Cities4Forest – Urban Forest and Nature Conservancy Park, Marol, Andheri

Introduction

Mumbai city faces two major climate challenges – increasing temperature and increasing number of extreme rainfall events. Moreover, Mumbai is the least green metro[1] with lowest per capita green cover of 1.8 square meters[2], as compared to 10 to 12 square meters prescribed by the Urban and Regional Development Plans Formulation and Implementation (URDPFI) guidelines. From 1988 to 2018, the vegetation cover has reduced from 46.42% to 26.67%, especially in low-income areas. During the same period, mean land surface temperature of areas measuring around 30.5°C has increased from 5232 hectares in 1988 to 14,339 hectares in 2018[3].

As per the IPCC Fifth Assessment Report (Hijioka, et al,. 2014), Asia is also projected to face more frequent and intense heat waves and an intensified heat island effect, resulting in very high risk of heat-related mortalities in the long term, especially in vulnerable groups such as outdoor workers, residents of informal settlements, children or elderly people. For Mumbai region, the IPCC A6 Atlas indicates that the maximum temperatures, specifically the total days above 35°C per annum are expected to increase by 20-30 days under RCP 2.6 and by more than 40 days under RCP 8.5.

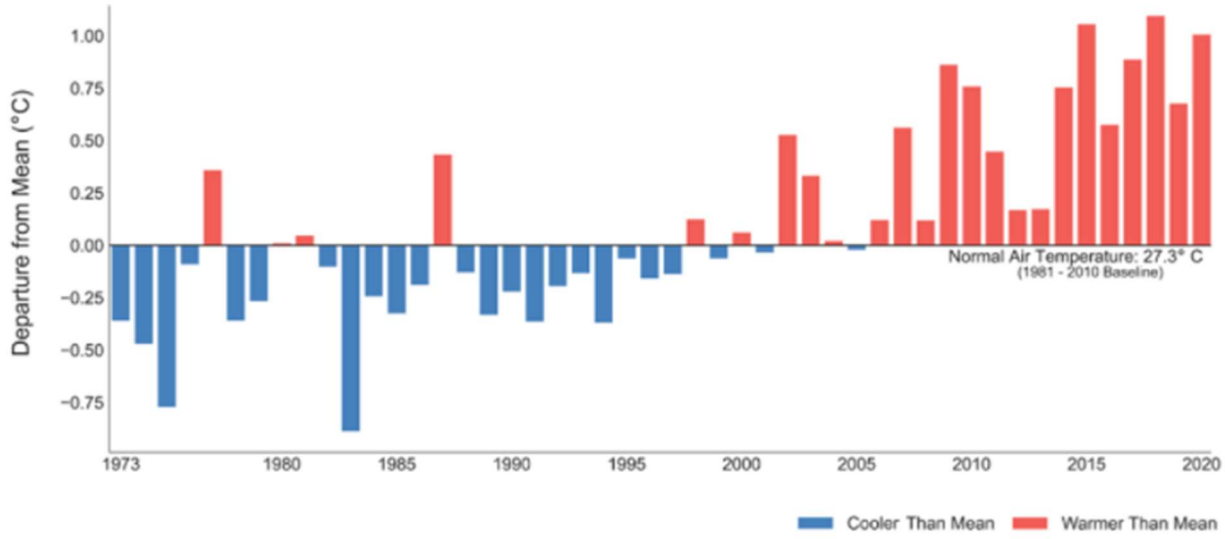

Figure 1: Annual air temperature anomalies between (1973 and 2020). Source: Meteorological data from IMD Santacruz station (1973-2020)

Urban Heat Island Effect

Land Surface Temperature analysis is focused on mapping certain areas in the city which experience increased heat stress due to heat that is reflected from the earth's surface wherever it is in contact with sunlight. Paved surfaces like concrete terraces, metal roofs, and roads reflect more heat, creating heat

[1] https://www.livemint.com/news/india/which-is-india-s-greenest-metro-11572280645457.html
[2] https://www.orfonline.org/expert-speak/peoples-struggle-green-spaces-cities/
[3] https://link.springer.com/article/10.1007/s10668-020-00882-z

islands, while natural landscapes with vegetation and waterbodies absorb heat reducing the prevalent temperature. Correlations with land use, land cover, roofing materials and vegetation cover (NDVI) are also assessed to understand areas that are more exposed to heat stress. Below are summarized observations for the same;

- Built-up surface temperatures are significantly higher with temperatures in informal settlements observed to be ~5 degrees warmer than neighboring residential areas.
- Surface temperatures vary with choice of roofing material; higher the temperature trends observed with metal/asbestos roofing of low-income housing and industrial areas.
- Surface temperatures indicate a negative relationship with green cover (NDVI), with higher temperatures observed in areas with lower green cover.

