



De- Landing Growth

Framing Alternative Perspectives to Evolution in Mumbai

**(De)landing Growth :
Framing Alternative Perspectives To
Evolution In Mumbai.**

P5 Report
Sanika Charatkar | 5499984

‘Transitional Territories 22’-23’

First Mentor | Taneha Kuzniecowa Bacchin
Second Mentor | Geert van der Meulen

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Urbanism and Building Sciences
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Acknowledgement

As I approach the final days of my master’s program, I am filled with an overwhelming sense of gratitude for the past two years. I am deeply thankful for my incredibly talented peers who have enriched my life in numerous ways. Throughout the final months, we have grown, struggled, and learned together as part of the TT cohort, and I couldn’t have asked for a more wonderful group to embark on this dissertation journey with. I am especially grateful to my first mentor, Taneha, whose personal and professional approach has been truly inspiring. The trajectory of this project would not have been the same without her guidance. I am also thankful for Geert’s unwavering support, both as a mentor and as a peer.

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Abstract

The unprecedented influx of migrants into Mumbai has already resulted in an ever-increasing contestation for land. The sheer volume of processes (material and im-material) stratified on land that sustains this large volume of habitat has given rise to several negative externalities. These implications originate from the surface but with time amplify into the atmosphere and subsurface systems, disrupting the natural systems and bodies. Primarily, land intensification in the form of large-scale infrastructural development is implemented at the cost of critical ecological systems, that are spatially and functionally marginalised. Thereby, feeding into a vicious cycle of resisting the resultant ecological instability that eventually yields, now more frequently than ever, rendering large volumes of people vulnerable/displaced.

There is a need to safegaurd not just the city but also its people from the climatic crisis that are arising from the rampant development. Especially critical in a region where degrowth, or non-development is not an option.



monsoon memories, from my window. June 2020

Motivation

Even today, clearly embedded in my memory are the traumas of the 26th of July, 2005 when my home town, Mumbai was deluged by about 944mm of rainfall in under 24 hours. While I was stranded relatively sheltered at school, my folks locked in their cars on uphill streets for over a day, not all were as fortunate to stay afloat (metaphorically as well as literally) at the end of those four devastating days. As the 13 million in the city living at 28,000 persons per square kilometer were affected. With 1290 direct deaths and thousands unregistered indirect losses in the form of infrastructure, health and monetary stability, truly put the vulnerability of the city into perspective. The need to pause and reassess. However, for a disaster dismissed as an one off event, flooding on the contrary has been increasingly frequenting ever since.

By virtue of having personally experienced at least seven of such major flooding events and countless annual water logging conditions since 2005, I have always been frustrated by the sheer inability of the city to safeguard itself and its people from inundating time and again.

Which when coupled with my education in the built environment, has seeded a strong inclination centred around the intersections between ecology and urban forms. Resuming the masters programme to study

how the urban form could be made “sustainable” has left me today questioning the very epistemology of this term. Which to me has now evolved to become about understanding the complexities that shape and sustain the habitat around us. Exploring these complexities through the realms of landscape, ecology, humanities, political geographies and particularly the techno management of water- I cannot help but speculate the possibilities of implementing this grasp to the context of developing regions. Which much like the Netherlands are also extremely vulnerable to flooding and other impacts of the climate change-like Mumbai, Philippines, Thailand, Dubai, Vietnam, Singapore, etc(cite). However the critical difference being the additional pressure of socio-economic acceleration, which pushes environmental concerns to the back seat.

Thus, I view this graduation project as a formal opportunity to translate and tap into these critical inquiries through the context of Mumbai. Not merely with the intent to address the flooding crisis but as an opportunity to investigate the larger scope of situating ecological concerns amidst hyperdense developing environments. Lastly, I strive for this project to be a confluence of my technical background and ethical values matured over time, possibly stir a new line of conversation for all.

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Reading Bombay

a diachronic analysis

“... For many a year the Heptanesia, as old Ptolemy called them in A.D. 150, were destined to glance at one another across the intervening waters; but the Providence which decreed their original dispersion willed also that, in after time, they should be once more united by the genius and energy of man.”
 -(S.M. Edwardes, 1902)

A diachronic reading of Bombay¹ reveals it to be a figment of colonial ambitions, extruded and prevailed through time, with the physical and mental entity called land becoming the object of construction. (andre cortez).

Referred to as “Heptanesia” by Ptolemy(cite) in 150AD, marks the earliest known documentation of the territory as the archipelago of seven islands that it was. These highlands were essentially rock outcrops separated by marsh that only partially revealed itself during low tides. Owing to which throughout the Portuguese Era in Bombay there was a relative ambiguity between what was land, what was water and which of them were a part of their territory. As reflected in cartographic representations of the region comprising of 4 instead of 7 islands. Sparsely populated, predominantly agrarian with salt farming in the inundated areas in areas that were otherwise not occupied by mangroves or tidal flats, allowed for a profiting and stable social habitat.

However in the 16th century when the city was handed over to the British Crown as a dowry from the Portuguese, the geographical misunderstandings of Bombay took central importance when the English preconceptions of the region being a larger territory were dumbfounded. In 1668, even when Bombay was bestowed to the East India Company, it was mapped as a single entity taking into account the centrally inundated land as a part of their territory as much as the islands. Which was more an act to assert the territory as a geographic marker to designate its colony. However this act of map making revealed the potential for land reclamation as tool to consolidate the English ambitions. Thus in the first decade of the 18th century, the chain of reclamation started with the construction of the Great Breach between Worli and Bombay islands, which was later followed by others to drain out the central marsh by keeping the sea out. All of which was done under the formal

¹. The city changed its name from Bombay to Mumbai in 1995. Thus until then will be referred to as Bombay, primarily addressing its colonial past.



Figure 1.Reclamation of Mumbai



Image 1. The Hornby Vellard, completed in 1784, is said to have given shape to the modern city of Mumbai. Photograph: Alamy 2020



Image 2. Bombay fort, circa 1850: by this time, the seven islets had been connected to form a contiguous city. Illustration: Alamy

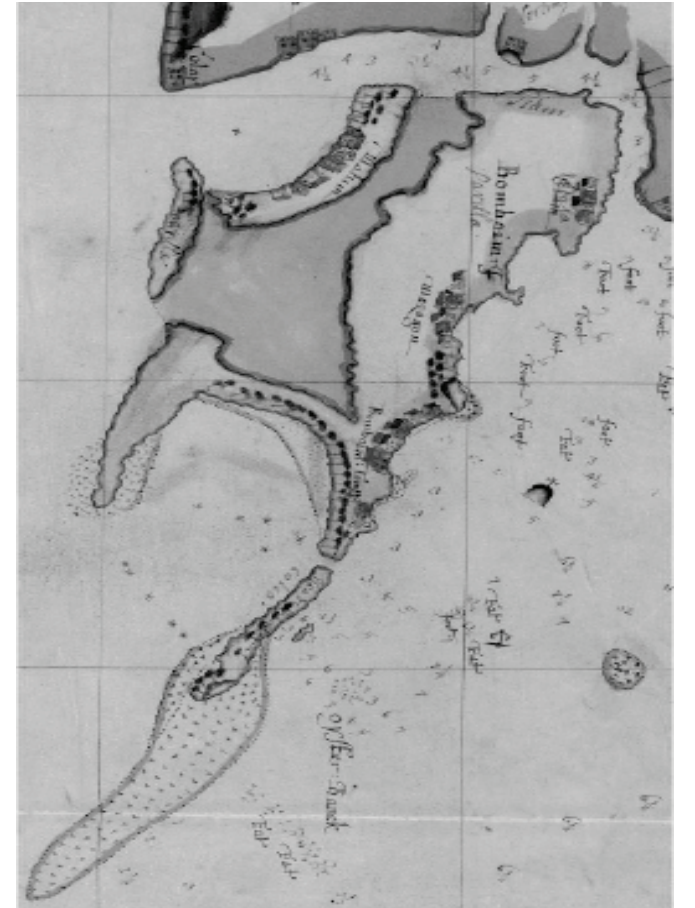


Image 3. First British map identifying the inundated land (shaded in grey) very much a part of the Bombaim territory. (1678)

pretext of acquiring more land for rice cultivation. Much of which was debatable as Bombay transitioned into a thriving port city with the opening of the Suez Canal, becoming the main trade link between Europe and the subcontinent, while agriculture shifted to the peripheral areas.

Deemed to be the “ubs prima in Indis”- first city of India, rampant land reclamation was sanctioned 1844 onwards. Marked not only by the draining out of inland water bodies but also extending into the sea and planning an entire “metropolis” inland starting with the “meet the most pressing wants of the military and civil administration.” as institutions of modernity. Particularly also because the city was still sparsely populated, which also followed by the incentivization of traders from eastern Europe to settle in this new age metropolis.

With the economic boom of trade in 1861-1865 as a consequence of the American Civil war, the city was now flourishing with heavy investments into land, infrastructure and particularly the port. Which

meant the need for more land, more dredging and particularly more sand, which was easily accessible from the persisting estuarine edges of the city. Consequently with the population doubling in mere 12 years, the demand for more labour, more housing and infrastructure accelerated the need and more importantly the value for land in Mumbai. Further advocating the proposal to reclaim more land from sea as a speculative real-estate venture.

Finally in 1878, the colonial period of building Mumbai from Bombay was concluded with the Black Bay reclamation for the establishment of an integrated transport hub connecting the port to the railways and to the roads.

Notable in this historic analysis are the shifting reasons that initiated the normalised reclamation processes and their limited association with the actual situated practice. -The practice of inhabiting the land for its present state, and not the actualization of a perceived reality.

From Bombay to Mumbai

neo-liberalisation and globalisation

Growth in the newly independent city can be attributed to functions of globalisation and neo-liberalism that carried forward the colonial attitude of building more. The production of globalisation, is very much embedded in the process of geographical reorganisation, that can be traced back to the larger history of capitalism([Harvey, 2000). Where in the various phases of the city’s becoming, through processes of production , expansion and accumulation in space, globalisation has materialised as a basic process by which life and economic activities of people have been shaped and reshaped only at accelerating rates. While it did establish a better living condition as opposed to any other city in the nation, the socio-spatial geographies of everyday life were superimposed by the ever compounding ambitions of the “Mega City” (United Nations,1993).

Marked by revanchist (Smith, 1996) methodology of socio-urban restructuring predicated on aggressive revamping of infrastructure and neo-liberal projects at diverse scales under the newly elected state. Marking a change of perspective from the extension and upgrade of basic services, towards competitive strategies aimed at transitioning from the “industrial capital” to the “financial capital” of the nation. As Manmohan Singh, who rose to become India’s prime minister in 2004, summed up the stakes, “If Mumbai fails, then India fails.” And this was achieved through production disaggregation (curbing of cotton mills), , tax intensives , de-regulation of labour , economic regeneration policies and interventionist control of urban space.

The distinction between the civil society, state and market (MacLeod,2002) got blurred further by “Vision 2013” a 10 year milestone prepared by McKinsey and Company, mobilised for a market oriented economic growth and elite consumption practice. Where the primary source of land was yet again identified by the “golden triangle” that included -mill lands, wetlands and slums made ready for development. While the land was opened up by the government, the projects were financed through the prevalence of “first worlding” (Katz,2001). Where large international corporate funds finance urban renewal projects in the city. With a growing demand for the limited land that the territory provided -further perpetuated the ethics of making more. And given the large availability of tidal sand from the innate estuarine

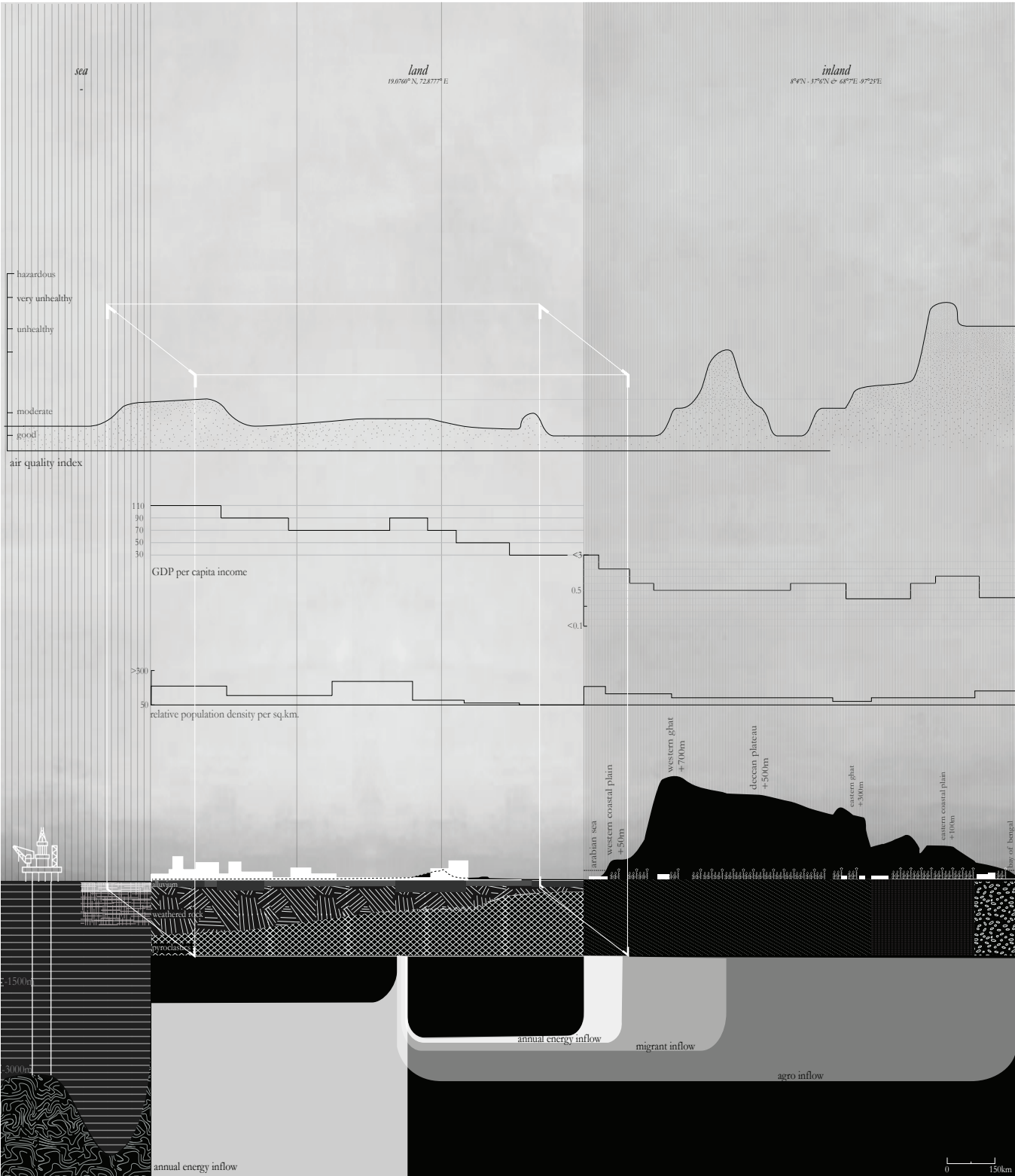


Figure 2. Transitions in the landscape due to the financial spur from globalisation in the city in comparison to the surrounding regions of its territory



Image 4. Mumbai 1970 . Source: <https://www.flickr.com/>



Image 5. Rampant construction for housing and commercial real-estate
Source: <https://www.flickr.com/>

nature of Mumbai, makes this task rather localised and hence financially favourable. Transitioning, growing, transposing, evolving, developing , growth – are some of the interchangeable terms that have defined the development of Mumbai. I would like to draw emphasis on the ephemeral attitude they project, which reflects the myopic understanding of evolution. Taking into account the needs of the prominent regions like the “golden heart “or “the island city” while being entirely oblivious to the happenings around the city’s fragile coast or communities excluded from these regions.

This economic coupling of the territory has had devastating effects on the socio-ecological relations in the city. As land was commodified ,its value was predominantly attributed to its static physicality that can be measured, quantified, politicised and above all bartered. Furthermore, this sporadic evolution of the city renegaded to the background several sectors of the society who are in need for basic living necessities, even today. On the other hand the high monetary valuation of land coupled with increasing population rendered inland waterbodies and coastal habitats highly vulnerable to encroachment. Particularly, due to the effect of a liberalised real-estate market. Which is very evident from the loss of 30% of the mangrove area in Mumbai during this decade. While these ethical shifts are noted in the recent past, they are still deeply rooted in the way growth and development is perceived for the territory, by the territory, but not with the territory.

Reading Mumbai

in land

“...not to call it the formal and the informal city, but I describe it as a third space—the kinetic city. This suggests a possibility to blur binaries and look at conditions such as the ephemeral, opening many other possibilities for urban design and architecture.” -Rahul Mebotra

Chaotic, informality, density are a few of the common terminologies that have come to describe the city that we know today. Currently housing 22 million people with a density of 25,300 sq.km is faced with faced yet again with the need to grow

Embedded within non-libreral ideologies, have perpetuated a domination of images and formed aspirations of urbanity, creating disruptions in urban form. Ones that transpose images of the built environment from cities like Singapore, Shanghai or even New York onto the social and ecological functions in place. Resulting in an glaring societal disparity across the city. Consequently, delineating from ideas of repair, restore, reuse or reform, to processes of accumulation yet again.

After years of normalising land intensification, its negative externalities have begun to surface, in the form of flooding, erratic rainfall and coastal erosion, since the past decade. And given the limited preparedness for any form of natural disasters, sets a strong blow to the city. As countless lives are lost, several rendered homeless and the loss of infrastructure. All of which take years to recover from the setback. However, blinded by capitalistic ambitions, the architectonic projects are still centred around high-end developments and large infrastructural projects like the coastal freeway that do nothing to address the more pressing societal/ecological concerns. The city today needs to find a tandem between the three pressures- the aspirations to evolve in this globalisation regime, the need to provide basic living infrastructure for its population, and the need to acknowledge and address the importance of safeguarding its natural systems to support it.

Development = Building More

expand

intensify

‘reclaim’



Image 6.Mumbai 2022 : Isolated patches of estuarine vegetation remaining amidst the built mass

Problem Field

An Altered Landscape to Point of no return

Land Intensification

Flooding

Climate Change

The landscape of Mumbai has continuously been transformed in time stemming from a perpetual dichotomy of its land and waters. Where varying geopolitical circumstances from its colonial past have normalised land reclamation as a formative trajectory forward.

Since then, while development orientations (incentives) have significantly transitioned in time, the humanist ethics of compounding grey infrastructure at the cost of ecological systems still persists. As large scale infrastructural projects are executed time and again inching into the sea and augmenting inland with little regard to the geomorphology of the territory.

Particularly, its innate estuarine nature that has been so drastically altered in the past century that it is no longer capacitated to absorb monsoon waters or act in symbiosis with the regional hydrological cycle. While hard, engineered, technocratic flood defence mechanisms have been superimposed on the pseudo island city , their lack of integration with the local socio-environmental rhythms environment and limited cognizance with critical territorial processes has rendered them counterproductive. Thus resulting in annual water logging events every monsoon.

This condition when evaluated against the impacts of climate change puts Mumbai under grave vulnerability.

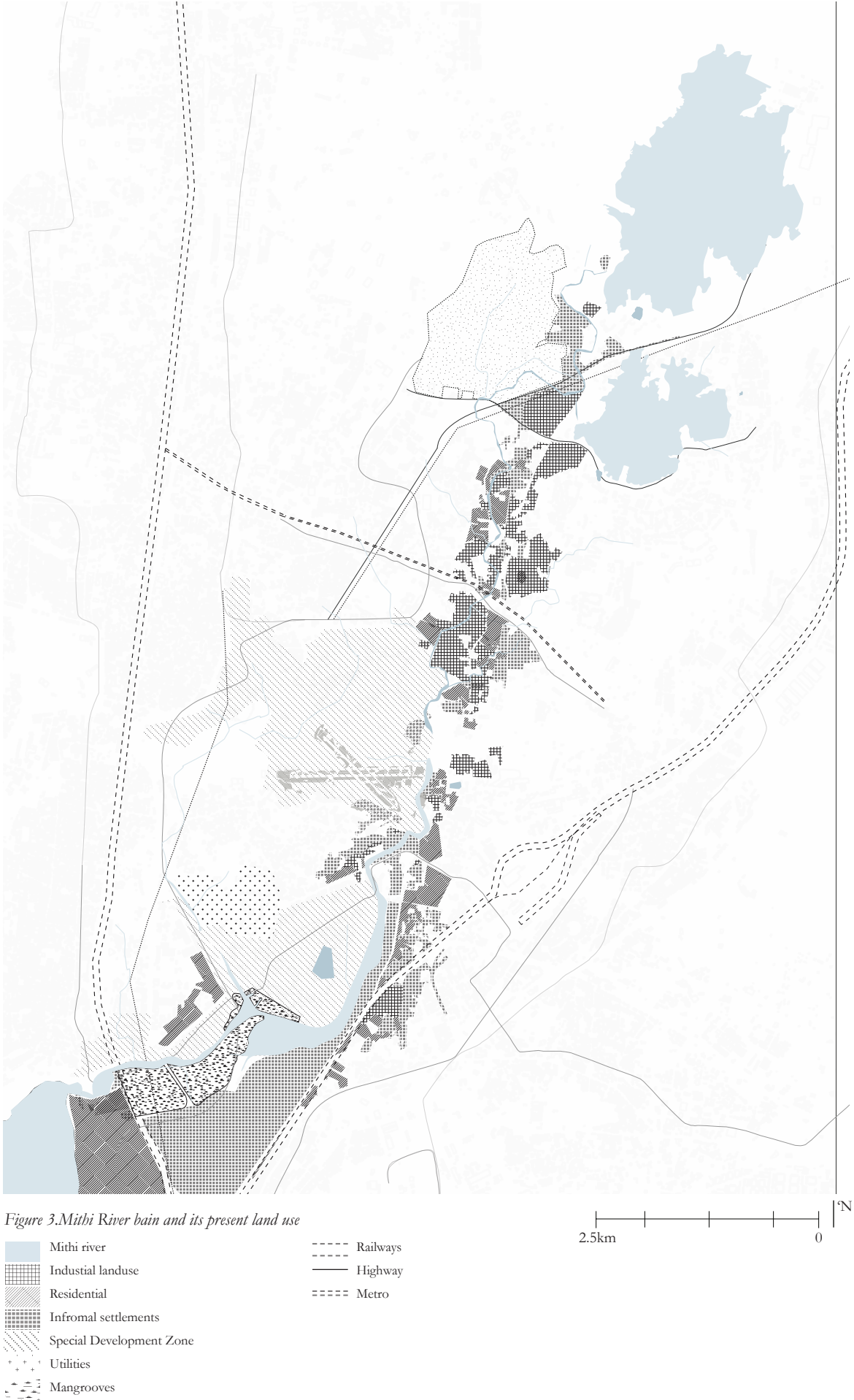


Image 7.Current Reclamation for the Coastal Road Project. Image ource : freepressjournal.in

This territorial dichotomy between land and sea can be further articulated at a local scale through the case study of the Mithi River. A meandering trail of water cutting across the city, that plays a critical role as a natural flood mitigator. In this analysis, the river is considered not as an isolated object of focus but more so as a body that has been in constant negotiation with contesting forces arising from the very saturated environment surrounding it. By analysing through lens of accumulation, alteration and limits, patterns can be traced that have marginalized the river and pushed the natural drainage system beyond its limits. Hence making a pressing case against the practices of land intensification that occurs at the cost of altering the innate estuarine nature of the territory.

