50	190.60	7622.80
	Average	1.54	28.37	21.29	8.15	0.85	1.54	10.29
	Highest	31.00	138.20	142.50	71.20	31.80	31.00	142.50
2011	Cumulative	2011.5	4780.91	2400.20	959.60	290.30		10442.51
	Average	16.76	38.56	19.36	8.00	2.34		17.00
	Highest	150.9	200.20	165.40	105.20	38.20		200.20
2012	Cumulative	1423.53	3223.50	1866.21	1921.50	583.71		9018.45
	Average	11.86	26.00	15.05	16.01	4.71		14.73
	Highest	90.50	201.30	152.50	156.90	93.40		201.30
2013	Cumulative	4784.70	5488.78	1506.20	1400.30	209.10		13389.08
	Average	39.87	44.26	12.15	11.67	1.69		21.93
	Highest	228.00	258.20	64.20	92.00	20.00		258.20
2014	Cumulative	631.70	6300.20	1929.00	1338.50	132.70		10332.10
	Average	5.26	50.81	15.56	11.15	1.07		16.77
	Highest	71.40	197.30	103.40	118.20	37.10		197.30
2015	Cumulative	2837.30	1829.70	2640.00	1896.71	765.90	186.72	10156.33
	Average	23.64	14.76	21.29	16.01	4.71	1.98	13.73
	Highest	178.20	111.80	142.50	156.90	93.40	35.7	178.20

Figure 5-25 NMMC rainfall trend



Existing infrastructure for flood management

The primary responsibility of flood rescue and management is that of the fire department. In a situation where the fire brigade is already under-staffed and over-burdened, flood management is an additional responsibility.

Before the rains, pumps are installed in regular water logging prone areas and few are kept for back up in emergencies. In case of unprecedented flooding and emergencies, the standard operating procedure is that once a call is received at the Disaster Management Cell, the message is passed on to the fire department Head Quarters. Depending on the location, the nearest fire station is sent for rescue and management.

Presently to manage floods the following equipment is available with the fire department.

- Boats: 2-3 (tender for additional 8 has been floated and is in final stage). In case of further shortage, boats are borrowed from the Koli and Agri population within the city.
- Pumping sets: 14
- Life jackets: 60
- Floats/ring buoys: 25
- Ropes: ample
- Nearly 75% of the fire brigade staff are good swimmers. There is separate staff trained for flood relief.

Other than the above efforts, every year during the monsoon, drain are as a preventive measure.

Social Vulnerability Index

Table 5-16 Social Vulnerability Index - Floods (NMMC)

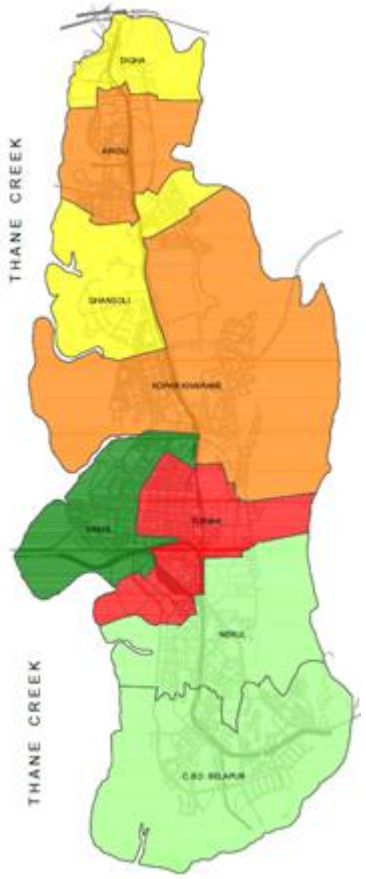
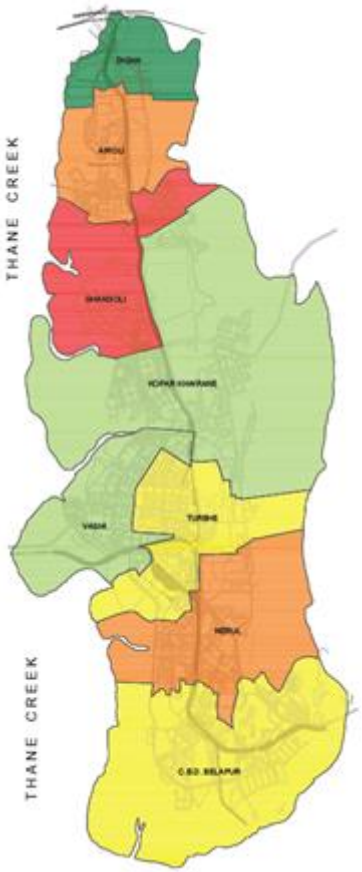
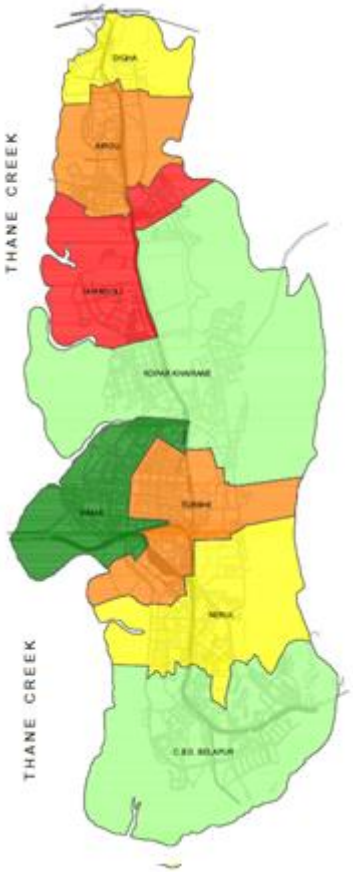
Sr. No	*Census Ward 2011*	*Physical Vul*	*Physical Vul Rank*	*Social Vul*	*Social Vul Rank*	*Overall SoVI*	*Overall Rank*
1	*DIGHA NODE*	*71.26*	*5*	*20.03*	*1*	*12.50*	*5*
2	*AIROLI NODE*	*76.34*	*6*	*23.69*	*6*	*12.71*	*6*
3	*GHANSOLI NODE*	*70.59*	*4*	*24.38*	*8*	*13.41*	*8*
4	*KOPARKHAIRNE NODE*	*92.25*	*8*	*22.58*	*3*	*11.82*	*3*
5	*VASHI NODE*	*59.56*	*1*	*21.13*	*2*	*11.55*	*1*
6	*TURBHE NODE*	*91.00*	*7*	*23.53*	*5*	*13.09*	*7*
7	*NERUL NODE*	*64.38*	*3*	*24.29*	*7*	*12.38*	*4*
8	*BELAPUR NODE*	*64.15*	*2*	*22.75*	*4*	*11.65*	*2*

When seen at the city level, Ghansoli is the most vulnerable ward in terms of flooding. The reason being the proximity of the ward to the thane creek which further leads to a higher water table thus resulting to water logging.

When seen at the nodal level, Vashi ranks 1st out of 8 in terms of overall vulnerability towards flood and it is the least vulnerable wards in terms flood vulnerability.

The spatial distribution of the vulnerability can be seen in the figure below.

Figure 5-26 Flood risk at node level

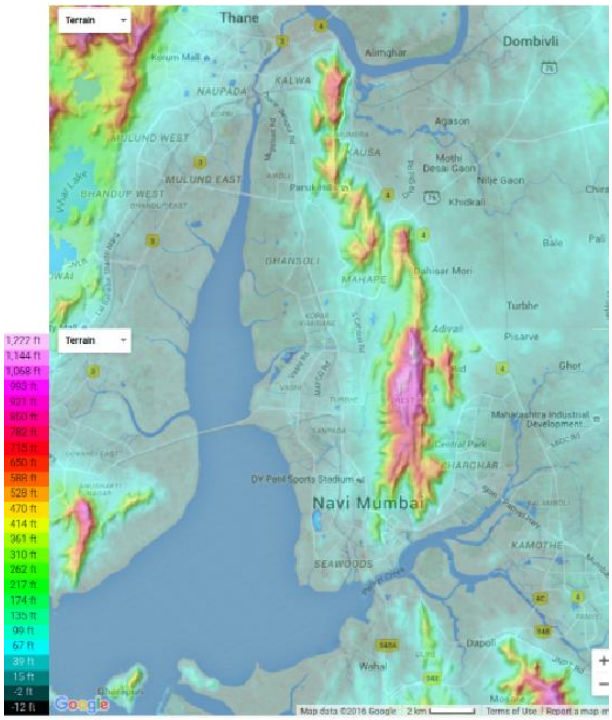
PHYSICAL VULNERABILITY RANK	SOCIAL VULNERABILITY RANK	OVERALL VULNERABILITY RANK
		

3 Building Collapse and Landslides

Present Situation

The boundary of NMMC is defined by the Parsik Hills on east and the Thane Creek on the west. The city thus slopes from east to west. The image shown below (*source: http://en-in.topographic-map.com/places/Mumbai-3575312/*) depicts that the region beyond the east of Thane-Belapur highway has varying contour whereas the western region slopes gradually towards the sea. Adjoining the Parsik Hills, the area has mostly been developed as an industrial belt with small hamlets of earlier villages part of it.

Figure 5-27 Contour Map



Source: http://en-in.topographic-map.com/places/Mumbai-3575312/

Through discussions it was concluded that there are issues of landslides and possibilities of building collapse in the city. Few incidences of mining and blasting have been recorded in the Parsik Hills. This has resulted in loosening of the soil and thus during the monsoon large amount of soil run off is seen. The Disaster Management Cell highlighted that during the monsoons quite a few complaints are received from the industrial belt stating that thick layers of mud and sludge have accumulated in the estate overnight. Other than that most of the landslide incidences have been reported in Digha and Airoli belt. As part of the resilience building effort, a bund wall was constructed to prevent life and property loss in the settlement at the base of the hills. However, in case of a landslide, there is high risk of building collapse also. Thus assessment of both has been considered together.

Other than owing to the natural contour and encroachments, NMMC is vulnerable to Building Collapse due to large stock of dilapidated and unsafe buildings. As per the list published by NMMC, in 2014-2015 there are 73 and as per 2015-2016 list, there are 92 dilapidated structures. The residents/users of such buildings have been given a notice to vacate and demolish the structure, failing which the municipal authority shall not be liable for property damage and life loss. Given below is the number of buildings in each ward which have been deemed as dilapidated.

Table 5-17 Node wise number of dilapidated buildings

Sr. No	*Ward*	*Year 2014-2015*	*Year 2015-2016*
1	*Digha*	*9*	*9*
2	*Airoli*	*6*	*6*
3	*Ghansoli*	*10*	*10*
4	*Koparkhairane*	*7*	*7*
5	*Turbhe*	*3*	*3*
6	*Vashi*	*11*	*11*
7	*Nerul*	*27*	*27*
8	*Belapur*	*0*	*19*
	TOTAL	*73*	*92*

As clearly seen in the list above, other than Belapur, the same buildings (address mention in the list of both years have been compared) have been mentioned in both years, which is an indicator that the building have not been evacuated and demolished as per the notice, thus leaving a large population vulnerable to building collapse.

Existing infrastructure for landslide and building collapse management

Presently to facilitate rescue in case of a landslide or building collapse the following equipment is available with the fire department.

- Hydraulic cutters: 3
- Hydraulic telescopic ramp: 1
- Hydraulic power units (lifting, spreading and cutting): 3
- Portable emergency lamps: 5
- Hydraulic combination tools: 2
- High pressure lifting bags: 2
- Multi gas detectors: 3
- Breathing apparatus with additional cylinders: ample
- Other than the above 1 rescue van with equipment has been purchased worth 1.3cr.

Other than the above efforts, every year during the monsoon, hutments in the landslide prone areas (i.e. along the Parsik Hills) are evacuated as a preventive measure

Social Vulnerability Index

Table 5-18 Social Vulnerability Index - Building Collapse and Landslides (NMMC)

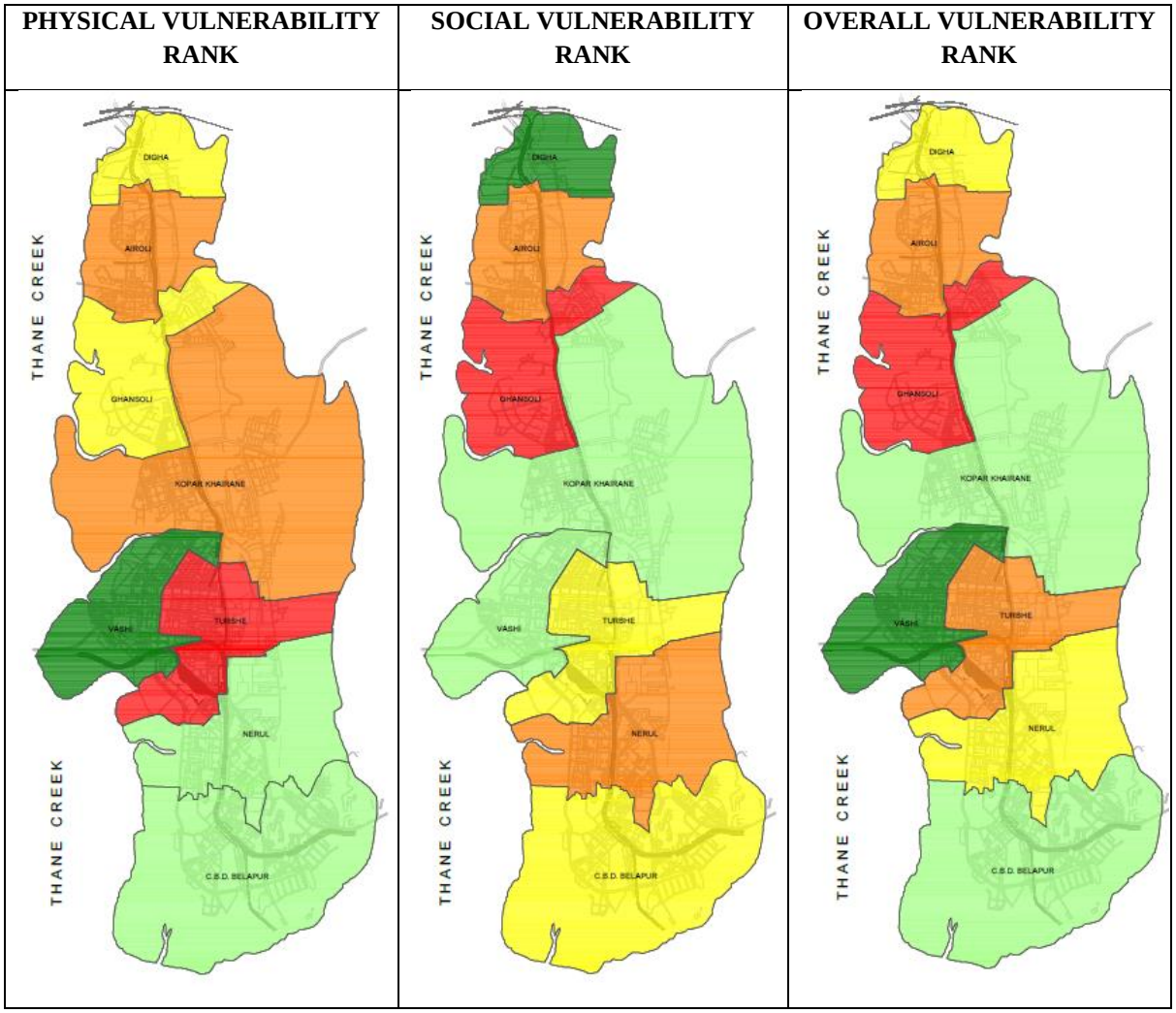
Sr. No	*Census Ward 2011*	*Physical Vul*	*Physical Vul Rank*	*Social Vul*	*Social Vul Rank*	*Overall SoVI*	*Overall Rank*
1	*DIGHA NODE*	*71.38*	*4*	*20.03*	*1*	*12.48*	*5*
2	*AIROLI NODE*	*76.57*	*6*	*23.69*	*6*	*12.75*	*6*
3	*GHANSOLI NODE*	*75.13*	*5*	*24.38*	*8*	*13.69*	*8*
4	*KOPARKHAIRNE NODE*	*92.46*	*7*	*22.58*	*3*	*11.84*	*3*
5	*VASHI NODE*	*55.42*	*1*	*21.13*	*2*	*11.58*	*1*
6	*TURBHE NODE*	*93.18*	*8*	*23.53*	*5*	*13.15*	*7*
7	*NERUL NODE*	*63.89*	*2*	*24.29*	*7*	*12.34*	*4*
8	*BELAPUR NODE*	*68.76*	*3*	*22.75*	*4*	*11.82*	*2*

When seen at the city level, Ghansoli is the most vulnerable ward in terms of flooding. Large numbers of slums have developed along the slopes in the node, thus leading to high vulnerability

When seen at the nodal level, Vashi ranks 1st out of 8 in terms of overall vulnerability towards flood and it is the least vulnerable wards in terms flood vulnerability.

The spatial distribution of the vulnerability can be seen in the figure below.

Figure 5-28 Risk at node level - Building collapse/landslide



5.1.14. Disaster Management: Administrative structure

City Emergency Operation Centre and Regional Disaster Management Centre (RDMC) was set up in 2006 at the Municipal Head Office of Navi Mumbai to tackle disasters especially after the July 2005 deluge at Mumbai. It was equipped with modern equipment to handle emergency situations in the city of Navi Mumbai and the neighbouring region.

The RDMC works round the clock throughout the year. It serves as a Command & Control agency between the administration and incident site. It coordinates with various key stakeholders for quick and effective response during a disaster.

In order to ensure speedy and effective response, the execution of disaster related activities are undertaken under the direction of the NMMC Disaster Management Committee. The Navi Mumbai Disaster Management Committee is headed by the Municipal Commissioner (MC). Depending upon the type of disaster the MC appoints one of the committee members to deal with the disaster. The Committee is responsible for continuous monitoring of all disaster related activities.

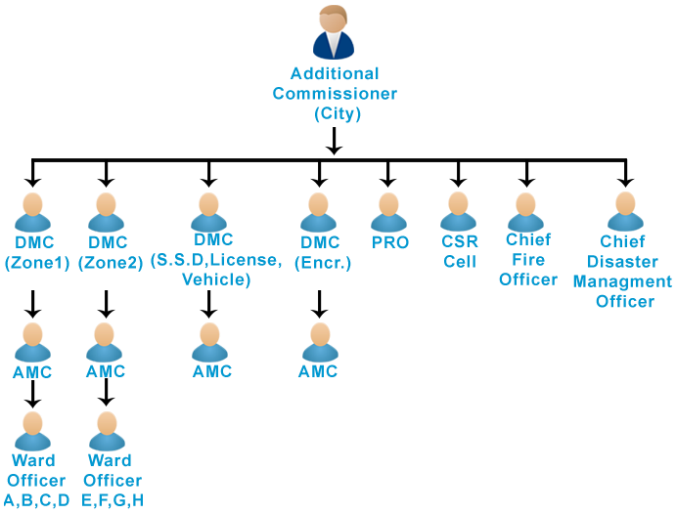
The DM cell is headed by Additional Municipal Commissioner (City). It has staff strength of one Assistant Commissioner, one clerk and five personnel from the Fire Department. The five

personnel, who manage the cell round the clock, have a duty roaster and they are from the fire department. They work in shifts and at any given point of time there are two to three people in the Cell. The Cell also serves as control room for complaints related to encroachment and other issues. The personnel appointed in NMMC are subjected to periodic transfer to various other offices of NMMC. Due to these transfer of personnel within NMMC, wherein many people get trained on job

This department can be accessed through the NMMC website: www.nnmc.gov.in where complaints can be lodged or through Toll free numbers 1800222309 and 1800222310.

NMMC is also supported by one officer employed by UNDP under Climate Risk Management in Urban Area Project to facilitate risk assessment, assessment of early warning, city DM Plan, capacity building of municipal staff and knowledge management.

Figure 5-29 Organogram of NMMC administrative structure



Source: www.NMMC.gov.in

Physically, the Disaster Management Cell of NMMC is housed in the ground floor of NMMC headquarter at Belapur. The building is well-constructed with earthquake resilient technology. Due to its location, it has a quick access to all the important emergency managers. Municipal Commissioner and Mayor operate from this building. It is located in uncongested area which ensures clear access to and exit from the building. The building has a large open area and a huge parking lot. Movement within the building can be done through four sets of staircases and five lifts.

For communication, it has ten hot lines which connects DM department with Fire department at Vashi, Traffic control room, Police control room, Thane District DM cell, Vashi Railway, BMC control room, Mantralay control room, Vashi –FRU hospital, BEST Wadala and CIDM Parel. It has Very High Frequency (VHF) wireless communication system for effective communication with key stakeholders and important agencies at all times to cater to any emergency. They are also equipped with Computers, laptops, scanners, fax machines etc.