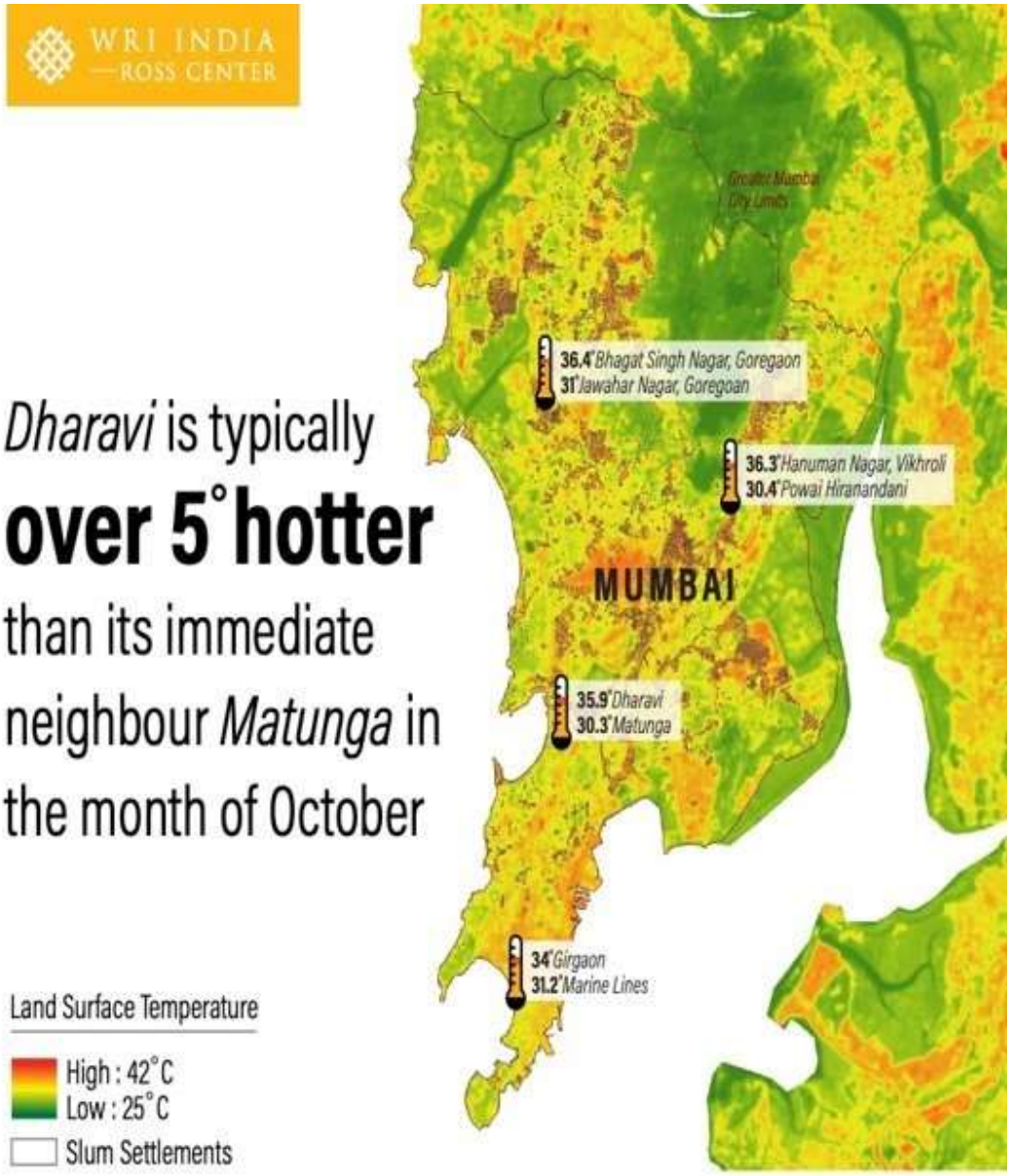

Figure 2: Land Surface Temperature map of Mumbai highlighting the temperature difference in low-income areas and surrounding neighbourhoods

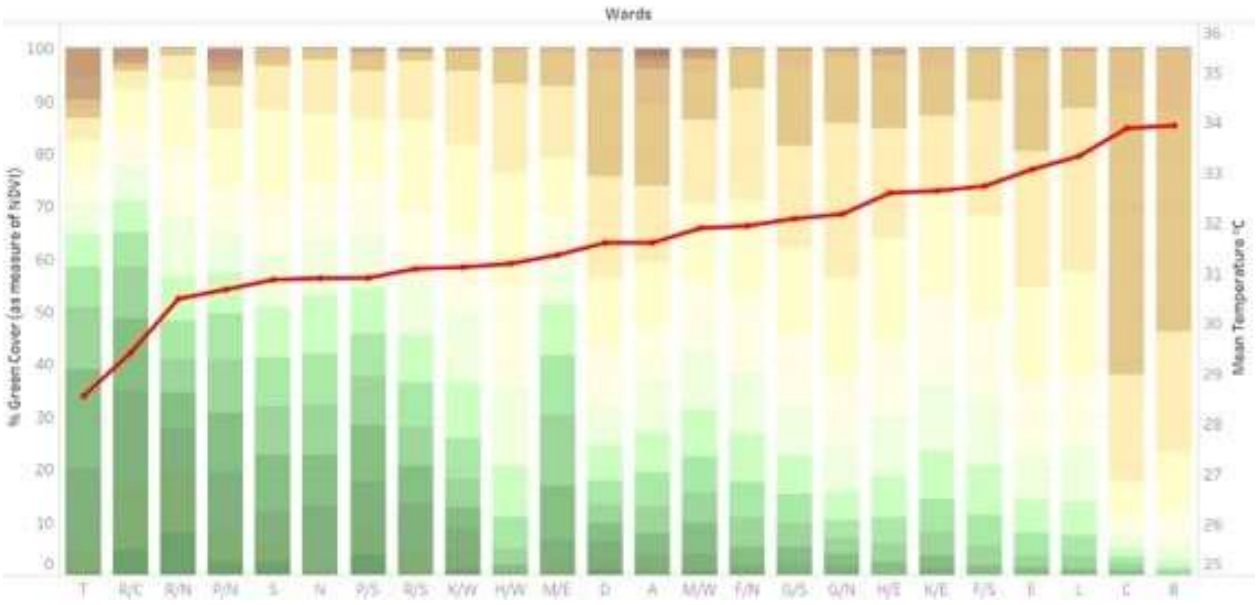

Figure 3: Ward-wise distribution of Mean LST in comparison with Mean Vegetation Cover. Source: Modified Copernicus Sentinel Data (2015-2020); LandSat 8, USGS

City Targets and Commitments

Mumbai city has joined Cities4Forest initiative and has signed the Call to Action for Forests and Climate, and C40 Cities Urban Nature Declaration which intends to conserve, manage, and protect its natural ecosystem. Under Mumbai Climate Action, the city is committed to

- Increasing its vegetation cover and permeable surface to 30-40% of its total surface area
- Equitable access to open spaces
- Restore and enhance biodiversity in city
- Build flood resilient systems
- Localized water conservation and efficiency

Nature-Based Solutions Approach

Mumbai city is facing flood, heat, coastal and landslide related risks. Engineered grey infrastructure-based solutions are important to tackle these risks, however, they may fall short in an extreme weather event. Nature-based solution is an approach where natural systems are managed to tackle climate risks. The intention is not to replace the grey infrastructure but to create a cushion/buffer and complement the engineered solutions. Urban Forest is one of the methods to tackle urban heat island issues, increase permeable surface areas in city and enhance biodiversity.