Originally a part of the Arabian Sea, the river was perennial water body that supplied fresh drinking water from the vihar lake at the top of the Salleset hill to the rest of the city before it opened up to the sea. By virtue of its geomorphology the river basin is one of the lowest lying regions in the territory with a significant part of its downstream body below the mean sea level. However much of this has significantly transformed in time.

The water edge today is defined by a variety of intensive land uses like industrial setups, commercial estates, residential dwellings, transit infrastructures cutting across it as well as informal dwellings.



These functions have not only altered the natural state of the river by concreting its bed and edges beyond limits, but also through the accumulation of pollutant have drained it dry in most parts of its stream. Indeed transforming the Mithi River (translates to “sweet water river” in local language) to Mithi Nallah (which translates to “drain”).

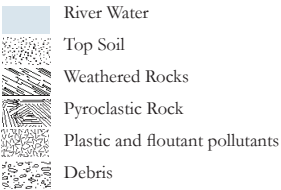
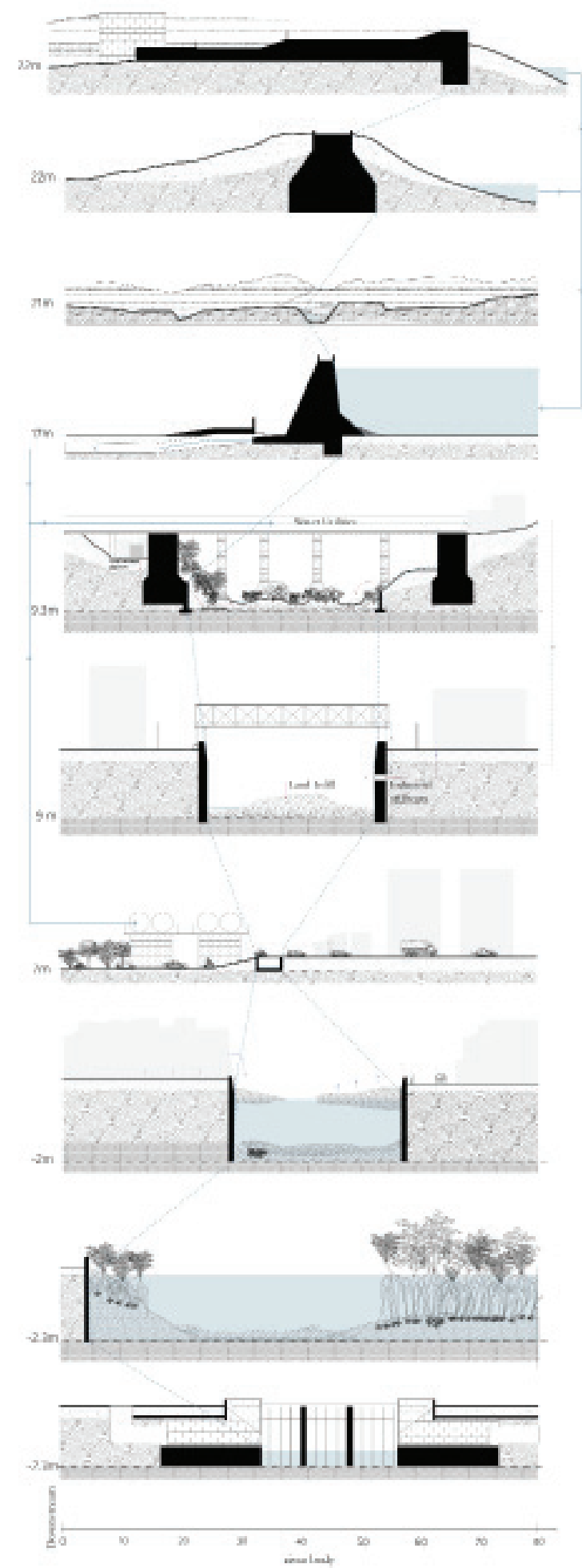


Figure 4. A section through the manipulated river body



Alterations: In time, the body of the river has been shrunk by land-infilling , dewatering and desicating almost all of the marshland habitat in just a decade. Followed by ground stabilization (by concreting) and the embankment of river edges to make the land stable and suitable for more permanent human occupation patterns. These land intensification process neither take into account the local social consturcts nor do they respond to the natural habitat.



Image 8. Current state of the Mitbi river. Image source: DNA India

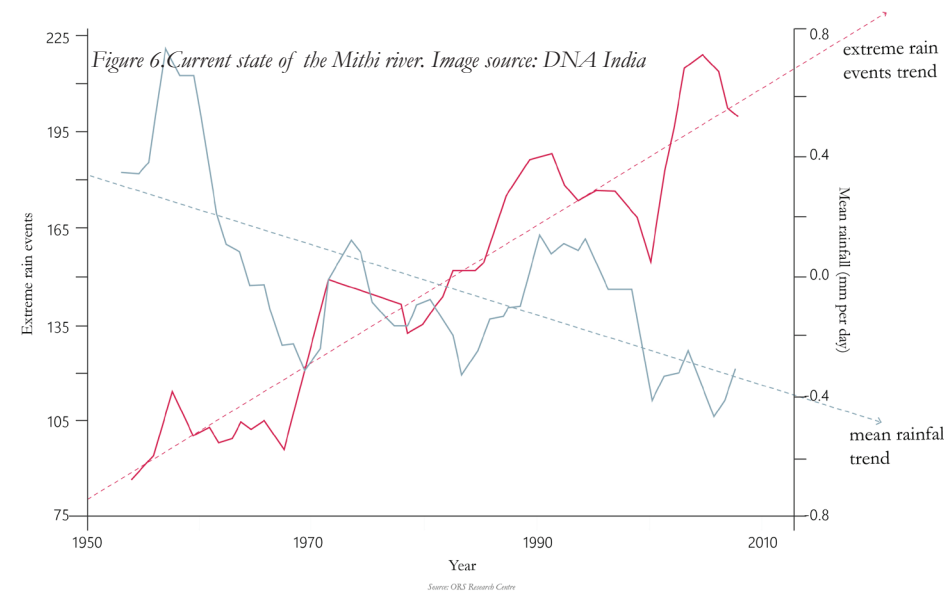
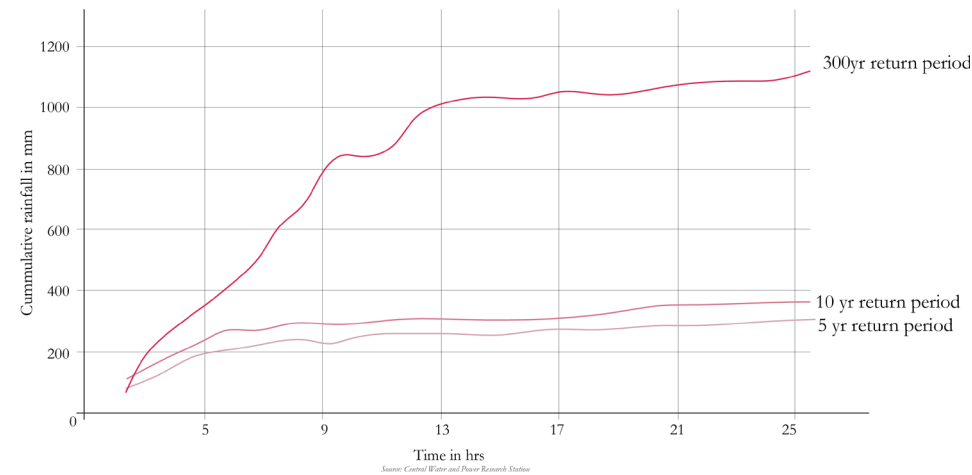


Figure 5. Rainfall fluctuation trend

Impact: This extreme biophysical alteration has rendered inland catchment areas incapacitated to handle large volumes of water. Thus it is a rather a common occurrence for the river to flood on a weekly basis during the monsoon as it overflows, throwing out the accumulated sediments and pollution from the river bed onto the adjacent land. While several engineered measures have been implemented in the form of higher embankments, seep holes, flood gates, sluice, water pumps, etc. They fail to address the issue, and simply add to the accumulated mass and consequently abet to the flooding.

Urgency: This act of intensification in response to water is indeed reaching its limits, which are evident during the monsoons. Where with the high volumes of erratic rainfall displaces not only human lives, but also more than humans and not to mention the infrastructural loss that is incurred, as the entire area is cleared out by water. Additionally, when periods of heavy rainfall occur concurrently with high tides, there is a backflow of water experienced from the bay. Where the water gushes inland from the sea to the river and other drainage outlets resulting in catastrophic floods (a combination of fluvial and pluvial flooding). Whose impact if experienced across the city.



2009



2013



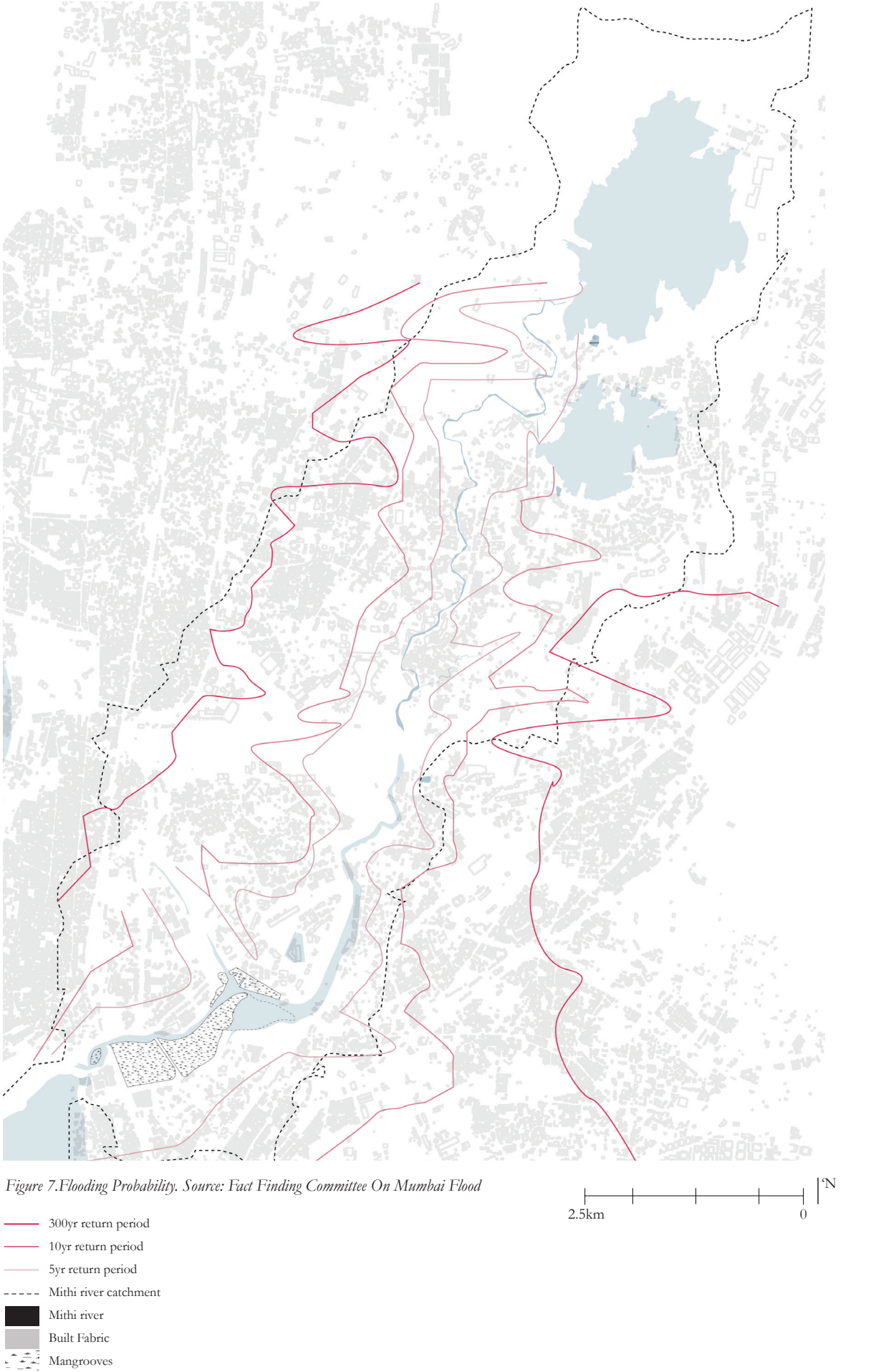
2017



2021

Image 9. Frequent flooding. Source: flicker.in

Need: Formally, mapping the spatial extent of areas prone to flooding does not encompass in entirety the gravity of the crisis. This is for two reasons: most flood maps generated are purely based on the topography and rainfall capacity. With limited understanding of the surface and infrastructural conditions. This results in a underestimation of the disaster, its cause, frequency as well as intensity, and this unpreparedness only results in more losses. Additionally, although the spatial extent of the innudation prone areas maybe a few sq. km. the sheer density of the region, coupled with the informal nature of dwellings and inefficient infrastructure, accentuates the vulnerability of the inhabitants within this region. One that not only perisists during the disaster but for years following it.



Further more, this condition is further accentuated under the impacts of climate change , that puts Mumbai under even greater vulnerability. As it is experiencing a shift in its climate belt which means, longer and more erratic periods of precipitation, that the territory is incapacitated to endure this downpour. Additionally the inland movement of water due to rising sea levels is also eroding the coastline as it creeps landwards and is set to reclaim 30% of its coastal area by 2030.

Ultimately, the cumulative effect of marginalised estuarine ecosystems, aggressive land-intensification processes ,hampered hydrological cycles and sea level rise manifest in a combination of falluvial and coastal flooding that has catastrophic impacts on the region .

Thus there is an urgent need to re-evaluate the prevalent practices of development which revolves around building more,framed as a component of resilience. To establish a tandem between the societal pressures in the form of aspirations to evolve in this globalisation regime, the need to provide basic living infrastructure for its population, against the pressing need to acknowledge and address the importance of safeguarding its natural systems to support it.

Bringing to ponder, if it is truly land reclaiming water or in reality land being reclaimed by water? In which case what does this hold for the future of Mumbai? Would it once again return to its original nature of the 7 islands?

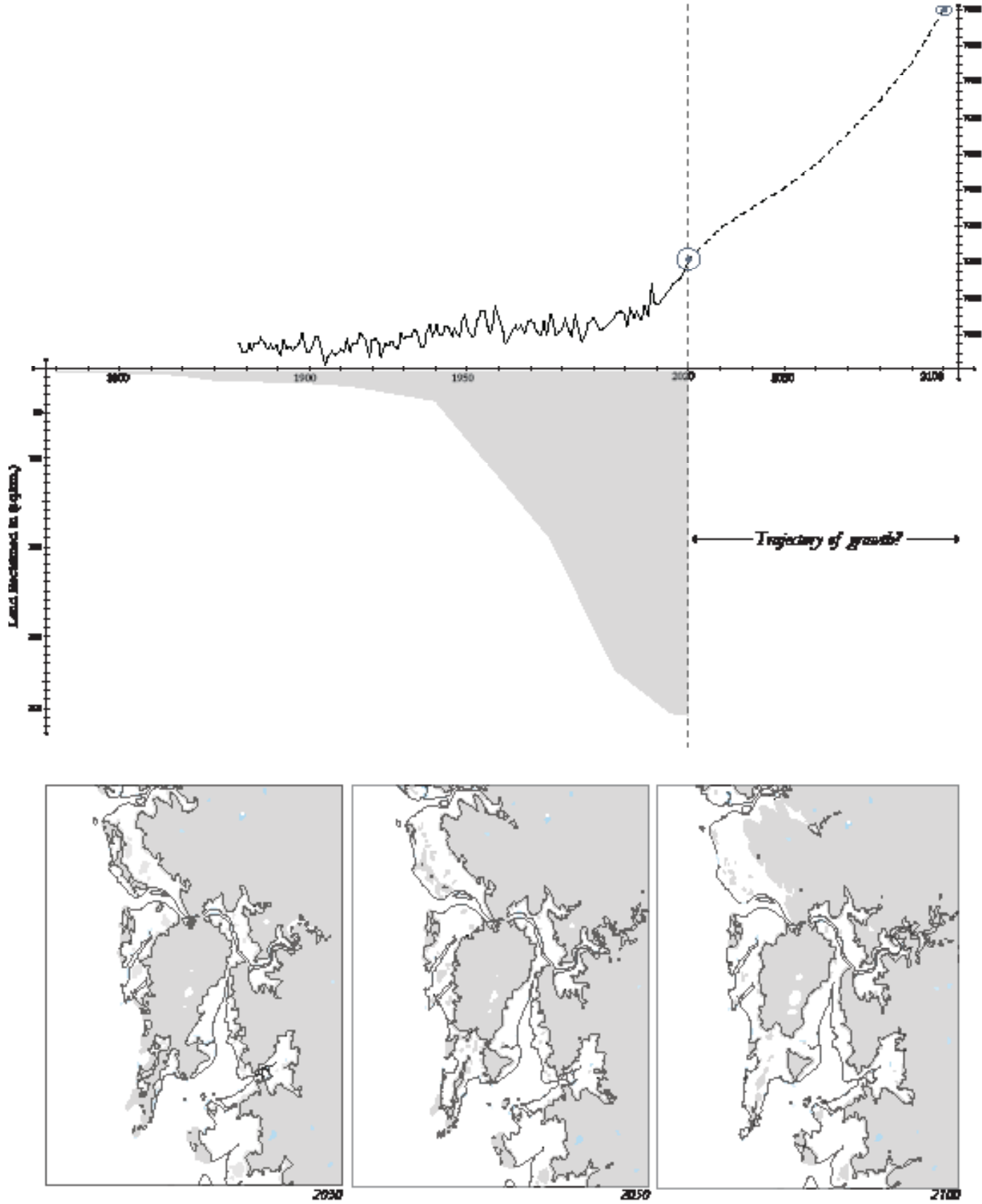
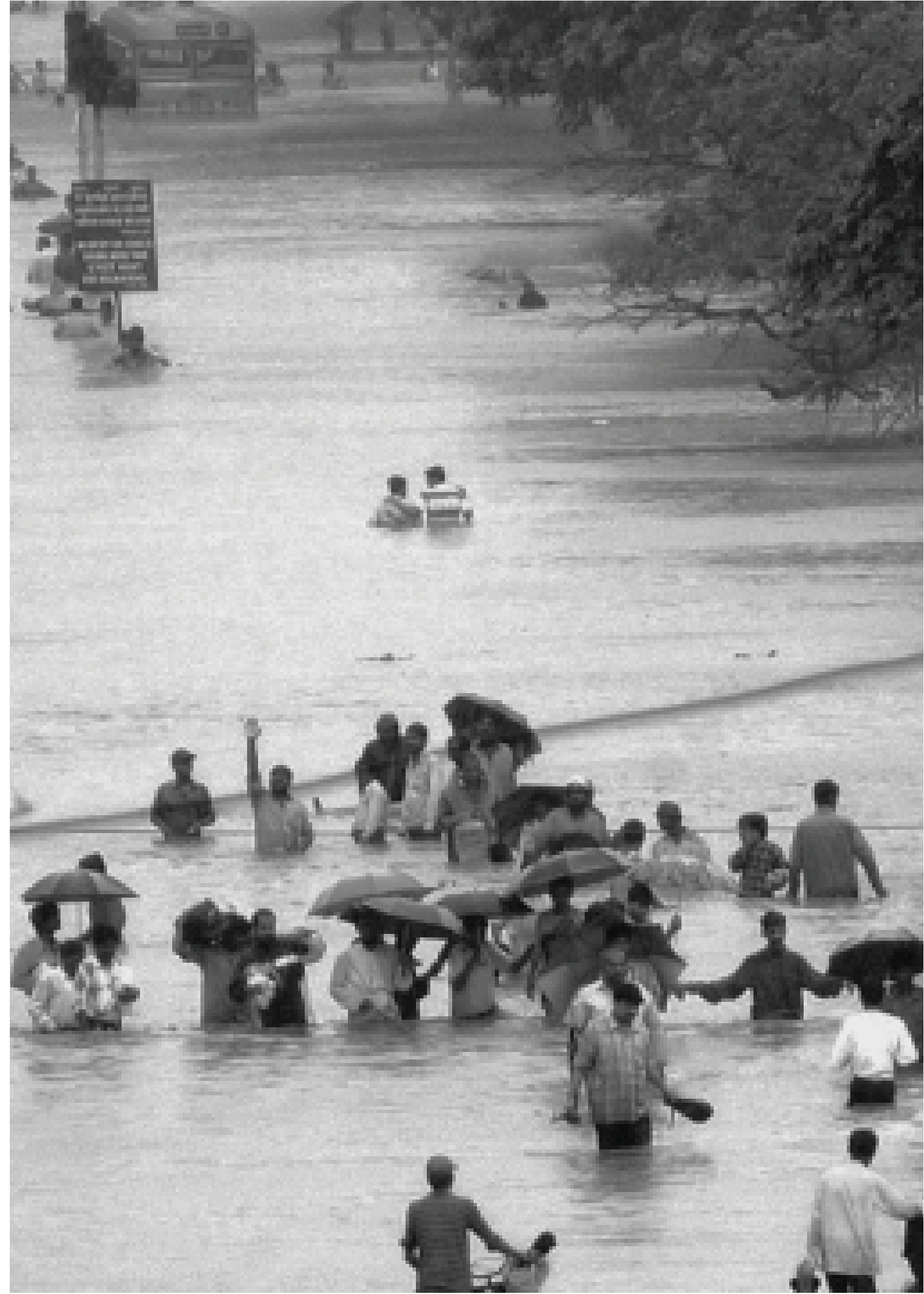


Figure 8.Projected Sealevel rise



Problem Statement

The prevalent paradigm of development in Mumbai are defined by anthropogenic processes aimed at building more. Manifesting in the form of inland architectonic augmentations or outward reclamations into the sea, these interventions are dissociated/incongruently positioned in the territorial ecosystem. Thereby altering natural cycles, disrupting habitats ,and ultimately rendering critical ecological systems spatially and functionally marginalized. The resultant instability in the territory is evident as large volumes of humans and non-humans alike are lost, set-back or displaced, by catastrophic floods, that are further exacerbate by the adapting territorial landscape.