For planning, preparing, mitigating or responding to any disaster, the Navi Mumbai Municipal Corporation plays a lead role along with its support departments. The complete command and

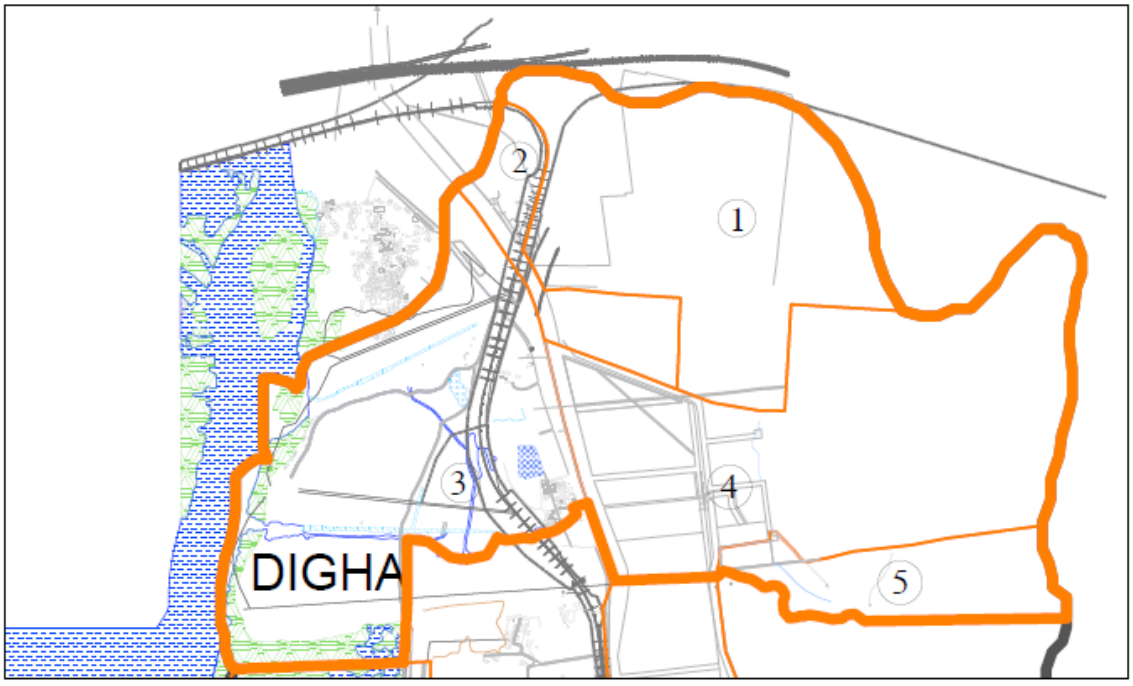
control would be established and it would function from the NMMC headquarter. Few aspects in this regard that need to be reviewed have been given in the chapter 6.10 on Observation and Recommendations.

5.2. Digha Node

Note: Analysis is based on Census 2011 data and thus comprises 89 electoral wards. Map in the chapter can be referred to for ward boundaries. Detailed chapter on node is placed at Appendix 54

Digha is the northern most Node within NMMC, and it has Airoli Node to its south and to the north is the boundary of the adjoining Thane Municipal Corporation. **The ward officers and planners are therefore requested to refer to the reports of the adjoining node Airoli for a comprehensive long term DRR approach to Digha.** NMMC's 89 electoral wards are based on the Census 2011 data. Digha as a node comprises 5 such Electoral Wards. Spread over an area of 5.25 sq. km., Digha constitutes the northern entry point to NMMC region through the Thane Belapur road.

Figure 5-30 Electoral Wards with numbers– Digha 2011



Source: AutoCAD Map, NMMC, TP Department

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire;
- Floods and water logging and
- Building Collapse and Landslides.

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through a rise in number of high rise building with central AC systems. High-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging

incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire department aerial devices, and the chance of rescuing victims from the exterior is near zero once the fire is above the operational reach of aerial ladders or elevating platforms. The industrial area cuts through the length of the city, the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

Physical and Social Vulnerability

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicator of physical and social vulnerability are considered these are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicators of social vulnerability on which data is available (Census 2011) are demographic, marginalized population, economic status and using these indicators all the nodes of NMMC were analysed.

The area is characterized by haphazard development informal housing and squatters. Digha is mostly occupied by informal settlements and has a major jurisdiction issue as the land belongs to MIDC while NMMC has administrative responsibility of governance. The on ground reality is far different from the one envisaged in land use plans. Maximum area is earmarked for industrial use (ref Map no: B2), but most of the land has informal settlements and also some illegal construction. Like all urban areas, Digha is also vulnerable in certain ways to several hazards. Vulnerability of Digha can be analysed based on indicators discussed earlier.

The actual land use in Digha according to an analysis done by "Navi Mumbai Municipal Corporation Fire Hazards Response and Mitigation Plan, 2010" is predominantly residential (68.94%) with only 20% for Industrial development. Discussions with the Ward/Node Officer highlighted the fact that land in Digha is under the jurisdiction of MIDC. As per the circular of the Revenue Department in 2010, the responsibility of keeping a check on encroachments is that of the authority under whose jurisdiction the land is. Since in Digha, most of the land is under the jurisdiction of MIDC, there is very little that NMMC can do in the prevention of squatter development. Digha also has development taking place along the slope and around old mining sites, leading to increased risk of building collapse and landslides.

A 400 KV receiving electric station which supplies and distributes power to the entire state of Maharashtra is also located in Digha. Due to this, there is a power corridor marked as no development zones within the ward. Unauthorized development can be seen in this zone, posing potential threat to lives.

NMMC has a total population of 11, 20, 547 (census 2011) out of which 59,995 (around 5% of NMMC population) reside in Digha. Digha is spread in 5.62 sq. km. and is predominantly residential (68.94%). Ward No 2 and 5 occupy 0.72 sq. km. in area but 33% of the nodes population reside in these wards. The population density of Digha (10,674) is much higher than the city average (8934). Population distribution information helps the city planners in

assessment of casualties, determination of shelter needs and proper implementation of evacuation plans in pre- and/or post-disaster phases.

Female population comprises 45% of the total population of Digha. This also constitutes 5% of the total city's female population which is in Digha. The sex ratio is 806:1000, which is lower than the city's ratio of 837:1000. 13% of the node population is below 6 years of age. Since women and children are more vulnerable during disasters, it is important to note that a total of 58% of the node's population falls into the socially vulnerable category. Disaster preparedness activities should include programmes for women and children and their caretakers.

From the perspective of marginalized population, Digha comprises 14% Schedule Castes and 2% Schedule Tribe population and 28% of people residing in Digha are illiterate as per Census 2011 data. Certain sections of the society have limited access to resources and information. The skew increases in post disaster situation and this population would need special attention in pre and post disaster situation. Strategies of preparedness and response must be inclusive.

40% of people residing in Digha are working thus leaving 60% of the population under non-working category of the Census [population who did not participate in any economic activity paid or unpaid, this category includes students, persons engaged in household duties, dependents, pensioners, beggars, etc. provided they were not engaged in any economically productive activity during the last one year preceding the date of enumeration[7]] Out of the total working population of Digha (40%), 90% come under the category of main working population [Workers who were employed for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers] leaving 10% under the marginal worker category [Workers who worked for less than six months (180 days) in the reference period are termed as Marginal Workers.] Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

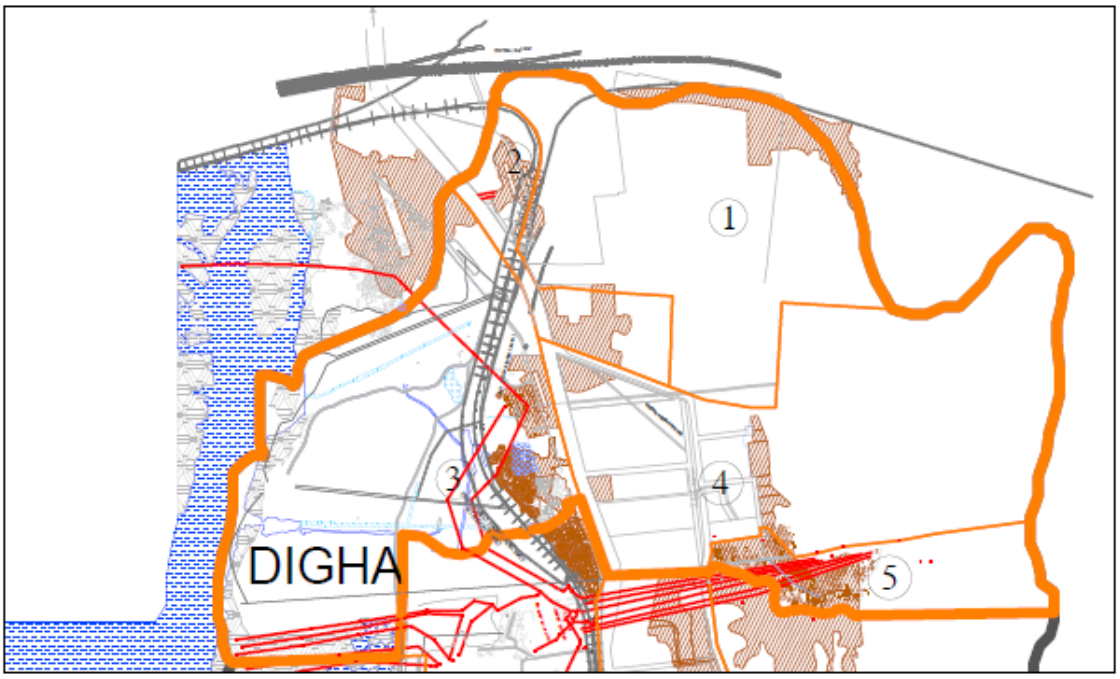
The Census 2011 data on slums with number of households and population data; NMMCs list of slums and encroachments along with the Auto Cad drawings given by the Town Planning Department, NMMC were all collated and 18 slums / hutment pockets were identified in Digha. These are home to 67% of the total population of Digha. In the image below, the areas shown in brown are the slums (as per the AutoCAD map provided by the TP Department, NMMC.) Fig 5-29 shows that most of the slums are located under high tension wires (seen in red in figure 5-29), thus further increasing the vulnerability of the population residing there.

Based on the field interaction it emerged that as the jurisdictional charge for Digha is under MIDC, NMMC cannot restrict the encroachment. Due to the administrative responsibility and keeping in mind the safety of community, NMMC officials have been taking measures to remove such settlements from hazard prone area. These mitigation measures are temporary in nature and result in constant economic burden as no stringent law is in place to restrict such

[7] www.Censusdata.gov.in

settlements, a joint mechanism between MIDC and NMMC can be worked out so as to permanently restrict any informal settlement especially in hazard prone areas.

Figure 5-31 Slums under high tension wires – Digha



Source: AutoCAD Map, NMMC, TP Department

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented house just own the assets inside the house. The vulnerability of those who live in rented houses is potentially higher. In Digha approximately 35% of the population resides in self-owned houses indicating majority of population resides in rented accommodation thus increasing vulnerability. Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts are less vulnerable than households without bank accounts.

The table below gives a graphic representation of the vulnerability based on social parameters.

Table 5-19 Social Vulnerability Indicators - Digha[8]

S No	***Social Vulnerability Indicators / Rating***	***High***	***High Medium***	***Medium***	***Low Medium***	***Low***
1.	*Population density*					
2.	*Percentage of illiterate population*					
3.	*Percentage of female population*					
4.	*Percentage of SC & ST population*					
5.	*Population below 6 years*					

[8] Detailed analysis is given in the NMMC chapter and Digha chapter

S No	*Social Vulnerability Indicators* / *Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

Higher the value of all the above vulnerability indicators higher is the vulnerability, except for the tenth indicator. Bank accounts can be of great help during crisis situation so community with higher value of this indicator reduce the vulnerability.

When the built environment is assessed based on Census 2011 data, the haphazard development and non-engineered construction becomes obvious. All five wards of Digha indicate higher percentage of households with vulnerable roof material and wall material whereas ward No 1 and 3 have a large number of dilapidated buildings. Thus, overall the built environment of Digha is not very safe and poses high risk in the event of an earthquake, building collapse and other damage due to material failure.

Digha also has an 18th century dam towards it east. This dam was built by the British to provide water source for the steam engines running from Thane. Over a period of time usage of this water for railways reduced. This dam was built to capture the runoff from Parsik hills and even today holds a large quantity of water. With the existence of informal settlement (Kanheiya Nagar) in the vicinity the pipeline and natural drain which existed once upon a time has been affected. Every monsoon when the dam overflows, all the houses build in the way of natural flow of water get flooded. Even the dam is not being maintained and poses a potential danger.

Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event. When node Digha is analysed with respect to various physical indicators the area seems to be compromising on all aspects thus the vulnerability of Digha to disasters is high.

Having a connection to tap-water within the premise ensures safe drinking water. This is significant for good health and for avoiding diseases. This is also important in disaster situation and also supply during fire breakouts, thus reducing vulnerability. However, a source away from the house would increase vulnerability. Thus percentage of houses with water source outside its premise are considered vulnerable and used as an indicator of vulnerability.

More than 50% households in Digha do not have source of water within the premise of residence. Medium used for providing light to the house can add to the vulnerability of any household, in Digha wards 1, 2 and 4 when compared with the average city percentage of unsafe light source, have higher average percentages indicating non availability of safer source of light and thus use of unwanted source like kerosene and oil. Ward No 3 and 4 have higher percentage of residents with no access to latrine posing health hazard and increasing

vulnerability during floods. Drainage has been compromised in all the wards of Digha and the medium of domestic fuel is also unsafe.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. With population of about 60,000 the entire 5.2 sq. km. of Digha is serviced by one Government health post. No private hospitals are available in this node. Digha has few roads with 15 mts. width and the rest are of very bad quality and mostly less than 6 mts. width. This poses obstruction to free movement of emergency vehicles and personnel. Many bye lanes of the slums have width less than a meter posing hurdles during emergencies. There is no fire station within the ward and the closest one is the Airoli Fire Station.

A fire station is supposed to service 10.5 sq. km. area, when the 10.5 sq.km radius is mapped (see map no D2), it is seen that most of Digha node lies in the red zone i.e. not easily accessible zone. Moreover, Airoli fire station which is supposed to service Digha comes under FST-2 category, which means they have limited resources and due to the large area, including the industrial area which it caters to, their capacity to respond would be stretched and likely to fail in the event of a large fire in the node.

Along the eastern edge of the node are hills which have witnessed mining activities and thus are vulnerable to landslides and consequently building collapse. Also during the rains, the runoff from the hills carries the loose soil, covering the foothills with sludge.

Navi Mumbai is bound by the Parsik Hills, part of the Sahyadri Range on the east and the Thane Creek on the west, and the entire region naturally slopes from the east to the west. The region is the catchment of the various creeks, which form sub-catchment areas and drain off the rain water. The western edge of the city was originally below mean sea level and has been reclaimed to develop NMMC.

To safe-guard the city from flooding, holding ponds, based on the concept of Dutch Dykes were created along the western edge, between the mainland and the sea. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff. For lakes and holding ponds buffers on 100, 200 and 300mts were extracted and for nallahs buffers of 25, 50 and 100mts were considered. Most of the developed part of Digha node falls in these zones thus increasing the flood vulnerability of the area. Out of 18 slums identified (through Census 2011 data), 6 slums fall in the flood-prone area.

The table below gives a graphic representation of the vulnerability based on physical parameters.

Table 5-20 Physical Vulnerability Indicators - Digha

S No	*Physical Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

It is evident that social and physical vulnerability of Digha ranges from medium to high.

To overcome these vulnerabilities and to increase resilience of this node certain recommendations may be considered:

- As Digha houses a large number of informal settlements with congested bye lanes, a fire station is recommended. This is also recommended in the NMMC Fire Hazard Response and Mitigation Plan 2010. A mini fire station or Mobile Fire Motor Cycle can be explored.
- As Airoli Fire station is currently extending support to Digha, upgrading it with trained manpower and state of art equipment will be helpful;
- Considering their safety, people residing in the no development zone should be moved to safer areas. The evacuated areas should be protected from future encroachment. How and through what processes are people permitted to occupy these lands informally may be examined to prevent the same in the future.
- Condition of the roads to be improved and access route to slums need to be widened;
- As these informal settlements have non engineered structures, awareness programme for the occupant and masonry training for the masons for better construction can be a mitigation measure.
- Local people need to be trained in firefighting and emergency response;

- Dilapidated buildings should be inspected on priority and based on the analysis, either ensure that the people residing either vacate or get the building retrofitted, else this is disaster waiting to happen.
- The Ittanpada dam is very old. Structural assessment is recommended from the perspective of safety. Because of the natural landscape, this dam falls in the catchment area and can be revived with a positive impact.
- The informal settlement which has come up in the natural drain path of the dam should be cleared.
- Preparedness and trainings in the wards, localities and schools to raise the awareness would go a long way in preparedness.
- Providing amenities and improved access to water, hospital, schools and public transport may be considered.
- A planned approach to Digha's development with DRR in mind must be emphasized through cooperation between NMMC and MIDC. Such an approach offers a good opportunity to mainstream DRR.
- Mutual response mechanism should be worked out for Digha between NMMC, MIDC and Central Railways to address issues of encroachment, water logging and Ilthanpada dam.
- Most of these settlements are supported by the local politicians. It will be beneficial to sensitise them regarding the various hazards and utilize their resources to spread awareness amongst citizens.
- GIS maps for Digha need to be updated.

5.3. Airoli Node

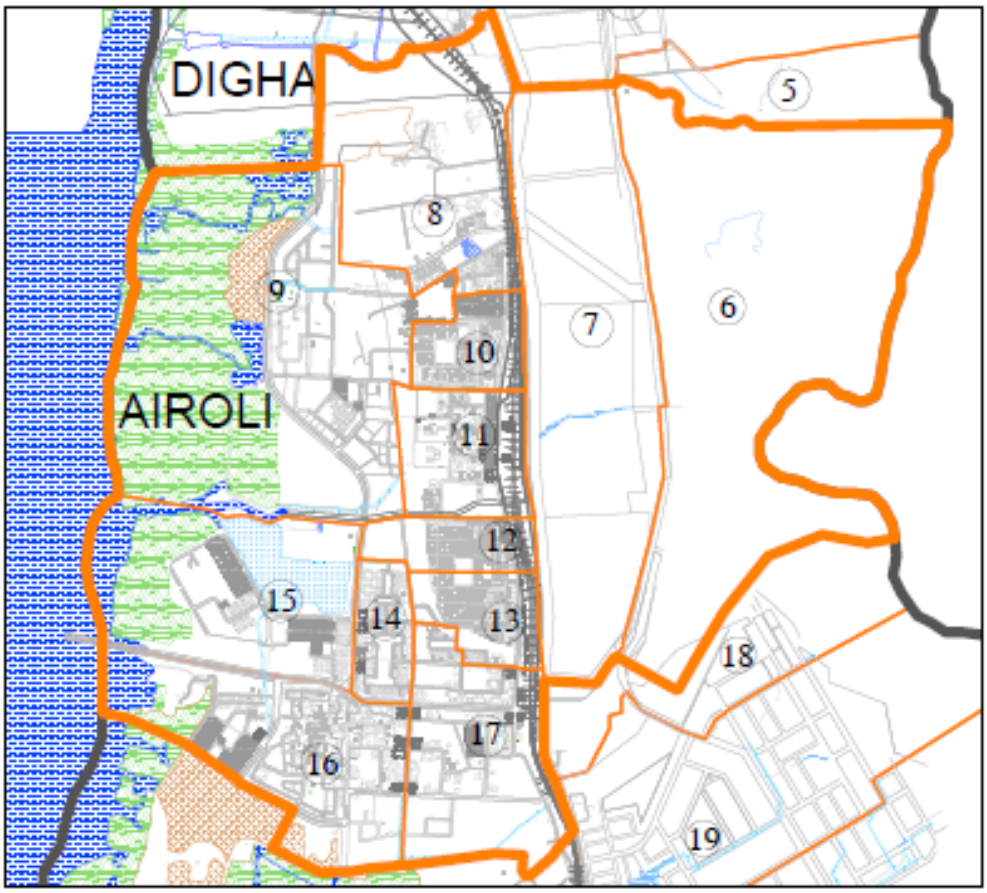
Note: Analysis is based on Census 2011 data and thus comprises 89 electoral wards. Map in the chapter can be referred to for ward boundaries. Detailed chapter on node is placed at Appendix 54

Airoli has Digha to its north, Ghansoli to its south, Thane creek to its west and the Parsik hill ranges to its east, Airoli is connected to Mumbai by road through Airoli Bridge. **The ward officers and planners are therefore requested to refer to the reports of the adjoining nodes, Digha and Ghansoli for a comprehensive long term DRR approach to this node.**

Airoli is a residential and commercial area of Navi Mumbai and is a part of the Mumbai Metropolitan Region administered by Navi Mumbai Municipal Corporation. The entire node is developed by CIDCO except sector 1 and 1A (encroached) sector 9 (Diva gaon), sector 20 (Airoli gaon).

The Census 2011 is based on NMMC's 89 electoral wards. Airoli as a node comprises 12 such Electoral Wards spread over an area of 9.11 sq. km., Airoli was developed to cater to the residential demands of the industrial areas (MIDC) in the Thane Belapur belt.

Figure 5-32 Electoral Wards with numbers – Airoli 2011



Source: AutoCAD Map, NMMC, TP Department

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire;
- Floods and water logging and
- Building Collapse and Landslides.

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through a rise in number of high rise building with central AC systems. High-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire department aerial devices, and the chance of rescuing victims from the exterior is near zero once the fire is above the operational reach of aerial ladders or elevating platforms. The industrial area cuts through the length of the city, the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

Physical and Social Vulnerability

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicator of physical and social vulnerability are considered these are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicators of social vulnerability on which data is available (Census 2011) are demographic, marginalized population, economic status and using these indicators all the nodes of NMMC were analysed.

The land use in Airoli as per the "Navi Mumbai Municipal Corporation Fire Hazards Response and Mitigation Plan, 2010" is predominantly residential (35.54%) with less than a percent for Industrial development. Being predominantly a residential area, Airoli caters to all the sections of society. Several renowned builders have their residential projects in Airoli and Bombay Urban Development Project (BUDP) has also taken up housing for urban poor.