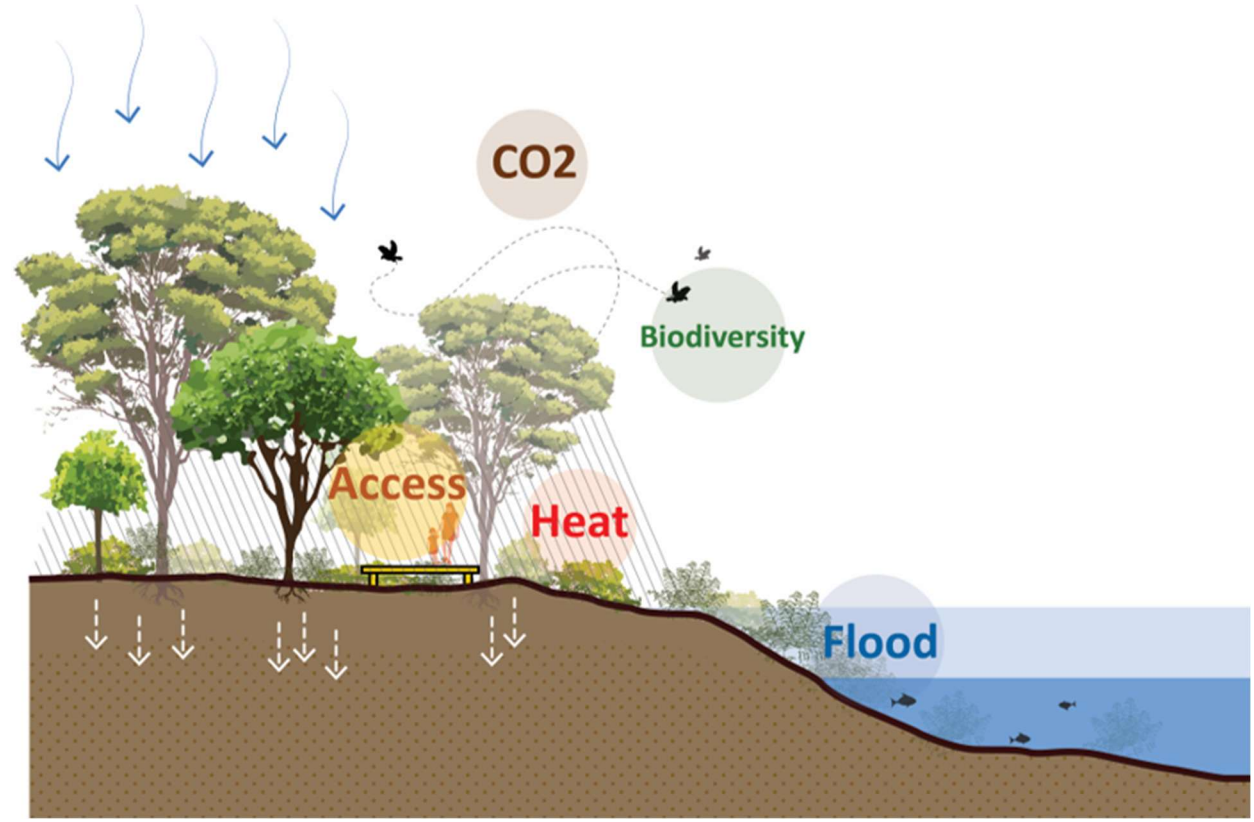

Figure 4: Co-benefits of Nature-Based Solutions

Context

The Marol Industrial Estate is located within the K/E ward which is one of the least performing wards in terms of tree coverage with high mean land surface temperatures. Moreover, the metro line 1 which is in proximity has experienced substantial change in its LST since 2005. The observed land surface temperature along the metro stretch before the construction between 2005 and 2010 has been 29.27 to 33.64 degree Celsius. However, post metro construction, there has been an increase in land surface temperature to around 32.65 to 38.83 degree Celsius. This has multiple factors to contribute to; increased concrete surface due to metro construction, reduction in tree coverage, accelerated urban development due to metro connectivity.