Hypothesis

The territory of Mumbai is dynamic, and in a state of constant formation through inland and seaward processes, that include a combination of both anthropogenic and natural movements. While the two may not always be in sync, they do exist in tandem to which the environment adapts. Thus resulting in a dynamic landform that is based on the net gain or loss of land to the sea (both from inland as well as the coast).

However when these territorial processes function in an increasingly antagonistic manner, or the surrounding environment reaches its threshold to accommodate resulting alterations, there is a condition of instability in the ecosystem-and this is witnessed in Mumbai as an altered hydrological cycle. One that renders both humans and more than-humans vulnerable to short term intense impacts followed by long term cumulated and permanent modifications in the territory.

Since most anthropogenic functions are centered around building more, with little regard to the negative externalities manifesting on the ecological cycles. With landscape ecology at the centre of the narrative, the concept of growth can be decoupled from building more to processes of repair and restoration. Presenting a new avenue for evolution that aims to sustain the habitability on land by forging new relationships founded on symbiotic living conditions between the biotic and abiotics of the region. That not only mitigates the externalities of growth as well as empowers the territory to persist the impending insurgencies of the fluctuating hydrological conditions.

Research Aim

To steer the prevalent trajectory of growth in Mumbai to be founded on systems of care and symbiotic co-habitation of its human and more than human occupants. As a means to ensure a resilient habitat against the externalities of its unprecedented growth that manifests in the form of monsoonal flooding and sea level rise .

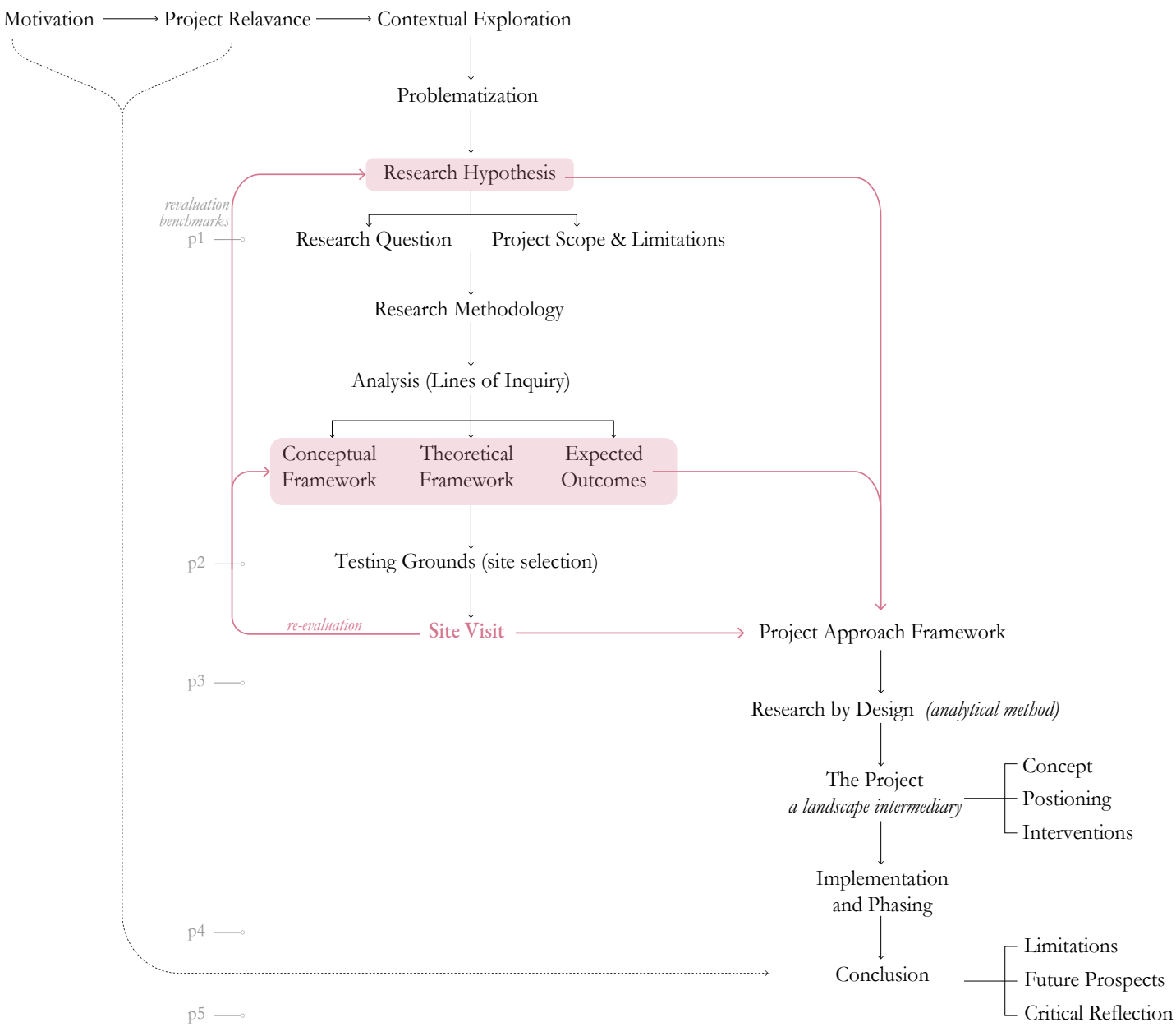


Image 11.Coastal Road Mumbai. Source: flicker.in

Research Goals

1. To mark a shift in the prevalent interpretation of Mumbai as a static territory bounded by its administrative outlines. By **decentralizing human positioning** and understanding the city concurrently -as an act as well as a resultant of **territorial socio-ecological dynamics**.
2. To delineate its development trajectory from neo-liberal and modernism paradigms of growth to becoming cognizant of the complex path dependencies between the biotic and abiotic agents of its land transformation. Thereby initiating an **ethico-political redefinition of ecological relations** in the region.
3. To project growth as **moving target** that can mediate and respond to fluctuations in the society as well as the resultant urgent and insurgent externalities that manifest in the altered hydrological cycle at vary scales and frequencies.
4. Reorient development strategies to **establish interdependencies** between decision-making and socio-scientific, political, climatic and biochemical processes in the ecosystem, transforming it into an **adaptive collaboration** aimed at achieving a condition of **homeostasis** in the ecosystem. One that manifests as emergent forms and orderings that will ensure a resilient territory capable of safeguarding the existence of humans and more than humans against the impending floods and sea-level rise.
5. Develop a critical stance backed by research to **wager socio-economic vulnerabilities against ecological liabilities in the critical zone**, given that they persist at varying scales, intensities and rhythms in the territory. Further ensuring their inclusion (human and more than human) in the various stages of development planning and implementation as a means to foster a **just approach**.

Research Framework



Research Question

What forms of **new territorial practices** can redefine paradigms of growth in Mumbai? That responds to the necessity to accommodate the growing population and their neo-liberal/globalization ambitions whilst addressing its **externalities** that manifest in the form of a **disrupted hydrological cycle**- causing recurring and intense flooding every monsoon. So as to foster an **evolutionary** and **symbiotic** relationship between its **critical ecosystem cycles** (geological and hydrological) and **habitation patterns** as a means to safeguard the existence of humans and more than humans alike .

Sub-Questions

Contextualizing

1. Which natural (biotic + abiotic) cycles of the ecosystem are fundamental in shaping the morpho-dynamics of the territory and how do they manifest spatially in time?

Research by Design

2. What are the critical anthropogenic dependencies and ambitions embedded/positioned in these ecosystem cycles and in which form?

Grounding

3. What are the thresholds of the prevalent human appropriation and growth patterns in Mumbai before they are incongruently positioned in the territorial ecosystem cycles? How is their impact witnessed in the region across the varying scales of space and time?

Evaluation:

4. What are the limits of growth and how can they be directed progressively to influence the morphodynamics of the territorial landscape so as to mitigate the externalities of intensifying anthropogenic functions on the estuarine territory to ensure its functional health?

Methodology

<u>Data Collection</u>	<u>Data Synthesis</u>	<u>Expected Outcome</u>
i) GIS Data	Diachronic Mapping <i>(iii, v)</i>	To develop a deeper understanding of Mumbai’s colonial past, relating changes in its physical land mass to the prevalent socio-political conditions in time. Touching upon the power structures, governing norms, and ambitions that prevailed under the British rule and how it has transitioned in time to other values of a globalised democratic city.
ii) Government Masterplans	Analytical Mapping <i>(i, ii, iv, v, vi,vii, viii)</i>	A synthetic mapping and representation of prevalent critical processes that shape territorial formations, identifying points of incongruency within them. Relating social processes on site with their corresponding bio-physical conditions creates basis to derive conclusions and hypothesis that help synthesis some of the complexities of the site, that substantiate the problem field as well as reveal prospects for collaboration.
iii) Literature Review	Counter Mapping <i>(i, ii, iv, vii, viii, ix, x, xi)</i>	There are several informal settlements and smaller local communities in the territory that are often not reflected in official plans or GIS data sets, owing to their organic,ephimeral nature or even illegal status. However they are very essential to the context of the project as these communities often lie in zones most vulnerable to inundation and this exclusion also reveals underlying socio-political dynamics on site. By aligning formal plans with real time satellite data, alterations have been made in the resultant map.
iv) Policy and Legal Documents	Critical Cartography <i>(i, ii, iv, v, vi, vii, viii, ix, x)</i>	To use arrative as a tool for awareness and initiative by reflecting upon the hydrological crisis through the lens of the terrain.
v) Archival records and Biographies	Projective Mapping <i>(i, ii, iii, iv, vi, vii, viii, x, xi)</i>	To envision realities based on current trends and can precede or compliment future design scenarios.
vi) Academic and Scientific Research Papers	Flow Mapping <i>(i, ii, vi, vii,viii)</i>	To determine the nature flow of water in the territory by virtue of its landscape. Understanding the basin and innundation dynamics. Which when overlayed on the ground realities, can reveal points of landscape alterations. That can be addressed as a part of the design intent.
vii) Visual Documentation	Visual Montage <i>(v, vi, vii, ix, x, xi)</i>	As a method to engage with the intricacies of the site and local communities. Since there is limited consolidated data that provides valid information about their practices and bodies of knowledge that has defined them as a community, these cross media methods reflect an attempt to establish their narrative and position in this subject.
viii) Satellite Imagery		
ix)Site visit	Stakeholder Analysis <i>(i, ii, iii, iv, vi, ix, x, xi)</i>	Gives insight into the agencies, communities and institutions involved and or affected by the terraforming of the territory. Grouped and graduated based on their levels of participation, interest and power in this transition. Thereby creating a basis for social evaluation of decisions and forms of action.
x) News Articles	Power Interest Matrix <i>(i, ii, iii, iv, vi, ix, x, xi)</i>	
xi) Interviews - expert and community	Case Studies <i>(iii, v, vi, x, xi)</i>	The scope of the case studies has been define under 2 categories- a) contextual case studies that includes research , assessment and design practices in the asian or indian contexts. To specifically ground the project to the existing realities and explore ways to practically implement the proposed goals b) techno-scientific case studies that are relevant to subjects of landscape ecology, terraforming, land reclamation, flooding and disaster management as developing a body of knowledge.

Research Limitations

1. There is very sparse and disparate information available about the history of territorial formations in the region. And among those available are rather non-objective colonial documentations.
2. Due to the absence of a single platform for all territorial data, it is rather limiting to gather congruent information for any particular site. i.e -data of matching resolutions, time frames or even departmental sources. Under such circumstances, educated assumptions or data from similar time frames have been referred to.
3. Access to information related to territorial waters very restricted due to security reasons. As a result of which global large scale and low resolution (national trans-boundary) data sets have been used to fill in the gap. Alternatively satellite images have been referred to enhance resolution of this information.
4. Due to the complex urban fabric of the city as a mix of formal and informal occupation, and the lack of an updated master plan there are several regions particularly along the coast where the official plans do not align with the realities on site. Based on personal awareness and cross-verification with satellite imagery, alterations in the GIS/ governmental plans have been made.
5. Socio-political bureaucracy, is very evident in the filtered data available in local research papers. While it is difficult to make tampered information out from ground realities, an awareness about these conditions have been incorporated in the project.

Research Scope & Preconditions

The overarching aim of the project tries to position the duality of socio-ecological crisis faced by Mumbai as a rampantly developing city. Given the sheer multitude and intricacies of the humanitarian and environmental factors contributing to its condition, the project does acknowledge their existence but its scope has been structured around specific parameters.

The Territorial Extent- The narrative of the project is structured around establishing an expanded understanding of Mumbai, through its geomorphology. Thus in addressing its territory, the project spatially takes into account -the administrative land parcel as well as the water bodies that surround it, namely- Thane creek (east) , Ulhas river(north) and the Arabian sea .

Ecological Scope- Water has always played a significant role in Mumbai, not only from a physiographic perspective but also for the sustenance of its occupants through time. However the influence of its altered hydrological cycle goes beyond the erratic tides or forms of precipitation. As when it interacts with the societal framings of the city- it feeds into other corresponding crisis of water scarcity, water pollution, ground water crisis, fluvial, coastal and fluvial Flooding as well as the water mafia. Whilst acknowledging the inherent and interconnected complexities of each of these concerns, owing to the time frame of the graduation project, the scope of inquiry has been focused on flooding as an annual as well as recurring event. Whose impacts are prevalent across scales and time in the territory. Which aligns with investigations into the disturbed hydrological cycle that prevails in form of monsoon as a reckoning force followed by long durations of dryness . And in the longer scales of time is coupled with the impending sea level rise-given that the city has been has been declared one of the most vulnerable to climate change and a consequent sea level rise of about 0.2m – 2.8m over mean level in the near future.

Societal Scope- Growth and development norms in Mumbai have always been focused at accommodating its expanding population. However, in the past decade there has been a flattening of this ascending

curve (world population review, 2023), raising several questions about its future prospects. In this context, while being cognizant of the socio-political and economic variables that define the rates of land intensification in the city, the project shall predominantly address the landscape implications of the population increase against the ecological crisis faced by the city in time.

Time frame - While Mumbai witnesses flooding almost annually, the impacts of sea level rise are only substantially manifested by 2030 with a significant part of its coastline critically vulnerable and below sea level. While the prevalent development plan for the Region of Mumbai is also defined until 2034. It would be valuable to draw comparisons and speculate in the short term scale of 2034. While long term period in the project extend to 2050 due to limited accuracy of data beyond it.



Image 12 Mumbai a land water dichotomy

Source: cpw.in

Lines of Inquiry

Understanding the dynamics of incongruencies in the territorial ecosystem. Based on the hypothesis of the territory being a living geosocial formation.

A diachronic reading and analysis of Mumbai's contemporary morphology reveals it to be a highly dynamic territory . Where within a period of 400 years the region transformed from seven anonymous ephemeral highlands that revealed themselves only during low tides to the unified landform that we acknowledged today. Resulting from a multitude of processes causing the accumulation and clearance of matter that have composed the region in time and still are. It can indeed be concluded as a territory constantly in the making, *alive* (J. Lovelock, 2000) and living as much as the organisms that inhabit it.

Founding on the interpretation of the natural world as a living being or '*Gaia*'-its existence can not only be attributed to the cycles of the atmosphere, biosphere and hydrosphere taken apart but 'living' with the anthropogenic (human, material and technical) functions embedded,as a whole.

This plurality can be traced in the sheer multiplicity of the territory's elements, circulations, life forms, and environments that operate across a gradient of dimensions, energies, and rhythms. – Thereby, dubbing the myopic purview of a territory as a bounded entity (B. Latour, 2018), that have predominantly defined investigations into this context in the past. Consequently, this develops the necessity to acknowledging the realities of these transformative processes.

This chapter of the thesis thus aims to unpack some of these complex relationships through the lens of matter, topos, habitat and geopolitics, as a means to evaluate their agency in the territorial sentient process. Methodically, taking into account the reciprocal and harmonious relations between the non-human and human inhabitants.

Through a critical cartography of the '*archeosphere*' (Edgeworth. M, 2018) as a physical and functional entity nested in the natural systems, the elements of strata (spanning across the biosphere,troposphere

and hydrosphere) are not only accounted for as a formative part of the landscape, but as the very ground itself. Transforming into new hybrid forms of environmental agencies , that are shaping its surroundings as much as they are being shaped by it.

This specific focus on identifying discordant relations in the ecosystem will serve as a basis to articulate the problem field and define its scope based on thresholds. Which have been calibrated by overlaying adaptive capacities of these discordant functions , across geological, ecological ,socio-cultural, political as well as economic spheres of influence. Each of which come into prominence at varying scales, addressed by the lines of inquiry.



There are no territorial boundaries, and the territory isn't a specific space but "all the entities that allow a particular agent to subsist" ("We Don't Seem to Live on the Same Planet" - A Fictional Planetarium,

image source: earewater.org

Matter

Tracing patterns of mobilization of matter-in the forming, transforming and terraforming of Mumbai.

The territory of Mumbai as a geosocial entity is constantly in the process of being formed, transformed and terraformed by the movement of matter. In this contiguous process, not only is the land under inquiry being morphed but at the same time, so is the matter in motion just as much as the medium that transposes it. Taking into account the heterogenous impact of reciprocal anthropogenic and natural processes of the ecosystem, the composition of the bounded territory Mumbai can only be aptly studied by tracing the mobilization of matter, its deposition and removal across its unbounded territory. Thus predominant focus has been laid on this highly malleable littoral edge between land and sea that buffers the two interpretations of territorial expanses. This edge condition holds immense centrality in the morpho dynamics of the territory concurrently functioning as a resource of extraction, medium of mobilization as well as a ground for accumulation of matter.

Acting in varying rhythms, the aforementioned matter stratifies in time to forge ephemeral landforms that via their inherent conditions of stability or instability tend to afford diverse habitats, occupation patterns and consequently embed themselves in its long durée.

Through this inquiry critical parallels have been drawn between notions of stability as a component of time as well as the physio-chemical attributes of their material existence. Thereby laying foundations to questioning the existing static basis of designing as- building and growing to a more aqueous and malleable interpretation of land making as aligned with its socio-ecological materiality.



The mobilization of matter has been traced by dissecting the processes down into its, agency, matter, medium and resultant. Which can are mutually interchangeable as well as exist as multiple states along the same process line.

Sediment brings together two of the earth’s great cycles – the tectonic and the hydrologic (Thornbury, [1954]2004). It is the product of interacting earth systems - the lithosphere, the biosphere, the hydrosphere and the atmosphere.And the most predominant overarching process defining the morpho-dynamics of Mumbai is its hydrological cycle, encompassing the southwest monsoon winds, motion of inland water bodies and tidal patterns-accounted for a as cumulative outcome of human and more than human.

- Southwest monsoon winds- bring a torrential downpour of about 400mm (I.M.D) annually from June to September. Causing a massive flux of matter- soil ,sediments and pollutants- inland as well as seawards.
- Motion of Inland waterbodies- Which are although inherently perennial ,they tend to erode and carry sediments, pollutants and other flocculant particles downstream, accumulating and stratifying them throughout the year. This not only transforms the body of the river as a resultant entity but also hampers its perennial nature as a medium for movement, as clogs or dries the water body up. However this condition is altered seasonally during the monsoons as the river is reinforced by rainfall and the coagulated matter is set in motion once again, ultimately being deposited into the sea bed.
- Tides – While tides are relatively consistent in their rhythms and region of influence. The cumulative extent of their action can be accounted for in a relatively longer timeframe. Which when coupled with impacts of climate change particularly sea level rise , are found to be harsher and more erratic in nature, particularly during the monsoons (IMD, 2018). However the most significant role of the tides is to nourish the estuarine ecosystem.