NMMC has a total population of 11, 20,547 (census 2011) out of which 1, 60,538 (around 14% of NMMC population) reside in Airoli. Also, population density of Airoli is 17621 which is much higher than NMMC (8934). It is the most densely populated node amongst all nodes of NMMC. Airoli is spread over 9.11 sq. km., out of which ward No 6, 7 and 9 together occupy 5.19 sq. km. of Airoli and caters to 35% of the total population whereas all the other wards together occupy 3.92 sq. km. of the total area of Airoli and houses to 65% of the population. The population density of most of the wards is much higher than the city average. Ward no 14 is the most densely populated ward and ward 6 in least densely populated in Airoli. Ward No. 14, is located in the centre of Airoli node and is also one of the smallest ward in the node. The ward is also completely developed vis-à-vis other wards which are larger and have non-developed areas. Population distribution information helps city planners to assess the number

of people affected, possible casualties, determining shelter needs and proper implementation of evacuation plans in pre- and/or post-disaster phases.

Female population comprises 46% of the total population of Airoli. This also constitutes about 14% of the total city's female population. The sex ratio is 856:1000, which is higher than the city's ratio of 837:1000. About 12% of the node population is below 6 years of age. Since women and children are more vulnerable during disasters, it is important to note that a total of 58% of the node population falls into this socially vulnerable category. The disaster preparedness activities should include having programmes for women and children and their caretakers.

From the perspective of marginalized population, Airoli comprises 9.87% Schedule Castes and 1.73% Schedule Tribe population. 20.41% of people residing in Airoli are illiterate as per Census 2011 data. Certain sections of the society have limited access to resources and information. The skew increases in post disaster situation and this population would need special attention in pre and post disaster situation. Strategies of preparedness and response must be inclusive.

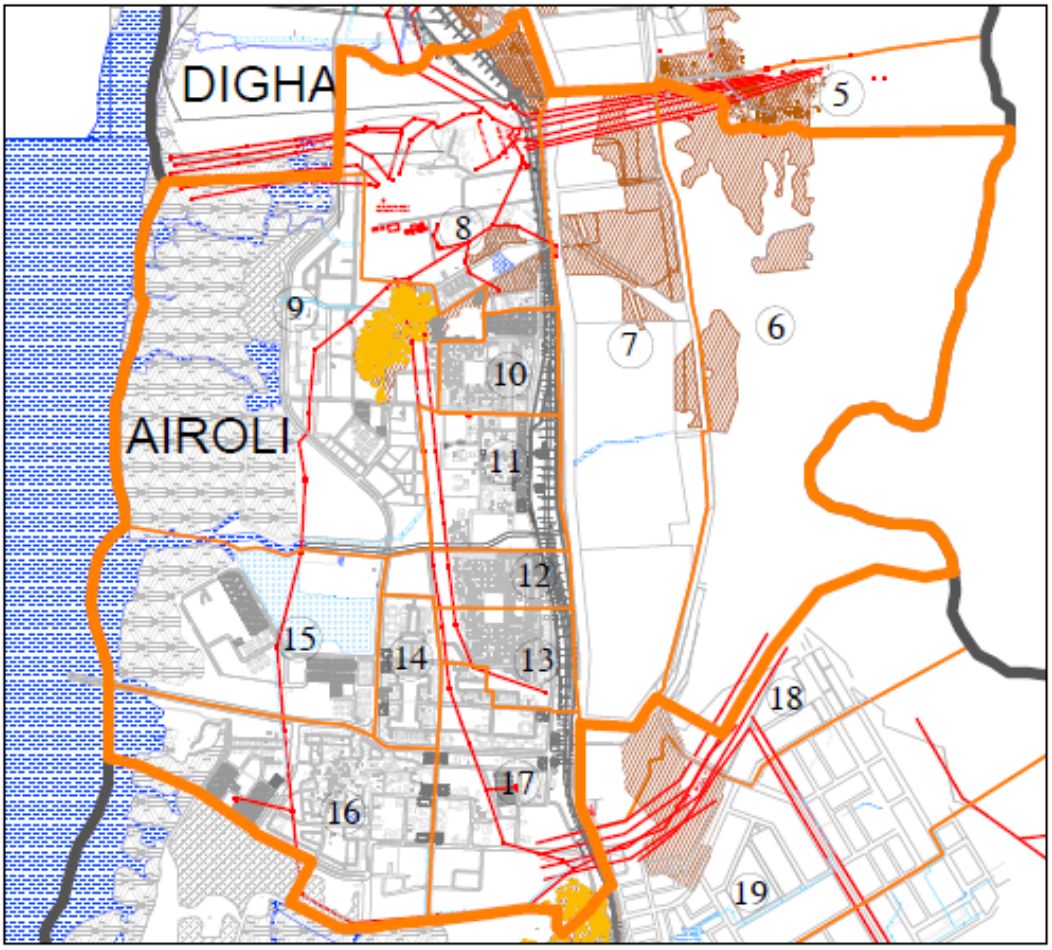
39% of people residing in Airoli are working thus leaving 61% of the population under non-working category of the Census [population who did not participate in any economic activity paid or unpaid, this category includes students, persons engaged in household duties, dependents, pensioners, beggars, etc. provided they were not engaged in any economically productive activity during the last one year preceding the date of enumeration[9]] Out of the total working population of Airoli (39%), 92% come under the category of main working population [Workers who were employed for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers] leaving 8% under the marginal worker category [Workers who worked for less than six months (180 days) in the reference period are termed as Marginal Workers.] Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

The Census 2011 data on slums with number of households and population data and NMMC's list of slums and encroachments (along with the Auto Cad drawings given by the Town Planning Department) NMMC were collated. Here, 6 slums / hutment pockets were identified in Airoli which accommodate 18.60% population of Airoli. In the map below, areas shown in brown are slums and the red lines are high tension wires as per the AutoCAD map provided by the TP Department, NMMC. The slum map has further revealed that most of this development is on land below high tension wires which further augments their vulnerability to fire. Slums and other development located below and around these high tension wires are exposed to high frequency electromagnetic radiations which makes them vulnerable to a large range of health issues like damaging DNA, cancer, neuro-degenerative disease and miscarriage. Field interactions revealed that most of the area under the high tension wires is under the jurisdiction of MIDC, the impending disaster can be avoided as this falls under non development zone. A

[9] www.Censusdata.gov.in

strict action followed by constant vigilance can help avoid any encroachment in these areas but MIDC needs to be sensitized regarding the same.

Figure 5-33 Slum Location – Airoli



Source: AutoCAD Map, NMMC, TP Department

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented houses only assets inside the house. The vulnerability of those who live in rented houses is potentially higher. In Airoli approximately 32% of the population resides in self-owned houses indicating majority of population resides in rented accommodation thus increasing vulnerability. Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts are less vulnerable than households without bank accounts. In Airoli 86% of population avail banking facility.

Table 5-21 Social Vulnerability Indicator - Airoli

S No	*Social Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Population density*					
2.	*Percentage of female population*					
3.	*Population below 6 years*					
4.	*Percentage of illiterate population*					
5.	*Percentage of SC & ST population*					
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

This chart is generated based on the comparative analysis of individual parameters of social vulnerability for all the nodes.

In the table 5-20 all indicators (except one) are directly proportional to vulnerability i.e. higher the value, greater the vulnerability. However banking services suggesting financial inclusion may have a positive influence as bank accounts may be of great help during a crisis situation. Therefore, higher the value of this indicator, lesser the vulnerability.

The building stock of any locality has a direct impact on its vulnerability. The Land use has to consider flood plain, seismic vulnerability, soil strata and the built environment has to be aware of hazards before selecting the building material. When the built environment is assessed based on Census 2011 data, the development pattern and degree of non-engineered construction becomes obvious. Building material used for construction, non-engineered construction, lack of awareness regarding their vulnerability, construction without referring to BIS standards and construction in vulnerable areas are the parameters that need to be looked at by the city planners.

When Airoli is analysed with reference to housing vulnerability indicator, ward 6 has more than 13% of its building stock dilapidated Ward no. 6 reveals very high value for all the vulnerability parameters. Ward no. 7, 8 and 10 indicating a highly vulnerable building stock with reference to roof material. Even the material used for construction of wall increases the vulnerability and ward 7, 8 and 10 appear vulnerable. This is the most densely populated node of NMMC, vulnerable building stock is an area of concern and needs attention.

Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event. When node

Airoli is analysed with respect to various physical indicators few wards seems to be compromising on all parameters thus increasing the vulnerability.

Having a connection to tap-water within the premise ensures safe drinking water. This is significant for good health and for avoiding diseases. This is also important in disaster situation and can be useful during fire breakouts, thus reducing vulnerability. However, a source away from the house would increase vulnerability.

Thus percentage of houses with water source outside its premise are considered vulnerable and used as an indicator of vulnerability. More than 20% households in Airoli do not have source of water within the premise of residence. Medium used for providing light to the house can add to the vulnerability of any household, in Airoli wards 6, 7 and 8 when compared with the average city percentage of unsafe light source, have higher average percentages indicating non availability of safer source of light and usage of alternate source like kerosene and oil. Ward No 6 and 7 have higher percentage of residents with no access to latrine indicating health hazard and increasing vulnerability during floods. Drainage has been compromised in ward 6 and 7 of Airoli. Larger percentage of population residing in ward 6, 7 and 8 use unsafe medium of domestic fuel.

Out of 12 wards of Airoli, four Wards (no 6, 7, 8 and 9) score very low on physical vulnerability indicator, demanding attention.

Data for slums has been collated from three sources; Census list of slums with number of households and population data, list of slums provided by NMMC ward officer and slums and encroachments as shown in Auto Cad drawings given by the TP Department, NMMC. The slums and encroachment as shown in the maps C3 have been referred to as hutments hereafter.

6 slums were identified in Airoli. Population and household details of few are listed in the Census 2011, based on which the following data has been composed. It is quite possible that the slums with missing data are the ones identified post 2011. Field interactions revealed that ward no 6 and 10 have several gaonthans and informal settlements. These are highly congested posing problem of first responders during emergencies. The building stock here needs intervention and as the land comes under the jurisdiction of MIDC, joint exercise and measures is required.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. With population of about 1, 60, 538 the entire 9.11 sq. km. of Airoli is serviced by 2 Government health post and 21private hospitals. Airoli has most roads with 15 mts. width or 6 mts. – 15mts width. Most of the roads are of very bad quality and mostly less than 6 mts. width. This poses obstruction to free movement of emergency vehicles and personnel. Many bye lanes of the slums have width less than a meter, posing hurdles during emergencies.

Airoli has a fire station which also caters to Digha and Ghansoli. Airoli fire station comes under FST-2 category, which means they have limited resources and due to the large area, including the industrial area which it caters to along with the two nodes, their capacity to respond would be stretched and likely to be tested in the event of a large fire in the service area.

Along the eastern edge of the ward are hills which have witnessed ***mining*** activities and thus are vulnerable to land slide and consequently building collapse. Also during the rains, the runoff from the hills caries the loose soil thus covering the foothills with sludge. Along the foothills are few industries and hutments. When mining activities are underway, the area experienced high levels of air pollution and records high levels of SPM.

To safe-guard the city from flooding, holding ponds, based on the concept of Dutch Dykes were created along the western edge, between the mainland and the sea. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff. For lakes and holding ponds buffers on 100, 200 and 300mts were extracted and for nallahs buffers of 25, 50 and 100mts were considered. Owing to large water bodies in the node along with presence of large number of marginal population with vulnerable economic conditions, vulnerability of Airoli to ***floods*** is quite high. When compared with other nodes of NMMC, Airoli ranks 6th out of 8 nodes indicating towards high vulnerability to floods.

Table 5-22 Physical Vulnerability Indicator - Airoli

S No	*Physical Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

The analysis of social and physical vulnerability parameters of Airoli indicates towards a node which needs attention in various sectors. The built environment along with the social fabric has increased the vulnerability to fire, flooding, building collapse and other disaster related issues. When the individual wards of Airoli are analysed the disparity is very evident. Out of twelve wards of Airoli four wards need extensive attention. Airoli needs to take mitigation and preparedness measure to reduce the impact of these vulnerabilities.

To overcome these vulnerabilities and to increase resilience of this node certain recommendation may be considered:

- Airoli Fire station should be upgraded and better equipped;
- Informal settlements on the slopes need to be immediately attended to and permanent measures need to be taken.
- People residing in the no development zone should be moved to safer areas and areas protected from future encroachment.
- Overall built environment is very vulnerable because of either the construction material or the land used for construction, corrective action is required especially wards 6, 7, 8, and 9.
- Dilapidated buildings should be inspected on priority and based on the analysis, either vacated or demolished or retrofitted.
- Ward no. 7 is highly vulnerable to flooding and needs immediate and long term action. Airoli is at high risk to flooding, measures need to be incorporated in DP.
- Local people need to be trained in firefighting and emergency response;
- Preparedness and trainings in the wards, localities and schools to raise the awareness would go a long way.
- Providing amenities and improved access to water, hospital, schools and public transport may be considered.
- Most of the gaonthans and CIDCO buildings in the area in ward 10 are old and need engineering intervention
- Ward 6 has many dilapidated buildings and informal settlements, these are very vulnerable. The issue gets aggravated as it is on MIDC land. Reinforcing the requirement of agreement with MIDC
- Gaonthans and informal settlements have backing from the political fraternity, they need to be sensitized about the hazards and vulnerabilities.

5.4. Ghansoli Node

Note: Analysis is based on Census 2011 data and thus comprises of 89 electoral wards. Map Image in the chapter can be referred to for ward boundaries. Detailed chapter on node is placed at Appendix 6

Located towards the northern boundary of NMMC, Ghansoli has Airoli to its north, Thane Belapur road and Trans- Thane creek Industrial area on the east, Trans Thane creek to its west and Koparkhairane node and Shil Mahape Road to the south. **The ward officers and planners are therefore requested to refer to the reports of the adjoining nodes, Airoli and Koparkhairane for a comprehensive long term DRR approach to this node.**

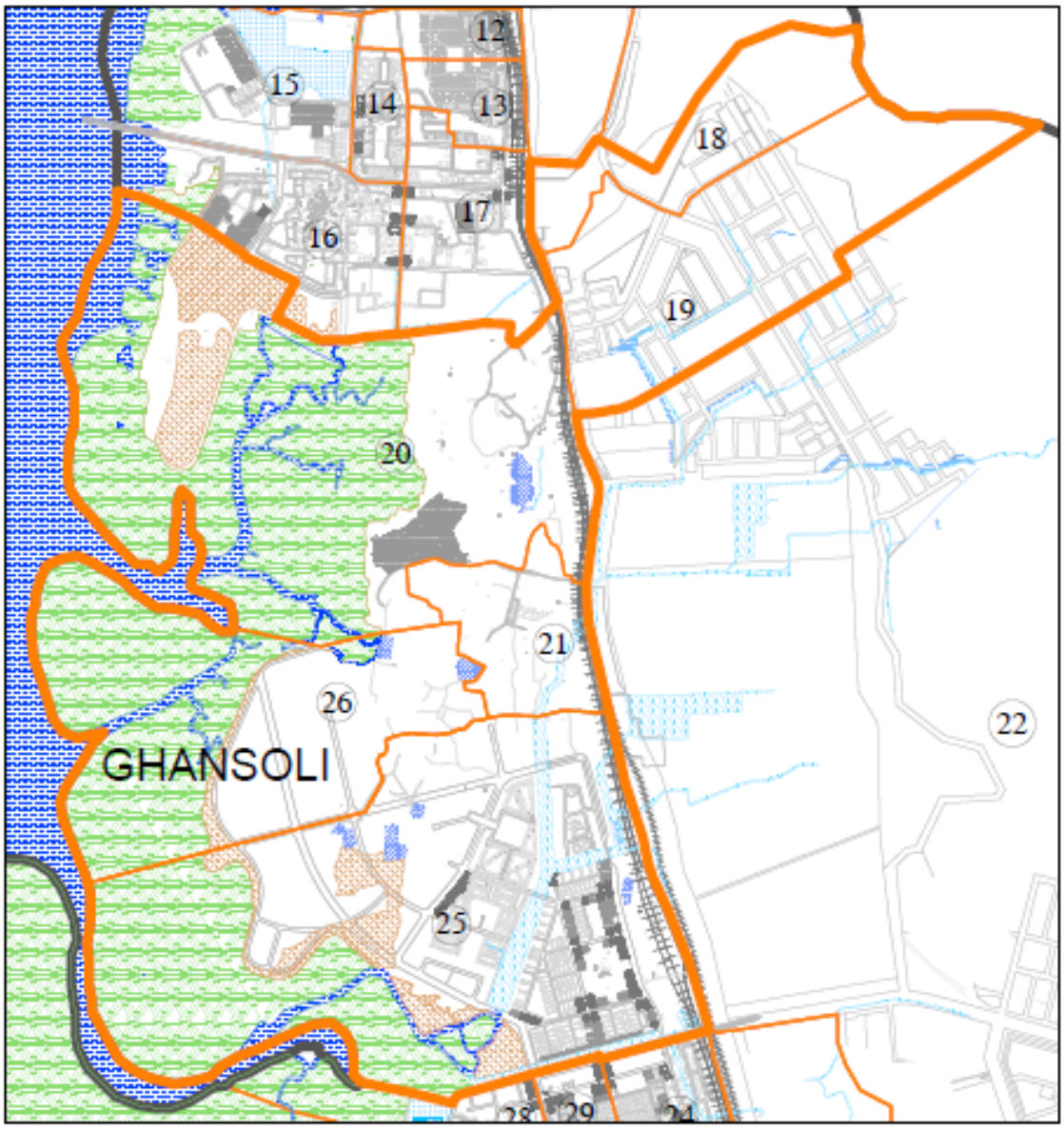
CIDCO handed Ghansoli to NMMC in 2010. Delay in handing over has probably resulted in Ghansoli being relatively unplanned with haphazard development and encroachments. Settlements have slum like appearance with small alleys and pathways. Ghansoli was once identified as home for middle income group and lower income group but now with several projects and high rises here, it now is going through a change in identity[10]. Big industrial companies like Reliance, Siemens, Standard Alkali[11] are also housed in Ghansoli.

The Census 2011 is based on NMMC's 89 electoral wards. Ghansoli as a node comprises 6 such Electoral Wards. Spread over an area of 11.20 sq. km., Ghansoli has largely been a residential area.

[10] Ghansoli is city's new realty goldmine as city's skyline plunge high, 19 Oct 2014-09:07am , Mumbai , DNA

[11] Wikipedia

Figure 5-34 Electoral Wards with numbers – Ghansoli 2011



Source: AutoCAD Map, NMMC, TP Department

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire
- Floods and water logging and
- Building Collapse and Landslides

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through a rise in number of high rise building with central AC systems. High-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire department aerial devices, and the chance of rescuing victims from the

exterior is near zero once the fire is above the operational reach of aerial ladders or elevating platforms. The industrial area cuts through the length of the city, the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

Physical and Social Vulnerability

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicator of physical and social vulnerability are considered these are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicators of social vulnerability on which data is available (Census 2011) are demographic, marginalized population, economic status and using these indicators all the nodes of NMMC were analysed.

NMMC has a total population of 11, 20, 547 (census 2011) out of which 1, 32, 880 (around 12% of NMMC population) reside in Ghansoli. The land use in Ghansoli is predominantly residential (40.49%) and caters to all the sections of society. With several renowned builders having invested in residential projects in Ghansoli the area is developing at a faster pace. Population density of Ghansoli is 11860 which is much higher than NMMC (8934).Ghansoli is spread in 11.20 sq. km. Ward 20 and 25 occupy 3.30 sq. km. and 3.50 sq. km. respectively whereas ward 18 and 21 together occupy 1.08 sq. km. is house to 23% Ghansoli Population. Population density of Ward 25 is very high compared to the city average. Population distribution information helps the city planners in assessment of casualties, determination of shelter needs and proper implementation of evacuation plans in pre- and/or post-disaster phases.

Female population comprises 43.80% of the total population of Ghansoli. The sex ratio is 779:1000, which is much lower than the city's ratio of 837:1000. Ward 25 has 19% of the total female population, highest amongst all wards of Ghansoli. About 14% of the node population is below 6 years of age. Since women and children are more vulnerable during disasters, it is important to note that a total of 58% of the node population falls into this socially vulnerable category. The disaster preparedness activities should include having programmes for women and children and their caretakers.

From the perspective of marginalized population, 13.27% of the node population belongs to scheduled castes and 2.19% to scheduled tribes. The city's 18% SC population and 15% ST population reside in Ghansoli. As per Census 2011 data, nearly 24% of people residing in Ghansoli are illiterate. Certain sections of the society have limited access to resources and information. This skews increases in post disaster situation and thus need special attention in pre and post disaster situation.