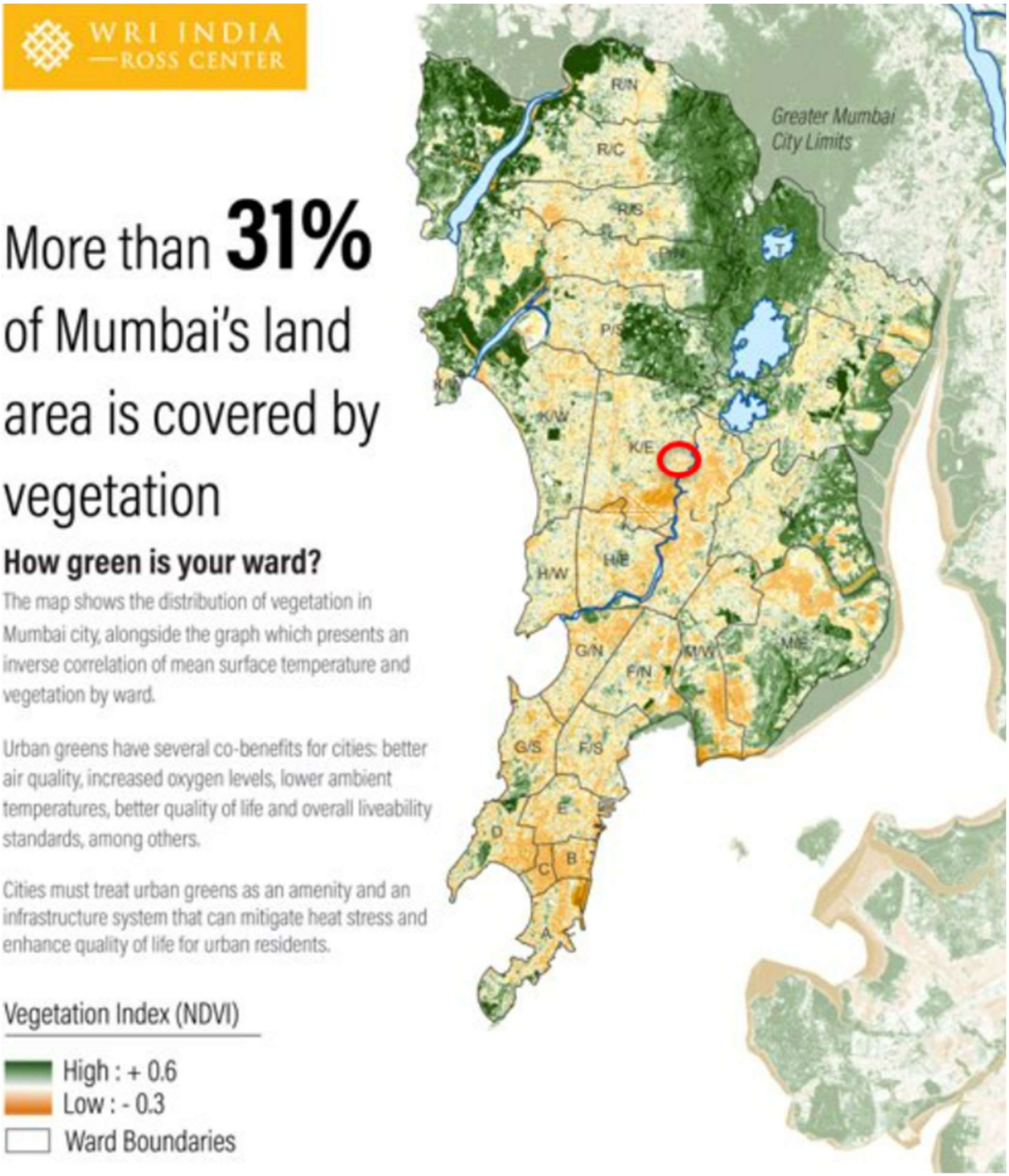

Figure 5: LST in comparison with Mean Vegetation Cover highlighting the Marol area

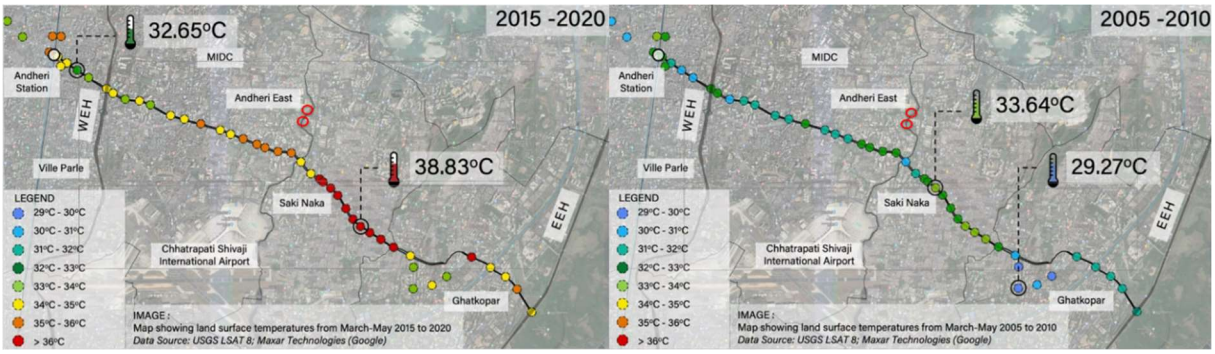

Figure 6: Change in LST along the metro line 1 since 2005 to 2020

Having said that, in the context of Mithi river, it is critical to develop buffer zones which not only absorb river flood during heavy rainfall event coupled with high tide scenario but also act as natural filtration system for surface run-off before discharging in the river. Furthermore, such an approach will help achieve city commitments of increasing green cover and permeable surfaces as well and enhance biodiversity too. Designating a function of forest or open space and further connecting such potential land parcels is important to reclaim the buffer zone and safeguard from any level of encroachment.

Figure 7: Marol site location

The location is 5 minutes' walk away from the nearest metro; Marol station. In the vicinity there is an existing MCGM park and a crematorium. Further south is a pedestrian bridge connecting to the opposite side of the river. With most of the industries slowly moving out of the city limits, there are commercial developments coming up replacing these industrial shades, one such development is a WeWork building adjacent to the location.

As per Development Plan reservation the land parcels under consideration are reserved open spaces, public open spaces, crematorium facility and electricity transmission and distribution facility.

Marol Co-operative Industrial Estate CTS number – 443/13, 443/14

MCGM park CTS number - 345 A/5, 345 A/6, 710 D, 710 E, 718, 719, 720, 721, 722 and 732.

MCGM reserved open space CTS number – 657, 658

Crematorium CTS number – 655

Figure 8: Development Plan

Objective

- Increase vegetation cover and permeable surface area
- Lower the mean land surface temperature through urban forest development
- Protect, conserve, and enhance biodiversity in the given context
- Accessible public open space
- Development of buffer zone along Mithi river with appropriate species selection to stabilize the edge, naturally filter storm water outfall and create retention area during heavy rainfall coupled with high tide event.
- Educational aspect to demonstrate nature-based solutions

Proposal

The vision is to create a 1-kilometer-long urban forest along the Mithi river acting as a buffer as well as a trail for people to walk along the riverbanks. Within this stretch there are several experiential and functional zones which perform as natural solutions to tackle heat and flood related risks. Starting with biofiltration systems using specific species to treat storm water outfall, to an elevated board walk for people to enjoy the forest walk while keeping the landscape on the surface intact, connecting people to the river while developing retention areas to hold seasonal water during heavy rainfall events.