While these elements of the hydrological cycle have had a relatively consistent/rhythmic influence on the movement of matter,they are strongly influenced and altered by active anthropogenic functions and their techno-material depositions on site. Some of which

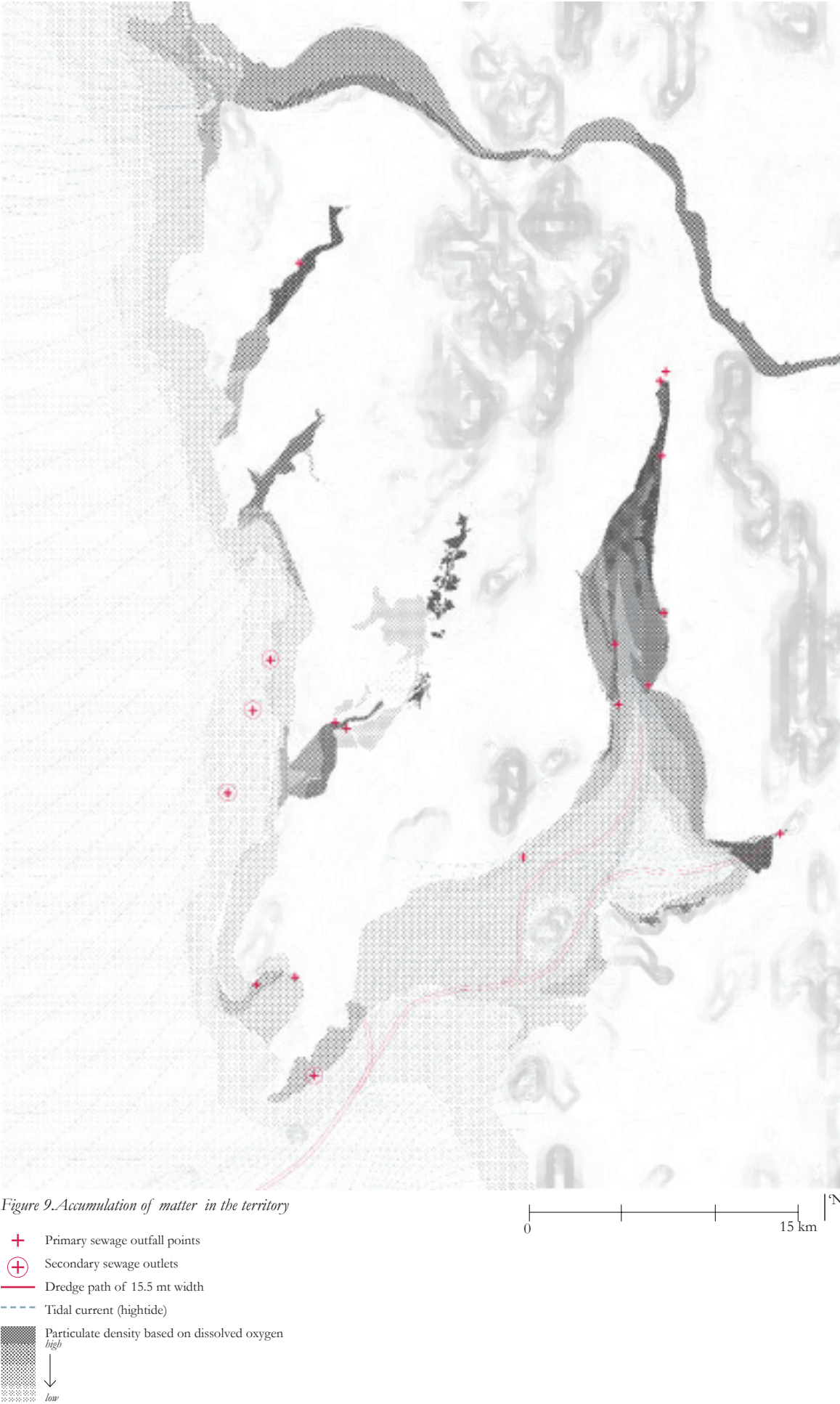


Figure 9. Accumulation of matter in the territory



Image 13. River Dredging. Source: WRI India



Image 14. Unchecked garbage disposal into inland river bodies. Source: DNA.in



Image 15. Real Estate construction encroaching into salt marsh areas.

can be noted in the form of –Inland architectonic projects, illicit garbage disposal, landfill, formal sewage expulsion, dredging and land reclamation. Where most of these depositions are set/ amplified in motion by the hydrological cycle.

It is of critical importance to acknowledge these processes not merely for their resultant accumulation of matter. But instead comprehend them as a part of the archeosphere (Edgeworth. M, 2018) , that takes into account the stratified totality of their techno-material presence in the biosphere across time. Thereby encompassing the contribution of such anthropogenic process to landmaking across time, that are far more widespread than the static infrastructural footprint or region of influence they function in. For instance, the outfall from sewage outlets in the eastern coast of Mumbai has been observed to flow and accumulate downstream. While some of it is eroded or dispersed by moving tides, rest of the material is compacted by the tidal inflow of sediments into the estuary. Giving rise to composite landform resulting from a combination of human and more than human processes. Only to be dredged out and deposited elsewhere as a part of clearance for ships to navigate into the bay.

‘mobility transforms the particles themselves. The surfaces they move over and the flows that move them into turbulent assemblages of terra-aqueous matter’ (Clark, 2017)

Shifting focus from the process to the matter and its movement, the scope of research now delves into two scales that determine the limits and nature of the alteration of matter. Thereby defining parameters that shape contemporary notions stability- often associated with concepts of the matter composite being dry, stable and bounded (Bremner, 2020).

Micro-scale: The materiality of the substance- its physical ,chemical and biological composition provides reasoning to its nature of movement, where matter on site is seen to – drift, weather, salt as well as alluviate. Where information about their composition is essential to determine their compatibility with other heterogeneous materials. Their tendency to dissociate, stratify, amalgamate or unify as an homogeneous entity. On the grounds of which speculations can be made about their ephemeral nature and sense of ‘stable ground’

Macro Scale: In the macro scale the movement of sediments is documented as a vital estuarine function. Since geomorphology of Mumbai can be traced back to its estuarine origin, that plays a critical role as a flood defence mechanism, it is of great relevance to understand the influence of anthropogenic activities on the prevalent tidal processes. Since the sewage outflows are located close to the mouth of the estuary, there is a condition of over nourishment observed along the eastern coast, that is marked by flocculant particles that hamper and slow down the tidal movement. Creating a stagnant environment, which gives rise to algal species in the summer, only to be dispersed during monsoons.

While at the northwestern end, as the tidal energy increases during monsoons, the tidal inlets expand, cutting the barrier, where the redistributed sand progressively builds a longitudinal tide bars. While in the central part, tidal channels are formed and sands of marine origin are deposited.

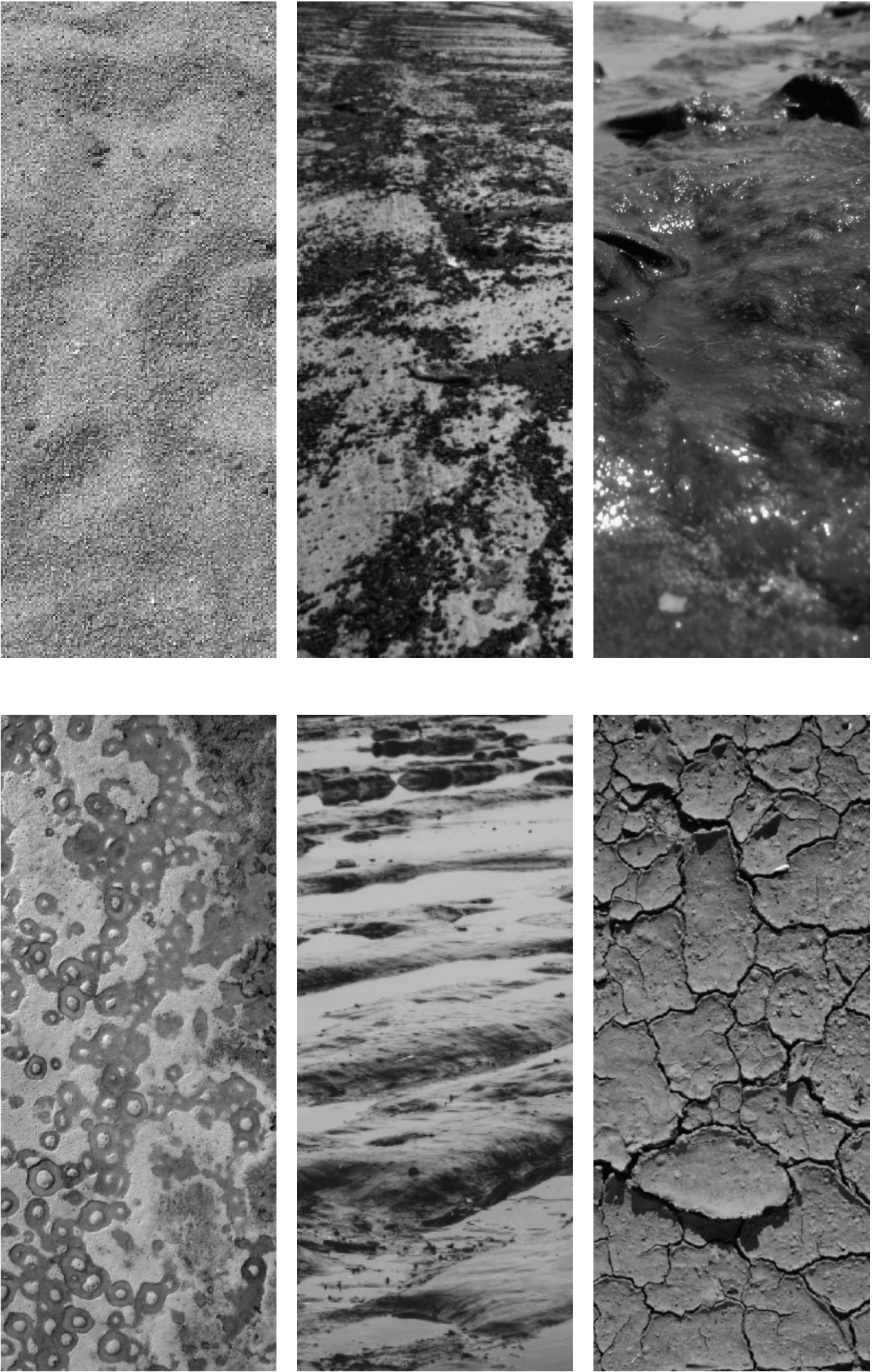
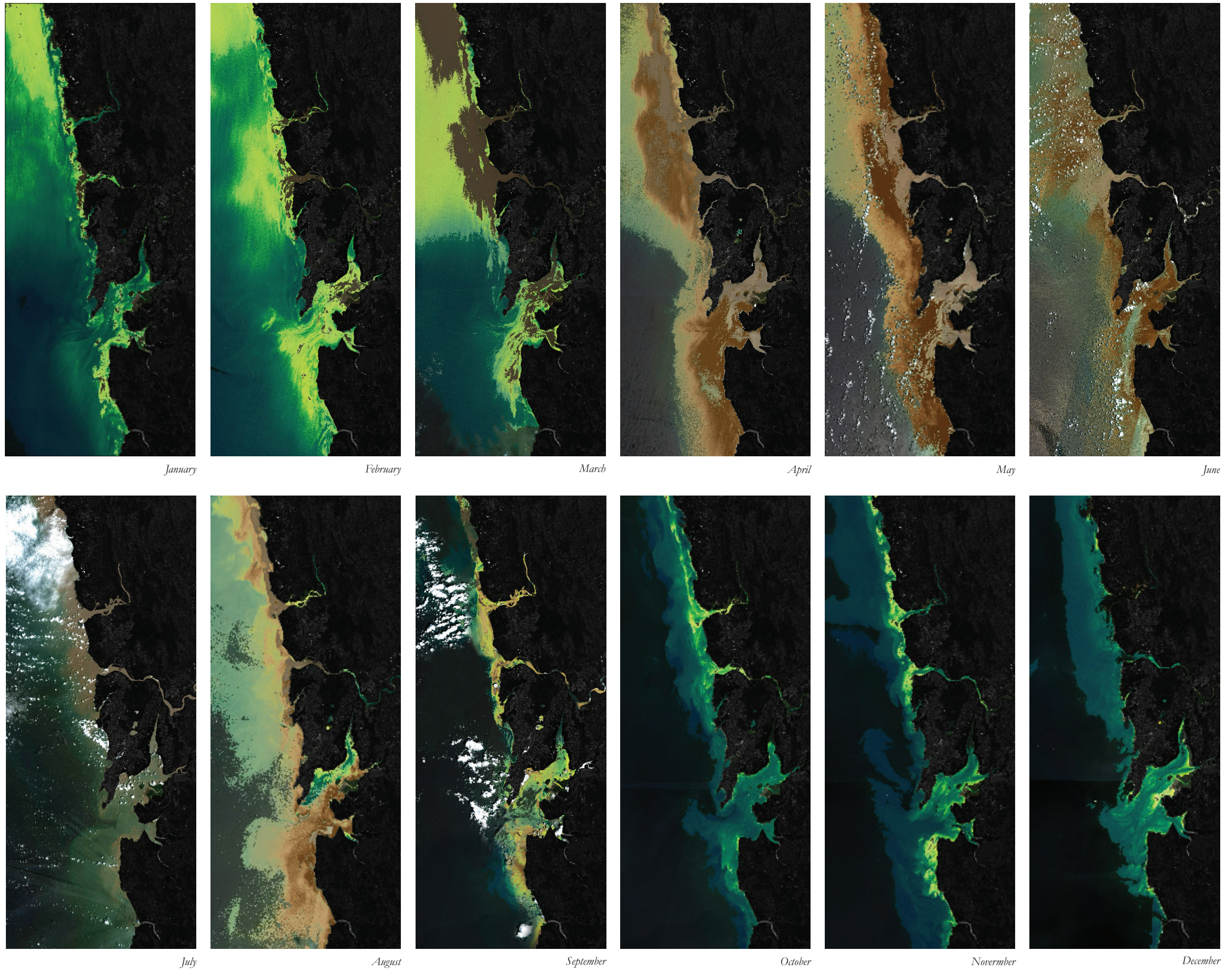


Image 16.Coastal sand conditions: from dry - terraqueous-dry



The movement of matter in the estuary greatly varies throughout the year based on the monsoon, tidal currents and climate (heat). Which affects, the very nature of these particles as they tend to grow, coagulate or transform into other ephemeral forms of land observed on the surface as well as below water.

Figure 10. Estuarine dynamics shaping the territory of Mumbai

While natural cycles can be deemed as reckoning forces that couple with other biotic agents to shape the territory through the dynamics of matter, the limits of these processes can be determined when the resultant land itself becomes an externality to existing land. Which is to say that the resultant form, hampers the functioning of other critical ecological systems. Setting in motion a vicious cycle of human interventions in response to these disrupted systems, marked by superimposed engineered solutions or repetitive acts of clearance. Both of which can be observed in the Mithi river, that accumulates pollutants throughout the year, reducing the net depth of the river body and eventually drains it dry.

However with the onset of monsoon the river is revitalised, however owing to its reduced depth it has a sever tendency of overflowing even with a short amount of rainfall, consequently spilling out the accumulated trash along with the polluted water. Acknowledging the this limit, the municipal authorities, conduct an annual cleaning of the river body as a temporary method to mitigate the scenario. However even this process has its own limits as it cannot withstand extreme volumes of rainfall particularly later in the season, owing to the reaccumulating of matter as the river gains momentum yet again

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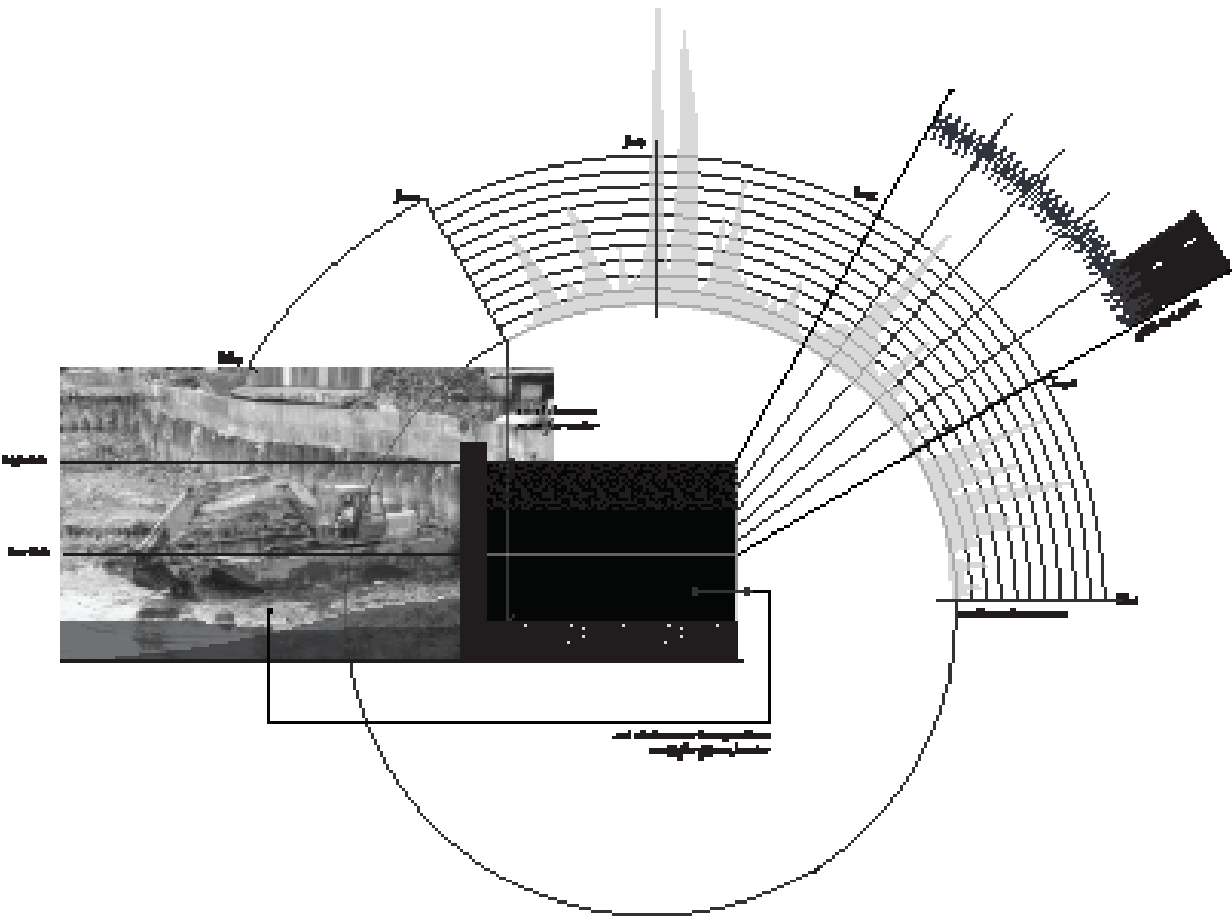


Figure 11.Cycles of clearance- cleaning of channelised river beds and storm water drains

Conclusion

“States of matter inflect, deflect or expedite matters of state through their unique dynamic states of matter.”

– Usher, *Territory incognita*

This line of inquiry articulates in greater detail the stratigraphic/antistratigraphic processes and conditions that define the dynamic nature of the territory. Which more than their source are valued based on their existence with respect to the surrounding environment as static, in stasis or as a dynamic entity. Revealing not just incongruent functions or discordantly accumulated compositions in time but also the how the temporalities, intensities and magnitudes of these geologic processes are embedded into the patterns and durations of everyday human life.

Based on these conditions of matter composites, opens up tangible avenues for speculation regarding the geosocial role of these evolutionary formations with respect to the bounded territory and how they could possibly symbiotically exist. Or alternatively be harnessed to safeguard the critically vulnerable zones against externalities arising from altered ecosystem functions.

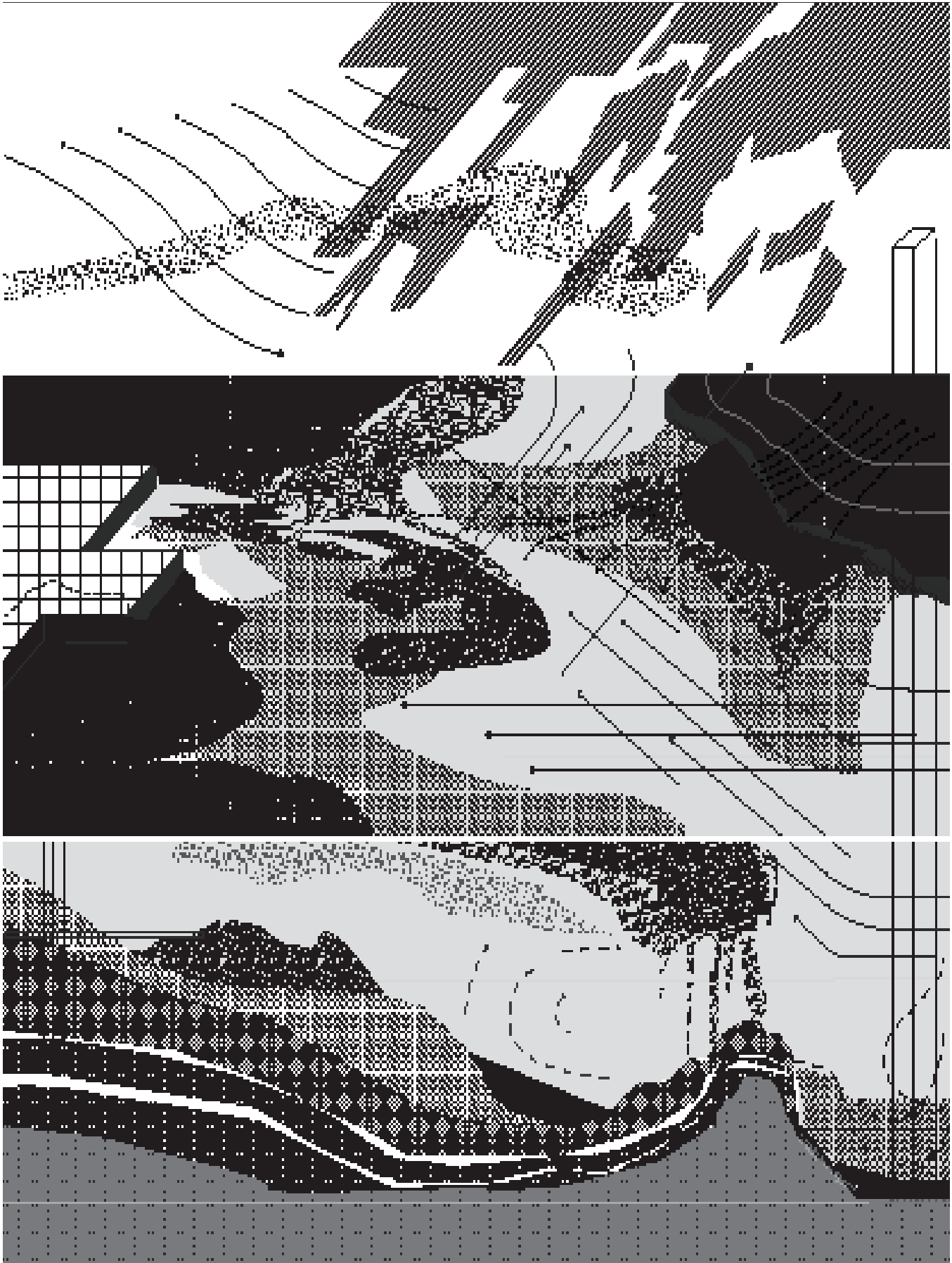


Figure 12. Movement patterns in the estuary shaping and reshaping new forms of land with varying stability. Through the continuous accumulation, consolidation, alteration and or clearance of matter by a combination of anthropogenic and natural processes.