41% of people residing in Ghansoli are working, thus leaving 59% of the population under non-working category of the Census [population who did not participate in any economic activity paid or unpaid, this category includes students, persons engaged in household duties, dependents, pensioners, beggars, etc. provided they were not engaged in any economically

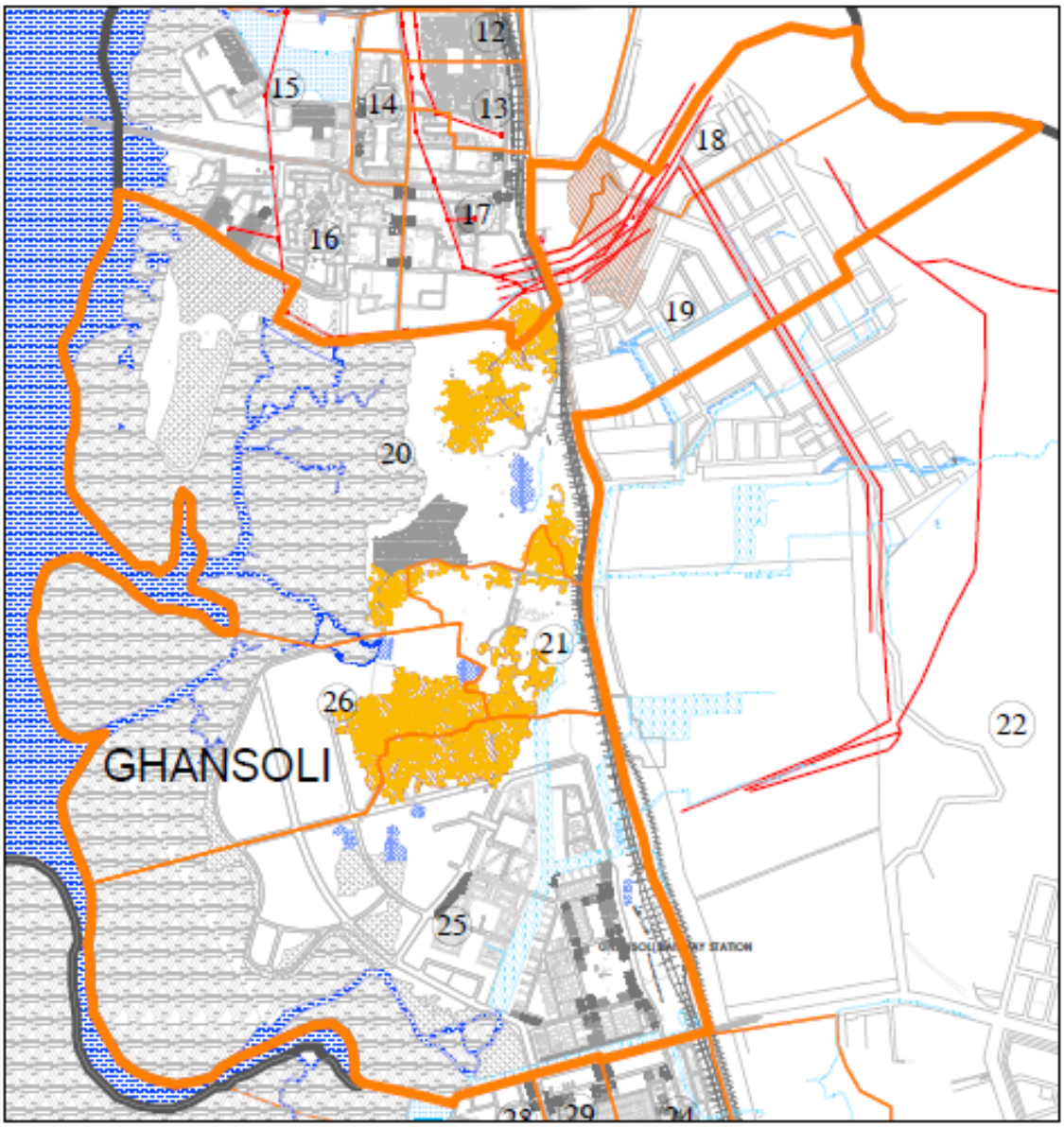
productive activity during the last one year preceding the date of enumeration[12]] Out of the total working population of Ghansoli (41%), 94% come under the category of main working population [Workers who were employed for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers] leaving 6% under the marginal worker category [Workers who worked for less than six months (180 days) in the reference period are termed as Marginal Workers.] Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

The Census 2011 data on slums with number of households and population data and NMMC's list of slums and encroachments (along with the Auto Cad drawings given by the Town Planning Department) NMMC were collated. Here, 5 slums / hutment pockets were identified in Ghansoli which accommodate 13% population of Ghansoli. Ward 21 has nearly 25% of its area covered by hutments. These slums / hutments cover 9.19% of total node area.

In the image below, the areas shown in brown and yellow are the slums and the red lines are high tension wires as per the AutoCAD map provided by the TP Department, NMMC. The slum map has further revealed that hutment development in ward 18 and 19 is on land below high tension wires which further augments their vulnerability to fire. Slums and other development located below and around these high tension wires are exposed to high frequency electromagnetic radiations which makes them vulnerable to a large range of health issues like damaging DNA, cancer, neuro-degenerative disease and miscarriage. Field interactions revealed that most of the area under the high tension wires is under the jurisdiction of MIDC, the impending disaster can be avoided as this falls under non development zone. A strict action followed by constant vigilance can help avoid any encroachment in these areas but MIDC needs to be sensitized regarding the same.

[12] www.Censusdata.gov.in

Figure 5-35 Slum Location – Ghansoli



Source: AutoCAD Map, NMMC, TP Department

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented houses only own the assets inside the house. The vulnerability of those who live in rented houses is potentially higher. In Ghansoli approximately 50% of the population resides in self-owned houses. Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts may be considered better than households without bank accounts. In Ghansoli 74% of the population avail banking facility.

Table 5-23 Social Vulnerability Indicator - Ghansoli

S No	*Social Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Population density*					
2.	*Percentage of female population*					
3.	*Population below 6 years*					
4.	*Percentage of illiterate population*					
5.	*Percentage of SC & ST population*					
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

In the table 5-22 all indicators except one are directly proportional to vulnerability i.e. higher the value greater the vulnerability. But banking services is a positive influence indicator, higher the value of parameter lesser the vulnerability, i.e. bank accounts can be of great help during a crisis situation. Therefore higher the value of this indicator, lesser the vulnerability.

The building stock of any locality has a direct impact on its vulnerability. The land use has to consider flood plain, seismic vulnerability, soil strata and the built environment has to be aware of hazards before selecting the building material. When the built environment is assessed based on Census 2011 data, the development pattern and degree of non-engineered construction becomes obvious.

When Ghansoli node is analysed with reference to housing vulnerability indicator, ward no. 18 has nearly 17% of its building stock dilapidated. Further, Ward 18 reveals very high value for all the vulnerability parameters. Ward 20 has 5% of its buildings dilapidated. All wards of Ghansoli have highly vulnerable building stock with reference to roof material. Even the material used for construction of wall increases the vulnerability and ward 18, 19, 20, 21 have vulnerability percentage much higher than that of the average city percentage. Based on the census 2011 data, ward 18 and 20 need special attention as far as building stock is concerned. A proper assessment of these buildings followed by necessary corrective measures like repair, evacuation or retrofitting needs to be done. Based on the soil strata, city planners need to bring in strict guidelines for building material to be used for construction, non-engineered construction, usage of BIS standards and model construction in vulnerable areas. Lack of awareness regarding their vulnerability and non-availability of simple and safe construction

technique forces economically backward people to go in for unsafe construction. Awareness in this area will be added advantage.

Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event. When node Ghansoli is analysed with respect to various physical indicators few wards seems to be compromising on all parameters thus increasing the vulnerability.

Having a connection to tap-water within the premise ensures safe drinking water. This is significant for good health and for avoiding diseases. This is also important in disaster situation and can also supply during fire breakouts, thus reducing vulnerability. However, a source away from the house would increase vulnerability.

When all the wards of Ghansoli are analysed, ward 18 scores very high on all the parameters of physical vulnerability indicating highly vulnerable community. Data regarding ward 19 also reveals that the community in this area has higher percentage of houses with water source out of premises, unsafe source of light, unsafe drainage and unsafe cooking fuel. Ward 20 and 21 higher percentages of houses with water source out of premises, unsafe drainage and unsafe cooking fuel.

When Ghansoli is looked at holistically, it is evident that more than 16% of the households in Ghansoli do not have source of water within the premise of residence, 23% of the households do not have access to safe drainage and 32% of the households use unsafe source of fuel for cooking. Out of the six wards of Ghansoli, ward 18 and 19 have 48% of the households with water source outside its premise and ward 20 and 21 have 22% of the households with water source outside its premise.

When Ghansoli is compared with other nodes for all the parameters of physical vulnerability, Ghansoli scores second highest in unsafe drainage and unsafe source of fuel for cooking.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. There is no fire station within the ward and the closest one is the Airoli Fire Station. Airoli fire station comes under FST-2 category, it has limited resources and it caters to a large area, including three nodes: Digha, Airoli and Ghansoli along with the industrial area. Thus their capacity to respond would be stretched and likely to be tested in the event of a large fire in the service area.

In a city, amongst many duties of the personnel from fire department, one major responsibility is that of first responder which also get tested during time of crisis. Moreover, Ghansoli has a hilly terrain and thus there are incidences of rock falling in the area, especially in the settlements which are situated on the slopes.

With population of about 1, 32, 880 the entire 11.2 sq. km. of Ghansoli is serviced by 4 Government health posts and 12 private hospitals. Ghansoli has roads with 15 mts. width and several 6mts roads also but most of the roads are of very bad quality and some are very narrow posing difficulty for the fire engines or other emergency vehicle to ply. Many bye lanes of the slums have width less than a meter posing hurdles during emergencies.

To safe-guard the city from flooding, holding ponds, based on the concept of Dutch Dykes were created along the western edge, between the mainland and the sea. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff. For lakes and holding ponds buffers on 100, 200 and 300mts were extracted and for nallahs buffers of 25, 50 and 100mts were considered.

Ghansoli scores the highest amongst all the nodes when analysed for vulnerability to floods. It has several water bodies which add to the vulnerability. Most of the developed part of Ghansoli node falls in these zones thus increasing the flood vulnerability of the area. Out of 18 slums identified (through Census 2011 data), 6 slums fall in the flood-prone area.

Table 5-24 Physical Vulnerability Indicator - Ghansoli

S No	*Physical Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

The social and physical vulnerability of Ghansoli as a whole falls in High Medium to Medium risk. But when the individual wards are analysed the disparity is very evident. Out of six wards of Ghansoli ward 18 need immediate interventions whereas ward 19, 20 and 21 need attention in some specific areas like drainage, cooking fuel and building stock etc.

To overcome these vulnerabilities and to increase resilience of this node certain recommendation may be considered:

- Airoli Fire station should be upgraded and better equipped or Ghansoli be provided with basic firefighting equipment along with trained manpower ;
- Local people need to be trained in firefighting and emergency response;

- Dilapidated buildings should be inspected on priority and based on the analysis, either vacated or demolished or retrofitted.
- Ward 18 needs immediate intervention in all the parameters related to physical vulnerability.
- Ward 21 is prone to flooding, need immediate and long term intervention.
- Ward 18, 21 and 25 are at high risk from Fire hazard, immediate measures need to be taken.
- Informal settlements that are located on the slopes of Parsik Hills need to be addressed as they are prone to collapse and damage due to rock fall / landslide. Ghansoli have witnessed several causalities due to falling rocks in past, it is advised necessary action should be taken. Either people should be restricted from building in this area or better preparedness and mitigation measures should be adopted.
- Ensuring higher level of school coverage and increasing literacy.
- Preparedness and trainings in the wards, localities and schools to raise the awareness would go a long way.
- Providing amenities and improved access to water, hospital and public transport needs considered and planned action with long term view of improving quality of life of people.
- Strict regulation for ensuring no encroachment under the high tension wires is a must.
- Mutual response group with MIDC to be formed for better coordination and mitigation measures.

5.5. Koparkhairane Node

Note: Analysis is based on Census 2011 data and thus comprises of 89 electoral wards. Image in the chapter can be referred for ward boundaries. Detailed chapter on node is placed at Appendix 7

Located in the central part of Navi Mumbai, Koparkhairane has Ghansoli to its north, Thane Belapur road and Trans- Thane creek Industrial area on the east, Trans Thane creek to its west and Vashi and Turbhe node to the south. **The ward officers and planners are therefore requested to refer to the reports of the adjoining nodes, Vashi and Ghansoli for a comprehensive long term DRR approach to Koparkhairane.**

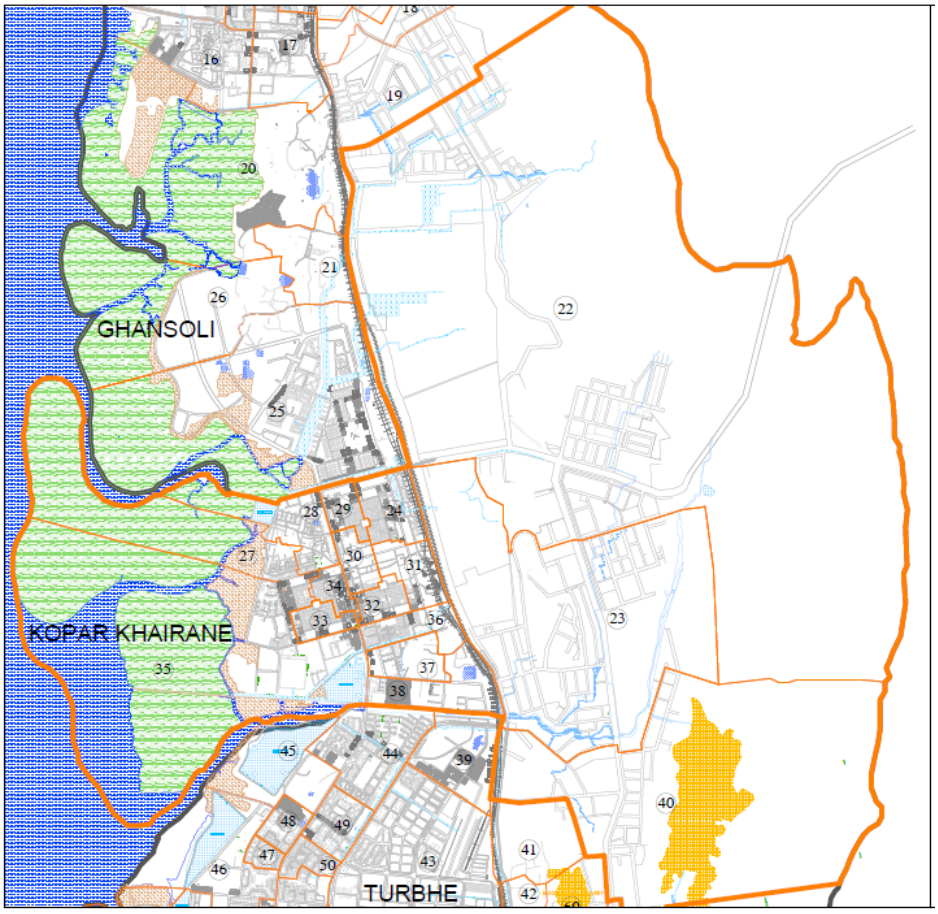
This node, on one side has units constructed under Bombay Urban Development Project (BUDP) by CIDCO and World Bank, mainly for Economically Weaker Sections (EWS) & Low Income Group (LIG) citizens and on other side it has private owners developing this area for a population of high level executives and engineers which adds to the gentility of Navi Mumbai[13].

Initially it was an extension of Vashi Node but after the development of the Koparkhairane Station and DKC Knowledge City across the Thane-Belapur Road, this area gained impetus and was designated as a separate node.

The Census 2011 is based on NMMC's 89 electoral wards. Koparkhairane as a node comprises 16 such Electoral wards spread over an area of 36.80 sq. km., it is the largest node of NMMC.

[13] http://www.koparkhairanenavimumbai.elisting.in/

Figure 5-36 Electoral Wards – Koparkhairane 2011



Source: AutoCAD Map, NMMC, TP Department

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire
- Floods and water logging and
- Building Collapse and Landslides

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through a rise in number of high rise building with central AC systems. High-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire department aerial devices, and the chance of rescuing victims from the exterior is near zero once the fire is above the operational reach of aerial ladders or elevating platforms. The industrial area cuts through the length of the city, the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

Physical and Social Vulnerability

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicator of physical and social vulnerability are considered these are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicators of social vulnerability on which data is available (Census 2011) are demographic, marginalized population, economic status and using these indicators all the nodes of NMMC were analysed.

NMMC has a total population of 1120547 (Census 2011) out of which 180161 (around 16% of NMMC population) reside in Koparkhairane. It is spread in 36.80 sq. km., ward 22 alone occupies 17.83 sq. km. and ward 23, 35 and 40 together occupy 14.62 sq. km. remaining area of 4.35 sq. km. is distributed amongst remaining 12 wards. The land use in Koparkhairane is predominantly residential (39.55%) and it caters to all the section of society. The population distribution is very uneven in this node; wards with larger area have very less population whereas nodes with less than 1 sq. km. area are very densely populated, indicating unplanned growth to some extent. But when the node is analysed as a whole, it has very less population density (4895) compared to NMMC (8934).

Female population comprises 43.36% of the total population of Koparkhairane. The sex ratio is 765:1000, which is much lower than NMMC's ratio of 837:1000. Ward 22 has only 32% female population, whereas the average female population in the node is 43%. This node has 15% of NMMCs Female population. 11.51% of the node population is below 6 years of age. Since women and children are more vulnerable during disaster, it is important to note nearly 54% of the node population falls into this socially vulnerable category. Disaster preparedness activities should include programmes for women and children and their caretakers.

From the perspective of marginalized population, Koparkhairane houses 6.41% Schedule Castes and 1.94% Schedule Tribe population. Approximately 12% SC population and 19% ST population of NMMC resides in Koparkhairane. Ward 22 has highest percentage of ST population and ward 23 has highest percentage of SC population. As per Census 2011 data, nearly 20% of people residing in Koparkhairane are illiterate. In ward 22 and 23, 30% and 40% of total population respectively is illiterate. Thus, ward 22 and 23 houses higher percentage of marginalized population. Certain sections of the society have limited access to resources and information. The skew increases in post disaster situation and these population would need special attention in pre and post disaster situation. Strategies of preparedness and response must be inclusive.

Workers who had worked for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers and Koparkhairane comprises only 42% of such population thus leaving 58% of the population under non-working category of the Census (i.e. constituting of population who did not participate in any economic activity paid or unpaid and performing household duties like attending to daily household chores like cooking, cleaning utensils,

looking after children, fetching water etc.[14]) 94% of the total working population comes under the category of main working population leaving only 6% under the marginal worker category.

42% of people residing in Koparkhairane are working thus leaving 58% of the population under non-working category of the Census [population who did not participate in any economic activity paid or unpaid, this category includes students, persons engaged in household duties, dependents, pensioners, beggars, etc. provided they were not engaged in any economically productive activity during the last one year preceding the date of enumeration[15]] Out of the total working population of Koparkhairane (42%), 94% come under the category of main working population [Workers who were employed for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers] leaving 6% under the marginal worker category [Workers who worked for less than six months (180 days) in the reference period are termed as Marginal Workers.] Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

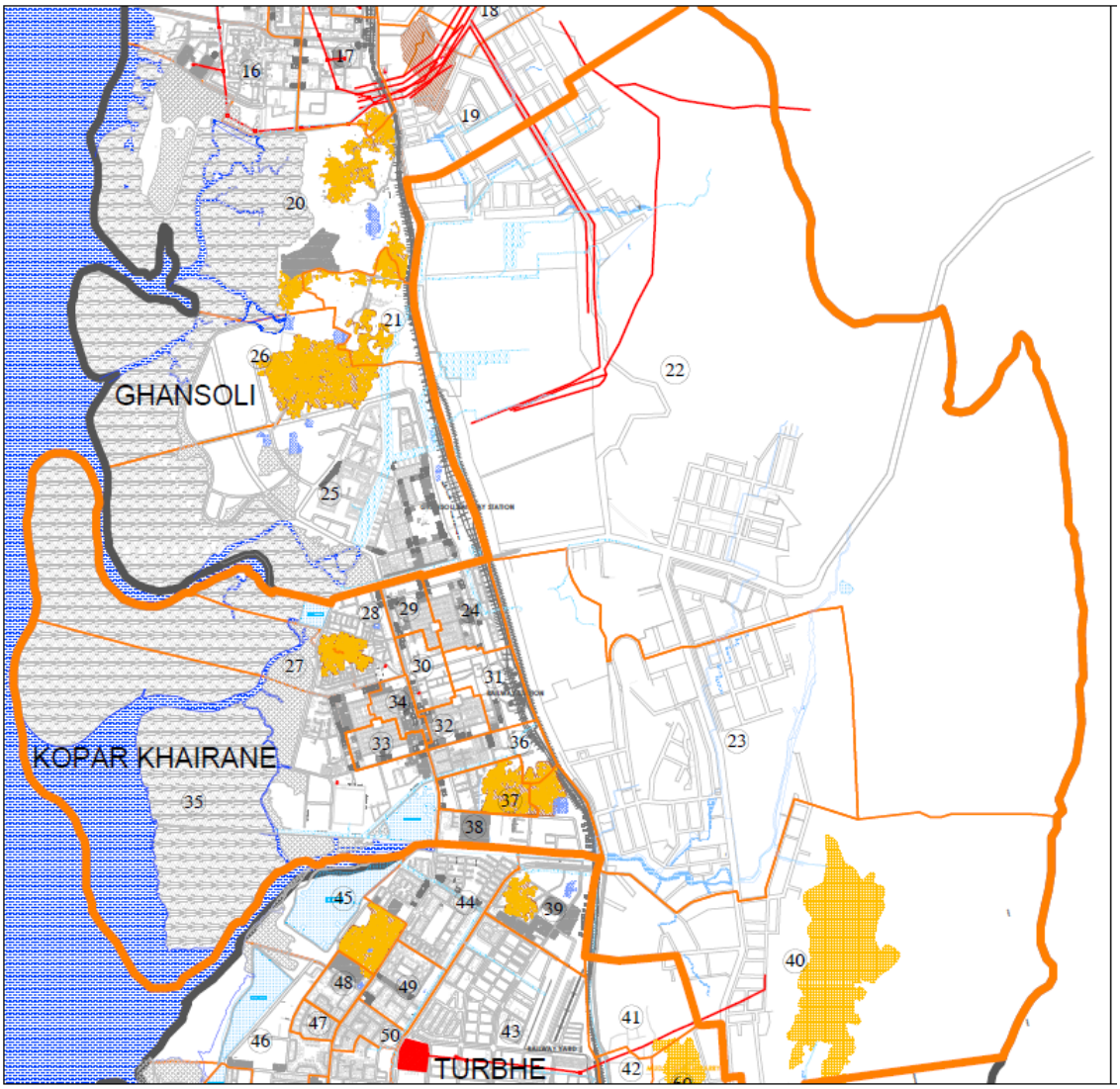
The Census 2011 data on slums with number of households and population data and NMMC's list of slums and encroachments (along with the Auto Cad drawings given by the Town Planning Department) NMMC were collated. Here, 5 slums / hutment pockets were identified in Koparkhairane which accommodate nearly 11% population of Koparkhairane. Ward 38 of node has the highest percentage of area under slums. These slums / hutments cover 0.77% of total node area. Jurisdiction issue emerged as one of the major problem area during field interaction. These slums have come up in areas that are not in the jurisdiction purview of NMMC. But these are extended support, especially during emergency situation like flooding and fire.

