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Socio-Ecological Resilience of Peri-Urban Coastal Areas Climate Change and its Impact on Urban Peripheries of Mumbai

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Abstract: Coastal areas face multiple risks related to the climate change crisis and allied bio-geoclimatic variability thus affecting a large population. Vulnerability of coastal areas to climate change is an issue that has gained attention globally. Peri-urban areas in the global south have peculiarities and challenges which are different from urban cores and these needs to be addressed while dealing with issues of ensuring resilience. They are often characterized by communities whose existence and livelihoods have been traditionally dependent on the environmental resources which are undergoing rapid change with time. Through a diachronic understanding and a detailed community survey, the study approaches the issues with socio-ecological resilience of three peri-urban communities and their vulnerable habitats north of the city of Mumbai, along the River Ulhas. The study brings out the importance of expanding the understanding of socio-ecological resilience to include ‘everyday resilience’ to address the vulnerabilities faced by the coastal peri-urban communities.

1 Introduction

Cities are ‘systems of systems’ and are in constant change. The nature of cities—their infrastructure, environmental resources, consumption patterns and socio-economic systems—have profound consequences on our planet and her people. Even though cities may seem spatially and socially separate from rural areas, they are connected to a much larger shadow region for their survival. The human imprint through agriculture, urbanisation and industrialization has induced conspicuous and irreversible changes in the atmospheric, biochemical and geological characteristics of the planet that it requires for an entirely new epoch:

‘The Anthropocene’ to be coined to describe the current ecological reality of the planet (Curtzen, 2002). The current ecological reality of this modified land-water systems are probably most apparent in the peri-urban edges of coastal cities wherein both social and ecological systems are embedded into a modified geography—one that has been obliterated by the anthropocentric activities rather than the natural processes which have been acting on it for years.

Mumbai along with its peri-urban conglomeration is symptomatic of a 21st century city with rising inequality where risks and opportunities are not equally shared by all the city dwellers (Gangan, 2017). In a space crunched city as contested as Mumbai,

the marginalized socio-economically weaker sections are often pushed to occupy lands that are highly vulnerable to climate change related stress like flood risks, coastal erosion, sea level rise related inundation or landslides. A cursory aerial survey of the city of Mumbai reveals the inequalities in the city. The majority of slums and densely populated informal settlements are concentrated on either erstwhile wetlands or on precarious slopes of the vestiges of the hillocks in the city. These informal settlements take the position of ‘encroachments’ on land which was left ‘unbuildable’ by the city planners in the past, thus rendering them illegal as well as highly vulnerable to disasters. Most of these lands supported diverse biodiversity in the past which has now been erased.

1.1 Ecological resilience and systems theory

Resilience, in the ecological domain, has been defined as “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.” (Walker, 2004, p. 5). The goal of ecological resilience thinking is to identify and avoid thresholds that will lead to undesirable “regime shifts” in natural systems. An ecosystem can fluctuate between different states within a general “stability basin” or “regime,” but can also flip into a dramatically different state if the key thresholds are crossed (Harte, 2009). These often lead to irreversible changes in the ecosystem affecting the communities dependent on them.

Ecological resilience thinking is rooted in systems theory, which holds that nothing exists in isolation (Kresge Foundation, 2017) and not in the usually accepted worldview which reduces systems to their component

parts. Cities are viewed as complex human-dominated ecosystems in that they are diverse and composed of multiple, interconnected elements; they are adaptive in that they have the capacity to change and self-organize.

Resilience thinking has evolved in the recent decades to accommodate the advancements in understanding of the ecological equilibrium states. The theory on ‘Socio-Ecological Resilience’ addresses the newer understanding that ecosystems are continuously changing and there does not exist one constant equilibrium. Socio-ecological systems are complex adaptive systems wherein agents often interact in unplanned and unpredictable ways to internal as well as external shocks and stresses (Folke, et al., 2016) . Socio-ecological resilience gives emphasis to persistence, adaptability, flexibility and the potential of the human agency to transform its surroundings (Holz, 2017).

Vulnerability, resilience and adaptation are interrelated concepts. Vulnerability has been defined as the flip-side of resilience, when a socio-ecological system loses its resilience and becomes vulnerable to changes that could have previously been absorbed by the system (Kasperson & Kasperson, 2001).

Adaptability refers to the ability of species to sustain, innovate, and improve the development on current pathways, while transformability refers to shifting development into newer pathways including creating novel ones (Walker, 2004) (Folke, et al., 2016)

1.2 Vulnerability of Coastal Areas to Climate Change

Mumbai is one of the twenty megacities in the world. Fifteen of these twenty cities, including

Mumbai are located on the low-lying coast. According to the World Bank, “more than 600 million people globally live in these low elevation, high risk coastal zones.” (World Bank, 2010, p. 91). Coastal areas face multiple risks related to the climate change crisis and allied bio-geo-climatic variability thus affecting a large population.

Vulnerability of coastal areas to climate change is an issue that has gained attention globally but most studies and research regarding the same focuses on the urban cores mostly in the global north due to their prominence. The research outcomes of urban cores may not be enough to understand the issues of peri-urban areas especially in the urban peripheries of the cities in the global south. Peri-Urban zones have peculiarities and challenges which are different from urban cores and these need to be addressed while dealing with issues of ensuring resilience. They are often characterized by communities whose existence and livelihoods have been traditionally dependent on the environmental resources which are undergoing rapid change with time. This is especially true in the cities of the global south since the nature of urban peripheries are far more complex and interrelated with the larger environment in these regions. The fact that most of the large coastal cities in the global south are concentrated in the tropical zone only emphasizes the need for research in this realm.

The questions of resilience and vulnerability are often either related to either preparing for a ‘catastrophe’ or for ‘post-disaster management’. However, in the cities of the global south, the questions of ‘everyday resilience’ are pertinent. This is especially true when dealing with communities whose livelihoods heavily dependent on the environment/seasons are often ignored in the studies. The coastal peri-urban regions of the global south not only are vulnerable to climate related vagaries but also

to the impending urban pressures of sprawl which often threaten their land holdings and their communities’ livelihood. The lack of infrastructural inputs due to myopic planning policies also make these communities vulnerable, not just, to climatic incidents but also for their sustenance.