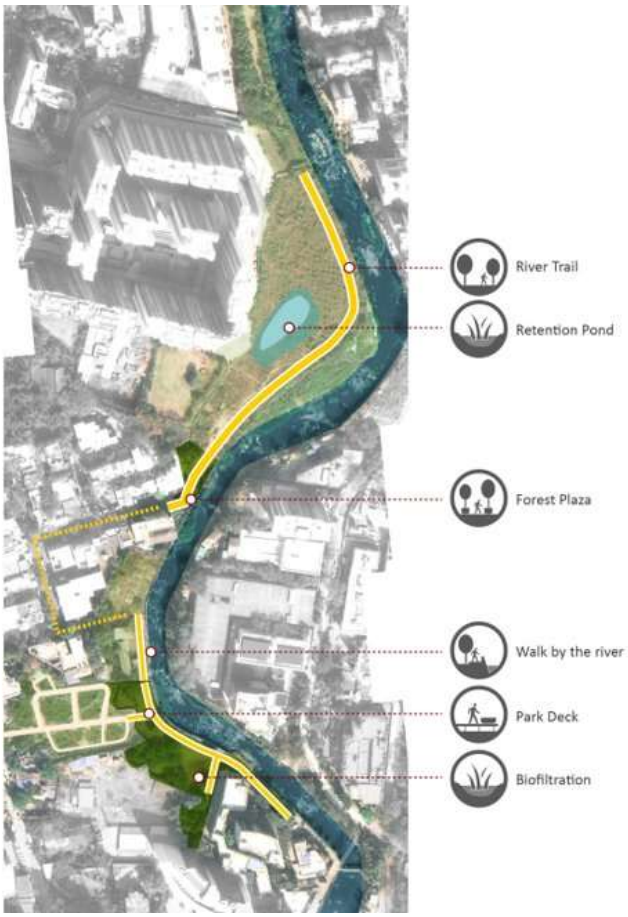

Figure 9: Vision for Urban Forest and Nature Conservancy Park, Marol

Project is divided into three phases. Phase 1 consists of Marol Co-operative Industrial Estate owned land CTS number 443/14 and existing MCGM Garden. Phase 2 is the crematorium land parcel, wherein a narrow stretch along the river is a requirement acting as a pedestrian connector. Phase 3 comprises of Marol Co-operative Industrial Estate owned land parcel CTS number 443/13 and MCGM owned land parcel under open space reservation.

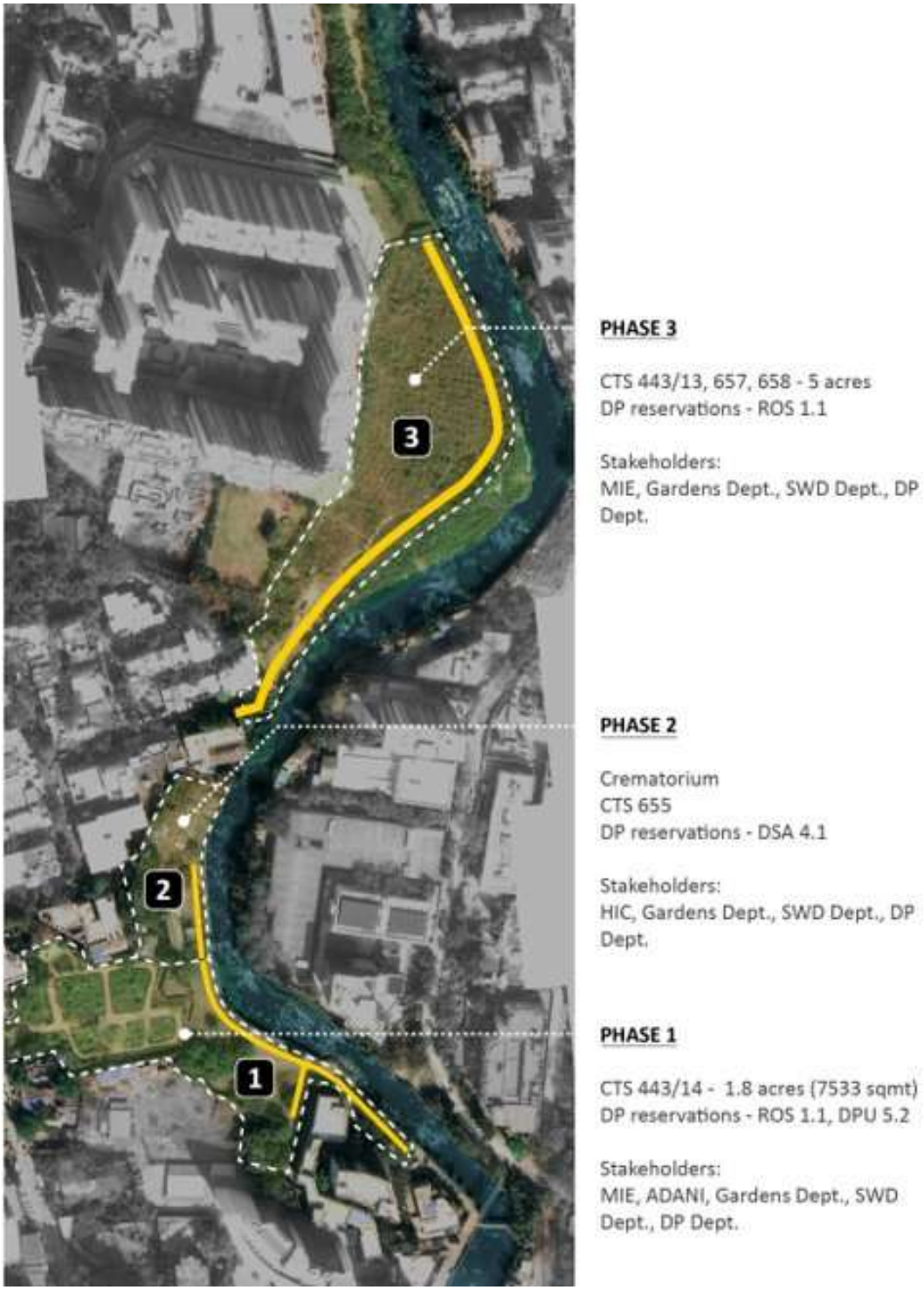

Figure 10: Phasing plan for Urban Forest and Nature Conservancy Park

Phase 1

Phase 1 focuses on merging the existing MCGM park with the Marol Co-operative Industrial Estate owned land parcel to create an urban forest with educational aspect focusing on eco-system service, biodiversity and nature-based solutions. The MCGM park will be acting as an active recreational space with enough space for sitting and information related to Urban Forst and Nature Conservancy Park. It would display the concepts of eco-system services, biodiversity and nature-based solutions which can be seen in the forest. The Marol Co-operative Industrial Estate owned land will act as the passive educational trail in the forest with the experiential aspect of the flora and fauna associated with the urban forest.