Topos

Questioning the 'linear temporalities of technoscientific productionism'

Resuming from the conditions of incongruency observed in the territorial dynamics of matter, through topos this investigation is furthered by focusing on the static engineered interventions that have been stratified onto this very active territory. Commencing from the innate estuarine nature of Mumbai by virtue of which it must compliment the intensities of the hydrological cycle this investigation aims to reason out the prevalent necessity for engineered resistance to water. And how this technoscientific productionism has proven and continues to be an unsustainable and ubiquitous approach against the externalities caused by the destabilized hydrological cycle- namely flooding.

The topos in this context is accounted for as a lamellae that brings together two of earths formative cycles- the tectonic and the hydrologic. (Thornbury, [1954]2004). Constituting sediments, stratified and embedded in time, it is indeed a product of interacting earth systems - the lithosphere, the biosphere, the hydrosphere and the atmosphere, that supports the existence of life.

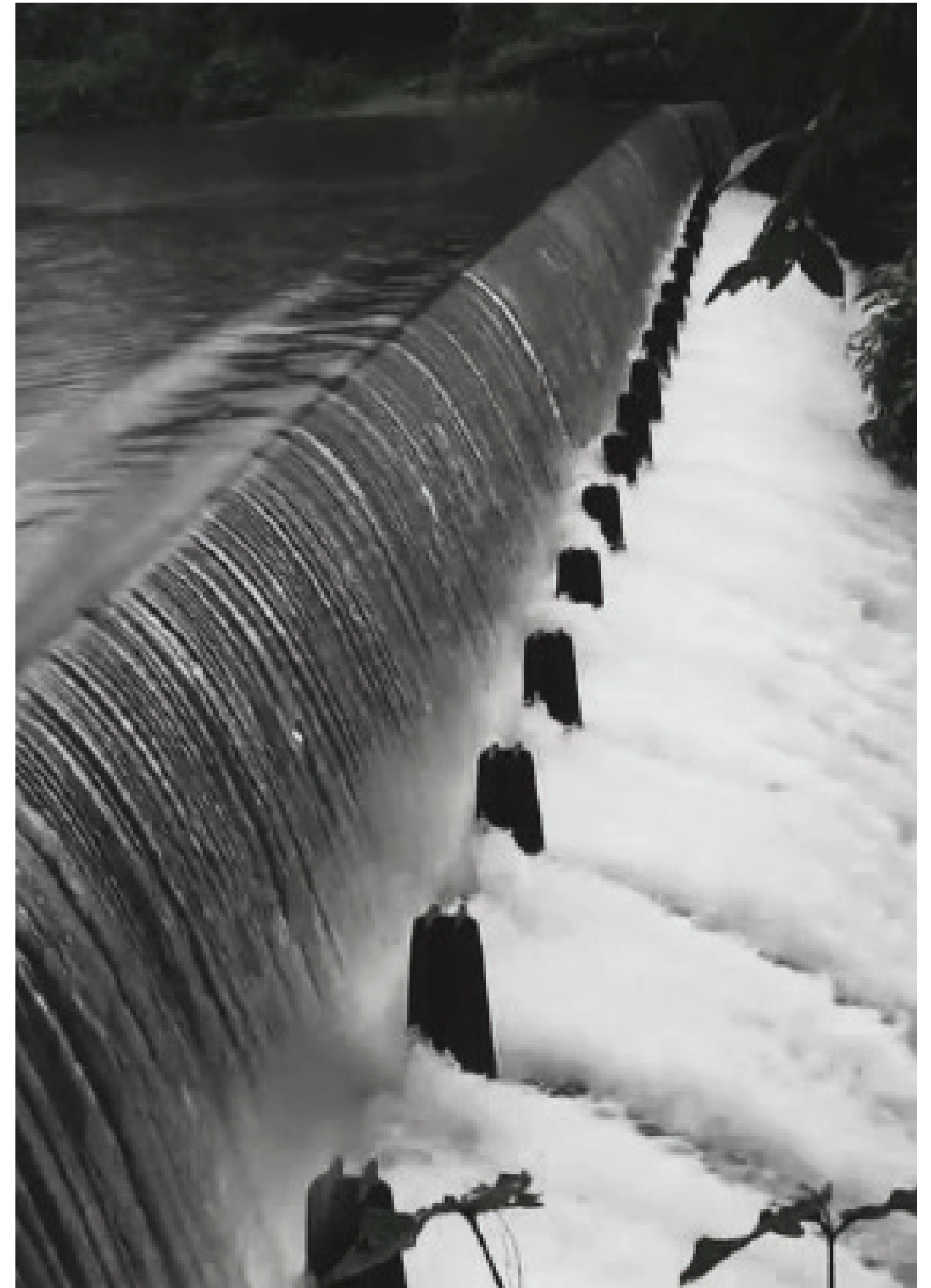


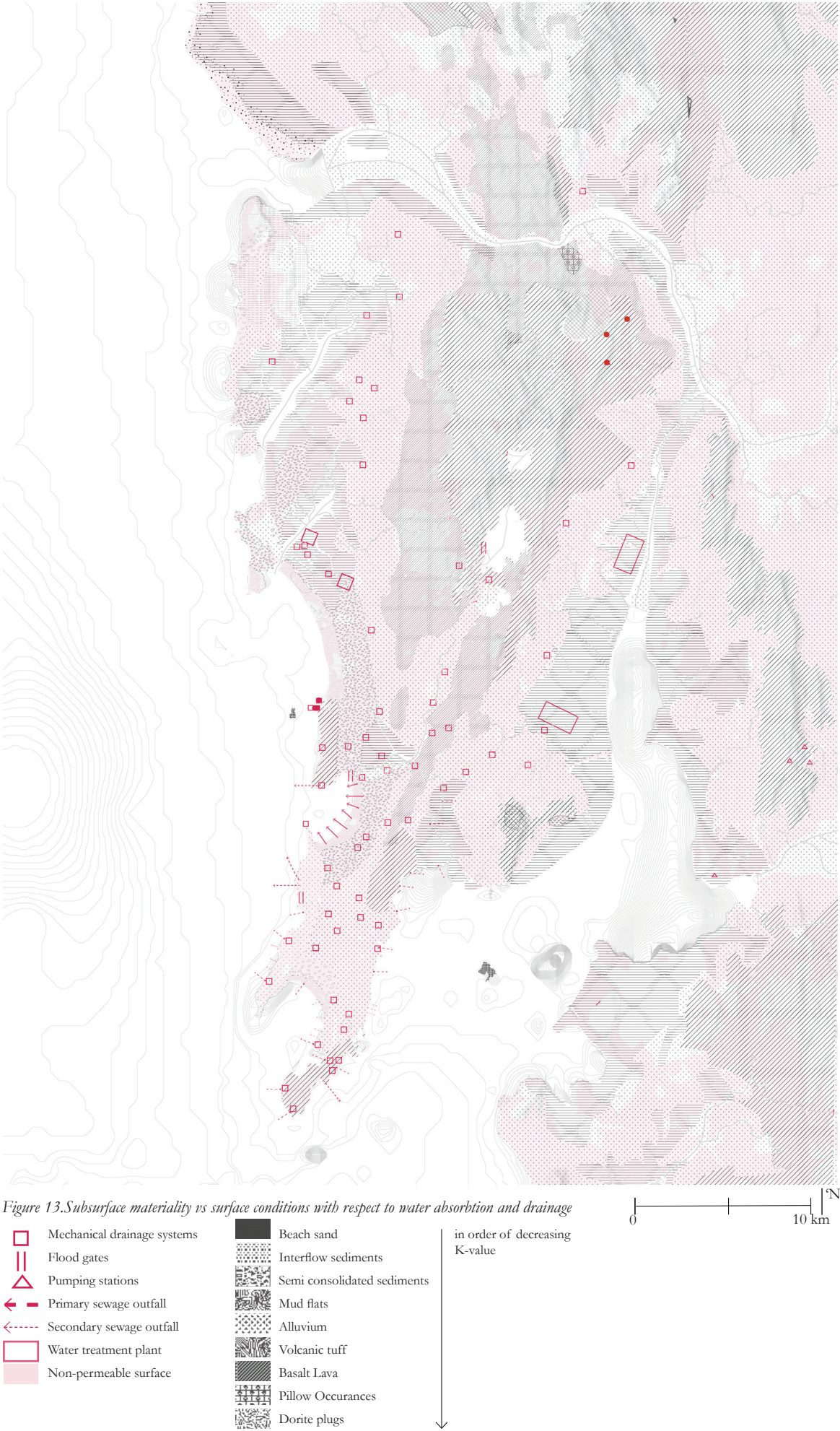
Image 17. Powai holding barrage overflowing every monsoon. Source: Mumbai mirror

The need for engineered resistance and regulation of water systems in Mumbai arises from the inability of the altered estuary to function in symbiosis with the changing hydrological cycle. The capacity of the topos (a stratification of static, in stasis and dynamic composites of matter in time) to absorb the torrential annual rainfall or withstand tidal alterations along its littoral edge, is based on the reciprocal functioning of its topography and its inherent materiality.

Topography: By large Mumbai is situated very close to the mean sea level, with some regions even dipping below it. Since most of the inland regions are flat with the exception of a rock outcrop to the north, it is implicit that the natural drainage into the sea will be gradual. Which is when the inland water bodies with their catchments come into prominence as natural drains that either serve as reservoirs, that recharge the ground water table or drain the water directly into the seas, thereby inhibiting inundation during monsoons.

Materiality: This natural drainage system is further complimented by its subsurface geomorphology. Which has been determined by mapping the coefficients of permeability (K) for the subsurface composites, - a measure of the velocity of water through the soil in meters per second. Which means that that fine grained soils at the coastal edge have a higher K- value, and will rapidly drain the water out. While inland subsurface composites particularly those of basalt rock show great potential for storing the surface drainoffs. Like, the Aarey hill that constitutes Tulsi and Vihar lake which are 2 of the 7 water supplying bodies to the city.

However most of these natural conditions fail to persist or function in reality as they are blanketed by a layer of concrete. Since 65% of the topos is covered by impermeable surfaces, the aforementioned drainage cycle is hampered. Furthermore, the inland water bodies have been time and again actively marginalised as victims of rampant urbanisation- namely by concretizing their beds, embanking edges, shrinking their bodies, encapsulating them underground, subjecting them to sharp diversions as well as clogging them with waste disposal, just to name a few. Thus justifying the need for an infrastructural network that can compensate these shortcomings of the altered topos. An overlay of the natural terrain with water supply pipelines, dams, floodgates, causeways, sluices, pumps and drainage lines , emphasize upon points



of manipulation as permanent scars in the topos that become necessary as they deviate or manipulate the water flow against the inherent terrain and subsurface geomorphology.

These hard, engineered interventions fail to take into account the regional scale of the hydrological system and how it is inherently coupled with other subsurface and atmospheric cycles like the ground water or evaporation. Thus these inserts are often highly localized with a myopic function and almost no contextual relevance or integration with other territorial processes. This renders the entire network static and thereby ineffective in responding to the hydrological fluctuations resulting from the territorial dynamics of material mobilization that is further amplified by climate change.

The over lay of these incongruent water systems also brings to attention the alarming condition of the ground water table in Mumbai that has significantly dropped in level and increased in its salinity in the past decade. Predominantly, due to over pumping and polluted water runoffs. Since most of the groundwater in the coastal region is not potable, due to high levels of salinity, the net useable ground water is spatially limited. Given the water security crisis already prevalent in the city, it is thus of absolute necessity to align water management solutions, to the monsoon, topos and ground water cycles.

Limits of Stratification

In the context of inland water catchment areas, the limits of topos have well exceeded over a decade ago which manifested in the form of catastrophic floods on the 26th of July 2005. Which are now followed by annually water logging conditions. As observed from the transect, today about 60% of the river bed is impermeable and consequently dissociated from the subsurface and atmosphere. With a significant portion of the river bed below the critically low level there is a general tendency of the river to inundate due to a backflow from the sea cause by the alignment of a period of hightide and heavy rainfall². And in the

last 10 years, Mumbai’s monsoon has seen an average of six heavy, five very heavy and four extremely heavy rainfall events in a year (Climate & Air Pollution Risks and Vulnerability Assessment, March 2022). Thus the probability of innundation is only enhanced as the river bed get accumulated with pollutants in time, further reducing its capacity to hold monsoon waters. It is evident from this line of inquiry that the prevalent land water dichotomy has reached its threshold as engineered solutions are no longer able to resist the monsoons, let alone the rising sea levels.

Conclusion

The city is conceptualised in many different ways – as a body, a machine, an organism, a second nature and now a third or even a fourth nature. These readings of the city (or settlements), however, have been conceived on dry ground separated from water as an element that is managed or controlled. While, the city’s relationship with water is defined with the latter contained as an entity, whether a river, sea or pipes and drains. Hence there is now a pressing need for a shift from the prevalent orthodox methods of regulating the hydrological system, to those that exist in symbiosis with in. Possibly, achieved by speculating up the potentials oif the terrain as a link to remediate the fragmented hydrological cycle. Marking a shift from reactive to projective design strategies.

² India Metereological Department (IMD) catergorises heavy rainfall for Mumbai as greater than 64.5mm in 24 hrs. Categorised into - heavy rainfall days (64.5 – 115.5 mm), very heavy rainfall days (115.6 – 204.4 mm) , and extremely heavy rainfall days (> 204.5 mm)

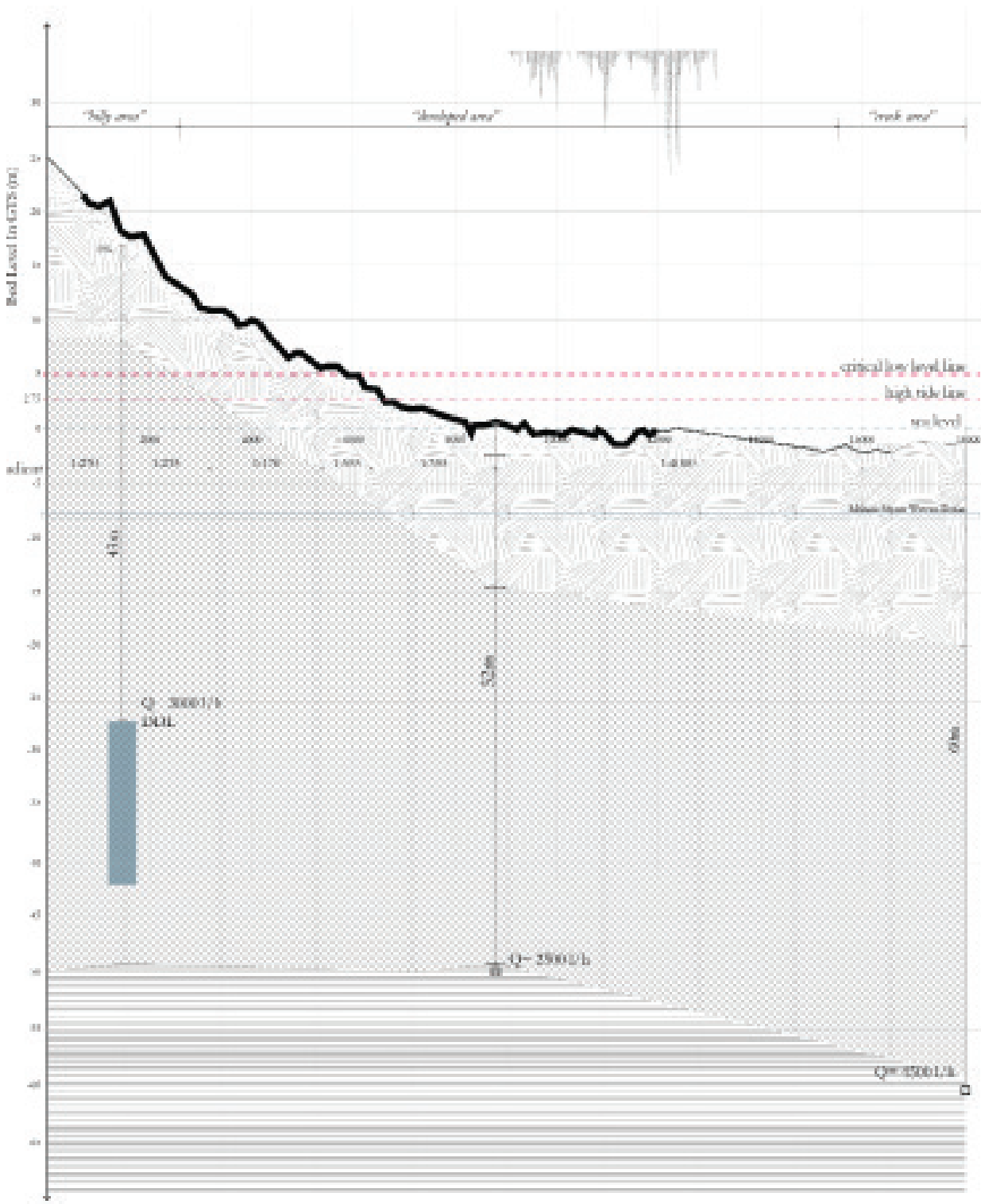


Figure 14. Transect through the Mithi River showing alterations in its topos

- River bed
- Embanked river bed
- - - Sea Level
- - - High tide level
- . - Critical Low level
- Primary storm water drain pipe
- Aquifer
- Top Soil
- Weathered rock
- Pyroclastics and tuff
- Basalt rock
- Monsoon
- DDD: water draw down level
- Q: Rate of Water Discharge in liters per hr

Habitat

Mapping the shifting socio-ecological relations in space and time

The topos not only acts as a resultant of all ecosystem cycles but also as an abstract mediator between the non-human process and their human appropriators .The influence of human appropriators has been taken into account from a tangible perspective of the technosphere as well as the intangible purview of social-sciences.

Where the technosphere as defined here comprises of complex social structures together with the physical infrastructure and technological artefacts supporting energy, information and material flows that supports the society.

Factors and conditions (process of land alteration) have been identified that are curbing/ changing the habitat and those extending it. Through critical cartography of the relational cycles between species and ecosystems, a method has been established to analyse deflections in the habitat(altering human and more than human occupation of the space).This forms a basis to qualify the terraformed resultants and identify sectors of conflict and critical vulnerability in this constant redefinition of the critical zone. While the biochemical conditions essential for the continuance of life can be easily parametrised, it is further essential to determine how these material “planetary limits” behave in conjunction with the immaterial planetary conditions in ways of living, values and political systems?(Katrin Klingan, 2022)



Statistically the habitat of mumbai constitutes of 22 million humans and ** more than human organisms. This urges us to repositions the valuation of land given the sheer extent of losses incurred for every inundated unit of space. Almost interpreting the entire city as a critical zone. (Latour, 2020)

In the past decades, owing to the influence of globalization, there has been a remarkable shift in who its occupants are, how they live and respond to the biotic and abiotic environment around them. The transient and varied nature of their spatial occupation, institutional and social ethics, as well as their sense of situated-ness, has indeed developed a ‘crisis of belonging.’ Where belonging can be examined both by ‘our attachment to places and collectivities— as a relation to the objects we own share and exchange.’ (Lui, 2018).

To a a great extent this has dissociated society’s sense of connectedness, association or belonging to the natural environment, as they position themselves outside the natural web of life. Looking into the nature as a resource to be preserved and controlled out of obligation to disaster management and not as much about care.

In this context of humanist positioning, the mapping lays emphasis on indigenous communities that exist the city as anomalies to this hypothesis. Contrary to the widespread ethics, they embody a notion of caring that comes from maintaining and living with.

There are 3 kinds of indigenous communities in Mumbai, the largest being the kolis(fishing community) along the coast, salt farmers and the aadiwais (farmers). However, given the pressures of urbanisation creeping into the coastal areas, the sea rising landwards coupled with erratic precipitation events, these indegenous communities can be deemed as double losers (O’Brien & Leichenko,2000). As their habitat is curbed by the both climate change and neo-libralisation in the city.