2 Case selection

2.1 Need and Inquiry

The focus of the study centres on the threatened communities, their vulnerable habitats and their environment dependent livelihoods which may be affected adversely by the frequent and erratic climatic events often linked to the current climate crisis. The situation is aggravated by the fact that the governmental bodies, professionals and organizations in the countries of the global south, who are often responsible for management and ensuring safety of its citizens, do not necessarily have the right tool kits/indices for vulnerability assessment nor for ensuring resilience of such habitats. Their understanding of the concepts of resilience and vulnerability are limited to the studies which often concentrate on the cities of the global north.

A comprehensive understanding of the concepts related to vulnerability of coastal peri-urban conditions require inclusion of diverse case study sites since the land-water interface types could vary with respect to varying geographic conditions.

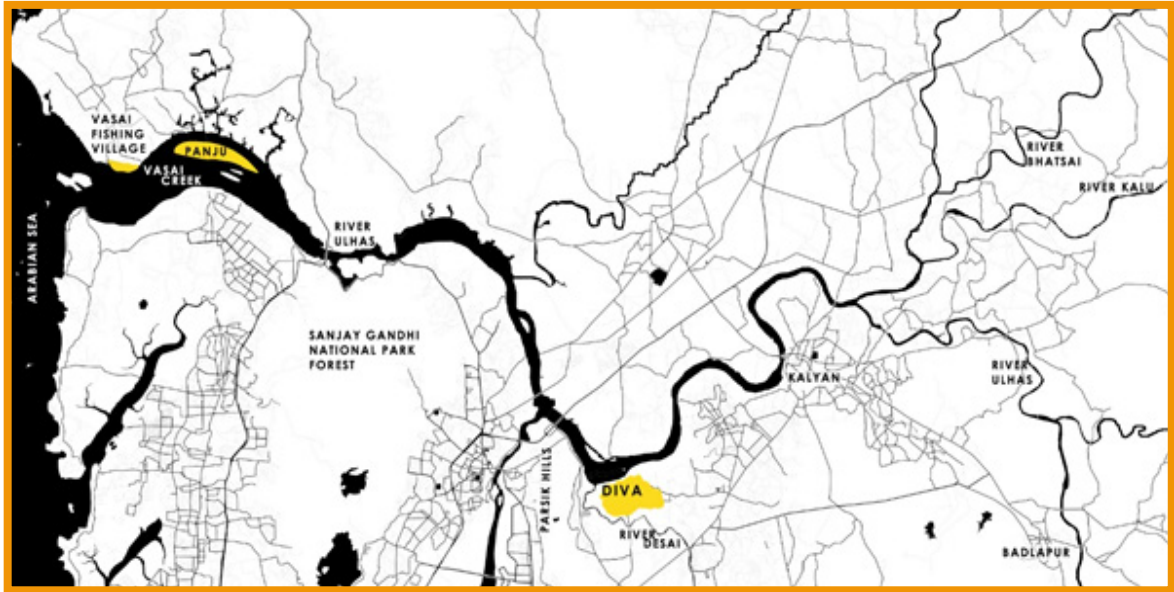


Figure 1 The Ulhas River Precinct along with the sites of the study

2.2 Placing Case in the Context

The case study sites are chosen based on the following criteria:

- a. They are peri-urban sites north of the metropolis of Mumbai city along the Ulhas River which separates the erstwhile Salsette Island of Greater Mumbai from the Mainland of the Indian peninsula-each of the three sites chosen are vulnerable to climatic change effects.
- b. Each of the sites has a distinct relationship with the water's edge- Coastal Edge settlement, Settlement on an estuarine island, a settlement on the Riverine Floodplain.

2.2.1 Ulhas River-An Introduction

Ulhas River (about 135 km long) originates in the rain fed forested mountains of the *Bhor Ghat* between the steep scarps of the *Sahyadri* and *Matheran* ridge. The river flows into the plains

past Karjat. Near Badlapur, the river is dammed as a drinking water reservoir for the satellite cities of Badlapur, Kalyan and Ambernath; beyond the peri-urban developments of North West Mumbai.

Ulhas River joins with its tributaries, River Kalu and River Bhatsai at the region east of Kalyan. The River then flows North and then turns west past the escarpment of the Parsik Hills (west of Diva) to develop an estuary. The estuary (often referred to as the Vasai Creek) is about 3 km wide near the sea mouth and joins the Arabian Sea south of the Vasai Fort and the Vasai Fishing Village. The island of Panju is located in this portion of the estuary. The river is distinctly tidal as far as the city of Kalyan.

The three sites identified (Figure 1) are as follows:

- a. *Vasai Fishing Village*
- b. *Panju Island*
- c. *Diva*

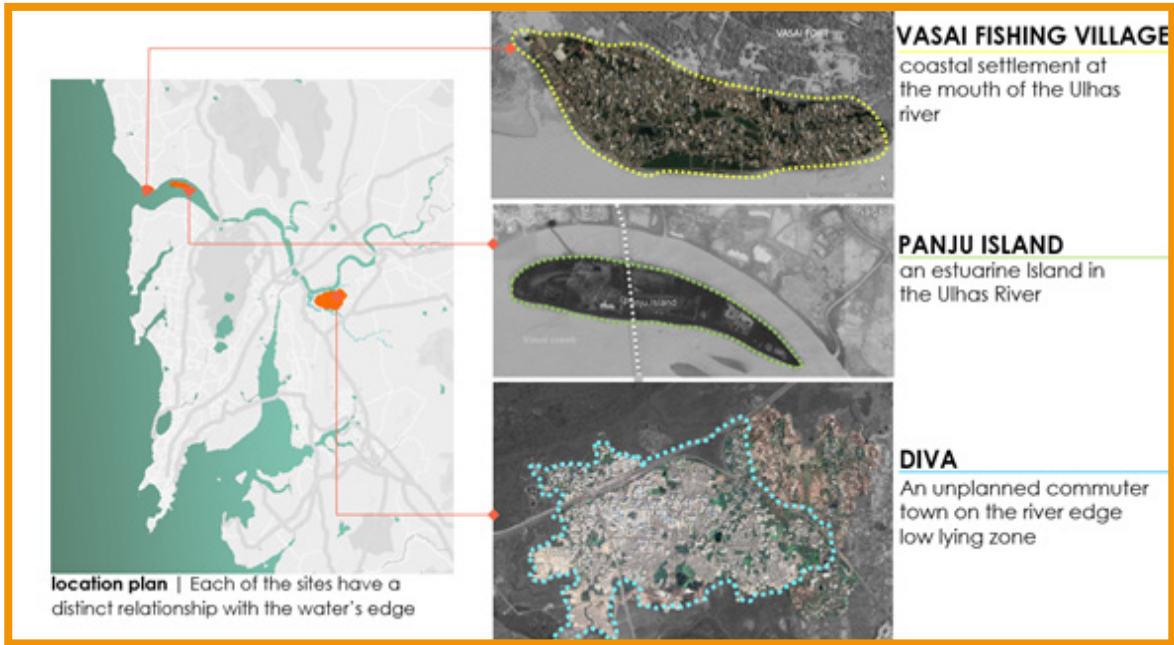


Figure 2 Location Plan showing the three case study sites –Vasai Fishing Village, Panju Island and Diva.

2.3 Case Study Site Profiles

2.3.1 Vasai Fishing Village

A coastal settlement predominantly occupied by fishing communities at the helm of succumbing to urban pressures located at the north of the Vasai Creek-Arabian Sea interface.

2.3.2 Panju Island

An estuarine island (with a general topography of about 1m above MSL) inhabited by agrarian/fishing/ salt pan-based communities with marked environmental/season based occupational patterns. The island is yet not urbanized due to its locational peculiarities and lack of direct road/rail connectivity to the mainland.

2.3.3 Diva

A river edge unplanned new town developed haphazardly along the Diva Junction Suburban Train Station. Formerly known as *Diva Gaon*, an agrarian based village, the urban extensions of Diva developed haphazardly in the last two decades especially post the extreme flood event in 2005 which affected not just Diva but the whole of the Mumbai Metropolitan Region (MMR). The flood affected the agrarian based livelihood of the people and prompted many to quickly convert their farmlands into shed like semi-permanent built structures which could then be rented to the migrant labourers who find it difficult to afford a place in the city.

3 Structure of the Study

The general structure adopted for the study is as explained in the following sections.

3.1 Literature Review for the study and its relevance

- a. The *first stage* of literature review dealt with the evolution of the concepts of urban resilience and its relationship with vulnerability and adaptability.
- b. The *second stage* of the literature review focused on the concept of ‘Socio-Ecological Resilience’ in particular.

The relevance of conducting the literature review in two stages is that it allowed for a thorough understanding of the current research and available knowledge pertaining to the topic.

3.2 Contextual Study adopted and its relevance

The *contextual study* was conducted keeping in mind the lack of relevant research in the context of coastal peri-urban areas in the global south. The stages of this framework involved:

- a. Identifying diverse peri-urban sites appropriate for representing the various geographic conditions of land-water interfaces.
- b. Collecting data pertaining to the sites which involved both anthropogenic as well as the other environmental entities.
- c. Formulating a thorough methodology which involves the analysis of the case study sites.

The results of the analysis were synthesised to identify embedded cues of socio-ecological resilience in the sites. The analysis also aimed to identify the lacunae in the current tools available to assess resilience in the peri urban areas.

The contextual study allowed for understanding the nuances of the site and the possibilities of leaning from the sites.

4 Research Methods

Both qualitative as well as quantitative research methods were used to collect data in this study. The Literature Review allowed for a clear understanding of the existing knowledge while the sites were analysed for its ‘diachronic’ history to understand the various bio-geo-climatic factors that shaped the site. This analysis also helped in understanding aspects which may have contributed to the present state of vulnerability of the landscape. The following methods were used to ascertain the various biotic and abiotic factors of the site:

Topography: Topographical sheets by the Survey of India were used along with data accessed through QGIS, open source Geographical information Systems software

Hydrology and water supply: The open source data available on the Central Ground Water Board web portal yielded maps which were used to ascertain the data. (Board, Central Ground Water, 2010)

Vegetation and Biodiversity: Literature review and field observations at the sites during the site visits. (MMR-EIS, 2012)

Occupation and Livelihoods: The Census of India Data as well as the field studies conducted by the

researcher and the students of KRVIA yielded the data for this aspect.

The anthropogenic factors in the diachronic analysis were assessed too in order to generate a thorough understanding of the evolution of the land and its changing relevance to the communities inhabiting the region.

The diachronic study was supported by visualisations of simulations of future scenarios of inundation extents with respect to sea level rise and possible flooding patterns to demarcate zones which maybe under varying degrees of vulnerability.¹

The study was backed by a detailed community survey which dealt with aspects of ‘perceptions of vulnerability’ and the well-being of the communities inhabiting the three study zones (Martinez & van den Bosch, 2019).²

Students pursuing the Postgraduate Program in Urban Design and Urban Conservation at the Kamla Raheja Vidyanidhi Institute for Architecture and Environmental Studies (KRVIA), Mumbai were involved in the survey. SPARC, Mumbai conducted a workshop with the students at KRVIA to sensitise them on the various aspects of undertaking a community survey and assessment of qualitative survey responses. The survey was conducted in the months of August and September 2019 in the three sites. The sample size of approximately 35 respondents was identified for the survey at each of these sites. The survey included both quantitative as well as qualitative responses.³

The results of the site analyses were then synthesised to arrive at the findings. These were crosschecked with the survey results and survey locations and the observations were noted.

The outcome of the study will be collated to form the basis to formulate Open Courseware (OCW) as well as Professional Development Programme (PDP) Modules that will be used for capacity building in higher education programmes pertaining to urbanism.