A deck will be extending out into the forest as an entry and focal point of the forest. An existing storm water outfall will be addressed using natural filtration mechanism using appropriate plant species. Land parcel reserved for Electricity Transmission and Distribution Facility will have minimum tree plantation, but the land will be re-graded which can perform as a retention area with plants and shrubs to treat water and avoid mosquito breeding.

Next to the river retaining wall is a requirement of a 7 meter wide service road for de-siltation of river. An interceptor drain will be running below this road which is part of Mithi River project to intercept the storm water outfall so that it can be treated in the STP before discharging into the river. It is recommended to avoid a connection to the existing storm water outfall on site, so this outfall can be used for a nature-based approach of treatment using plant species and reed bed. The service road will act as a pedestrian walking area lined with benches for people to sit.

Recommendations:

- Avoid connecting existing storm water outfall on the site to the upcoming interceptor drain, as this outfall will be used to display the nature-based solution approach of treating the storm water using plant species and reed bed.
- Avoid concretization or asphalting for the service road to maintain the permeability of the site. Permeable paver blocks can be used, or compressed dirt/stone path can be constructed maintaining the structural integrity.
- Suction methods for de-silting to be considered for a more resource efficient approach.

Figure 11: Marol Co-operative Industrial Estate land parcel CTS 443/14 approach road