For instance in the case of the koli community due to waste water disposal in the creeks, and depleted mangrove belts, the fish population has been observed to have decreased significantly . As a result of which the fishermen have to venture into deep seas to get their catch, which is an expensive ordeal. Thus making it difficult for this once thriving community to sustain their livelihood. Stemming from this strong

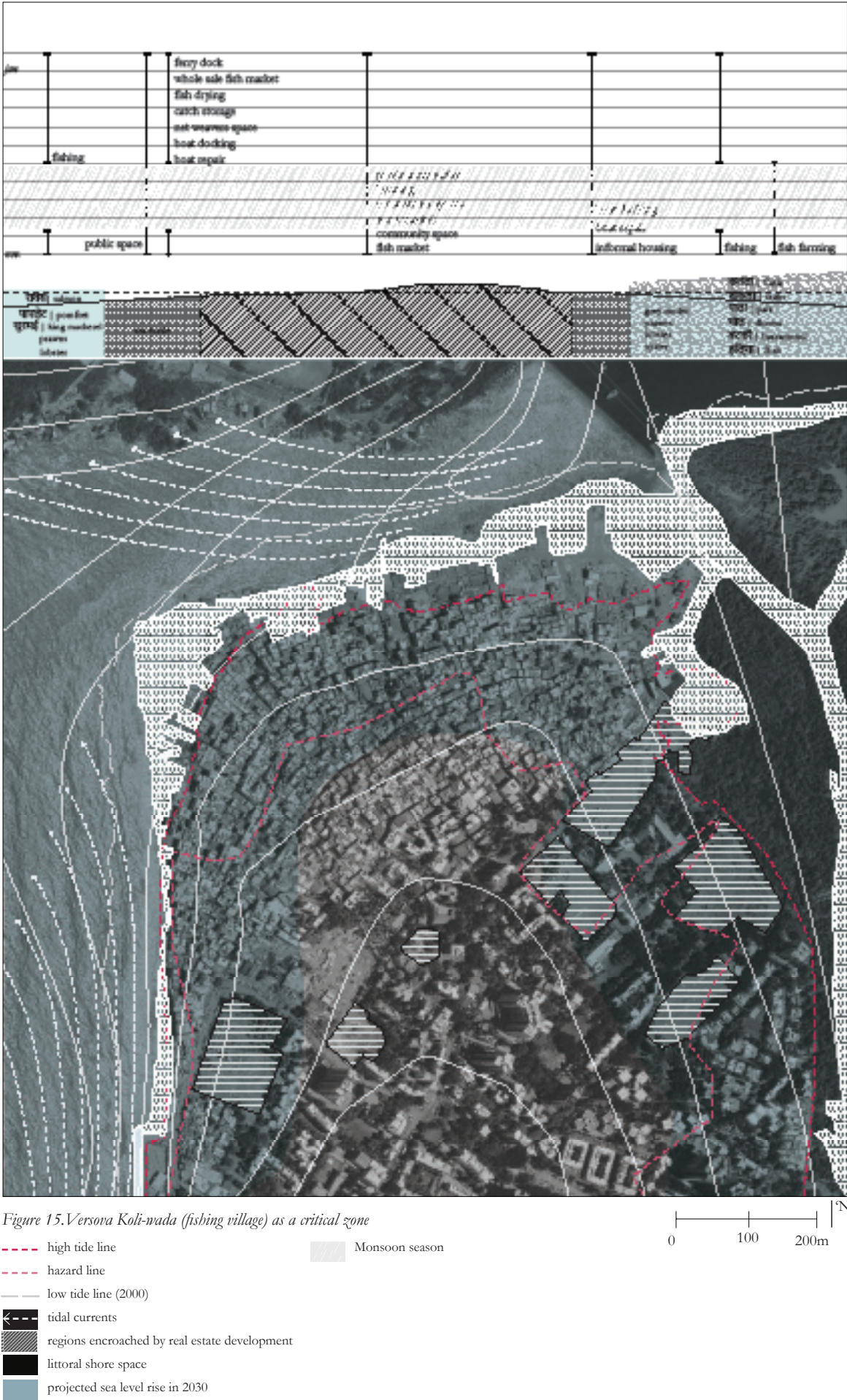




Image 18. Worli Koliwada. Source: scroll.in



Image 19. Kolis involved in local creek clean up. Source: Scroll.in

interdependency, they are often involved in creek cleaning projects.

The expanse of their habitat is not just limited to their inland dwelling spaces or the seas but also the littoral edge. Where each of these regions observe different functional, organisational and socio-cultural patterns in response to the variations in the hydrological cycle.

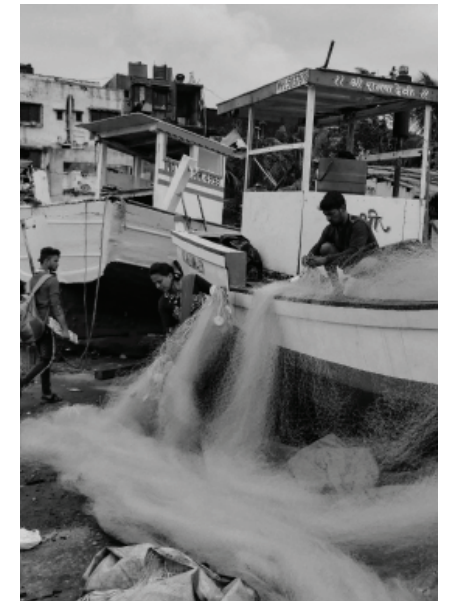
A study of these indigenous and contemporary practices of cohabitation reveals potentialities of condensing this interplay between material and symbol, biology and meaning -one that characterize human life and collective living. These categories are paradigmatic for the human attribute of impacting the material environment, through the collaborative production of knowledge as well as its dissemination and application.



boat docking



fishing



net weaving



wholesale fish market



fish drying



ice industry



local spice industry



public space



cultural space

Image 20.Habitat palette. Source:the locavore

While local specificities and indigenous knowledge of ecologically embedded processes & practices play a vital role in symbiotic co-habitation of the ecosystem. More often than not they also end up being eulogized as models of identity and togetherness with nature. However, blinded by the ethical righteousness of this approach, there is little attention paid to the prevalent socio-ecological viability and the prospects of evolution for these indigenous habitats (human and more than human) amidst the coastal morphodynamics. The alteration monograph delves into one such indigenous community, that of the salt farmers whose habitat is victimized by both seaward development of land in the evenements and the landward shifting of ecotones in the long duree.

Sharing the littoral edge with mangroves along the eastern coast of the city, the socio-cultural practices of salt making and dwelling are strongly associated with the local ecology. That creates an environment conducive for salt farming in the dry seasons and shrimp cultivation during monsoons. Noting the critical role played by the mangrove forests as a tidal buffer and sediment filter that safeguards the salt marshes, it also maintains the necessary bio-chemical composition of the soil for this practice to continue.

However in the past decade, the littoral edge is undergoing a significant transformation, specifically in the following ways-

Construction in salt marshes- The Coastal Regulation Zone Notification of 2019 dictated the availability of landward salt marshes for the construction of low cost housing. A process that has lead to the reclamation of marshes across several parts of the city. Not only will this practice hampering its habitat but is also hazardous for the communities living in these constructions. Besides its innate tendency to flood, the salinity of the soil and its compactness, makes the land highly susceptible to subsidence and the building foundations to corrosion and salting. Thus bringing to question the very sustainability of this development strategy.

Wetland alterations and mangrove adaptation- In this inquiry wetland has been expressed as a proportion of the sum of estuarine areas by both intertidal and subtidal habitats which encompasses mangroves, saltmarsh, saline clay pans, seagrass, lower intertidal flats and open water. (Bucher and Saenger, 1994)



Image 21. Saltfarmers

In the past decades, there has also been a notable change in the mangrove belt along the eastern edge of the city. Marked by an increase in the vegetative cover, species composition and the biomass of tidal wetlands.(Climate & Air Pollution Risks and Vulnerability Assessment, March 2022) This can be attributed to a combination of anthropogenic and climate factors-

- Anthropogenic: The organic matter ejected from the sewage outfalls in the Thane creek is deposited by water currents along with the tidal sediments, causing an over nourishment of the wetlands.
- Climatic-. These include rising sea levels leading to upland encroachment, increases in temperature, driving species shifts to higher latitudes, and increasing rainfall, which expands the vegetation cover within the tidal-zone habitat (Eslami-Andargoli et al. 2013; Osland et al. 2014, 2016)

As a cumulative result of these factors, the strand plain of the mangroves has diminished, thereby affecting the migratory birds and other organisms that occupied it. The seaward species are predicted to become hardier and taller while more tender species are observed and predicted to flourish in the inland salt marshes. The inland retreat will eventually begin to alter the subsurface compositions of the surrounding areas as well. Accommodating and supporting new forms of organism and natural cycles, marking a shift in the ecotones.

Taking into account the seaward land reclamation as well as the landward wetland migration, there is a need to re-evaluate and monitor the dynamic salt marsh habitat. Namely-

- To study the conditions and health of the biotic and abiotic environments of the wetland,as well as corresponding it to its flood management and coastal protection attributes.
- Evaluate the socio-economic viability and sustenance of the indigenous salt farming community in this context. Their agency in this transition and how that could manifest in changing or diminishing the practice of salt farming. Critically evaluating the socio-economic sustainability of these primitive but symbiotic practices.

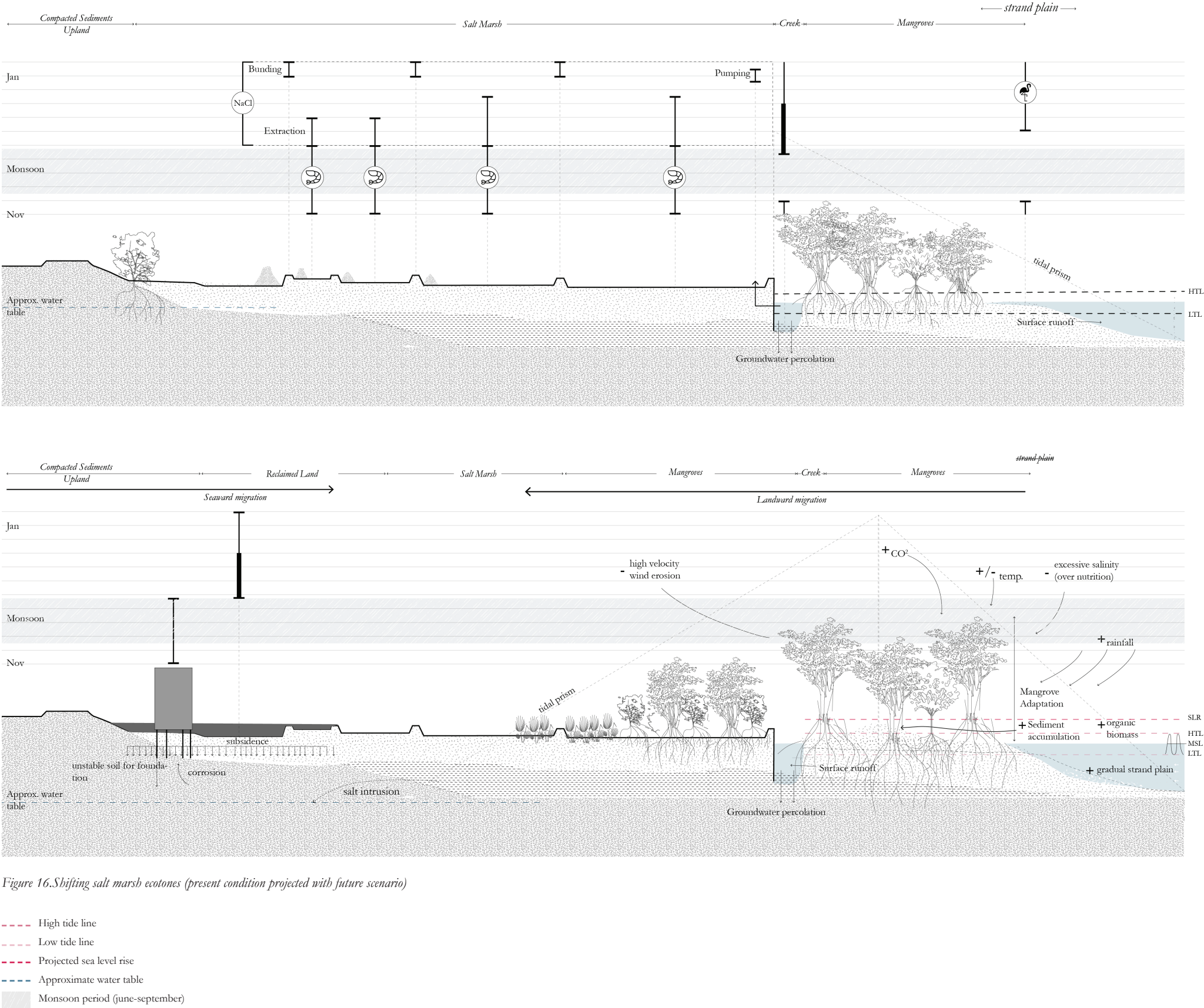


Figure 16.Shifting salt marsh ecotones (present condition projected with future scenario)

- High tide line
- Low tide line
- Projected sea level rise
- Approximate water table
- Monsoon period (June-September)



budding ariel roots in inland salt marshes. (image source: Sejal Mehta)

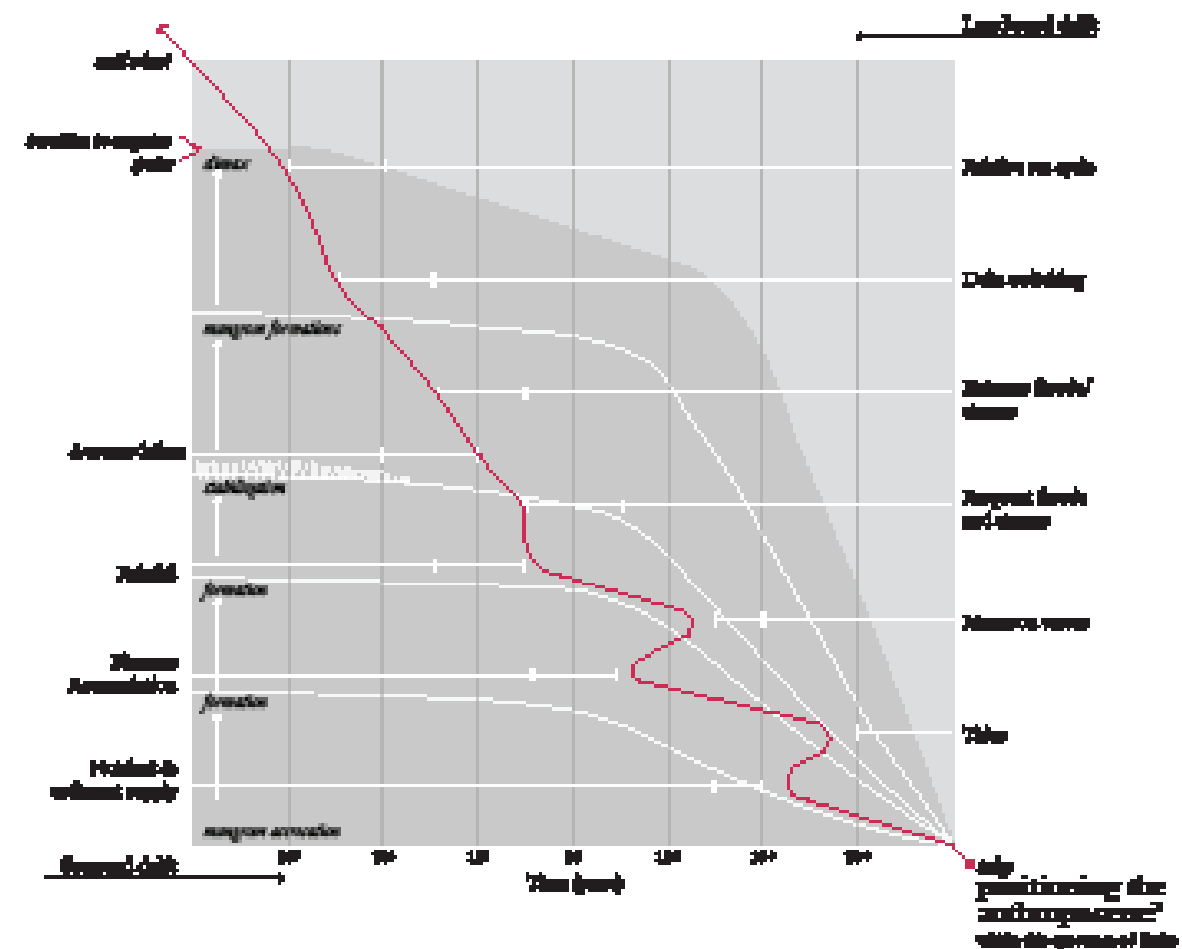


Figure 17. Relative range of design between landward and seaward pressures of encroachment in time

In the context of the shrinking saltmarshes, the monography of limits lays out the different factors that cause a landward or seaward shift of the littoral edge. Arranged in accordance to their time and the extent of influence on their respective phenomenon, defines a spectrum for action. This not only establishes a time frame for strategic implementations but explores potentialities of coupling multiple agencies that influence the geomorphology of the littoral edge, which can be based on a strong analytic and ethical underpinning.

Conclusion:

Mumbai constitutes of a diverse habitat (human and non-human) each simultaneously responding and stemming from local as well as regional conditions. Thus establishing the need to address the crisis of flooding and sea level rise across scales, giving agency not only to those directly vulnerable to the hydrological upheavals but also to the adapting ecosystems. It brings

to forefront two ethical crossroads in the project- 1. Human response to ecosystem habitats, particularly those that come at a negative externality to its human occupants. And how do we(humans) position ourselves in this natural adaptive transition. Would it be defined by an act of retreat, reappropriation or resistance. Each marked by their own societal as well as ecological externalities.

2. Articulating the prevalent and proposed interdependencies between humans and non-humans- While the need for a symbiotic relationship between the two has been long established, it is necessary to move beyond its binaries and articulate it as a situated practice. By flattening the non-human entities via their large systemic understanding, there arises a case of the colonisation of matter. Thus it must be avoided by the act of being specific about which actants are participating, engaged, accessible and shaping the transition.

Geopolitics

Territorial configuration through development, control and regulation

The the region of Mumbai has a very complex governance system, with the Mumbai Metropolitan Regional Development Authority (MMRDA) at the head of it. It currently constitutes of the following districts- Mumbai city, Mumbai suburban, parts of Thane and parts of Raigad.

The MMRDA is responsible for planning, coordinating, and supervising the development of the region and executing related plans and projects. For this purpose, the MMRDA publishes Regional Plans (RP) that spans over a period of 20 years, after which it is revised and newly sanctioned, the first one being executed in 1970.

An overview of its components reveals generalised and ambiguous objectives which allows for easy manipulation and breach of these plans. (attach the table). While most of them vaguely address climate change or environmental concerns, they lack specificity. To the extent that in the latest regional plan the objectives of flooding and climate change have only been explicitly cited 3 and 1 time respectively.

While the Regional Plan dictates the general land use. Its detailed components are categorised based on their sectors, like transport, development, housing , environment etc. Defined by their roles and objectives at a regional level, with no cleard spatial delineation, there arise sevel power and interest conflicts over a single peice of land. Particularly glaring is the complete exclusion of the territorial waters which are a part of an entirely independant maritime sector. Like in the case of the eastern magroove belt whose either territorial expanse or components of it fall under categories of environment management , waste management and urban development where each one is motivated by a different objective. Each of the categories have a multitude of policies formulated and functioning at varying scales- as well as have very different periods of implementation. Besides resulting in a chaotic management of the territory, it tends to objectify the habitat as a resource to be regulated.

With barely any acknowlegemnt or integrating the local socio-ecological dynamics.

There is a need for a shift in the basis upon which these strategies have been formulated. From being object oriented to more processes oriented goals by a holistic integration of the movements that shape the habitat. Furthermore this will provide a better basis for synchronisation amidst the many departments.

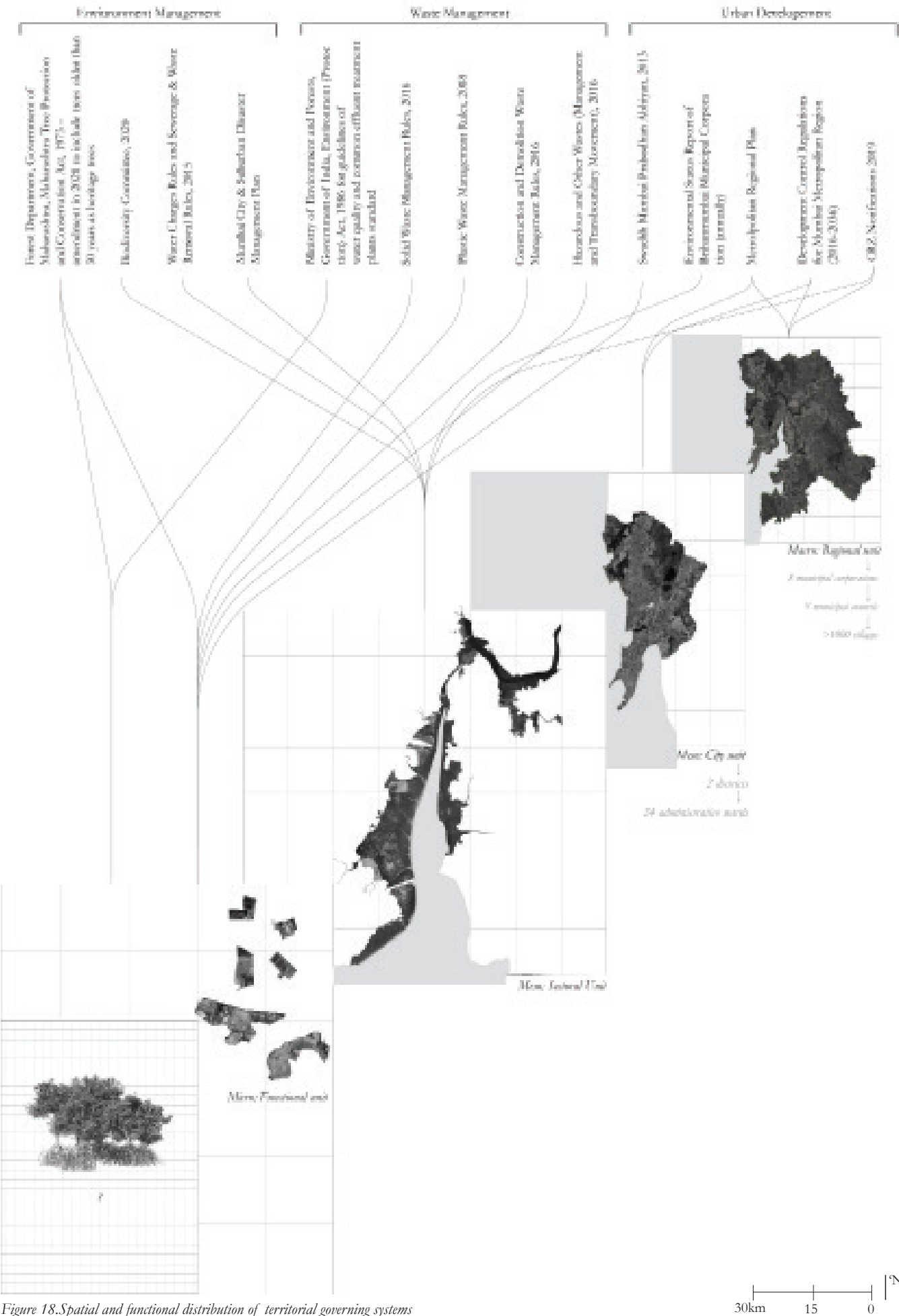


Figure 18.Spatial and functional distribution of territorial governing systems

Regulating Lines

Growth in the form of land intensification is defined by the Regional plan (land use) coupled with Floor space index (built intensity) and regulated by the Coastal Zone Management Plan. Focusing on 150 kms of the Mumbai Metropolitan Region’s coastline, the Coastal Regulation Zone(CRZ) is the strongest regulatory framework that addresses land use in the context of environmental vulnerability. Strategized at a national level, it essentially demarcates the country’s coast line into 4 different zones with provisions and prohibitions for various activities, which is implemented via the Coastal Zone Management Plan(CZMP). Its geomorphic scope includes seas, bays, estuaries, creeks, rivers and backwaters each of which fall under one of the categoried in order of permissibility for anthropogenic functions.