5 Analysis and Discussion

The sites chosen had peculiarities representative of the typical conditions of land-water edge types one may encounter in the coastal peri-urban areas. Each site had specific vulnerabilities and required a specific approach to ensure resilience. The issue of everyday vulnerability was distinctly seen in each site. The following are the observations from the sites and the inferential discussion based on the diachronic study as well as the community wellbeing survey for the three sites.

1 The simulated future scenarios were generated using freely available online tools from the following websites: <https://sealevel.climatecentral.org> and <https://www.floodmap.net/>.

2 The Community Wellbeing Survey was modelled on a similar study conducted in Enschede, Netherlands by Javier Martinez and Frans van den Bosch on behalf of the Community Well-being Institute, Seoul National University. The survey questionnaire was originally designed by the Community Well-being Institute for the study of six districts in Seoul, South Korea, then adapted for Enschede and it has been suitably adapted with the help of Javier Martinez, ITC, Netherlands and the Indian NGO Partner –SPARC, Mumbai for this research. The survey is attached as an annexure to this study.

3 Open source software Kobo Tool Box was used as a mobile data collection tool for conducting the survey. <https://www.kobotoolbox.org>



Figure 3 Vasai Fishing Village- Location plan, Projected Flood Affected Scenario and Site Photographs

5.1 Vasai Fishing Village: Understanding the site

The Vasai Fishing Village has a unique location of being sandwiched between the Arabian Sea towards the west, the Vasai Fort (a mediaeval fort built in the 12th Century by the Yadava Dynasty and later strengthened and used by the Portuguese during the 16th Century). The Vasai Fishing Village faces storm surges every monsoon and is also susceptible to severe wave action.

Topography: The settlement is spread on the basaltic rock strata on the eastern part of the village and spreads onto the erstwhile sand bar towards the west. The sand bar is highly susceptible to erosion. To prevent the erosion of the habitable land, the government authorities had in the past made a wave breaker of broken boulders. The docking piers are not protected, and this leads to erosion in selected patches.

Hydrology and water supply: The village has a few

aquifers protected from the saltwater intrusion. There are two wells in the settlement which still yield sweet water. However, these wells are overused and water problems in the village are acute. The water supply system to the village is also highly erratic and the situation is salvaged by the unsuitable method of providing water through the ‘Tanker Lorry’ which leads to the villagers being exploited on a daily basis. The tanker lorries are operated by private entities and they charge varying rates of money from the villagers. Also, the source of the water supplied or the quality of water are not being verified by any agency leading to higher chances of spread of diseases due to consumption of contaminated water.

Vegetation and Biodiversity: The Village has remnant patches of highly disturbed and degraded Mangroves. It is imperative to note that Mangroves have been identified as effective bio-shields against coastal surges and wave action (Sandilyan & Kandaswamy, 2015). The Vasai Fishing Village owing to its proximity to both



Figure 4 Panju Island- Location plan, Projected Flood Affected Scenario and Site Photographs

the Sea and the Estuary is rich in biodiversity as well.

Occupation and Livelihoods: The community is predominantly involved in fishing related activities. Ever since the fish catch near to the seacoasts have declined due to a variety of reasons; the fishermen engage in deep sea fishing. Most of the deep-sea fishing is carried out by migrant workers who seasonally migrate from the inland states of Northern India. The wholesale fishing market on the north of the site is one of the major wholesale markets of the Mumbai Metropolitan Region (MMR). The newer generations of the village are more inclined to pursue higher education and move into the city for employment.

Anthropogenic Influences: The edges of the Vasai fishing village have been altered over time. There are clear indications of increased reclamations into the sea edge and of filling up of the low-lying areas between the rocky shore and the sand bar. The wave breaker has also been constructed along the sea edge to prevent further erosion. The population of the village shows a steady increase and the building activity of the village has also seen a steady increase. The site has a

natural slope towards the west with natural depressions and the houses constructed do not seem to have taken into cognisance the drainage patterns of the land. This leads to water logging of certain zones every monsoon.

5.2 Panju Island: Understanding the Site

Panju Island is a natural island inhabited by around 1365 people (Government of India, 2011). The predominant portion of the island is covered by either mangrove patches or by the salt pans. The island does not have road/rail connectivity to the mainland and the only connections are either the boat service (suspended during the heavy monsoon months) or an elevated abandoned railway line which is used as walkway from the mainland to the island. The abandoned railway line does not have lighting, nor a proper railing making it highly dangerous for people to travel on.

Topography: The island is predominantly composed of alluvial silt deposited by the Vasai



Figure 5 Diva - Location plan, Projected Flood Affected Scenario and Site Photographs

River. The predominant portion of the Island is about 1 meter above the mean sea level. This makes it highly susceptible to sea level rise. Illegal sand mining is an issue along the water edge of the island.

Hydrology and water supply: The ground water in the village is saline and cannot be used for consumption. The ground water table is very high and this often creates problems like water seepage through the building floors and poor drainage as observed by the team during the rainy season. Water connection to the city is brought in from the mainland in Bhayander via a submerged pipeline in the estuary. The water supply is regular and the village depends on this one pipeline for its daily sustenance. The island's habitable zones which are relatively higher than the vegetated parts of the island predominantly used for agricultural usage and as salt pans. However, in the recent past there have been increased incidences of flooding during those periods of monsoon when the heavy rains coincide with the high tide in the estuary.

Vegetation and Biodiversity: The Island is predominantly covered with healthy mangrove

patches and salt pans. The mangrove patches are dense and support an appreciable biodiversity. The relative absence of pathways and access paths into the mangrove zones ensure minimal human interference. The salt pans are also home to a certain species of birds and halophytic plants.

Anthropogenic Influences: There is an ill-conceived proposal by the local government to build an edge wall to 'protect' the island from erosion and flooding. Moreover the Vasai Development Plan identifies Panju Island as a potential tourist spot with road connectivity and land use changes in order to promote a large-scale construction of tourism-based infrastructure including multiple resorts that ignore the fragile state of the island's bio geography.

5.3 Diva: Understanding the Site

Divia saw an upsurge in construction activity post the 2005 floods. The traditional village core and the Diva Junction railway Station were built on the high lands and do not get flooded during the flood events. Divia is on the southern

banks of the Ulhas River and is bordered by River Desai on the southern and western edge where it meets the Ulhas River. This makes Diva highly precarious to flooding.