Figure 12: Existing MCGM Park

Figure 13: Storm water outfall

Figure 14: Phase 1 Concept Plan

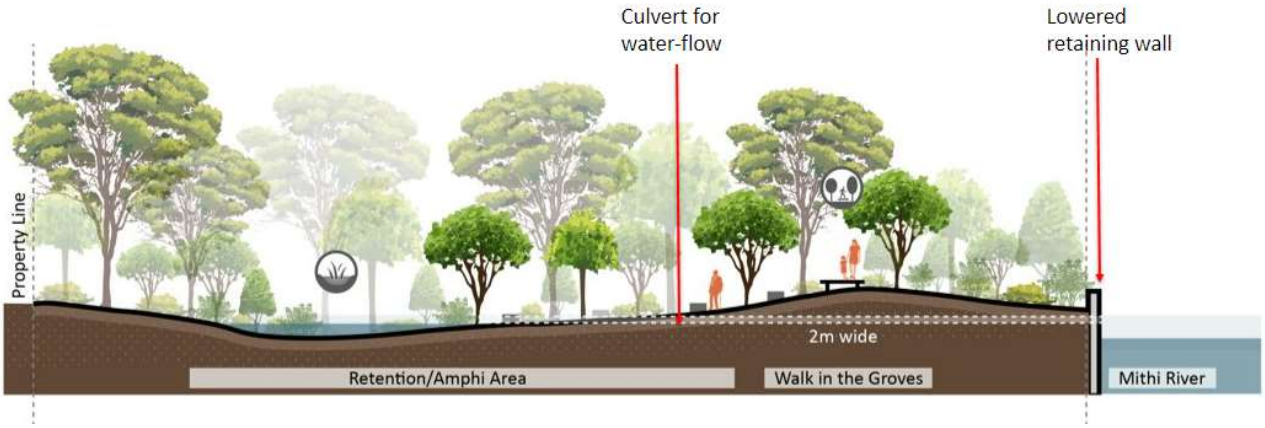

Figure 15: Conceptual section through retention area

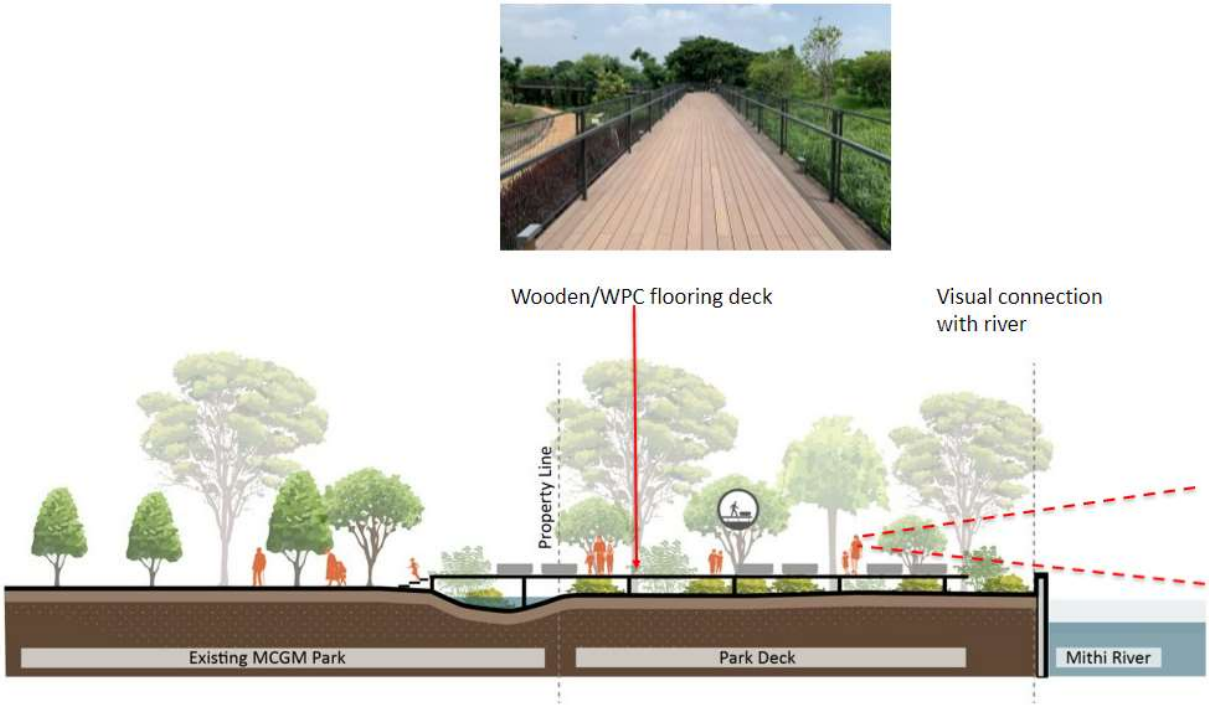

Figure 16: Conceptual section through Park deck

Figure 17: Phase 1 view 2022

Figure 18: Phase 1 view 2030

Reservation	ROS 1.1 + DPU 5.2	Reserved open space and Electricity Transmission and Diatribution Facility
Ownership	Marol Co-operative Industrial Estate	Complete Land ownership with Marol Co-operative Industrial Estate, Adani will construct upon agreement with with MCIE
Area	5833 sqmt + 1700 sqmt	Total area of 7533 sqmt (1.8 acres)
Estimated cost	26904673.5	in crores 2.7 INR
Operations and Maintenance	2690467.35	in crores 0.26 INR annually

Marol Co-operative Industrial Estate - Land ownership will stay with Marol Co-operative Industrial Estate and land would be developed for the project upon receiving the NOC for the same.

Gardens department – Lead agency to detail out the proposal and execute the project.

Adani – Upon the agreement between Marol Co-operative Industrial Estate and Adani, the utility structure will be constructed, keeping the intent of Urban Forest and Nature Conservancy Park intact.

Operation and Maintenance:

- The financing for the execution of the project and maintenance for the next 3 years will be borne by MCGM.
- The tender will consist of execution and operation and maintenance for the next 3 years to be taken up by the same agency.
- Security for the Urban Forest and Nature Conservancy Park will be jointly handled by the MCGM and Marol Co-operative Industrial Estate.

Critical Points:

- Water supply for execution and further operations and maintenance to be arranged in-situ.
- Avoid water tankers or MCGM water supply connection.

Phase 2

Phase 2 is primarily the crematorium land acting as a connector between Phase 1 and Phase 3. The cremation building is positioned around 6 meter away from the retaining wall. This space can be used for pedestrian boardwalk and plantation buffer.

However, the challenge lies further ahead in site near children burial grounds. The space between the burial ground and the retaining wall is hardly a meter wide. This would require either creating a cantilever over the retaining wall or shifting of the burial ground position to connect to the phase 3 pf the project.

Critical points

- The children burial ground is located hardly a meter away from the retaining wall. Creating a pedestrian connection would be a challenge.

Figure 19: Children Burial Ground

Figure 20: Phase 2 Concept Plan

Phase 3

Phase 3 comprises of multiple land ownerships. CTS number 433/13 belongs to Marol Co-operative Industrial Estate, whereas CTS number 657 and 658 belongs to MCGM. Both land parcels combined together measure up to 5 acres of area. The intention is to continue the pedestrian boardwalk from Phase 1 and 2 into Phase 3 creating 1km long walk along the river in a forest set up.

However, there are future plans of potential holding pond/tank in CTS 657 and 658. This tank/pond is subject to feasibility study taken up from the entire Mithi river catchment. Upon understanding the the requirements of the holding tank/pond, possible integration with the urban forest will be worked out.

Moreover, there is requirement of 7 meter wide service road for de-silting purpose of Mithi river and a 12.2 meter wide DP road is proposed in the development plan. Considering the width and lengths of both the roads, approximately 30% of land parcel will fall under the road with either concrete or asphalt finish. This is heavily reducing the permeability of the land parcel which is under open space reservation.

Recommendations:

- Study the requirement of the DP road based on the adjoining land parcels, if the road can be avoided that is desirable.
- If the DP road is mandatory, it is suggested to overlap 12.2 meter wide DP road with 7 meter wide service and realign both the roads along the river retaining wall. This would reduce the possible width of 19.2 meter (12.2+7 meter) to 12.2 meter width.
- Construction of the service road and DP road in permeable surface maintaining the structural integrity.