Category-I (CRZ I)-It includes ecologically sensitive areas like mangroves, inter tidal zones, national parks/ marine parks, sanctuaries, reserve forests, wildlife habitats, coral reefs and areas likely to be inundated due to rise in sea level. Here generally no activities are permitted however with certain exceptions like that of ecotourism or road construction ‘by way of reclamation’, on stilts in ‘exceptional cases.’ or even that of pipelines, salination and sewage plants etc.

Category-II (CRZ-II)

It includes economically important areas and areas that have already been developed upto close to the shoreline. Where generally most construction is permitted.

Category-III (CRZ-III)

Regions that are relatively undisturbed ,also including the area upto 200 metres from the high tide line is demarked as ‘No Development Zone’. These regions are ususally not supposed to be substantially built up

Category IV (CRZ - 1V)-

Includes territorial waters from low tide line to 12 nautical miles into the sea and areas pertaining other small islands. And rewuires special approval to build.

However on account of the extreme vulnerability of Mumbai to sea-level rise and flooding due to its geomorphology, the city is granted a special status as a Critically Vulnerable Coastal Area(CVCA) which empowers it to make amendments in the otherwise



Figure 19.Coastal development regulations

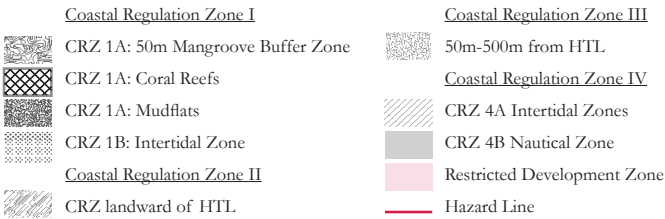




Figure 20. Coastal zone violations in the intertidal zones

Nationalised Coastal Management plan.

The spatial scope of the CRZ jurisdiction for Mumbai now includes- The land area from High Tide Line (HTL) to 500 meters on the landward side along the sea front. However due to Mumbai's linear morphology with creeks puncturing through it, the resultant developable areas according to this policy would be limited. Thus it was reduced to 100m from creeks and bay areas in 2011. Which was further reduced in the latest amendment of 2021 to 50 m. thereby opening up opportunities for largescale real estate development in these land parcels.

These lax rules have allowed for several violations of the CRZ norms.

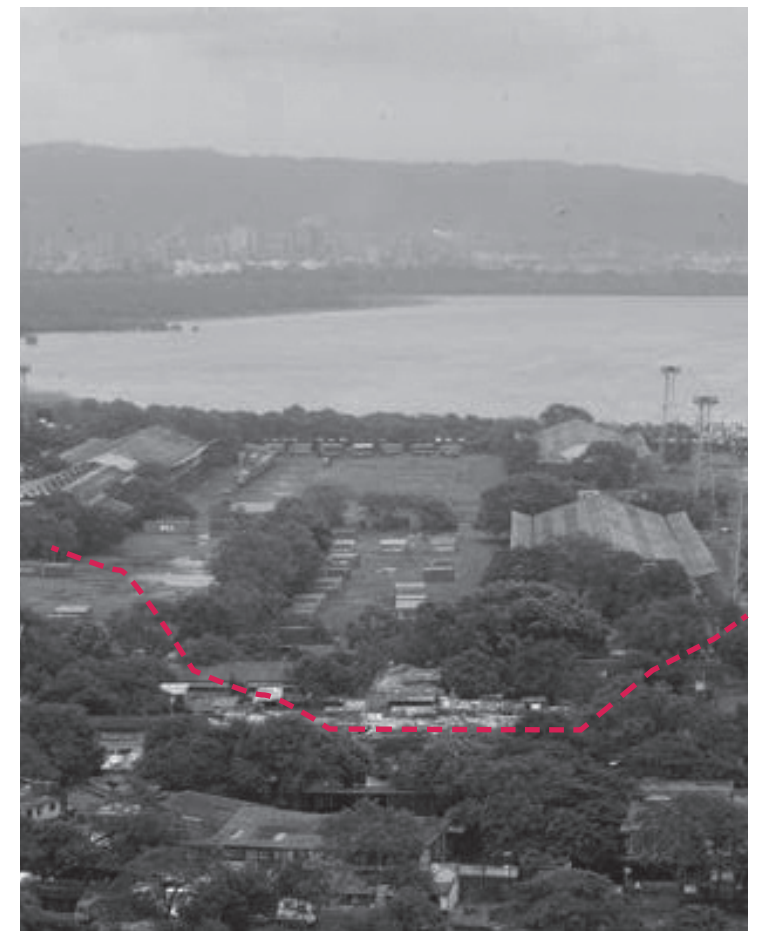


Figure 21. Coastal zone violations in the intertidal zones

Beauraucratic Complexities

The district of Mumbai has a complex and hierarchical governance system spanning across a multitude of departments. Which make the process of legislation, execution and management of its land a tedious and bureaucratic task. The adjoining monography establishes this hypothesis through a test case of the Mithi River. All though a single continuous water body, it has been segmented into non-contiguous entities by an overlap of multiple governmental agencies whose ambitions for the river do not necessarily align.

Additionally there is also a hierarchy amidst the authorities in control of the varied segments of the river based on their role and scale of operation. And lastly the authority over the river is also distributed based on the local ward it falls under, where each ward has a different budget allotted to carry out functions in regards to it. This complexity dilutes departmental goals aimed at safeguarding the river. it is almost impossible to generate consensus amidst the various segment and ensure accountability for executing and maintaining the river body. Ultimately, resulting doing more harm than good to the river, bringing into question the limits of bureaucracy in democracy.

Conclusion:

An overview of the planning and control measures that define the trajectory of growth in Mumbai reflect a clear orientation and prioritization of infrastructural intensification over other sectors that address the ecological systems present in the city's administrative limits. This delineation and hierarchy forms basis for the incongruencies that exist between the objectives of the development sectors and the management of natural environment. For instance currently the scope of "flooding" in the city falls under the department of water management and is completely absent from the regional plan, which manifests in a non-chalant attitude of the primary governing body to this critical crisis.

Given the susceptibility of the city to flooding ,sea-level rise and shrinking critical ecological systems, there is a pressing need to address, integrate and bring to predominance the role of ecology in the evolution of the city, especially in the Regional Planning Scheme. Which synchronizes goals of development, water , disasters as well as the environment to develop

a holistic vision for the city.

Since most of the regulatory structures and policies in Mumbai are static frameworks, besides the development plans which are amended every 20 years, they are often outdated and fail to respond to the changing and diverse habitation environments in the city. This manner of projecting growth not only fails to addressing the prevalent socio-ecological concerns but entirely negates the impending changes in the land water dynamics of , let alone its unprecedented fluctuations due to climate change. Thus highlighting the need for a development strategy that acknowledges this constant flux between the land and territorial waters of the region as a formative unit of the city.

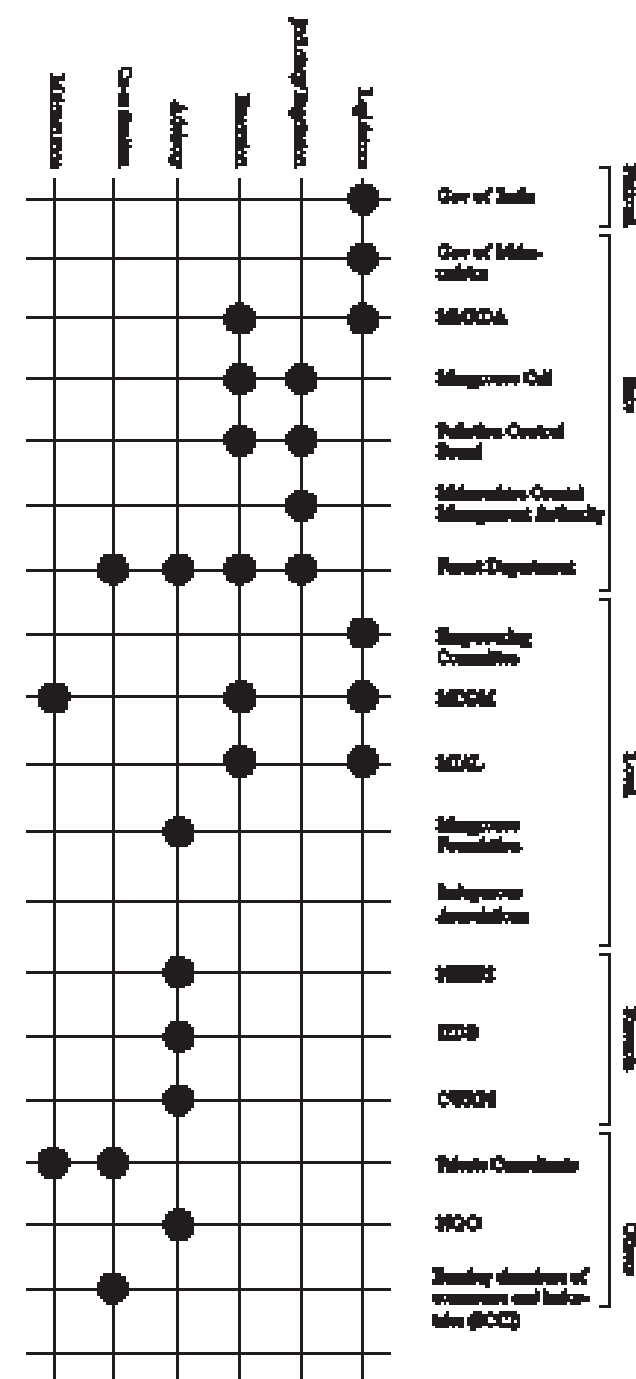


Figure 22.Planning agencies and role distributed across scales.

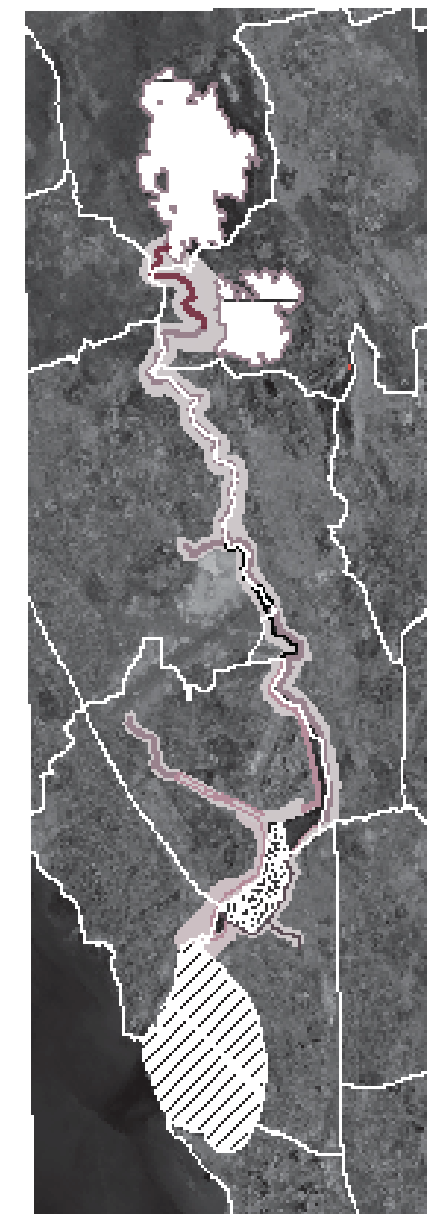
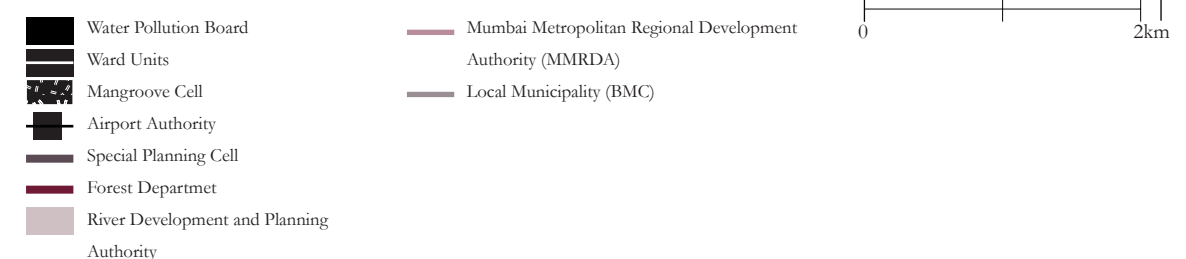


Figure 23. Planning complexities in inland, seaward water bodies



Conceptual Structure

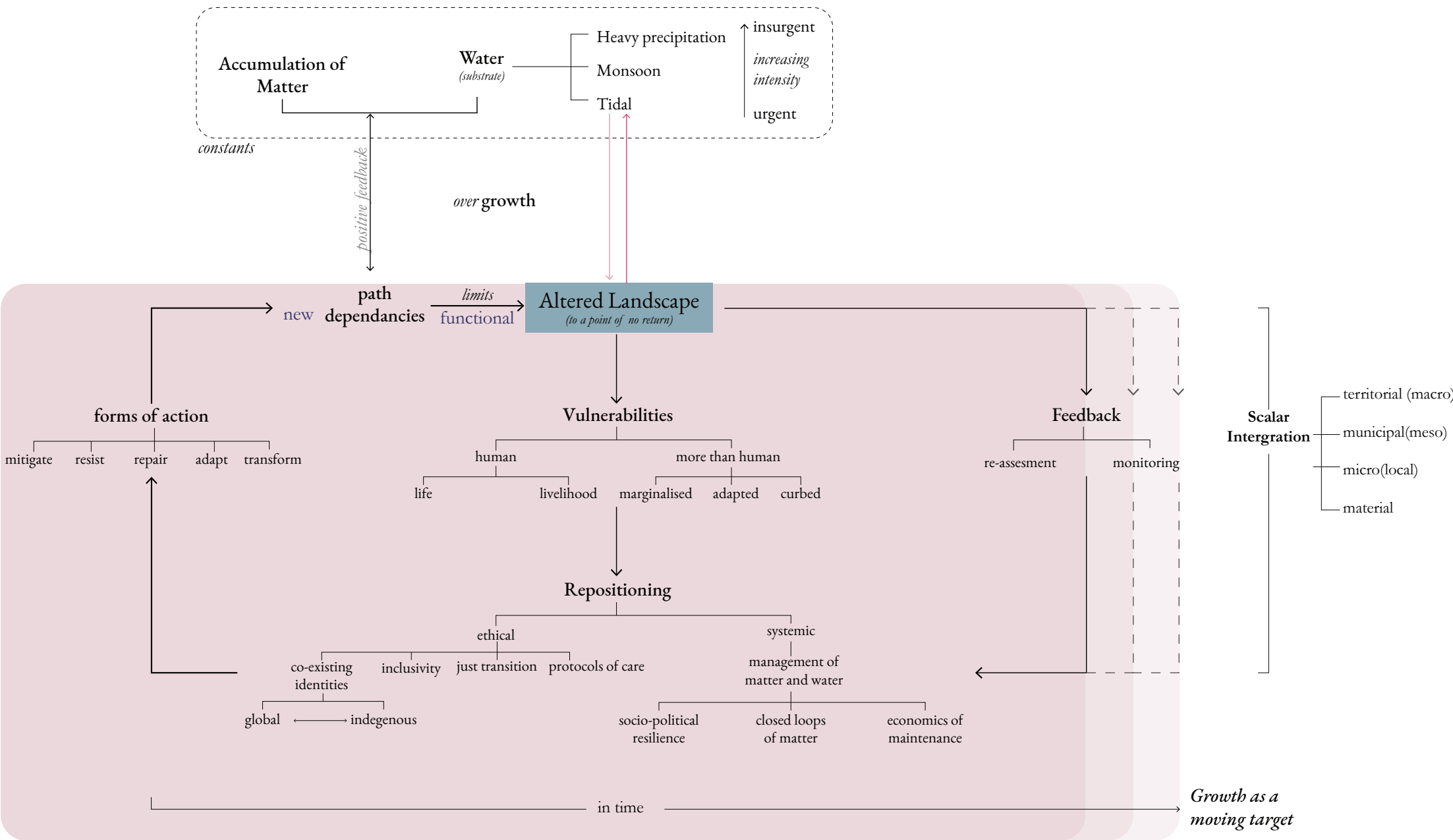
It has been well established that in the case of Mumbai the act of accumulation is ubiquitous, and yet in this vicious cycle of overgrowth, still prevails a necessity for more growth. Acknowledging these processes of accumulation as constants, the projected is nested within the grim realities of the city, being an estuarine landscape that has been altered landscape to a point of no return.

Thereby proposing to reposition the prevalent paradigm of development to be centred around acts of maintenance stemming from systems of care. Maintenance for a healthy estuarine landscape defined by its biophysical as well as functional capability to prevail as well as support and ensure the symbiotic co-existence of its human and more than human occupants.

Thus moving away from growth being marked by the permanence of a formation, to it becoming a moving target that is redefined at periodic intervals to accommodate changes in the territorial conditions (biophysical as well as social). Which go on to inform various forms of action across the material, local, municipal (meso) and territorial scale of the landscape.

By taking into account various alterations due to incongruent path dependencies between anthropogenic practices and the landscape functions can be shaped, to work along with the hydrological cycles, instead of against- by allowing new forms of terraformations to occur and persist. So as to allow the necessary time and space for remediation and adaptation of the ecosystem.

It is rather essential to take into account the time taken for these natural acts of formation to manifest in comparison to the social processes, as it is this careful synchronisation that will be essential in decentralising the humanist perspective and yet safeguarding their livelihood against environmental uncertainties. In which case the health of the landscape will be tested by the very same hydrological cycle that shapes it.



Cycles of maintenance

Figure 24. Conceptual framework

Theoretical Framework

Territorial Landscape Interpretations

Critical Zones: Bruno Latour

The theory of the Critical zones as a thin lamellae near the surface of the earth that sustains life, presents a starting point for the necessary shift in the way anthropogenic actions are position on land, today. This web of life is co-created and co-habited by humans as well as the “natural world” through an enmeshed network of dependencies. Furthermore it also dubs the objectification or re-sourcification of nature as a service to humans. It emphasises upon nature being all encompassing and resulting from the heterogeneity of the critical zone, i.e the intersection of areas , disciplines and entities. This body of theory expands the land bound perception of habitability on site and brings to attention the expanse of influence the environmental crisis has on the bioclimatic and ecological systems of the heterogenous bio-film. In this sense, it urges for the need to end the dualism between us(humans) / others, and nurture a symbiotic relationship with other biological, chemical, and geological realities as a means for mutual sustenance. Directing an exploration towards phenomena that make up the landscape, digressing from the vicious cycle of designing static and programmed obsolesce.

Gaia:

An understanding of the territorial relationships as Gaia presents the natural world (taking humans+ non-humans) as being an “alive world” . Where “nature” as “Gaia” is in itself constantly evolving in response to the environmental crisis through changes in its systems and feedback loops.

Stemming from analogies of bio-chemistry- the 3 principle characteristics of Gaia presents a scope to define human actions as part of the biosphere. a) Gaia has a tendency of maintaining a continuous state of homeostasis which must not be hampered. Addressing the evolving state reciprocal relations that sustain life in the biosphere. b) Gaia has a hierarchy of vital components, where the expendable/ redundant ones are primarily at the periphery. Thus the impact of alterations is greatly dependant

on an acknowledgement of its location. 3) Lastly, the awareness of the “cybernetic” nature of Gaia where certain vital alterations give least warnings of undesirable trends thus emphasising on the need for a “loop gain” and “time constant”. Emphasising on the need for continuous re-evaluation of actions as well as changes in the environmental conditions.

(Lovelock, 1979)

Overgrowth, Degrowth and the Limits to Growth:

In a hyper developing context as Mumbai, where growth has become associated with unlimited expansion and profit-making, with minimal care for its repercussions on people and places. The imaginary of Degrowth positions the notion of ‘the limit’ at the centre of existence (human and more than human). Where the limits posed by degrowth function both a constraint as well as an opportunity. On the one hand, it pushes us to deliberate about the necessary conditions for the biophysical wellbeing of the landscape. On the other, it defines the meaning of ‘excess’ as quantitative and qualitative parameters in urban development. With hopes to forge new opportunities, and alliances between the landscape and its occupants via socio-spatial reconfiguration.