In the image below, the areas shown in brown and yellow are the slums (as per the AutoCAD map provided by the TP Department, NMMC.)

[14] www.Censusdata.gov.in

[15] www.Censusdata.gov.in

Figure 5-37 Slum Location – Koparkhairane



Source: AutoCAD Map, NMMC, TP Department

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented houses only own the assets inside the house. The vulnerability of those who live in rented houses is potentially higher. In Koparkhairane approximately 50% of the population resides in self-owned houses. Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts may be considered better than households without bank accounts. In Koparkhairane only 85% of population avail banking facility.

Table 5-25 Social Vulnerability Indicator - Koparkhairane

S No	*Social Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Population density*					
2.	*Percentage of female population*					
3.	*Population below 6 years*					
4.	*Percentage of illiterate population*					
5.	*Percentage of SC & ST population*					
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

In the table 5-24 all indicators except one are directly proportional to vulnerability i.e. higher the value, greater the vulnerability. However, banking services is a positive influence indicator, higher the value of parameter lesser the vulnerability, i.e. bank accounts can be of great help during a crisis situation. Therefore higher the value of this indicator lesser the vulnerability.

The building stock of any locality has a direct impact on its vulnerability. The land use has to consider flood plain, seismic vulnerability, soil strata and the built environment has to be aware of hazards before selecting the building material. When the built environment is assessed based on Census 2011 data, the development pattern and degree of non-engineered construction becomes obvious.

When Koparkhairane is analysed with reference to housing vulnerability indicator, ward number 22, 31 and 36 have 4%, 6% and 7% of their building stock respectively dilapidated. Out of sixteen wards of Koparkhairane ten wards have highly vulnerable building stock with reference to roof material. The material used for construction of wall increases the vulnerability and ward 22, 23, 27, 31 and 40 have vulnerability percentage much higher than the average city percentage. Ward 22, 23, 31 and 40 need special attention and strict vigilance on new constructions.

Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event.

When Koparkhairane is looked at holistically, it is evident that more than 13% households in Koparkhairane do not have source of water within the premise of residence, 11% of the households do not have access to safe drainage and 17% of the households use unsafe source of fuel for cooking. When sixteen wards of Koparkhairane node are analysed with respect to

various physical indicators, ward 22, 23 and 40 urgently need systematic intervention and NMMC seems to be compromising on all parameters thus increasing the vulnerability of its population. Apart from these four wards some wards of node need attention on specific issues. Ward 27 has 4.5% of the households with unsafe drinking water; ward 35 and 36 have 25.6% and 16.3% of the households respectively with water source out of premises; and ward 31 has 4.1% of the households with no access to latrine. These wards need to be attended by respective municipal departments for corrective measures.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. Fire fighters also act as first responders, a fire station with well-trained manpower and state of art equipment will always be an asset for the community. Koparkhairane has a fire station which also provides assistance to Ghansoli node.

There is one fire station within the node and it also provides services to Ghansoli node. Koparkhairane is the largest node of NMMC and the fire station is supposed to provide services to Ghansoli also. As per the standard, a fire station in its best of capability, can service an area of 10.5 km, the map (ref map no D5) clearly depicts that the fire station is expected to cover a very large area than the standard prescribed area. Thus their capacity to respond would be stretched and likely to be tested in the event of a large fire in the service area.

The 5 Slum pockets are characterized by high density, substandard living condition and building material highly susceptible to fire. As per Census 2011 data, within Koparkhairane a population of 19637 is exposed to fire vulnerability. The slum map has further revealed that most of this development is on land below high tension wires which further augments their vulnerability to fire. When a holistic study for vulnerability to fire is done, most of the wards of Koparkhairane fall in the high to medium vulnerability zone. Wards 22 and 23 are amongst the most vulnerable ward in the city, they rank 81 and 80 respectively out of 89 wards.

With population of about 180161 the entire 36.80 sq. km. of Koparkhairane is serviced by four Government health post and 14 private hospitals.

Koparkhairane has many roads with 15 mts. width (ref map G4) but the roads that could not be captured through the GIS data look narrow. A ground survey of the location brought out that the roads are of very bad quality and mostly less than 6 mts. width. This poses obstruction to free movement of emergency vehicles and personnel. Many bye lanes of the slums have width less than a meter posing hurdles during emergencies.

The eastern edge of the ward has hills which have witnessed mining activities and thus are vulnerable to land slide and consequently building collapse. Also during the rains, the runoff from the hills caries the loose soil thus covering the foothills with sludge. Along the foothills are few industries and hutments. When mining activities are underway, the area experiences high levels of air pollution and high levels SPM.

To safe-guard the city from flooding, holding ponds, based on the concept of Dutch Dykes were created along the western edge, between the mainland and the sea. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff. For lakes and holding ponds buffers

on 100, 200 and 300mts were extracted and for nallahs buffers of 25, 50 and 100mts were considered. As seen in Map No: J3, most of the developed part of Koparkhairane node falls in these zones, thus increasing the flood vulnerability of the area. However, being in the 10.5sqkm ambit of the fire station slightly reduces the vulnerability. Koparkhairane ranks 3rd out of 8 nodes when analysed for flood hazard thus it falls in the medium low category.

Table 5-26 Physical Vulnerability Indicator- Koparkhairane

S No	*Physical Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

Koparkhairane as a whole falls in medium to low medium risk. But when the individual wards are analysed the disparity is very evident. Out of sixteen wards of Koparkhairane four wards need immediate interventions whereas ward 27, 31, 35 and 36 need attention in some specific areas like unsafe drinking water, water source out of premises and no access to latrine etc. Ward 22, 23 and 40 have high number of vulnerable housing and poor physical infrastructure thus indicating immediate attention.

To overcome these vulnerabilities and to increase resilience of this node certain recommendations may be considered:

- Local people need to be trained in firefighting and emergency response;
- Dilapidated buildings should be inspected on a priority and based on the analysis, either vacated or demolished or retrofitted.
- Built environment of ward 22, 23 and 40 needs immediate intervention.
- Ensuring higher level of school coverage and increasing literacy is important.

- Preparedness and trainings in the wards, localities and schools to raise the awareness would go a long way.
- Providing amenities and improved access to water, hospital and public transport needs considered and planned action with long term view of improving quality of life of people.

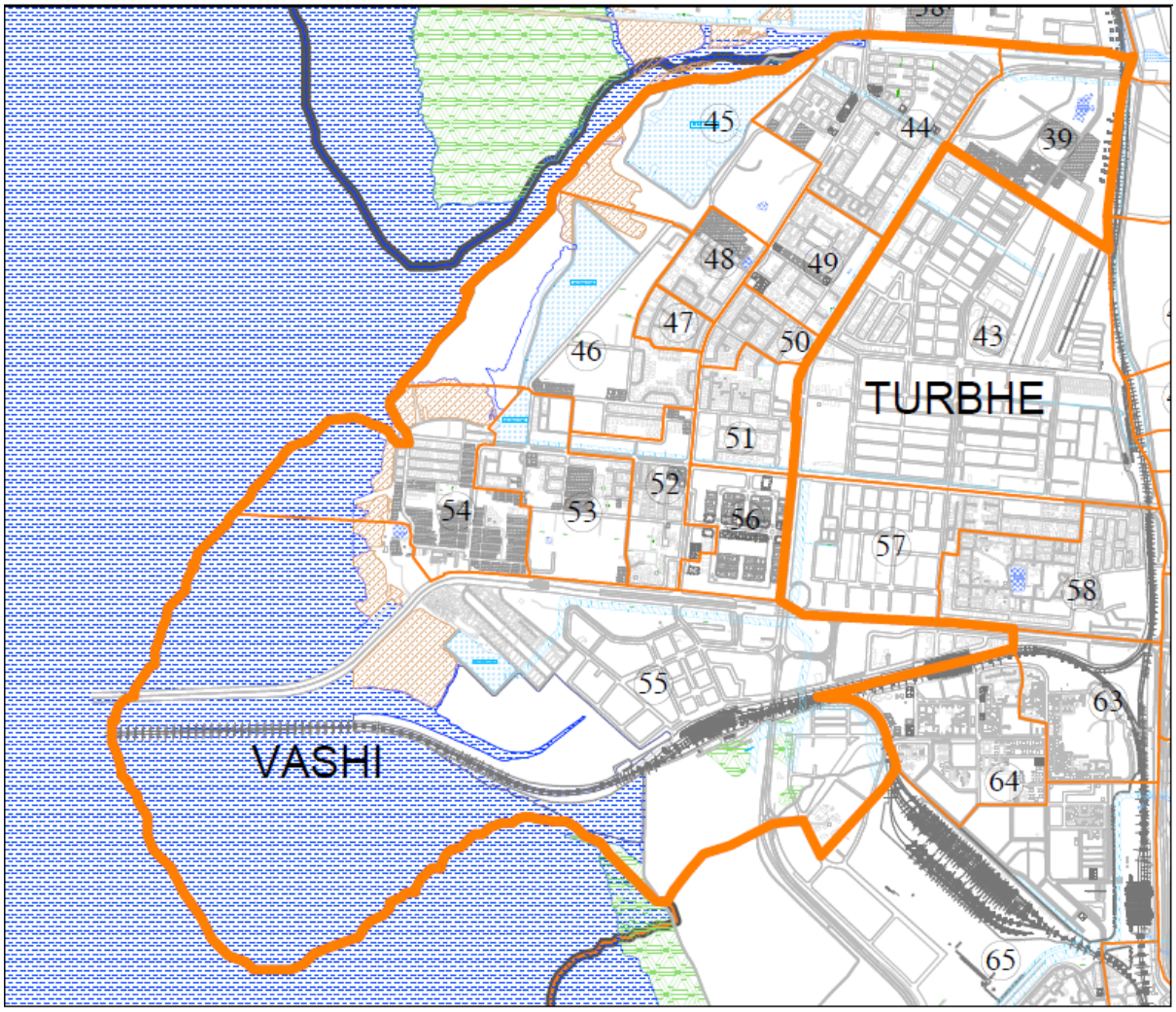
5.6. Vashi Node

Note: Analysis is based on Census 2011 data and thus comprises of 89 electoral wards. Map in the chapter can be referred to forward boundaries. Detailed chapter on node is placed at Appendix 8

Vashi node is the first node which was developed in NMMC area, with Koparkhairane to its north, Turbhe on the east, Trans Thane creek to its west and Nerul node to the south. **The ward officers and planners are therefore requested to refer to the reports of the adjoining nodes, Koparkhairane, Turbhe and Nerul for a comprehensive long term DRR approach to this node.**

The Census 2011 divides NMMC into 89 smaller wards and Vashi as a node comprises 14 such Census (2011) wards. Spread over an area of 10.35 sq. km., most of it is residential. Vashi is directly connected to Mumbai city by road through Thane creek (via the Mankhurd-Vashi Bridge) and railways via the harbour line of central railways.

Figure 5-38 Electoral Wards – Vashi 2011



Source: AutoCAD Map, NMMC, TP Department

This node was developed by CIDCO in a planned manner and the area was divided into sectors.

Initially all the construction was done by CIDCO and later private builders and cooperatives began developing the residential area.

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire
- Floods and water logging and
- Building Collapse and Landslides

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through gradual increase in the number of high rise buildings with central AC systems. High-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire departments aerial devices, and the chance of rescuing victims from the exterior is minimal once the fire is above the operational reach of aerial ladders or elevating platforms.

The industrial area cuts through the length of the city and the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

Physical and Social Vulnerability

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicators of physical and social vulnerability are considered. These are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicators of social vulnerability on which data (Census 2011) is available are: demographic, marginalized population and economic status. Using these indicators all the nodes of NMMC were analysed for their vulnerability:

NMMC has a total population of 11, 20,547 (census 2011) out of which 1, 39,371 (around 12% of NMMC population) reside in Vashi. Also, population density of Vashi is 13470 which is much higher than NMMC (8934).The 10.35 sq. km area is predominantly used for residential purpose (21%) [Ref map B6]. Ward 55 alone occupies 5.17 sq. km and houses the maximum population of Vashi. The remaining area of 4.18 sq. km is distributed amongst the remaining 13 wards, thus reducing the area of each ward to less than a square kilometre. Ward 47 barely occupies 0.07 sq. km and caters to a large population. It has the highest population density. Ward 48, 49 and 50 also have a very small area and are very densely populated. Population distribution information helps the city planners in assessment of casualties, determination of shelter needs and proper implementation of evacuation plans in pre- and/or post-disaster phases.

Female population comprises 47% of the total population of Vashi. The sex ratio is 898:1000, which is higher than the city's ratio of 837:1000. This node has 13% of NMMC's Female population. About 9.48% of the node population is below 6 years of age. Since women and children are more vulnerable during disasters, it is important to note that nearly 57% of the node's population falls into this socially vulnerable category. The disaster preparedness activities should include having programmes for women and children and their caretakers.

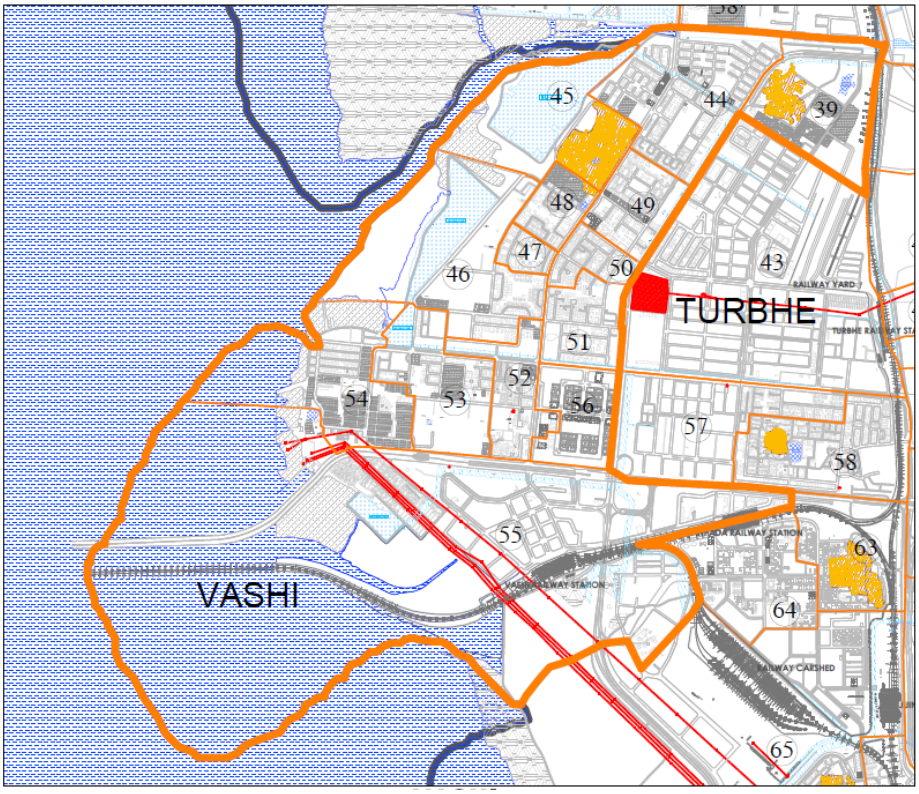
From the perspective of marginalized population, Vashi houses 5.37% Schedule Castes and 0.99% Schedule Tribe population. Approximately 7% SC and ST population of NMMC reside in Vashi. Ward 45 has highest percentage of ST population and ward 39 has highest percentage of SC population. As per Census 2011 data, nearly 16% of people residing in Vashi are illiterate. Ward 39 has the highest percentage of illiterate population. Certain sections of the society have limited access to resources and information. This skews increases in post disaster situation and thus need special attention in pre and post disaster situation.

42% of people residing in Vashi are working thus leaving 58% of the population under non-working category of the Census [population who did not participate in any economic activity paid or unpaid, this category includes students, persons engaged in household duties, dependents, pensioners, beggars, etc. provided they were not engaged in any economically productive activity during the last one year preceding the date of enumeration[16]] Out of the total working population of Vashi (42%), 91% come under the category of main working population [Workers who were employed for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers] leaving 9% under the marginal worker category [Workers who worked for less than six months (180 days) in the reference period are termed as Marginal Workers.] Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

The Census 2011 data on slums with number of households and population data and NMMC's list of slums and encroachments (along with the Auto Cad drawings given by the Town Planning Department) NMMC were collated. As this node is a planned node, the possibility of slum pockets is very less. Here, 2 slums / hutment pockets were identified in Vashi which occupy 2.43% area of Vashi. After discussions with the NMMC ward officers, it was understood that these are old gaonthans which in the process of development have become part of the city. These are not unauthorized development but part of the old gaonthans. However the census lists them as slums.

[16] www.Censusdata.gov.in

Figure 5-39 Slum Location – Vashi



Source: AutoCAD Map, NMMC, TP Department

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented houses only own the assets inside the house. The vulnerability of those who live in rented houses is potentially higher. In Vashi only 35% of the population resides in self-owned houses. Ward 39 and 45 have more than 60% population residing in self-owned houses. The point to remember is that these wards also have the only slum / hutment pockets in Vashi.

Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts may be considered better off than households without bank accounts. About 92% of population in Vashi avail banking facility. Ward 56 has 99.4% population availing the banking services.

Table 5-27 Social Vulnerability Indicator - Vashi[17]

S No	*Social Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Population density*					
2.	*Percentage of female population*					
3.	*Population below 6 years*					
4.	*Percentage of illiterate population*					
5.	*Percentage of SC & ST population*					
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

In the table 5-26 all indicators except one, are the indicators which are directly proportional to vulnerability i.e., the higher the value, greater the vulnerability. But however, banking services is a positive influence indicator, higher the value of parameter lesser the vulnerability, i.e. bank accounts can be of great help during a crisis situation. Therefore, higher the value of this indicator, lesser the vulnerability.

The building stock of any locality has a direct impact on its vulnerability. The land use has to consider flood plain, seismic vulnerability, soil strata and the built environment has to be aware of hazards before selecting the building material. When the built environment is assessed based on Census 2011 data, the development pattern and degree of non-engineered construction becomes obvious.

When Vashi is analysed with reference to housing vulnerability indicator, ward 39, 45 and 55 have 1% of their building stock dilapidated. Only ward 39 emerges as an area of concern for vulnerability of building stock. Building material used for construction, non-engineered construction, lack of awareness regarding their vulnerability, construction without referring to BIS standards and construction in vulnerable areas are the parameters that need to be looked at by the city planners.

Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event.

[17] Detailed analysis is given in the NMMC chapter and Vashi chapter

On the whole Vashi emerges as a node with good infrastructural facilities, although it does have some percentage of houses which lack basic amenities but overall percentage is very low when compared to the city's average.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. Fire fighters also act as first responders, a fire station with well-trained manpower and state of art equipment will always be an asset for the community. Vashi has one fire station.

There is one fire station within the ward known as the Vashi Fire Station, it is also the Headquarter of the Navi Mumbai Fire Services. It is currently undergoing renovation, but is still in service. When the 10.5 sq.km radius is mapped, it is seen that the entire node of Vashi is covered and thus the node lies in the green zone i.e. the easily accessible zone.

With population of about 139371 the entire 10.35 sq. km. of Vashi is serviced by one Government hospital and several private hospitals (though only two hospitals are located on the GIS map provided by NMMC).

To safe-guard the city from flooding, holding ponds, based on the concept of Dutch Dykes were created along the western edge, between the mainland and the sea. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff. For lakes and holding ponds buffers on 100, 200 and 300mts were extracted and for nallahs buffers of 25, 50 and 100mts were considered. Most of the developed part of Vashi node falls in safe zones and the areas with some water logging during heavy rains have been attended to and mitigation measures have been taken(as informed by the ward officer).

Table 5-28 Physical Vulnerability Indicator - Vashi

S No	*Physical Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					

S No	***Physical Vulnerability Indicator / Rating***	***High***	***High Medium***	***Medium***	***Low Medium***	***Low***
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

The social and physical vulnerability of Vashi as a whole falls in low risk. But when the individual wards are analysed, it is evident that ward 39 needs attention and for few parameters even ward 45 needs some intervention.