Figure 21: Existing situation of the large land parcel

Figure 22: Phase 3 Concept Plan

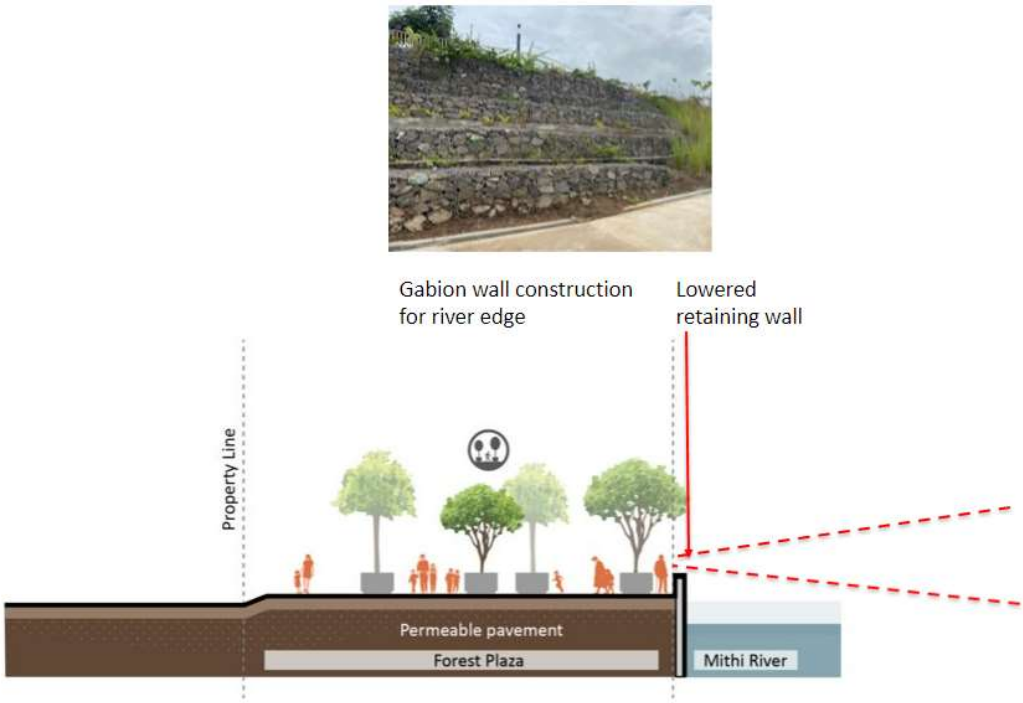

Figure 18: Conceptual section through Forest Plaza

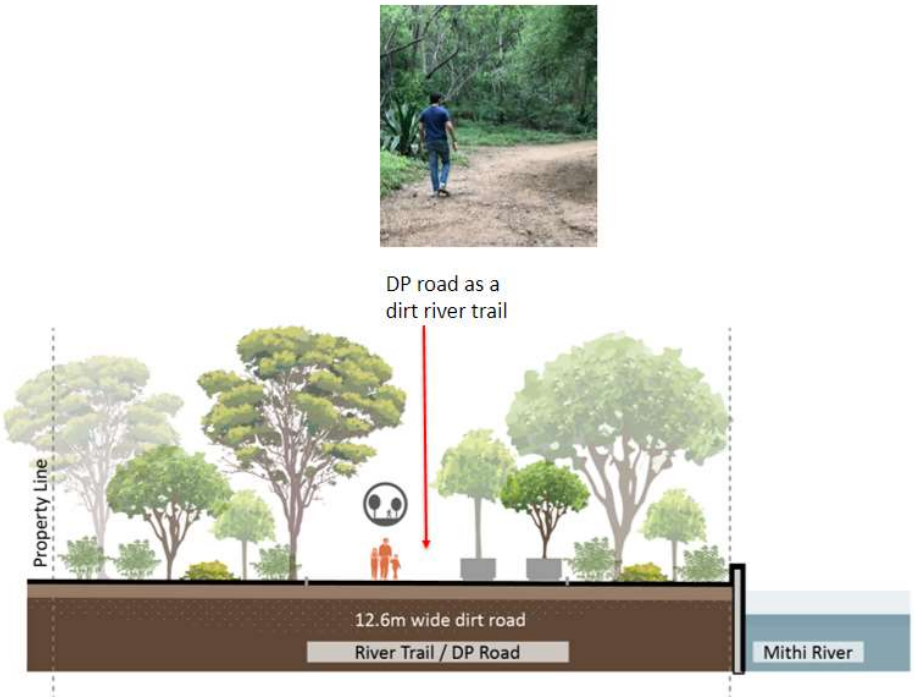

Figure 19: Conceptual section through River trail

Figure 20: Phase 3 view 2022

Figure 21: Phase 3 view 2030

Reservation	ROS 1.1	Reserved open space
Ownership	Marol Co-operative Industrial Estate + MCGM	Small land parcel measuring 1338 sqmt is owned my Marol Co-operative Industrial Estate rest is owned by MCGM
Area	1338 sqmt + 21101 sqmt	Total area of 22440 sqmt (5.5 acres)
Estimated cost	87895828.5	in crores 8.7 INR
Operations and Maintenance	8789582.85	in crores 0.87 INR annually

Marol Co-operative Industrial Estate - Land ownership will stay with Marol Co-operative Industrial Estate and land would be developed for the project upon receiving the NOC for the same.

Gardens department – Lead agency to detail out the proposal and execute the project.

SWD department – Lead agency in providing the details of the hold tank/pond and develop a plan to integrate with the Urban Forest and Nature Conservancy Park.

DP department – Possible solution on the realignment of the DP road.

Operation and Maintenance:

- The financing for the execution of the project and maintenance for the next 3 years will be borne by MCGM.
- The tender will consist of execution and operation and maintenance for the next 3 years to be taken up by the same agency.
- Security for the Urban Forest and Nature Conservancy Park will be jointly handled by the MCGM and Marol Co-operative Industrial Estate.

Critical points

- Re-alignment of 12.2m wide DP road and 7m wide service road for desilting purpose
- Integration of holding pond/tank as part of nature-based solution
- Funding for the execution of the project
- Funding for the operations and maintenance of the project post execution
- Water supply source for irrigation

Biodiversity

Urban Forest and Nature Conservancy Park intends to create a forest land equivalent to almost 7 acres which as per the Forest Survey of India can be demarcated as a forest. The intention is to enhance and conserve the biodiversity using native species appropriate to the river proximity. Increasing canopy cover to reduce urban heat island effect is critical to this project. A layered landscape approach is perceived with large trees with big canopy covers, medium sized plants and shrubs with medicinal and

herbal nature and ground cover and grasses. Noise reduction, heat mitigation, flood control, dust control, mosquito repellent species and biodiversity enhancing species are selected.

Creating a Micro People's Biodiversity Register is the intention. Parameters like temperature change, carbon capture capacity, water consumption and tolerance, flowering/fruit giving seasons, nesting species, fruit giving species, medicinal plants, nature of forest like deciduous/evergreen, species attracted due to plantation (birds/reptiles/etc).

Scalability of Nature-based solutions along Mithi river

- The Marol project will act as a proof of concept for nature-based approach to tackle heat reduction, flood mitigation and air pollution as part of Cities4Forest initiative and Mumbai Climate Action Plan.
- Upon successful implementation of the project, similar locations can be identified along the entire 17 kilometer stretch of the river.
- Based on the catchment study, land use and ownership and positioning along the flow of the river site specific nature-based solutions can be identified and implemented.
- In the process, a buffer can be developed along the entire river on either side, thereby re-naturalizing the river, restoring eco-system and biodiversity, and improving water quality.