Topography: Historically Diva was a marshy land between the Ulhas River and the River Desai. The old settlements of the Diva Gaon (village) came up on the highlands and the rest of the land was drained to allow for cultivation. But the recent surge of frenzied construction activities in Diva is located on the floodable erstwhile farmlands. These unauthorised and unregulated buildings are predominantly occupied by migrant labourers or the economically weaker sections looking for affordable housing.

Hydrology and water supply: As observed during the field visits as well as during the interactions with the inhabitants, the settlement has a high-water table but the water table is saline due to over use and unregulated digging of bore wells. There is a sanitary landfill within the urban edges of Diva which has also contributed to the contamination of the ground water table of Diva. The municipal water connections to the homes are dry for most parts of the year and water is supplied using 'Mobile Water Tankers'. It is ironical to note that during the monsoons, Diva floods but the inhabitants still do not have access to municipal piped water supply to their homes.

Vegetation and Biodiversity: The natural vegetation of this area has long been cleared for agriculture. Diva does have highly vulnerable mangrove patches along the water edges (MMR-EIS, 2012). These areas are often used for dumping of debris and wastes.

Anthropogenic Influences: The development of Diva has come about in the last 15 years in a haphazard manner with absolutely no regard to the natural processes. Diva also is home to a sanitary land fill dumping ground wherein

solid wastes from the Thane city are dumped without treatment. This archaic system of waste management causes severe pollution. As per news reports, 2.3 million Metric Tonnes of waste have been dumped in the Diva Dumping Grounds in the last few decades (Pol, 2020). Frequent fires at the dumping ground also leads to pollution and respiratory health problems in the residents.

There are no direct road connections to Diva from the cities of Mumbai and Navi Mumbai. This makes it highly vulnerable in case of an emergency. The rail lines to Diva also get submerged during the flood events.

6 Conclusion

6.1 Findings of the Study

The case study sites are unique in their physical geographic locations, communities inhabiting those areas and the way the communities and settlements interact with the larger landscape:

6.1.1 Unprecedented urbanisation and its consequences:

The unprecedented urban growth of Mumbai Metropolitan Region in the last 30 years has led to a state of rapid urbanisation in two of the three sites- Vasai Fishing Village and Diva as evident from the comparative mapping of the peri urban areas from the 1990s to 2019 extents. The increase in the pace of urbanisation and the unregulated and ill-informed urbanisation in the sites have made them more vulnerable to the increased frequencies and intensities of climatic events like flooding/ erosion and vector borne diseases.

Vasai Fishing Village has seen more people move in from the inland older settlement to be closer to the water edge. There has also been a steady migration of workers from the northern inland states of India to this settlement for aiding in the fishing activities. During the site visits, it was noted that the quality of construction of the newer homes, built in the last twenty years are sturdy and the houses are mostly brick and mortar construction with cast in situ concrete roofs. This is a deviation from the earlier thatched roof construction as evident in the old houses in the settlement. The residents claim that the concrete slab roof gives them better protection from the torrential rains than the traditional thatched or tiled roofs.

Panju Island has also seen a marginal increase in population as evident from the Census data (Government of India, 2011) and the Vasai Virar Municipality proposes it to be developed as a Tourism based destination. No action has been taken on the proposals; they remain on paper.

Divā has seen unprecedented growth in the last 15 years from being an agrarian based settlement to a 'commuter town' of Mumbai via the suburban rail network connectivity.

6.1.2 Disregarding environmental aspects for newer developments:

The recent urbanisation and construction activity in all the three case studies ignore the natural processes of the site. The newer developments are being constructed on land which is low lying which increases the chances of waterlogging during monsoons and also adversely affects the drainage pattern of the larger region.

Drainage patterns have been obliterated at Vasai Fishing Village due to the rampant construction

of homes on the sand bar edges of the settlement. The collected water becomes potential ground for mosquito breeding as noticed during the multiple site visits undertaken during the survey. Almost 50% of the surveyed responses on pest infestations pointed to problems with mosquitoes, cockroaches and rats. Two-thirds of the respondents noted that there have been changes in the shoreline in the recent past and 50% of the respondents attributed man-made causes for this shoreline change including sand mining as well as reclamation for building.

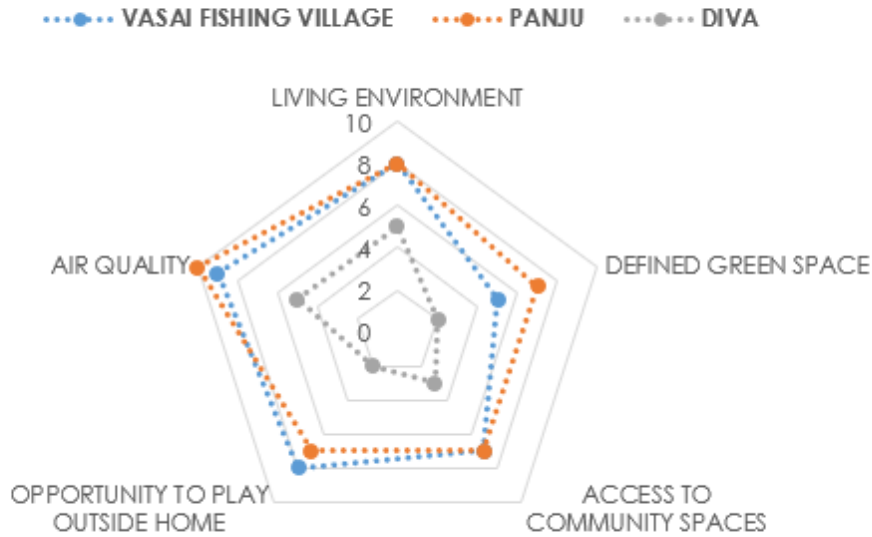
The developments in Divā and adjacent Mumbra have encroached into the wetlands and the ecologically fragile Mangroves have been cleared for construction. An affidavit filed in the Bombay High Court claims a loss of 11 hectares of mangroves near the Mumbra creek and Divā alone due to illegal construction and encroachment (Tandel, 2017). This further exacerbates the flooding in these areas. All the surveyed residents have confirmed being affected by floods in Divā and more than 90% of the respondents claimed that their residences have mold (fungus) infestation due to dampness.