To overcome these vulnerabilities and to increase resilience of this node certain recommendations may be considered are:

- Training of local people and communities in firefighting and emergency response;
- Dilapidated buildings should be inspected on priority and based on the analysis, either vacated or demolished or retrofitted.
- Wards 39 and 45 need immediate intervention.
- Ensuring higher level of school coverage and increasing literacy.
- Preparedness and trainings in all wards. Housing societies, hospitals and schools should undertake awareness related activities which would go a long way in disaster preparedness.
- Maps need to be updated in terms of critical infrastructure (particularly; schools, hospitals, fire stations, playgrounds, public buildings etc.) and also the recent development in the city needs.

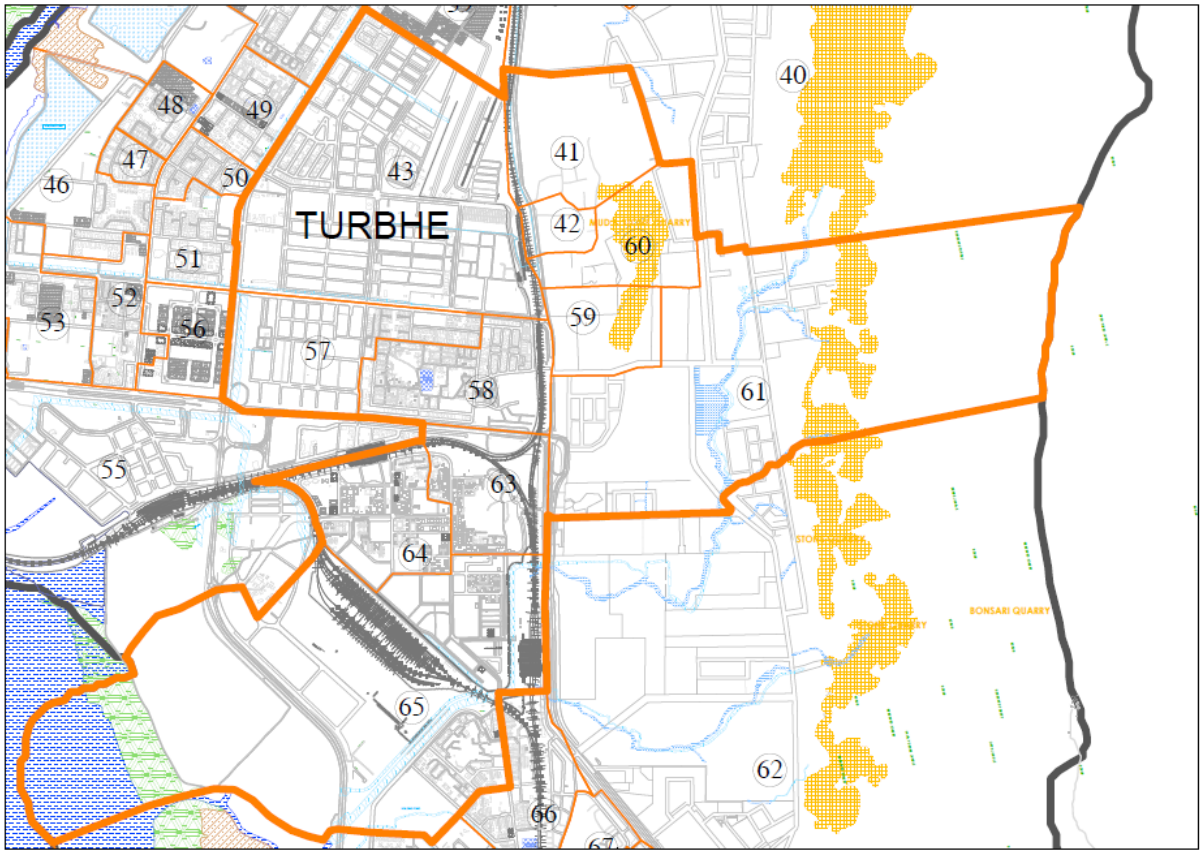
5.7. Turbhe Node

Note: Analysis is based on Census 2011 data and thus comprises of 89 electoral wards. Map in the chapter can be referred to for ward boundaries. Detailed chapter on node is placed at Appendix 9

Located in the central part of Navi Mumbai, Turbhe has Koparkhairane to its north, Thane Belapur road and Trans- Thane creek Industrial area on the east, Vashi to its west and Nerul to the south. . **The ward officers and planners are therefore requested to refer to the reports of the adjoining nodes Vashi and Koparkhairane for a comprehensive long term DRR approach to this node.**

The Census 2011 divides NMMC into 89 smaller wards and Turbhe as a node comprises 11 such Census (2011) wards spread over an area of 11.52 sq. km.

Figure 5-40 Electoral Wards – Turbhe 2011



Source: AutoCAD Map, NMMC, TP Department

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire
- Floods and water logging and
- Building Collapse and Landslides

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through a rise in number of high rise building with central AC systems. High-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire department aerial devices, and the chance of rescuing victims from the exterior is near zero once the fire is above the operational reach of aerial ladders or elevating platforms. The industrial area cuts through the length of the city, the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

Physical and Social Vulnerability

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicator of physical and social vulnerability are considered these are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicators of social vulnerability on which data is available (Census 2011) are demographic, marginalized population, economic status and using these indicators all the nodes of NMMC were analysed.

NMMC has a total population of 11,20,547 (census 2011) out of which 1,37,864 (around 12% of NMMC population) reside in Turbhe. It is spread in 11.52 sq. km., ward 43, 61 and 65 together occupy 8.13 sq. km. and remaining area of 3.39 sq. km. is distributed amongst remaining 11 wards. The population density of Turbhe (11,967) is much higher than the city average (8934). As many wards have area less than a kilometre, the population density is very high. Ward 43, 61 and 65 have population density less than the city average. Population distribution information helps city planners to assess the number of people affected, possible casualties, determining shelter needs and proper implementation of evacuation plans in pre- and/or post-disaster phases.

Female population comprises 45% of the total population of Turbhe. The sex ratio is 801:1000, which is lower than the city's ratio of 837:1000. This node has 12% of NMMCs Female population. Ward 41 has only 39% female population, whereas the average female population in node is 45%. About 12% of the node population is below 6 years of age. Since women and children are more vulnerable during disaster, it is important to note that nearly 44% of the node population falls into this socially vulnerable category. The disaster preparedness activities should include programmes for women and children and their caretakers.

From the perspective of marginalized population, Turbhe houses 10.65% Schedule Castes and 1.34% Schedule Tribe population. Approximately 15% SC population and 10% ST population of NMMC reside in Turbhe. Ward 59 has highest percentage of ST population and ward 65 has highest percentage of SC population. As per Census 2011 data, nearly 26% of people residing in Turbhe are illiterate. Except ward 64 and 65, all wards have percentage of illiterate population higher than the city average. Certain sections of the society have limited access to resources and information. This skews increases in post disaster situation and thus need special attention in pre and post disaster situation.

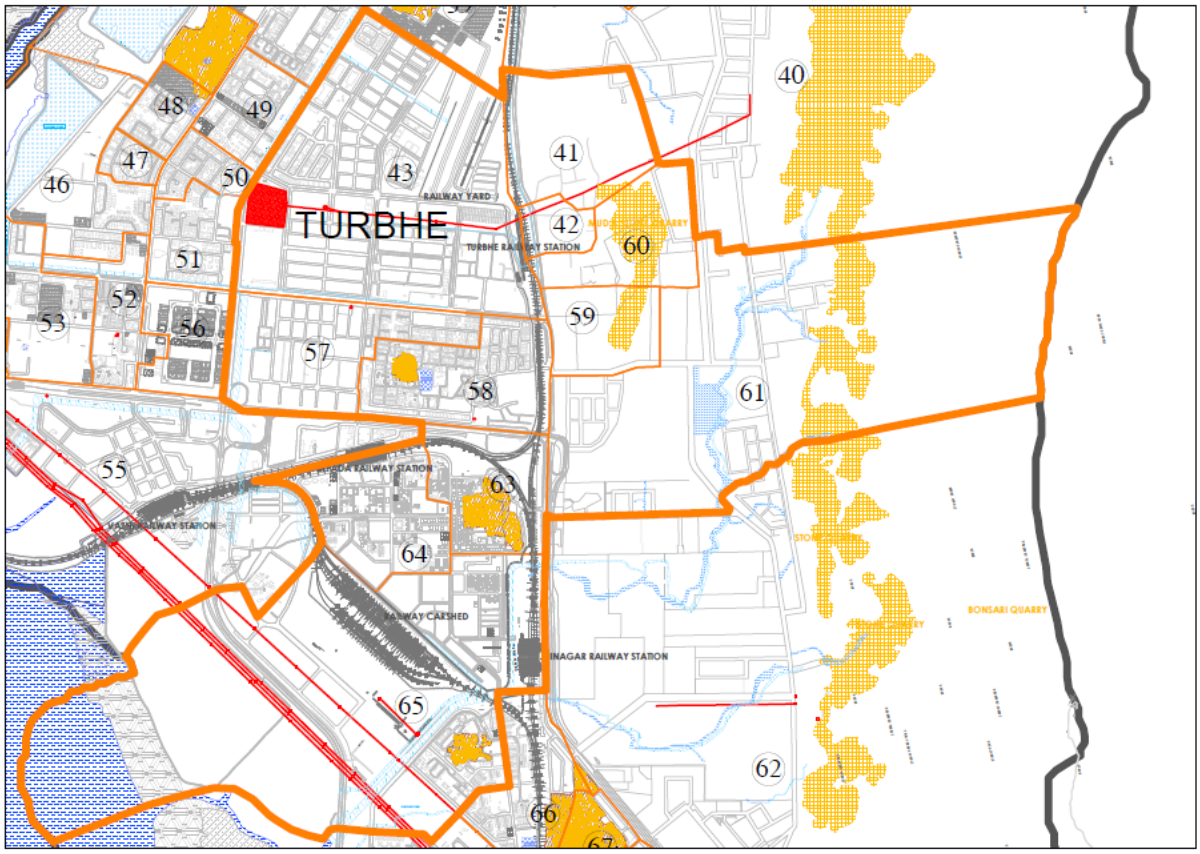
42% of people residing in Turbhe are working, thus leaving 58% of the population under non-working category of the Census [population who did not participate in any economic activity paid or unpaid, this category includes students, persons engaged in household duties, dependents, pensioners, beggars, etc. provided they were not engaged in any economically productive activity during the last one year preceding the date of enumeration[18]] Out of the total working population of Turbhe (42%), 92% come under the category of main working population [Workers who were employed for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers] leaving 8% under the marginal worker category [Workers who worked for less than six months (180 days) in the reference period are termed as Marginal Workers.] Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

The Census 2011 data on slums with number of households and population data; NMMC's list of slums and encroachments along with the Auto Cad drawings given by the Town Planning Department, NMMC was collated, 4 slums / hutment pockets were identified in Turbhe which accommodates nearly 47% population of Turbhe. Ward 58 and 65 of node houses this population in. These slums / hutments cover 0.59% of total node area and houses 46.83% of population of Turbhe, which suggests density. Some of these are also under high tension wires or near nallahs thus increasing vulnerability especially during rainy season.

Field interactions revealed that Turbhe has several informal settlements which are highly congested and vulnerable. Some of these informal settlements cater to the immigrant population who have come to Turbhe in search of work and are employed in mining jobs, later during rainy season when the work is stopped they move to other places in search of job. This floating population is one of the challenges that Turbhe faces. Moreover, Turbhe has a large population of people who fall into High Risk Group category as it houses one of the biggest red light area in NMMC and has a problem of drug pedalling as communicated by several people in the communities that the research team visited. Also due to the presence of a huge agro-produce market heavy vehicle movement is seen which needs adequate space to move and park. Heavy vehicular movement leads to increased pollution and dust in the air as well increases the vulnerability towards accidents.

Figure 5-41 Slum Location – Turbhe

[18] www.Censusdata.gov.in



Source: AutoCAD Map, NMMC, TP Department

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented houses own the assets inside the house. The vulnerability of those who live in rented houses is potentially higher. In Turbhe approximately 45% of the population resides in self-owned houses. Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts may be considered better than households without bank accounts. In Turbhe only 75% of population avail banking facility.

Table 5-29 Social Vulnerability Indicators - Turbhe[19]

S No	*Social Vulnerability Indicators / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Population density*					
2.	*Percentage of female population*					
3.	*Population below 6 years*					
4.	*Percentage of illiterate population*					
5.	*Percentage of SC & ST population*					

[19] Detailed analysis is given in the NMMC chapter and Turbhe chapter

S No	Social Vulnerability Indicators / Rating	High	High Medium	Medium	Low Medium	Low
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

In the table 5-28 all indicators except one are directly proportional to vulnerability i.e. higher the value, greater the vulnerability. However, banking services is a positive influence indicator, higher the value of parameter lesser the vulnerability, i.e. bank accounts can be of great help during a crisis situation. Therefore higher the value of this indicator, lesser the vulnerability.

The building stock of any locality has a direct impact on its vulnerability. The Land Use has to consider flood plain, seismic vulnerability, soil strata and the built environment has to be aware of hazards before selecting the building material. When the built environment is assessed based on Census 2011 data, the development pattern and degree of non-engineered construction becomes obvious.

When Turbhe is analysed with reference to housing vulnerability indicator, ward numbers 43, 57 and 61 have 5%, 2% and 1.7% of their building stock respectively dilapidated. Out of eleven wards of Turbhe 7 wards have highly vulnerable building stock with reference to roof material. In ward 59, about 80% of the building stock uses roof material which adds up to the vulnerability of the building. The material used for construction of wall increases the vulnerability and ward 59 and 57 have more than 30% and 10% respectively, of its building stock vulnerable. When the building stock is analysed based on the material used for construction, ward 57 and 59 emerge as wards in need of special attention and strict vigilance on new constructions.

Turbhe, like any other node of NMMC has jurisdiction issues with CIDCO and MIDC. Several times when a particular slum pocket or area is demarcated for demolition, the slum dwellers and local people use this issue as a tool and restrict the authorities from taking action. Similarly, MAFCO (Maharashtra Agro and Fruit Processing Corporation) market in Turbhe comes under the jurisdiction of MAFCO. Here some buildings are dilapidated and have been earmarked for demolition. MAFCO has requested CIDCO to clearly demarcate the area to be demolished along with proper paper work of occupancy so as to avoid issues post reconstruction. However, action; physical and administrative is yet to be taken. Such issues if not dealt with in a planned and coordinated manner could become a cause of concern should an event take place.

When Turbhe is looked at holistically, it is evident that more than 21% households in Turbhe do not have source of water within the premise of residence, 15% of the households do not have access to safe drainage and 34% of the households use unsafe source of fuel for cooking. When eleven wards of Turbhe node are analysed with respect to various physical indicators,

wards 41, 43, 57, and 61 have higher percentage of houses with unsafe drinking water, wards 41, 42, 59, 61, and 63 have higher percentage of houses with water source out of premises, wards 41, 43, 61 and 63 have higher percentage of houses with unsafe source of light, wards 43,59, and 63 have higher percentage of houses with no access to latrine, wards 41, 42, 59, 60, 61 and 63 have higher percentage of houses with unsafe drainage and wards 41, 42, 59, 60, 61 and 63 have higher percentage of houses that use unsafe medium as cooking fuel. This data indicates that except for ward 64 and 65 all the other wards of Turbhe needs systematic intervention on one parameter or other. Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. Fire fighters also act as first responders, a fire station with well-trained manpower and state of art equipment will always be an asset for the community.

The MIDC fire Station is located within the node. However there are jurisdiction issues when it comes to an emergency. NMMC has put up a request with the government to hand over the fire station to NMMC Fire Department; however this is still under process. Currently Vashi station serves the node. When the 10.5 sq.km radius is mapped, it is seen that most of the area is covered by the two fire stations, the NMMC fire station at Vashi and MIDC fire station at Turbhe, but the handing over of the MIDC fire station to NMMC will ease the issue further.

With population of about 1,37,864 the entire 11.52 sq. km. of Turbhe (as seen in the GIS map D7) is serviced by 4 hospitals / health posts.

In Turbhe, the map (refer map G7) shows most of the roads in the green category. However, in the image below the map, one can see many roads which are not captured in the GIS data. Thus a complete analysis could not be done. But as seen in most wards, the roads are narrow which will make it difficult for fire engines, ambulances and rescue vehicles to access and enter in case of a disaster.

Navi Mumbai is bound by the Parsik Hills, part of the Sahyadri Range on the east and the Thane Creek on the west, and the entire region naturally slopes from the east to the west. The region is the catchment of the various creeks, which form sub-catchment areas and drain off the rain water. Along the eastern edge of the node are hills which have witnessed mining activities and thus are vulnerable to landslides and consequently building collapse. When the mining activities are underway the area experiences high levels of air pollution and high levels SPM. During rains, the runoff from the hills carries the loose soil, covering the foothills with sludge and thus affecting the settlements in the area. Through discussions with the Deputy Chief Fire Officer, NMMC, it was understood that there are 6 low lying spots in Turbhe.

Table 5-30 Physical Vulnerability Indicators - Turbhe

S No	*Physical Vulnerability Indicators / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

The social and physical vulnerability of Turbhe as a whole falls in high medium to medium risk. But when the individual wards are analysed the disparity is very evident. Out of eleven wards of Turbhe except two all the other nine wards need immediate interventions in three or more parameters.

To overcome these vulnerabilities and to increase resilience of this node certain recommendation may be considered:

- Turbhe urgently needs one fire station, the possession of MIDC Fire station with NMMC will be of great help, process needs to be expedite;
- Local people need to be trained in firefighting and emergency response; especially in the congested market areas where large amount of flammable waste like cartons, boxes, papers etc. lies unattended.
- Dilapidated buildings should be inspected on priority and based on the analysis, either vacated or demolished or retrofitted.
- CIDCO should resolve issues such as that of MAFCO so as to avert impending disaster. Preparedness and trainings in the wards, localities and schools to raise the awareness would go a long way in saving lives should a disaster occurs.

- Ensure higher level of school coverage and increasing general literacy should also be a focus.
- Providing amenities and improved access to water, hospital and public transport needs considered and planned action with long term view of improving quality of life of people.
- Area specific mock drills, awareness programmes, workshops etc. to ensure better preparedness and preventive for informal settlements should be conducted.
- Marginalised and vulnerable population should be included in community drills
- Political leadership should be sensitized regarding the hazards in the area. GIS map to be updated to include recent developments in the city like critical infrastructure, roads, slums etc.
- Pollution due to mining and industrial belt is high. Therefore systematic measures need to be taken to avoid any health impact.
- Sludge disposal has to be addressed maybe by redirecting the sludge or usage for mine site rehabilitation or as landfill cover.
- Mutual response group to be made to tackle the jurisdiction issue.
- Periodic table top exercise to be followed by mock drills to be conducted to enhance coordinated response.
- Coordination with MIDC to be established for intimation of details of chemicals in drains and their disposal.

5.8. Nerul Node

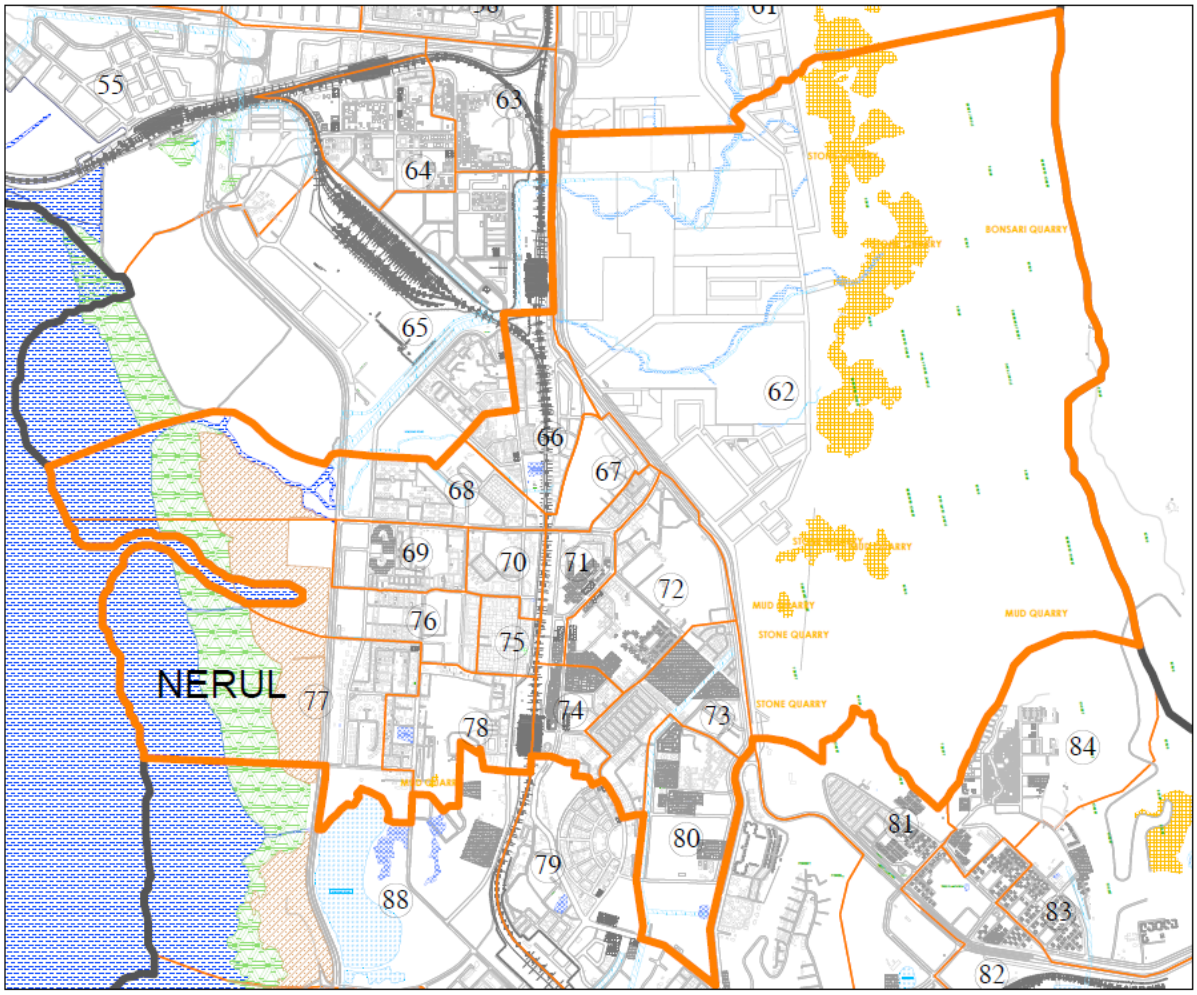
Note: Analysis is based on Census 2011 data and thus comprises of 89 electoral wards. Map in the chapter can be referred to for ward boundaries. Detailed chapter on node is placed at Appendix 10

Located in the central part of Navi Mumbai, Nerul has Turbhe to its north, Belapur to its south, Parsik hills to the east and Trans Thane creek to its west. **The ward officers and planners are therefore requested to refer to the reports of the adjoining nodes, Koparkhairane, Turbhe and Nerul for a comprehensive long term DRR approach to this node.**

It is the biggest node and most populated residential nodes of NMMC city with longest water front and many water bodies. It has longest segment of Mankhurd – Belapur - Panvel railway pass. After Vashi, Nerul is considered as the most developed node. It caters to several High Income Group (HIG) societies.