6.1.3 Everyday Vulnerabilities

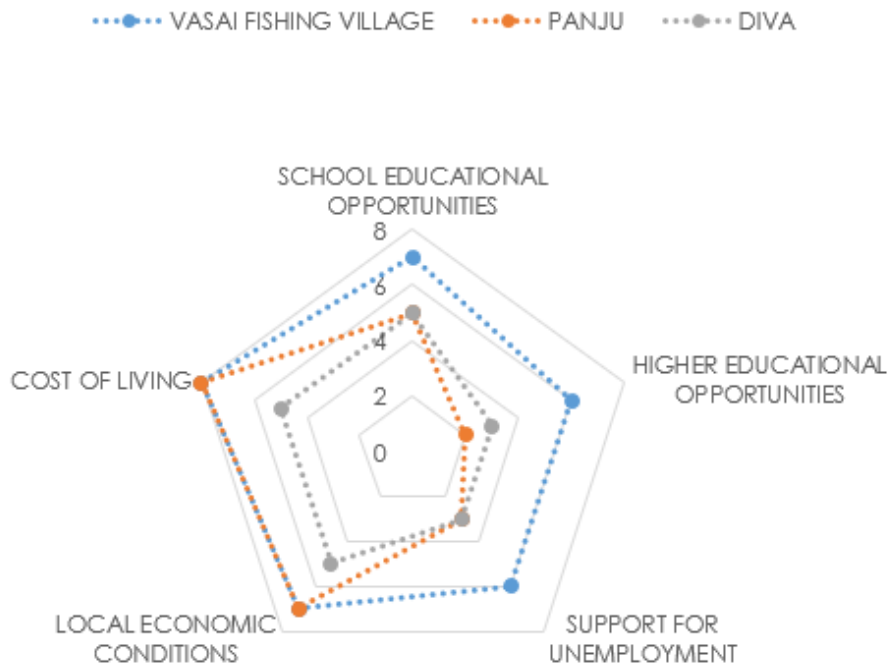
To ensure a comprehensive resilience strategy, aspects owing to day-to-day vulnerabilities in these settlements also need to be taken into consideration. Other than the climate induced catastrophic events like flooding, landslides etc. these communities are also vulnerable to everyday threats and hence the idea of resilience needs to take this aspect into consideration. The 'Community Wellbeing Survey' conducted as part of the study revealed the following:

Open space and Community Wellbeing: Respondents from Vasai Fishing Village and Panju Island were highly satisfied with the general living environment and air quality

OPEN SPACE AND ENVIRONMENTAL WELL BEING

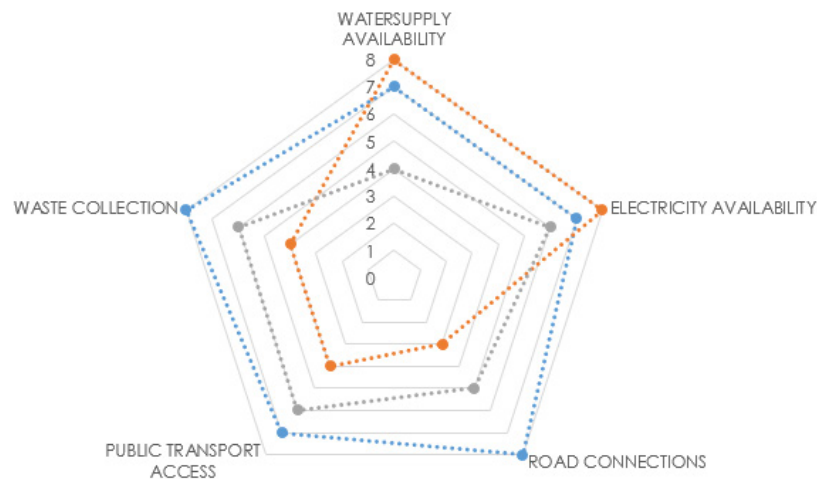


SOCIO-ECONOMIC OPPORTUNITIES



MUNICIPAL INFRASTRUCTURAL SERVICES

.....●..... VASAI FISHING VILLAGE
●..... PANJU
●..... DIVA



of their settlements while residents of Diva expressed their dissatisfaction regarding both the aspects. It should be noted that the presence of the Garbage dump at Diva plays a crucial role in polluting the air and water of Diva.

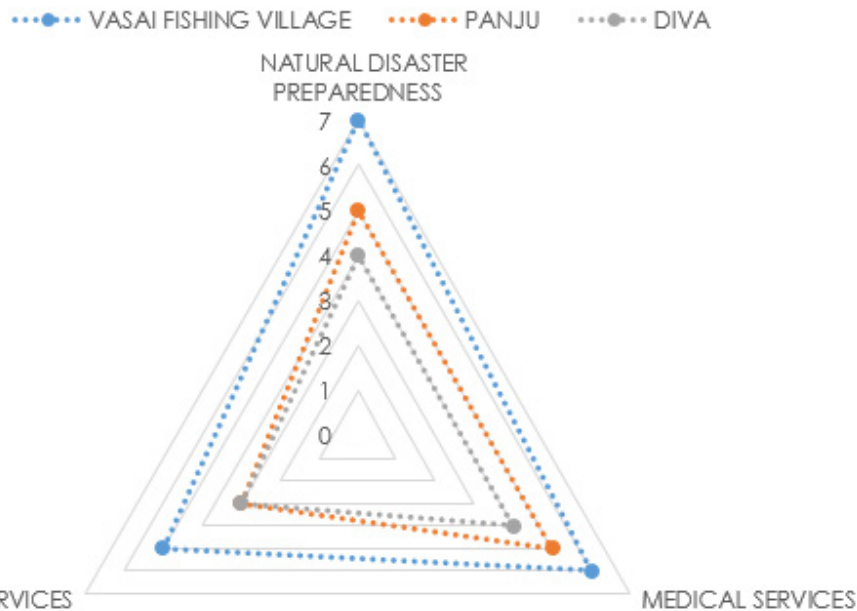
The responses to the presence of green spaces and access to designated open public spaces pointed to the conspicuous lack of them at Diva. Residents of Panju Island and Vasai Fishing Village both seemed to be fairly satisfied with the presence of green spaces, being able to access public open spaces and having opportunities to play outside the home.

Socio-economic Opportunities: The survey covered the following aspects –Educational Opportunities at a School Level, Higher Educational Opportunities, Support for the Unemployed, Cost of Living and people’s responses to Local Economic Conditions. Vasai Fishing Village scored appreciably high on

the scale while the respondents from Panju Island noted cost of living and local economic conditions to be satisfactory in the settlement. The respondents from Diva expressed their dissatisfaction regarding all the above five indicators. Higher educational opportunities as well as support for the unemployed were given low scores by most respondents in Diva and Panju Island.

Municipal Infrastructural Services: The questionnaire contained questions pertaining to the following aspects- Road Connections, Public Transport Access, Electricity Availability, Water supply and Waste collection by the municipal authorities. The respondents of Vasai Fishing Village seemed to be highly satisfied regarding all the above indicators. Respondents from Panju Island were mostly highly satisfied with the water and electricity supply to the Island while they expressed low satisfaction in waste collection and public transport access. The

DISASTER PREPAREDNESS AND HEALTH INFRASTRUCTURE



Island has no road connections to the mainland and residents depend on the boat service for commuting. During heavy rains, the boat service remains suspended. In such cases, the only pedestrian connection from Panju Island is via an abandoned railway bridge across the creek. The railway bridge is in a dilapidated condition and does not have railings, lighting nor a continuous solid surface to safely allow for people to walk across. This adds to the everyday risks taken by the residents who live in that island. Respondents from Diva have scored a low to okay satisfaction for the above aspects with water supply being the most dissatisfied entity. The second part of the survey also collected information on water supply conditions and 95% of respondents from Diva stated that they do not get municipal water for time spans of more than 4 hours a 24 hour cycle and the remaining 5% who did not display this observation had access to a water body like a pond or a well.

Disaster Preparedness and Health Infrastructure: This part of the survey comprised of three aspects- people's perception of the disaster preparedness of their settlement, the availability of emergency services and medical services. Most respondents from the Vasai Fishing Village consider their disaster preparedness to be high, along with an okay level of satisfaction in the medical and emergency services available to them. The respondents of Panju Island have expressed okay satisfaction in disaster preparedness and medical services while they have expressed low satisfaction in the availability of emergency services in case of a disaster. The respondents from Diva have expressed dissatisfaction in all the three aspects. A large percent of the households of Diva do not have municipal freshwater supply to their homes. The over dependence on tanker lorries lead to incidence of water borne diseases. The settlement does not have access to health centres.

In the detailed survey, 95% of respondents from Diva stated that communicable diseases are common in their locality, 32% of respondents added that respiratory and digestive disorders are too common. Also, 54% of the respondents believed that there is a correlation between the location of their living/ working, commuting and the presence of epidemics in the locality.

4. Through the initial surveys and interactions with the locals, it is clear that they do not depend on the government authorities during a flood event. No respondent from Vasai Fishing Village mentioned expecting Government's help during such an event. Respondents at Diva also echoed the same opinion with most people preferring to take help from community and relatives. About 25% of the respondents of Panju Island have expressed that they would take help from the government authority in the event of a flood or a catastrophe.

6.2 Learnings and Way Forward

The findings of the study point out to the fact that coastal peri-urban areas vary in their capacities and the existing socio-ecological networks of the peri urban sites are not robust enough to ensure climatic resilience to the inhabitants and the landscape. The key agenda of the way forward should be to aid the authorities identify the vulnerabilities of the peri-urban communities.

For this, the study aims at putting together a comprehensive Socio-ecological Resilience model for coastal peri-urban habitats covering sea-edge, estuarine and riverine edge conditions and develop the Academic Courseworks and PDPs based on the results inferred from the case studies and the literature review. The case studies could be used as a catalyst to bring about

positive differences to the communities, if the authorities are involved. The NGOs could play a role in bridging the gap between the pedagogy and praxis in this aspect. The outcomes of the research and the methods could be used to formulate a participatory approach wherein the community as stakeholders have a role in the possible resilience-based projects. The study is not seen as a medium to achieve a comprehensive solution for all coastal peri-urban areas but it is viewed as a means to bring awareness and an anvil for future trajectories to ensure effective resilience-based solutions which are rooted to the context of their application.

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8 Annexure

BUILDING RESILIENT URBAN COMMUNITIES (BReUCom Project)											
Socio-ecological resilience of peri-urban coastal edges											
KR VIA-ITC Collaboration											
 Co-funded by the Erasmus+ Programme of the European Union											
PART 1 COMMUNITY WELL BEING SURVEY											
The following questions are about various aspects of your city. For each item, please indicate your personal level of satisfaction where “1” is the lowest level of satisfaction or evaluation and “10” is the highest level of satisfaction or evaluation.											
SL.No	personal satisfaction										
	very high		high		okay		low		very low		
	10	9	8	7	6	5	4	3	2	1	
a											Overall Living Environment
b											Access to Medical Services
c											Access to emergency services (fire service)
d											Waste Collection services
e											Air Quality
f											Defined Green spaces/ parks
g											Access to Public transport
h											Road Connections
i											Access to Community spaces
j											Opportunities for the children to play outside home
k											School Educational opportunities
l											Higher studies Educational opportunities
m											Services for the elderly

n												Services for Specially abled/Divyangan
o												Natural disaster preparedness
p												Availability of watersupply
q												Availability of electricity
r												Public safety
s												Police Force
t												Support for the Unemployed
u												Local Economic Conditions
v												Cost of Living
CITY/TOWN/PLACE:												

PART II VULNERABILITY SURVEY

The following questions are about various aspects of your city. For each item, please indicate your choice or fill in the response