The Census 2011 divides NMMC into 89 smaller wards and Nerul as a node comprises 15 such Census (2011) wards. Spread over an area of 15.27 sq. km.

Figure 5-42 Electoral Wards – Nerul 2011



Source: AutoCAD Map, NMMC, TP Department

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire
- Floods and water logging and
- Building Collapse and Landslides

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through a rise in number of high rise building with central AC systems high-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire department aerial devices, and the chance of rescuing victims from the exterior is near zero once the fire is above the operational reach of aerial ladders or elevating platforms. The industrial area cuts through the length of the city, the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicator of physical and social vulnerability are considered these are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicators of social vulnerability on which data is available (Census 2011) are demographic, marginalized population, economic status and using these indicators all the nodes of NMMC were analysed.

NMMC has a total population of 11, 20, 547 (census 2011) out of which 1, 68, 647 (around 15% of NMMC population) reside in Nerul. Also, population density of Nerul is 11046 which is much higher than NMMC (8934). . The land use in Nerul is predominantly residential (29.70%), it caters to all the section of society. It is spread in 15.27 sq. km., ward 62 alone occupies 8.58 sq. km. and ward 68 and 77 together occupy 2.46 sq. km. remaining area of 4.22 sq. km. is distributed amongst remaining 12 wards. The population distribution is very uneven in this node; ward 62 with largest area caters to only 7% of the population whereas ward 78 with 0.44 sq. km. area caters to 13% of the nodes population. Ward 67 and 75 have high population density Population distribution information helps the city planners in assessment of casualties, determination of shelter needs and proper implementation of evacuation plans in pre- and/or post-disaster phases.

Female population comprises 46.64% of the total population of Nerul. Almost all wards of Nerul have percentage of female population more than the city average. The sex ratio is 874:1000, which is higher than the city's ratio of 837:1000. This node has 15% of NMMC's Female population. About 11% of the node population is below 6 years of age. Since women and children are more vulnerable during disaster, it is important to note that nearly 57% of the

node population falls into this socially vulnerable category. The disaster preparedness activities should include programmes for women and children and their caretakers.

From the perspective of marginalized population, Nerul houses 8.32% Schedule Castes and 1.36% Schedule Tribe population. Approximately 14% SC population and 17% ST population of NMMC reside in Nerul. Ward 62 has highest percentage of ST population and ward 69 has highest percentage of SC population. As per Census 2011 data, nearly 18% of people residing in Nerul are illiterate. In ward 62, 40% of total population is illiterate. . Certain sections of the society have limited access to resources and information. This skews increases in post disaster situation and thus need special attention in pre and post disaster situation.

39% of people residing in Turbhe are working, thus leaving 61% of the population under non-working category of the Census [population who did not participate in any economic activity paid or unpaid, this category includes students, persons engaged in household duties, dependents, pensioners, beggars, etc. provided they were not engaged in any economically productive activity during the last one year preceding the date of enumeration[20]] Out of the total working population of Turbhe (39%), 90% come under the category of main working population [Workers who were employed for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers] leaving 10% under the marginal worker category [Workers who worked for less than six months (180 days) in the reference period are termed as Marginal Workers.] Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

Data on slums have been collated from three sources; Census list of slums with number of households and population data, list of slums provided by NMMC ward officer and slums and encroachments as shown in Auto Cad drawings given by the TP Department, NMMC. The slums and encroachment as shown in the maps have been referred to as hutments hereafter. As per the various sources of data, there are no slums in Nerul (refer Map C8). However, during field interactions certain areas with informal settlements were located like Ramesh Metal, Shivaji Nagar, Bhonsari, Mahatma Gandhi Nagar, Shivaji Nagar and Chuna Bhatti. Most of these areas have comparatively better access except for Shivaji Nagar increasing the vulnerability.

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented houses only the assets inside the house. The vulnerability of those who live in rented houses is potentially higher. In Nerul approximately 40% of the population resides in self-owned houses. Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts may be considered better than households without bank accounts. In Nerul only 90% of population avail banking facility.

[20] www.Censusdata.gov.in

Table 5-31 Social Vulnerability Indicator - Nerul[21]

S No	*Social Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Population density*					
2.	*Percentage of female population*					
3.	*Population below 6 years*					
4.	*Percentage of illiterate population*					
5.	*Percentage of SC & ST population*					
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

In the table 5-30 all indicators except one are directly proportional to vulnerability, i.e. higher the value greater the vulnerability. However, banking services is a positive influence indicator, higher the value of parameter lesser the vulnerability, i.e. bank accounts can be of great help during a crisis situation. Therefore higher the value of this indicator, lesser the vulnerability.

The building stock of any locality has a direct impact on its vulnerability. The Land Use has to consider flood plain, seismic vulnerability, soil strata and the built environment has to be aware of hazards before selecting the building material. When the built environment is assessed based on Census 2011 data, the development pattern and degree of non-engineered construction becomes obvious.

When Nerul is analysed with reference to housing vulnerability indicator, ward 62 emerges as a ward requiring immediate attention. It has 6% of its building stock dilapidated, 92% of the building stock of ward 62 has vulnerable roofing, 31% has vulnerable wall and 9% has vulnerable floor material. Ward 69 also raises concern as far as building stock is concerned. Rest all 13 wards of Nerul score very less on all the parameters thus indicating a building stock built using better construction material.

Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event.

When Nerul node is compared with other nodes of NMMC, it emerges as a node with all basic amenities. It certainly has some areas with problems, 7% of the households have source of

[21] Detailed analysis is given in the NMMC chapter and Nerul chapter

water out of the premise of residence and also use unsafe source of light whereas 10% of household use unsafe fuel for cooking. But when all the wards of Nerul are analysed for the vulnerability parameters, ward 62 raises alarm. Ward 69 and 78 should also be attended to.

Nerul is located on rocky terrain thus issue of flooding and water logging is not a major issue with this node. Moreover places which had problems during heavy rain have been addressed by either widening the drains or joining few drains to segregate the pressure. But Railway colony at Juee Nagar is located in low lying area and falls in the jurisdiction of Railways, this area is extended support as and when required.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. Fire fighters also act as first responders, a fire station with well-trained manpower and state of art equipment will always be an asset for the community. Nerul has one fire station and also gets assistance from the MIDC fire station located at Turbhe.

With population of about 1,68,647 the entire 15.27 sq. km. of Nerul is serviced by one Government health post and 8 private hospitals.

Nerul also has network of road which is not mapped on GIS data. But, the map reveals that many roads are very narrow and can pose obstruction to free movement of emergency vehicles and personnel.

Located along the eastern edge of the node are hills which have witnessed mining activities and thus are vulnerable to landslides and consequently building collapse. Though mining activities are closed in most of the quarries, some areas it is still active. These active quarry remain close during monsoon season. Also during the rains, the runoff from the hills carries loose soil, covering the foothills with sludge followed by water logging. 5 low lying spots were mentioned during the discussion with the NMMC official. When mapped on the GIS maps, it reveals that these areas do not fall in the 10.5 km radii of the fire station thus increasing the access time having a direct effect on vulnerability.

Table 5-32 Physical Vulnerability Indicator - Nerul

S No	*Physical Vulnerability Indicator / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

The social and physical vulnerability of Nerul as a whole falls in low medium to low risk. But when the individual wards are analysed ward 62 emerges as highly vulnerable ward when analysed for physical infrastructure vulnerability.

To overcome these vulnerabilities and to increase resilience of this node certain recommendation may be considered:

- Nerul Fire station should be upgraded and better equipped;
- Local people need to be trained in firefighting and emergency response;
- Dilapidated buildings should be inspected on priority and based on the analysis, either vacated or demolished or retrofitted.
- Ward 62 needs immediate intervention.
- Ensuring higher level of school coverage and increasing literacy.
- Preparedness and trainings in the wards, localities and schools to raise the awareness would go a long way in saving life should a disaster occur.
- Providing amenities and improved access to water, hospital and public transport needs considered and planned action with long term view of improving quality of life of people.

- Agreement with CIDCO, Railway and MIDC is required for mitigation, preparedness and better coordinated efforts.
- A documentary on hazards and vulnerability for the masses can help drill the message of disaster safety.
- Cluster development to be explored in areas with informal settlements.
- Most of the informal settlements have open areas on all sides making it slightly easy to tackle emergency issues but Chunabhatti at Bhonsari and Ramesh metal at Mahatma Gandhi Nagar are very congested and need attention
    - Gaonthans do not comply with Environment Act, awareness can help achieve the compliance.
    - Sensitising the corporators or local leaders about the vulnerabilities can be a step towards making the people of informal settlements more aware of the vulnerability and mitigation measures.
- Due to soil strata and proximity to sea, the building stock needs engineering intervention.

5.9. Belapur Node

Note: Analysis is based on Census 2011 data and thus comprises of 89 electoral wards. Map in the chapter can be referred to for ward boundaries. Detailed chapter on node is placed at Appendix 11

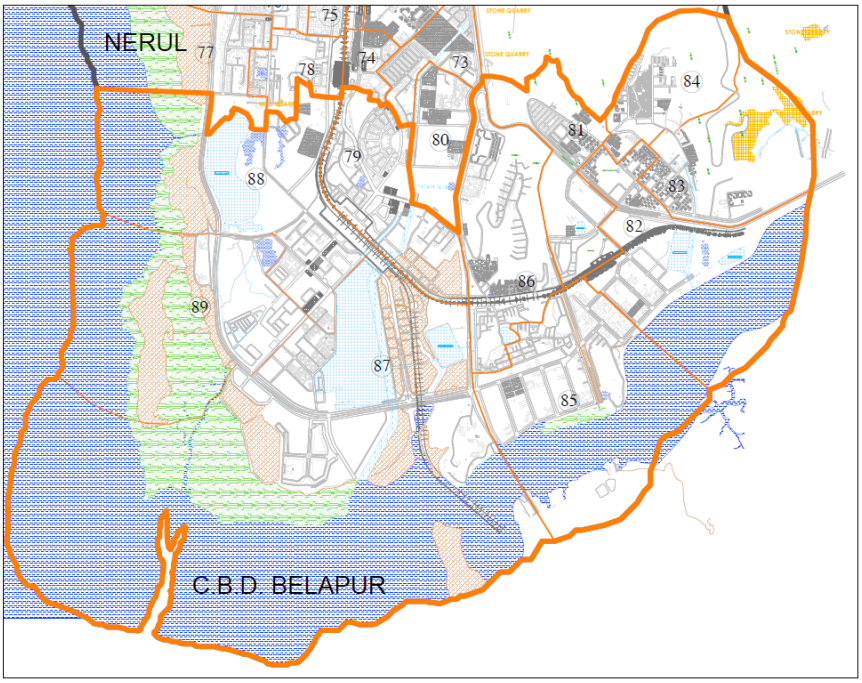
The southernmost node of NMMC, Belapur has Turbhe to its north, Thane Belapur road and Trans Thane creek Industrial area on the east and Trans Thane creek to its west. **The ward officers and planners are therefore requested to refer to the reports of the adjoining node Turbhe for a comprehensive long term DRR approach to this node.**

This area is most accessible within NMMC and is connected to Mumbai city through rail and road. It has state of art integrated railway station with shops, departmental stores, showrooms, communication centres, book stalls, restaurants and banks. It is blend of residential and commercial space. It is the main hub for commercial and official activities. Belapur is also important as regards to administrative purpose as many prominent central, state and local government offices are situated here.

Belapur along with Vashi node were amongst the initial areas to have residential population. Families began to reside here in early 1980s.

The Census 2011 divides NMMC into 89 smaller wards and Belapur as a node comprises 10 such Census (2011) wards. Spread over an area of 25.55 sq. km., Belapur is the second largest node of NMMC after Koparkhairane.

Figure 5-43 Electoral Wards – Belapur 2011



Source: AutoCAD Map, NMMC, TP Department

Based on the review of the past NMMC-City Disaster Management Plan and discussions with the officials from the corporation and local authorities, the node is analysed for following hazards:

- Fire
- Floods and water logging and
- Building Collapse and Landslides

In last decade, due to rapid urbanization, there have been several alterations in the natural drainage of the city leading to frequent flooding of certain areas. Development of the city is visible through a rise in number of high rise building with central AC systems high-rise fires represent an extraordinary challenge to fire departments and are some of the most challenging incidents a fire department encounter. High-rise buildings can hold thousands of people well above the reach of fire department aerial devices, and the chance of rescuing victims from the exterior is near zero once the fire is above the operational reach of aerial ladders or elevating platforms. The industrial area cuts through the length of the city, the proximity of residential area to the industrial area demand better planning and preparedness as it can result in an increased risk of serious health effects including but not limited to cardiovascular and respiratory illnesses. These areas are also vulnerable to fire and chemical hazards.

In order to help NMMC work on better preparedness and response, while listing and identifying the indicators, to ensure a more holistic study and analytically useful outputs, indicator of physical and social vulnerability are considered these are based on the data available in the Census and that which can be extracted from the maps. The vulnerability indicators are classified as Physical and Social. The Physical vulnerability is analysed based on living condition and physical infrastructure available at the household and ward levels. The indicator of social vulnerability on which data is available (Census 2011) are demographic, marginalized population, economic status and using these indicators all the nodes of NMMC were analysed.

The land use in Belapur is predominantly residential (17%) and 14% is used for commercial purpose. Being amongst the first few nodes to be developed for residential purpose, Belapur has homes build by several renowned builders and also caters to NRI population.

NMMC has a total population of 11,20,547 (census 2011) out of which 1,41,091 reside in Belapur (around 12% of NMMC population). Belapur is spread in 25.55 sq. km. Also, population density of Belapur is 5521 which is lower than NMMC (8934). Ward 87 is the largest ward of Belapur with 9.46 sq. km. area. Only ward 84 has 0.90 sq. km. area whereas all the other wards have area more than 1 sq. km. Ward 79, 84 and 86 are very densely populated. Ward 79 and 87 both cater to 14% of the total population of Belapur but because of the area, ward 79 is very densely populated. Population distribution information helps the city planners in assessment of casualties, determination of shelter needs and proper implementation of evacuation plans in pre- and/or post-disaster phases.

Female population comprises 48% of the total population of Belapur and caters to 13% of the NMMC's Female population. The sex ratio is 915:1000, which is higher than the city's ratio of 837:1000. 11% of the node population is below 6 years of age. Since women and children are more vulnerable during disasters, it is important to note that approximately 59% of the node population falls into this socially vulnerable category. The disaster preparedness activities should include programmes for women and children and their caretakers.

From the perspective of marginalized population, Belapur comprises 8.66% Schedule Castes and 1.79% Schedule Tribe population. NMMC's 11% SC population and 2% ST population

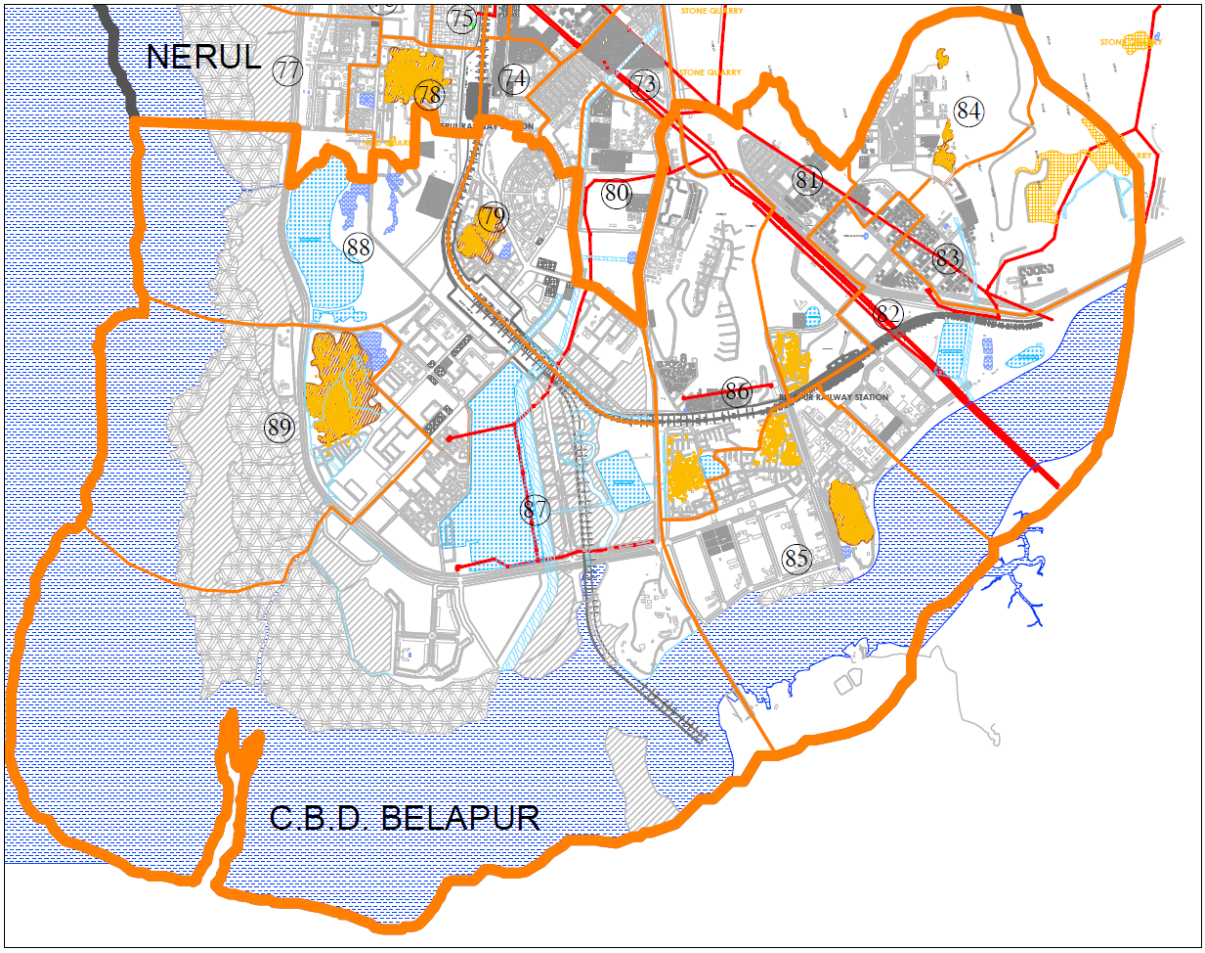
reside in Belapur. As per Census 2011 data, nearly 18% of people residing in Belapur are illiterate. Certain sections of the society have limited access to resources and information. This skews increases in post disaster situation and thus need special attention in pre and post disaster situation.

Workers who had worked for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers and Belapur comprises only 40% of such population thus leaving 60% of the population under non-working category of the Census (i.e. constituting of population who did not participate in any economic activity paid or unpaid and performing household duties like attending to daily household chores like cooking, cleaning utensils, looking after children, fetching water etc.) 90% of the total working population comes under the category of main working population leaving only 10% under the marginal worker category. Unemployment is relatively low and with the perspective of disaster management, the mobility of people in and out of their homes becomes a significant factor, should an event take place.

The Census 2011 data on slums with number of households & population data; NMMCs list of slums and encroachments along with the Auto Cad drawings given by the Town Planning Department, NMMC was collated, 5 slums / hutment pockets were identified in Belapur which accommodate 1.73% population of Belapur. Ward 89 has nearly 8% of its area covered by hutments. These slums / hutments cover 1.31% of total node area and only 1.73% of the total node population resides in these pockets.

Field interactions revealed that Jai Durga Mata Nagar, Ramabai Ambedkar Nagar, Sambaji Nagar, Urban Haat, Kille gaonthan are the areas vulnerable due to their location along the foothills of Parsik.

Figure 5-44 Slum Location – Belapur



Source: AutoCAD Map, NMMC, TP Department

It is rightly assumed that people who own a house have a larger resource base than those who do not and people living in rented house just own the assets inside the house. The vulnerability of those who live in rented houses is higher. In Belapur approximately 36% of the population resides in self-owned houses. Having a bank account is an asset and suggests savings of some sort. Thus in a disaster situation, households with bank accounts may be considered better than households without bank accounts. In Belapur 94% of population avail banking facility.