1 How long have you been living there?

- 0-5 years
- 5-10 years
- 10-15 years
- 15-20 years
- 20-25 years
- 25-30 years
- more than 30 years

2 Where do you live?

- geo tag the location

3 Where do you work/school?

- geo tag location

4 How do you commute?

- By Road Own Private Transport
- By Road Shared Private Transport
- By Road Public Transport
- By Rail
- By Boat/ waterway
- Any Other

5 Satisfaction of the commute

very high		high		okay		low		very low	
10	9	8	7	6	5	4	3	2	1

6 Is there anything in particular you would want to change about your commute?

7 Which is your Favourite season

- Monsoon
- Autumn
- Summer
- Winter

8 Has the rainfall increased or decreased?

- increased
- decreased

9 How many floods have you experienced here?

- none
- once
- two -five times
- more than five
- almost every year

10 How have you tackled/ accomodated /adapted to floods in the past?

10a who are you dependent upon during the needful hour?

relatives/extended family/ government authority/ community

- relatives
 extended family
 government authorities
 community

11 Do the seasons affect your daily life?

- Work related
 Physical health related
 Stress and emotional well being related

12 Do you do any adjustments to your lifestyle due to seasonal variation

12 what are the Source/s of water for your household

- lake/ pond
 well
 tanker supply
 Municipal piped water
 borewell

13 If dependant on Municipal Piped water, then what is the reliabilty of the water sources

- always available
 erratic(supply for more than 4 hours/day)
 erratic(supply for less than 4 hours/day)

14 Has the shoreline or land/water edge line changed over the course of time?

- yes
 no
 may be
 can't say

15 What do you think is the reason for the above?

- Natural causes-Erosion
 Natural causes-Deposition of soil
 Manmade causes-Sandminig
 Manmande causes-Reclamation

16 Have there been any issues of pest infestation?

- rats
 mosquito
 cockroach
 ant
 any other plant/ animal/insect etc.

Please specify.

17 Issues with moulds, fungus, dampness

- yes
 no

18 What kind of the illness are common in the locality?

- communicable diseases like fever, cold, flu
- respiratory ailment like asthma etc
- digestive disorder

20 Do you think your location of living/working/commute results in these diseases?

- yes
- no

21 What according to you are the problems that you may face in future due to changing weather patterns in your locality?

Comparative Case Study Lombardy Region, Italy – Panju Island, Mumbai, India: **Increasing Children’s Awareness of Flood Risk**

Funda Atun-Girgin and Javier Martinez, ITC, University of Twente, Netherlands

The capacity building project “Hey kids, are we prepared against environmental disasters?” was initiated first in the Lombardy Region in Italy in 2016 by The Others and Disasters NGO (www.gliatriedidisastri.org). In the Lombardy region in Varese, Como, Lecco and Milano, a total of 8 workshops were conducted in collaboration with 6 adults and around 100 children (age groups between 4-16 years) as co-researchers.

As a result of these workshops a flood education kit was prepared, including a book that is about how to behave before, during and after a flood event, rug-dolls and several educative games, together with an information leaflet from the municipality about emergency preparation for children’s families. The motivation of the flood education kit is that the current disaster risk-related informative children books, prepared by adults, do not correspond to children’s mindsets. Children use different words and draw reality based on metaphorical representations.

During the workshop, we used the mosaic approach, and we let children choose the tools to present their ideas in a format that they feel comfortable with. The ‘heroes’ in the educational kit are inspired by those in the children’s drawings and the story of the book is written by a 9-year-old girl, who had expressed that she felt more comfortable in writing.

In the workshops, first, children watched cartoons about flood disaster prepared by the Italian Umbria Region Civil Protection Authorities. Then they were asked to create a character, and draw a disaster scene by involving the character that they created.

The results of the “Hey kids are you aware of the flood risk?” capacity building project were presented at the October 2016 Habitat III conference in Quito, Ecuador. Habitat conferences are organized by the UN every 20 years. The focus of Habitat III was urban transformation and improving the quality of



Figure 1 and 2: Some drawings made by the children



Figure 3 and 4: One of the characters in the book was created by a 4 year old girl; The cover of the book



Figure 5: Map of the flooded Panju Island from the workshop in December 2019

life through a more equitable distribution of development benefits, planning and regulating land use, protecting the environment, as well as integrating women, children, youth, and leaving no one behind. With our flood education kit, we

attended an exhibition in Quito, Ecuador and several exhibitions and meetings in Milan, Italy.

As part of the BReUCom project the same methods were applied to increase the awareness

of children living in Panju Island, north of Mumbai, India. Panju is an estuarine island with more than a few thousand inhabitants. Climate adaptation challenges are most acutely felt in the most vulnerable locations like estuarine Islands. The topography of Panju is such that it is highly susceptible to flooding as well sea level rise. The workshop with 40 children in the Municipal School on Panju Island was jointly conducted by ITC (University of Twente), Kamla Raheja Vidyavidyalaya Institute for Architecture and Environmental Studies (KRVIA), Mumbai and the NGO partner- Society for Promotion of Area Resource Centers (SPARC) in the month of December in 2019.

The workshop started with the theatrical representation of a flood situation with puppets by the Masters Students (Departments of Urban Design and Urban Conversation) from KRVIA. Then, the children were divided into two groups based on whether they follow the primary (Age group: 5-9 years) or the secondary school (age group: 9 years -12 years) curriculum. The children

who were in the primary school were asked to create a character and draw a disaster scene by involving the character that they created, as was done in the workshops in Italy. The children in secondary school were asked to draw a map of the Island. At the end of the drawing session, the children were given copies of the book, which was based on the one prepared as a result of the workshops in Italy, translated into Marathi.

The workshop encouraged children to express themselves through the medium of drawing regarding their perceptions of flood risk. Different from the workshops in Italy, the children at Panju were not afraid of the water, as they live in an Island. They know the island very well, and they described the school, the temple and their home as the safest places on the island. The outcomes of the workshop are to be converted into a map with the support of children's drawings to increase awareness. It is going to be the first map drawn by children for an inhabited estuarine island which is highly prone to sea level rise.