Table 5-33 Social Vulnerability Indicators - Belapur[22]

S No	*Social Vulnerability Indicators / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Population density*					
2.	*Percentage of female population*					
3.	*Population below 6 years*					
4.	*Percentage of illiterate population*					
5.	*Percentage of SC & ST population*					
6.	*Area of hutments in each ward*					
7.	*Percentage of marginal workers*					
8.	*Percentage of non-workers*					
9.	*House ownership status*					
10.	***Availing banking services***					

In the table above, all indicators except one are the indicators which are directly proportional to vulnerability, the higher the value greater the vulnerability. But banking services is a positive influence indicator, higher the value of parameter lesser the vulnerability, i.e. bank accounts can be of great help during crisis situation, higher the value lesser the vulnerability.

The building stock of any locality has a direct impact on its vulnerability. The Land use has to consider flood plain, seismic vulnerability, soil strata and the built environment has to be aware of hazards before selecting the building material. When the built environment is assessed based on Census 2011 data, the development pattern and degree of non-engineered construction becomes obvious.

When Belapur is analysed with reference to housing vulnerability indicator, ward 86 has nearly 5.6% of its building stock dilapidated. All wards of Belapur when compared with the city average for parameters related to housing vulnerability emerge as less vulnerable. This means that the building stock of Belapur has followed better construction material and construction practices. However, ward 84 needs to be attended for roof material and ward 85 for material used for construction of wall. Ward 82, 84 and 86 need to be attended for material used for flooring.

Good basic services and amenities ensure enhanced quality of life. Such communities are considered to be resilient and are better equipped to handle any disaster event. When node

[22] Detailed analysis is given in the NMMC chapter and Belapur chapter

Belapur is analysed with respect to various physical indicators few wards seems to be compromising on all parameters thus increasing the vulnerability.

Having a connection to tap-water within the premise ensures safe drinking water. This is significant for good health and for avoiding diseases. This is also important in disaster situation and can also supply during fire breakouts, thus reducing vulnerability. However, a source away from the house would increase vulnerability.

When all the wards of Belapur are analysed for physical infrastructure vulnerability, in ward 85, 3.3% household do not have access to safe drinking water, ward 82, 84, 85 and 86 need attention regarding the source of light, ward 81 and 82 need some attention on access to latrine and ward 84 for drainage and cooking fuel.

When Belapur is looked at holistically, it is evident that more than 0.8% households in Belapur are dilapidated, 9% household have used vulnerable material for roof, 5.5% household use unsafe source of light.

The node as a whole scores very low on almost all the vulnerability parameters but some wards need attention in specific area as mentioned above.

Basic facilities which help the city to cope with any disaster event are availability of wide roads, connectivity to various means of transport, good health facilities, open spaces, and an efficient fire station as each of these play a major role in evacuation and speed of response. There is one fire station in Belapur which efficiently covers the entire node.

The node has identified schools / colleges as emergency shelters they are:

a. Schools /College-

   i. Vasudev Balvant Phadke, Artist village

   ii. Bhatiya Vidyapeeth College for Hotel Management

   iii. Vidya Prasarak High School, Belapur Gaon

   iv. DAV school

   v. Don Bosco School

b. Maidan (earmarked for emergency evacuation)-

   i. Sunil Gavaskar maidan

   ii. Yashvant Rao Chauhan Maidan

   iii. Ganpatsheth Tandel Maidan, Karve Gaon

This is a good step towards preparedness but it is advisable to adopt mitigation measures so as to avoid emergency evacuation and disruption of functioning of schools and colleges.

The data on exact number of Government hospitals or health posts along with private hospitals was not available with the ward office but the GIS map D9 provided, does show a few.

Belapur also has road network with 15 mts. and 6mts width but few roads are very narrow posing hurdles during emergencies.

With 2 low lying spots and settlements along the eastern edge of the node where mining activities are seen, vulnerability to flooding increases. Localities near hills are vulnerable to landslides and consequently building collapse. Also during the rains, the runoff from the hills carries the loose soil, covering the foothills with sludge causing water logging. Belapur gaonthan, Saiwadi, Koliwada, Karave village are few localities which face water logging problem. Good drainage system can solve this problem.

Table 5-34 Physical Vulnerability Indicators- Belapur

S No	*Physical Vulnerability Indicators / Rating*	*High*	*High Medium*	*Medium*	*Low Medium*	*Low*
1.	*Dilapidated housing*					
2.	*Vulnerable roof*					
3.	*Vulnerable wall*					
4.	*Vulnerable floor*					
5.	*Proximity to water body*					
6.	*Proximity to sloping or quarrying site*					
7.	*Unsafe source of drinking water*					
8.	*Water source out of premises*					
9.	*Unsafe Source of light*					
10.	*No access to latrine*					
11.	*Unsafe Drainage*					
12.	*Unsafe Cooking Fuel*					

To overcome these vulnerabilities and to increase resilience of this node certain recommendation may be considered:

- Belapur Fire station should be upgraded and better equipped;
- Local people need to be trained in firefighting and emergency response;
- Dilapidated buildings should be inspected on priority and based on the analysis, either vacated or demolished or retrofitted.
- Ensuring higher level of school coverage and increasing literacy.
- Preparedness and trainings in the wards, localities and schools to raise the awareness would go a long way.

- Providing amenities and improved access to water, hospital and public transport needs considered and planned action with long term view of improving quality of life of people.
- Informal settlements on the slopes or at the foothills of mountain in Belapur have led to several causalities due to falling rocks in past. Necessary preventive action should be taken. Either people should be restricted from building in this area or better preparedness and mitigation measures should be adopted.
- Drainage system needs to be relooked.
- Personnel from all departments should be trained in various aspects of disaster management.
- A ready reckoner with all the important helpline numbers for community should be prepared.

5.10. Observations and Recommendations

Disasters present challenges at different scales (the community, city and even the region) Therefore actions are required at different scales. Actions directed at reducing vulnerabilities at the city level require addressing systemic issues (such as such as water shortages and drainage clearance), and increasing the coordination and technical capacity of city agencies. These measures need to be implemented in conjunction with actions focused on the community scale, at specific vulnerable sites, and for vulnerable groups. Local communities should be empowered to take actions locally.

Presented below are a set of observations and recommendations at various scales for NMMC that would help reduce disaster risks and vulnerabilities, especially social vulnerabilities.

1. **Coordinated functioning**

- Navi Mumbai includes areas that are managed by NMMC, CIDCO and MIDC. There is some overlap and inadvertent intrusion into each other's jurisdiction, which creates complications and neglect. It would be useful if arrangements for coordinated functioning for disaster risk reduction and resilience building (mitigation, preparedness and response) are developed carefully. This will help avoid duplication and desertion during disaster events.
- Periodic joint meetings and exercises could foster greater coordination and role clarification.

2. In order to reduce vulnerability to disasters, the administration should **focus on legal and institutional frameworks**. Attention must be paid to the capacity of natural and social systems to absorb both exogenous and endogenous changes within the city. It is not enough to focus on a set of policies and instruments, but also to understand the intimate relationship between natural or physical and social factors. An assessment of the coping capacity of the wards and the city as a whole can only be done internally by each department working and reflecting in tandem with one another. Institutional arrangements for responding to various hazards must be reviewed periodically.

3. **Responsibility** needs to be placed with a specific unit or department (in rotation perhaps) at the city and ward level with appropriate personnel and budget provisions. The personnel will need training and capacity building and will require basic understanding of risk reduction approaches, tools and policies. Budgetary allocation for disaster risk reduction will enable the responsible department [s] to take decisive and positive actions at various levels.

4. **Shifting Boundaries and cascading impacts**

   Navi Mumbai is divided into 89 electoral wards (Census 2011), but these ward boundaries are dynamic and change, based on the population density. It is recommended that the ward officers within each node be made aware, in detail, about the issues of the neighbouring wards. This is because a particular area which is part of one node at a given point in time might move to another, to suit the administrative

requirements. Events or conditions in the neighbouring ward are likely to have a cascading impact and recognition of mutual vulnerabilities is important.

5. **Rapid urbanization** of the periphery of NMMC and CIDCO, the changing landscape along the coastline, destruction of mangroves and natural drainage systems during infrastructure development- all threaten to affect the city's long-term environmental sustainability by damaging the natural ecosystems, water bodies and wetlands. Immediate term measures are necessary to restore the city's medium and long- term ecological balance. Reduction in the rate of depletion of ecosystem services, improvements in urban land use, strengthening of rural livelihoods, specific advances in urban and rural governance, enhancing awareness, capacity building of the communities and poverty reduction are some of the effective long term strategies.

6. **Expanding city limits:** Well-planned urbanization presents an opportunity for disaster preparedness especially natural disasters, and factor in adaptation measures for local manifestations of global climate change. On the other hand haphazard urbanization will drastically increase the vulnerability. The rural to urban conversion along the peripheries of the city will increase vulnerability to hydro- meteorological hazards if measures are not taken to:

- restrict the spread of settlements to areas disconnected from public service networks,
- allocate sufficient resources to areas of rapid population growth and critical systems (i.e. the water supply system),
- ensure traditional activities and sustainable livelihoods of communities displaced by new developments, so that they are able to avail of the development opportunities and ensure social and economic inclusion.

7. Addressing the **needs of those living in informal settlements**: The planned city of Navi Mumbai has a considerable population living in informal settlements which lack access to basic services including storm water drainage and sanitation. Ensuring these basic services will have a positive impact on the lives of the residents, in terms of better health and living conditions, whilst also reducing the vulnerability of city-dwellers to future extreme climate events.

8. **Fire Stations**

- **Avoid overstretching:** The Fire stations at Navi Mumbai in tandem with the MIDC Fire Stations have been performing well but the fact remains that these are over stretched.
    - **Upgradation** of already existing fire stations with state of art machinery and more trained personnel is recommended. **NDMA guidelines** on 'Scaling, Type of Equipment and training of the services' may be followed.
    - **Installing new fire stations** as proposed in the Navi Mumbai Municipal Corporation Fire Hazards Response and Mitigation Plan, 2010 should be taken up on priority.

- **Informed Fire Stations**: Keeping in view the proximity to Industrial area, a blue print of the industries along with the details of hazmat should be made available to the local fire station. An agreement or MoU may need to be worked out between NMMC,

MIDC and industries located in the area.

- **Mini fire stations or Mobile Fire Motor Cycle**: Nodes and wards with hutments and narrow roads, inaccessible to the fire tenders should be provided with mini fire stations or mobile fire motor cycle.

- **Updated GIS map** of Navi Mumbai with all roads and critical infrastructure to be provided for decision support system to all response agencies who may find it useful to have them framed in their office for immediate reference.

- **Periodic Trainings**: Fire Personnel should undergo periodic training as they are the first responders during any emergency. This could also include familiarity with the Incident Response System.

- **Mutual aid response group** to be formed between all agencies to work on issues related to jurisdiction

- **Periodic table top exercises and mock drills** to be conducted for better coordination and familiarization.

- **Height of the buildings** to be restricted (Thane model to be used as reference)

- As SFAC norms are dynamic, a **periodic assessment** status of Fire Brigade should be done and changes to be implemented on priority.

- Citizens (occupants / owners) must be encouraged to inform authorities about structural changes or modifications made to the building after the issuance of commencement certificate.

- Upgradation plan for fire stations to be prepared:
    - Short term plan: This may include purchase of mini fire stations and also assessment of old buildings followed by necessary action (repair, evacuation, retrofitting.)
    - Long term plan: Based on the recommendations and SFAC norms, new fire stations may be sanctioned.
    - Plots for new fire stations need to be earmarked beforehand.

9. **Maintaining tree cover, open spaces, water bodies**: Floods are caused by the uneven distribution of rainfall, rapid urbanization, and the encroachment into and the filling up or blockage of natural drainage channels and urban lakes. This may be due to various reasons such as the construction of buildings on high-value urban land. Informal or low income settlements and the lack of proper planning for these, often means that they lack drainage systems, thus making them particularly vulnerable to flooding.

- By **restoring wetlands and urban water bodies**, the risk of flooding can be reduced. Restoration may also help provide an alternative water source in a context of growing water scarcity.
- **Avoid ad hoc, stopgap measures**: It is observed that stopgap or interim measures are adopted to deal with recurrent problems instead of implementing long term and

technically sound ones. For example: certain areas in NMMC experience water logging when heavy rain is accompanied with high tide. Ward officers have found a temporary solution to this problem. They either evacuate the residents or use pumps to flush out the water. Pumping the water out is effective but places where this solution fails, need attention. Possibilities of systematic channelising of water into holding ponds or nearby water bodies may be explored.

- **Maintaining inhabitable area**: Several unauthorised residential areas come up in low lying areas. It is recommended that this should be strictly regulated and such areas need to be marked unfit for residential activity by the DP department as they create potential vulnerabilities.
- **Maintenance of drainage to avoid flooding**: During heavy rains, sludge from the Parsik hills (due to mining activity) flows into the settlements and the industrial belt below, creating filth and water logging. It is recommended that proper drainage of water is created to avoid flooding.
- **Desilting, deepening and clearing of dumped solid waste** from water bodies, nallahs or streams, clearing the criss-crossing communication cables and utility pipelines- all need to be undertaken as a priority to reduce disaster risks.

10. **Hazard risk-reduction strategies**: The analysis of the city's coping capacity shows that their hazard-reducing measures are limited. Existing inadequacies in the implementation of building bye-laws and codes, development control regulations and land-use planning guidelines should be addressed and used to strengthen the compliance framework for addressing urban risk reduction issues. Coordinated activities with the District Disaster Management Authority and neighbouring panchayats for disaster preparedness, response, mitigation and climate change adaptation need to be specifically designed and undertaken with urgency.

- **Preventing casualties due to building collapse:** Building stock of Navi Mumbai shows a varied type of construction. Some areas have planned high rises whereas some areas have haphazard non engineered constructions. Some are constructed as per government permit whereas some are unauthorized. It was observed that some of the dilapidated buildings have been either evacuated or repaired but some are still occupied. Moreover census data also points to vulnerability due to construction material used. Thus it is recommended that:
    - Residents of dilapidated buildings may be asked to undertake evaluation through authorised structural engineers and based on the result, either evacuate or repair the building.
    - Better vigilance to stop unauthorised construction.
    - Building bye laws be strictly implemented.

Implementing stringent rules and measures especially for old buildings is suggested to avoid building collapse related injuries and deaths.

11. **Mangroves**

Policy decision is needed regarding the removal of mangroves from the holding ponds. Mangroves are important coastal environmental resources which provide habitat for marine species and protection from extreme weather events. But in holding ponds they do not perform any of these functions. Rather they hamper the holding capacity of these ponds. Permission may be given to remove them.

12. **Updation and periodic revision of HRVA**: this social vulnerability assessment should be viewed as a base document which must be updated and revised periodically. (Say every two years.)

13. **Developing in-house capacities** through which all staff across departments maybe trained on various aspects of disaster management will help mainstream disaster risk reduction. Developing capabilities for conducting a detailed HRVA is recommended. A consultant's report is most likely to sit on shelves and not internalized by the administration.

14. **Systematic Training**: Periodic training on various aspects of disaster management should be conducted for all government employees. Printing and dissemination of IEC material by each department would help. Currently there are only pre monsoon preparatory meetings that take place to discuss communication and response strategies. Table top exercises would also help.

15. **Community Preparedness**: Awareness generation on DRR preparedness through campaigns and prevention, should be organised periodically and systematically. Preparedness and trainings in the wards, localities and schools will help raise awareness. Mock drills and social audits should also be conducted with participation of the community with coordinated action from various departments.

16. The city's resilience would be enhanced by augmenting **its governance capacity on disaster risk reduction**. Introduction of capacity building programme for government officials and City Councillors in order to enhance understanding and raise awareness about: i) budget allocations for climate change and disaster risk reduction related projects, and ii) the need to monitor actions and implement the plans through the lens of "disaster audit", could go a long way in DRR.

17. **Mainstreaming and Forward Planning**: A futuristic understanding of how the region is growing with an awareness of the need to check newer risks and vulnerabilities, moving beyond disaster response to prevention is recommended. All new projects proposed by different departments must interface with planning department systematically. Mainstreaming DRR or even a 20 year development vision requires considerable effort and the idea of possible disaster must be included in the development plan of the city and the region around it.

18. **Disaster Management Cell**

- The current shape and size of the room where the DM cell is housed (approximately 350 sq ft) are grossly inadequate for crisis situations or for disaster management teams to function during an emergency. Either a bigger room should be allocated or an alternate room needs to be identified as EOC which can be used during an emergency.
- This room does not have any windows. It therefore compromises on ventilation and also visibility of the surrounding for better situational assessment. ("In case of heavy downpour we have no way of knowing the weather condition", was the lament of the staff!)

- The room should have dynamic layouts as different emergencies will require different setups. The communication system available should be detachable, so that it can be moved to other location if required until larger space is allocated for EOC.
- The communication system needs to be upgraded; communication equipment (such as SAT phones, Wireless Set, HAM Radios) with trained personnel may be considered.
- Updated GIS maps with locations of critical facilities clearly marked are required to be put up on the walls for rapid decision making.
- Currently the DM department is understaffed (3 - 4 personnel are present in the Cell at any given point of time). More staff with good grounding or training in DM is required. Personnel in DM Cell should be well aware of the potential hazard situations in the city (Navi Mumbai) and should be able to mobilise initial support during emergencies.
- As the formal systems and directives on Disaster Management from the state and centre are expanding, it will be beneficial if the personnel at the DM Cell / department are abreast with all the current policies, plans and decisions taken at the central level as well as best practices from other cities. They should work towards periodically upgrading and applying these guidelines to respective departments of NMMC.
- Agreements and joint exercises with various stakeholders (like railways, industries, private hospitals, schools, marketing co-operatives, warehouses, residential societies etc) for support and enhanced coordination during emergencies would help.
- Hazard based SOPs should be prepared. All departments need to participate in periodic hazard based exercises for better preparedness. The outcome of these exercises should be used to amend SOPs and should feed into periodic updates of Disaster Management Plans.
- EOCs at the ward level will be an added asset. If not, Control rooms or equivalent entities may be set up in all wards. This EOC should have the basic infrastructure for disaster response, should an event occur.
- Video conferencing with ward officers, Fire control room, Mantralaya control room will help establish a system which will be able to respond with speed. This can also be utilized for providing training for disaster preparedness and to bring in experts from across the country to review, train and update emergency systems. The city should strive to continuously update its DM response capabilities.

19. **Ready Reckoner**: Node wise reckoner enlisting the problem areas along with SOPs should be prepared for all ward officers. This will come handy for orientation of new officials in each ward, build institutional memory and enable efficient response in situations of emergencies.

20. **Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA):** Both these represent policy goals, one concerned with an ongoing problem (disasters) and the other with an emerging issue (climate change). Navi Mumbai is relatively less vulnerable to natural disasters (compared to many other cities) but there is a possibility of increase in the frequency and intensity of disasters due to climate change. As a priority, the City should concentrate on disaster risk reduction, climate change adaptation and resilience building. Some of the actions suggested are:

- DRR and CCA must be implemented through the policies of other sectors and departments, in particular, those of industry and agriculture, water resources, health, education, sanitation, land use, environment, finance and planning.
- Linkages with other policies, most notably poverty reduction, public health care, education and planning for sustainable development, should be the focus. It would be

prudent, therefore, to consider them and implement them in a systematic and integrated manner with a long term vision.

- Declaring 'pedestrians only' streets
- Ensure at least a 1:30 green area ratio in the city at plot level, street level, ward level, region level and city level
- Subsidy in taxes for households without vehicles using petroleum fuels
- Promotion of "reduce, reuse, recycle" policy with regard to waste management
- Motivating housing societies / wards to segregate garbage and work on ideas of composting, vermiculture, etc.
- Around every bridge and culvert in the City, a voluntary team in collaboration with civil society organizations such as residents' associations may be formed by the City to oversee the cleaning and clearing of any blockages due to waste dumping or siltation on a regular basis.

Conclusion

Navi Mumbai is a multi-hazard prone region vulnerable to natural disasters like earthquakes, floods, landslides, and manmade disasters such as road accidents and fires etc. Human activities disturbing the ecological balance in most cases directly results in disastrous events or exacerbates a natural hazard. With projected increase in the frequency and intensity of extreme events including cyclones, droughts, and floods, disaster management will need greater attention.

Disasters erode environmental and social resilience, and thus increase vulnerability to climate change. Moreover climate variability is projected to result in more frequent and intensive disasters - with the most severe consequences on infrastructure, food security and livelihoods of natural resource and dependent vulnerable communities. Since both disaster risk (including climate associated disaster risk) and climate related vulnerabilities are likely to undermine the economic sustainability and development, it is important that planned disaster risk management strategies and climate change adaptation be integrated in context of development and development planning. The physical and social determinants of disaster risk and climate vulnerabilities are dependent upon the intensity of the extreme events and the level of exposure and vulnerability. The impacts of hazardous physical events including climate extremes disproportionately affect resources, poor communities with little access to alternatives, exposure, and vulnerability. Strategizing disaster risk mitigation techniques (reactive, adaptive, and anticipatory) or adaptation planning therefore requires a thorough assessment of the social profile including the vulnerability of a region; exposure of the community to extreme events or chronic risks, development practice and preparedness. The plan should therefore be to improve resilience by a better understanding of disaster risk, foster disaster risk reduction and promote continuous improvement in disaster preparedness, response, and recovery practices.


AIROLI
GHANSOLI
KOPERKHAIRANE
PARSIK
HILLS
VASHI
NERUL
BELAPUR