(Meadows, Donnela H., et al., 1972)

(Randers, Meadows & Meadows, 2004) (Kallis, 2020)

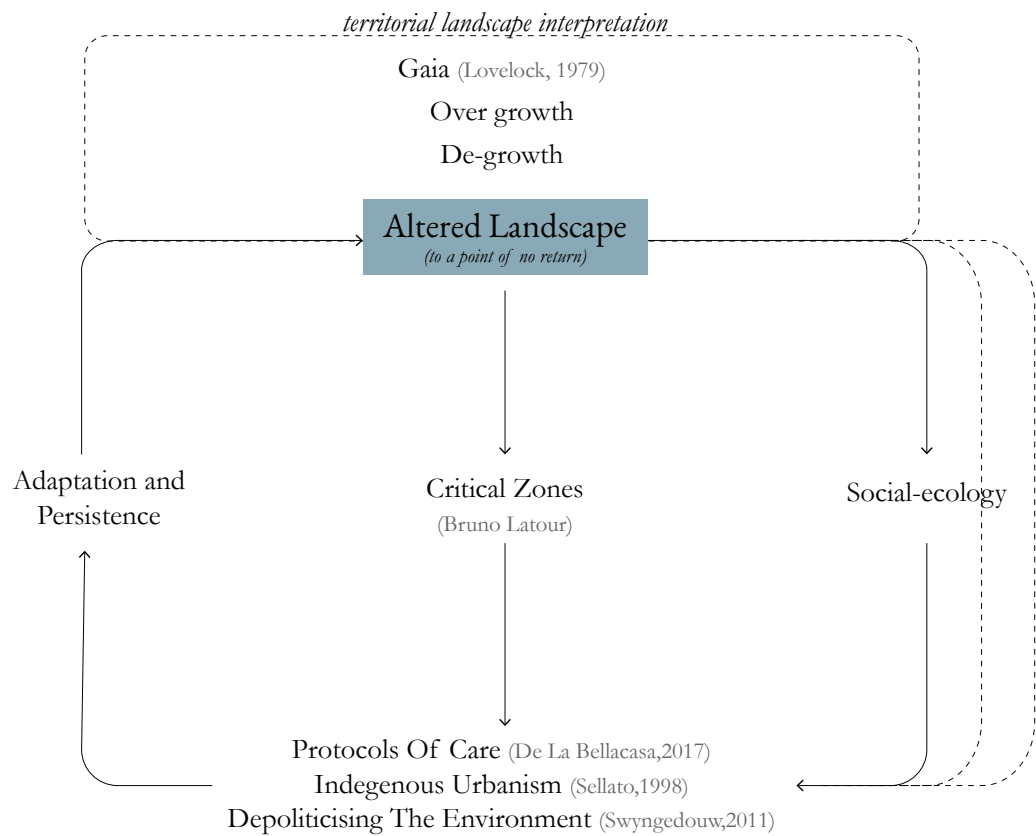


Figure 25. Theoretical framework

Repositioning

Matters of care

Its scope explores the transformative ability of care, that stems and yet can potentially alter the prevalent hegemonic ethics in the city. Highlighting how the engagement of various human and more than human entities with care can make specific contributions to the its very understanding and meaning. Revealing how caring implicates different relationalities, issues, and practices in different settings. Stemming from neo-liberal ideas of evolution and co-existence, an understanding of the political dimension of care is just as essential. Based on the three dimensions of care- labour/work, affect/affections, ethics/politics, along with their relations and non-relations, forms of actions can be critically defined that go beyond the mere re-naturalization of this relationship with more than human. Through concepts of eco-commoning, distributed intervention of power, making common the matter, balance of obligation and responsibility, presents critical ways of reassessing human appropriations in the critical zone.

Lastly, of eminent value to this project is the emphasis upon the recognition of situated care. That not only creates a dialogue between empirical research and social practices but also reconfigures the prevalent societal hierarchies based on values and models of co-existing .

However, the most significant acknowledgement in the practice of caring is its values, given the fact that it is never “neutral” Making it essential to be critical about what what care is given- being aware of the relations between other.

(De La Bellacasa,2017)

Indegenous Urbanism

The idea of establishing symbiotic relations in critical ecological habitats through practices of local indigenous communities remains an essential starting point in bottom up urbanisation. However simply transposing and applying existing indigenous management knowledge in unqualified ways proves

to be a greater threat to the entire habitat.

Thus concepts of co-management of natural resources,behavioral model of the collective (Ostrom ,1998) digress from the homogenised understanding of indigenous communities on site. Emphasising on the need for an awareness about linkages between community practices and the variable circumstances that shaped them over time- as a means to prevent ‘a-historicization’ or ‘generaticization’ of local management practices (Sellato,1998). Investigation into the socio-economic traits endogenous to a community, social life of resources ,the capacity of the state and community to forge effective partnerships in management as well as the socio-ethical embedding of technology in community practices within a situated context, presents a complex range of variables that cumulatively influence the course of indigenous Urbanism. Going to the extent of projecting its viability in the changing rhythms of territorial dynamics.

De Certeau’s notions of strategies and tactics can also be leveraged as conceptual tools for expanding the way we engage with new regimes of climate change adaptation. In the context of retreat, design practices have the potential to amplify injustices, but there is also potential to leverage our collective disciplines to envision equitable climate-changed futures.

(Watson, 2020)

De-politicising the environment

In wake of, political ambiguity and yet flexibility of terminologies like “sustainability” there is a need to give agency to our interpretation of “Nature” defined by both its material and symbolic value. Framed within the nature-human dichotomy, the theory acknowledges the heterogeneity of Nature, in the multitudes of its forms and existence. As a result of which a singular climate policy or future cannot be superimpose upon it, giving rise to the need for

a politicised environment. Aimed at re-configuring socio-environmental orderings, that shape geological as well as ecological processes forming the territory. It acknowledges the dynamic nature of the critical zones and and its ethics are based on a the objective of equality, yet based on the conflicting interests as potential for exploring multiple possible futures without concrete singular intervention. But instead by coupling multiple interests across scales. This brings to question the the prevalent post-political approach of social reconfiguration in the habitat in the city that is reduced to the domain of governing and policyming through allegedly participatory deliberative procedures, within a given hierarchical distribution of places and functions.

(Swyngedouw, 2011)

Adaptation and Persistence

Aimed at maintaining socio-ecological stability in the face of environmental crisis, the “adaptation frontier” defines a safe functioning domain delineated by the many biophysical as well as societal thresholds of the crisis. It is defined by the cumulative effect of path dependencies, adaptation/development deficits, values conflicts and vulnerabilities inflicted as loss or damage, across time. Thereby establishing a basis for parametric risk analysis coupled with societal evaluation of ethics that informs the course of action. Furthermore, in response to the dynamics of the critical zones, the adaptation frontier has been interpreted as gradient that is influenced by pressures of interest, as well as the effectiveness of its adaptive response. Where adaptation can be seen to act in 2 ways, either by reducing vulnerability(moving away from the threshold in the gradient) or enhancing resilience (which is to persist in its existing state). Thereby providing basis for evaluating a multitude of actions between the two forms of movement in the frontier, against the environmental crisis. Like planning for mitigation, adaptation, repair, restoration or complete transformation.

There is critical need for being explicit with the concept of “persistence” which in the context of the project involves both humans and more than humans in planning not only for recovery from shocks but also cultivating preparedness, and seeking potential transformative opportunities which emerge from change. This evolutionary nature of planning thus gives room for feedback from societal, institutional and ecological potentials to persist. Thereby informing a wide range of actions from- preparedness, mitigation, adaptation, transformation, repair and persistence.

(Preston et al., 2013)

(Pelling, M., 2011)

(Folke, Colding & Berkes, 2002)

Social Ecology

Challenging the dominant archetype of large-scale, centralized urban analysis that categorically dissociates environmental elements from its societal functions, this concept tries to ground the project within their intricate realities. It addresses the complex relations between nature and society, how they can be conceptualized, analysed, and shaped through design. Focus is laid on the path dependencies between the two through patterns and modes of appropriation. Where pattern represents the biophysical and material movements in the landscape while modes of regulation take into account the norms and power dynamics that prevail. This transcalar approach will form the basis not only for a thorough site analysis but also contextualise local dynamics within the territorial movements in time.

(Hummel et al., 2017)

Role of Time

Central to the approach of this project is the role of time in defining the landscape. Where the linear non-reversible trajectory of growth and development in the city is being incrementally shaped by rhythms and patterns of the ecosystem. The seasonal cycles of the atmosphere, surface and subsurface that shape and in turn are being shaped by urbanisation processes. This concept of temporality in urbanism acknowledges the interplay between the linear and cyclic time as a critical method of designing and projecting into the future of the territory. These mutually inclusive processes of time play a key role in establishing relations between the movements/ changes at the local, meso and territorial scale that cumulatively shape the estuarine landscape of the region.

Expected Outcomes

1. The **land as a palimpsest**, a diachronic documentation of the process and circumstances that led to the formation of Mumbai from the anonymous 7 islands to the unified land mass that exists today.
2. **An atlas of critical cartography** charting the complex relationships between the human and more than human movements occurring at varying temporalities and scales that are continuously shaping the territory of Mumbai. With particular focus on points of incongruency between the current habitation practices (biophysical as well as social) and the landscape conditions that cause disturbances in the hydrological cycle resulting in frequent flooding during monsoons or vastly dry conditions during peak summers.
3. **Video Montage**- a biography of the estuarine landscape, community, and their potential for symbiotic inhabitation. A visual ethnographic account used as a medium of research, survey, and data synthesis. Centered around exploring the littoral edge as a dynamic zone the documentary traces inland and offshore processes that lead to the accumulation and clearance of matter in the Mumbai estuary thereby influencing its eastern coastal morpho dynamics. It traces the different compositions of matter, its materiality, wetness, and movement at different scales (micro, meso and macro scale) both above as well as below the water surface. The documentary also acts as a mouthpiece for the indigenous as well as more than human occupants of the region that depend and reside on these shifting wetland conditions. Through visuals, audio archives, surveys and interviews, their accounts, experiences, knowledge, and concerns regarding the impacts of the altered hydrological cycle have been synthesised as vital information to supplement the otherwise technoscientific approach to wetland research (landscape ecology/urbanism).
4. **An alternative research by design approach/praxis**- Based on a material reading of the estuarine processes as a design methodology. This approach analyses the estuarine dynamics as patterns of accumulation of matter perpetuated by the varying hydrological movements in time. Which when

embedded with the prevalent habitation patterns are seen to continuously form and transform the estuarine landscape. Central to this approach are the scales of time. This praxis it aims to design with time instead of for time, aligning the thresholds of landscape adaptation, anthropogenic appropriation processes and the regional hydrological cycle.

5. A strategic methodology for an adaptive management of an estuarine landscape -

- **Monitoring** – Monitoring alterations in specific landscape elements of the estuary as primary indicators of change in the biochemistry of the region. Which can be traced and compared through time to speculate upon the health of the natural system.
- **Performance testing**- The wellbeing of an estuarine landscape can be determined by the cumulative health of its constituting biotic and abiotic elements as well as their ability to function symbiotically with the hydrological cycles on site. Which can be determined based on their threshold to capacitate the varying volumes of water witnessed by the region through the year – namely, the diurnal tidal fluctuations, annual monsoonal conditions and one off events of heavy to extreme precipitation.
- **An autonomous organizational structure** – based on grassroots level of collaboration within the occupation patterns of littoral edge. A method to not only close loops of matter in the region by assimilating in within the existing functionalities on site but also as a means to assert responsibility and the incentive/necessity for maintenance of a healthy landscape.

6. **New mapping system** – tracing the materiality of the estuary and grading it based on the time taken for it to adapt / transform under certain environmental conditions. This acts not only as a manner of synthesizing the aforementioned research by design but pave way for a new method of reading, and analyzing the dynamics on site. A nascent yet vital body of knowledge that can be potentially pursued further as a way of simplified and yet calibrated design approaches in highly dynamic and complex environments.

Testing Grounds

The project will be grounded in the Thane Creek situated along the eastern coast of Mumbai . Which together with the adjoining inland regions constitutes a predominant hydrological basin for the territory. Draining out water not only from Mumbai but also its satellite city Navi Mumbai, located on the eastern bank of the water body.

Macro scale:

- Morphological relevance: Thane creek is the last remaining continuous estuarine feature of the territory, fed by the Ulhas river in the North and the tidal waters of the Arabian Sea tide from the south. Resulting in a geomorphological environment conducive to not only draining out the storm water but also protecting the two cities from tidal erosion and coastal flooding. However due to its altering form, the creek is no longer able to maintain its role in the hydrological cycle of the territory.

Meso Scale:

- Appropriation: Exploiting the hydrological dynamics of the Thane creek, its littoral has through out history been populated with intensive infrastructures like outfall points, landfills, sewage plants, industries etc., giving rise to the infamous identity of this region as a 'service core' in support of the growing city.
- Occupational vulnerability: The inland regions of this basin are one of the most heavily populated parts of the city with majority of them belonging to socio-economically weaker sections of the society. Which when overlayed upon the high probability of this region to flood as a result of its low lying topography founds it as a particularly critical zone in need for urgent actions. Especially given the absolute lack of flood management plans implemented in this region owing to its complex socio-economic fabric.

Micro scale:

- Along side the densely occupied basin, the region also supports the livelihood of indigenous communities like the Koli and Salt farmers. Which

are not only threatened by extreme water events due o the disrupted hydrological cycle . But more frequently by the altered estuarine landscape of the region, that directly affects their livelihood and threatens the economic feasibility of their communities.

An altering landscape a video montage.

<https://vimeo.com/839670310>



Micro Scale:

Economies of life, particularly those of indigenous origins, dependant on the landscape.

Meso Scale:

The littoral edge marked by mangroves and other intertidal vegetation. Addressed with respect to its interface & interaction with intensive anthropogenic functions.

Macro scale:

Critical hydrological movements



Figure 26. Proposed site for intervention. Scales of operation

Geomorphology:

A part of the Deccan trap that was formed by volcanic effusions at the end of the cretaceous period (Blasco, 1975). The creek is narrow and shallow at the riverine end due to the presence of geomorphic head and broader and deeper towards the sea. The creek is tidally influenced with the dominance of neretic waters and negligible fresh water flow except during the monsoon. The substratum of the creek in the midstream is made up of consolidated and unconsolidated boulders intermingled with loose rocks and rarely with sand and gravel. Consequently, mudflats are formed along both the banks of the creek which are characterized by the growth of mangroves.

In Land-

Being one of the few parts of the city with remnant space for new developments or the potential for gentrification, today this edge is highly sought after for infrastructural projects. Which is evident from the spatial and policy framework transformations that have been implemented in the past decade. Indicating a strong stand towards an architectonic trajectory of growth for the city.

Thus in light of the socio-ecological importance of the Thane creek, the project proposes to critically reevaluate the role of this region, and what it holds for the growth of the city by large.

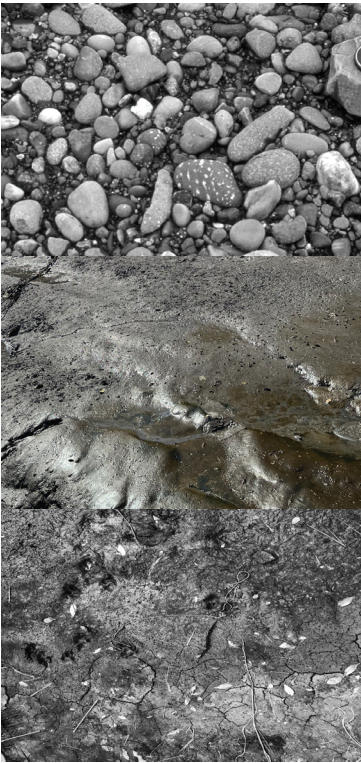


Image 22.Surface conditions from creek to land, flood tide. March '23.



Image 24.Water supply lines



Image 23. Land opened for formal realstate development within the mangrove forested area. Source:midday times



Image 25.Stormwater, transport and commercial infrastructure projects currently sanctioned in the creek. Source: midday times

Field Visit

re-flection
re-postion
re-configuration



A thriving landscape

*Contrary to the aforementioned and rather popular narrative of ecological elements, presented as vulnerable victims to human actions and climate change, the conditions on site highlight a slightly shifted perspective. Where most elements of the natural landscape have been fluently adapting for years to changes in the climate and water quality. Either by mitigating, retreating, migrating or resisting through change in form. However, these adaptation patterns are rather incongruently positioned with the static anthropogenic dependencies. Leaving the human habitation patterns vulnerable to its externalities, manifesting in the **changed** hydrological cycle.*

The two directions of time

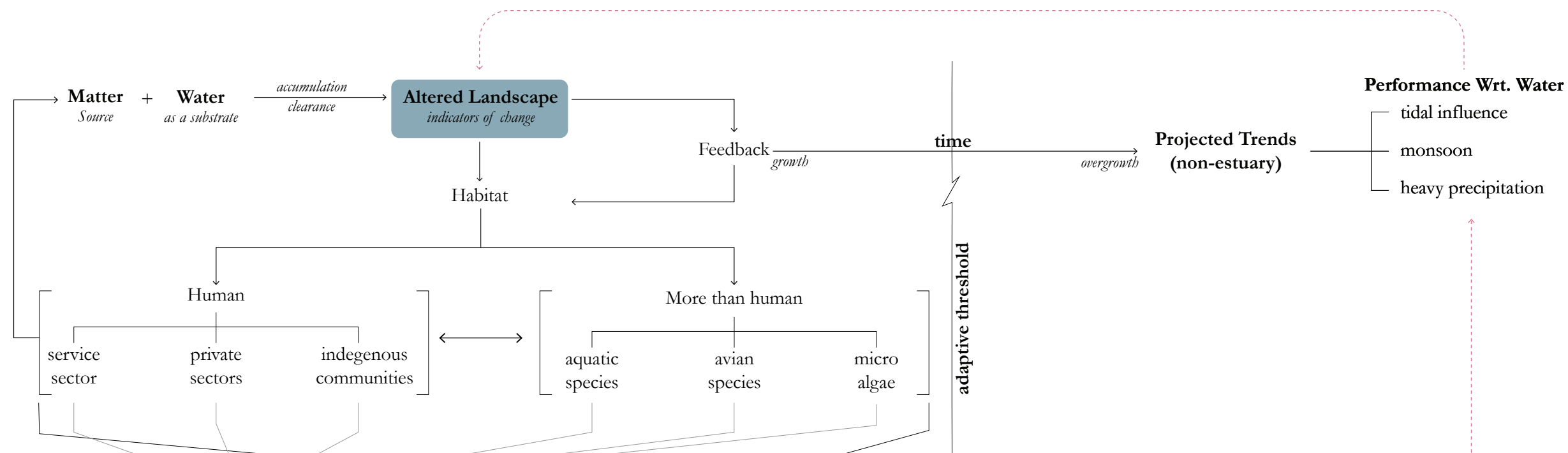
From its very conception the project took into account the dynamics of water in varying time frames and how it affects the landscape. However with the estuarine landscape adapting, materials changing and the anthropogenic vulnerabilities exceeding in time, there is a need to work backwards from these multiple limits. Thresholds not only of individual elements but more so of path dependencies, which will not function in symbiosis beyond a particular environmental condition in time. Presenting the need to position the project between the prevalent environmental forces and the adaptive thresholds of the ecosystem relations.

Archiving indigenuity

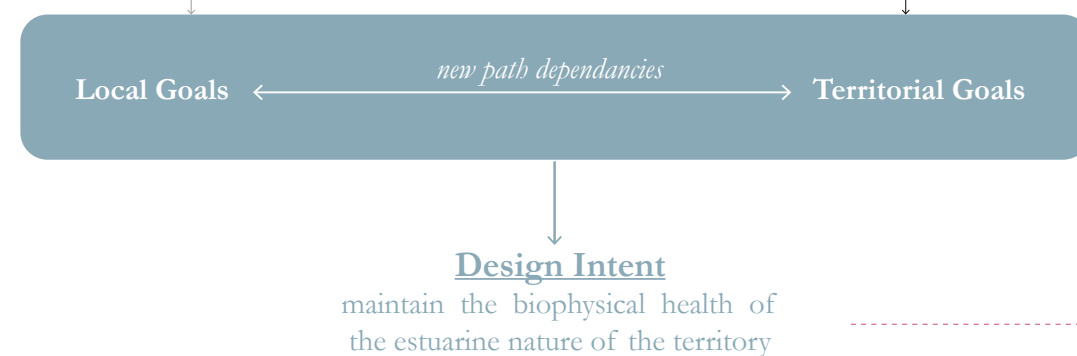
In a rampantly altering societal setting it is critical to evaluate the values and meaning of indignity. Is it a social stratum that one is born into? Or does it bind itself to certain spatial or communal connotations? And what does empowering indigenous community mean? In the scope of the project – while the Kolis themselves were deterred by the idea of safeguarding their community owing to its limited prospects of viability. On the other hand, the act of Salt farming itself has been deconstructed into smaller commercial workflows, leaving behind a mere labour intensive primitive manner of harvesting salt in the name of “indigenous practice”. Putting forth tricky ethical realities for the project to navigate.

The Approach

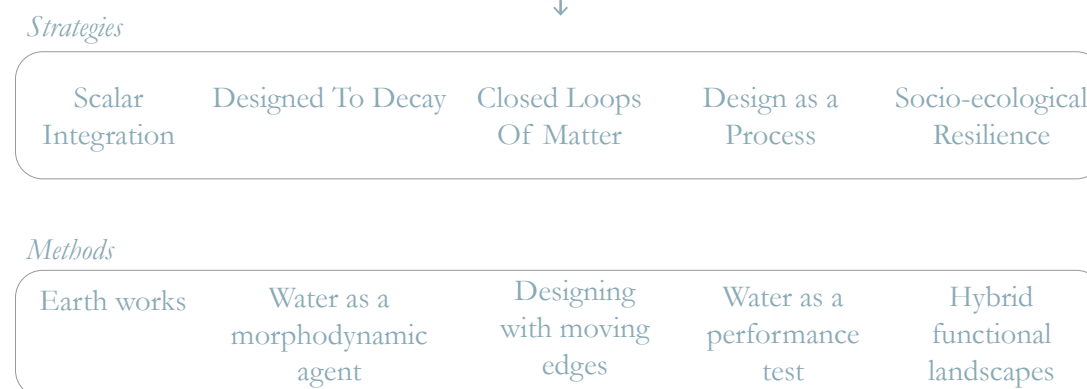
I. Research by Design



II. The Project



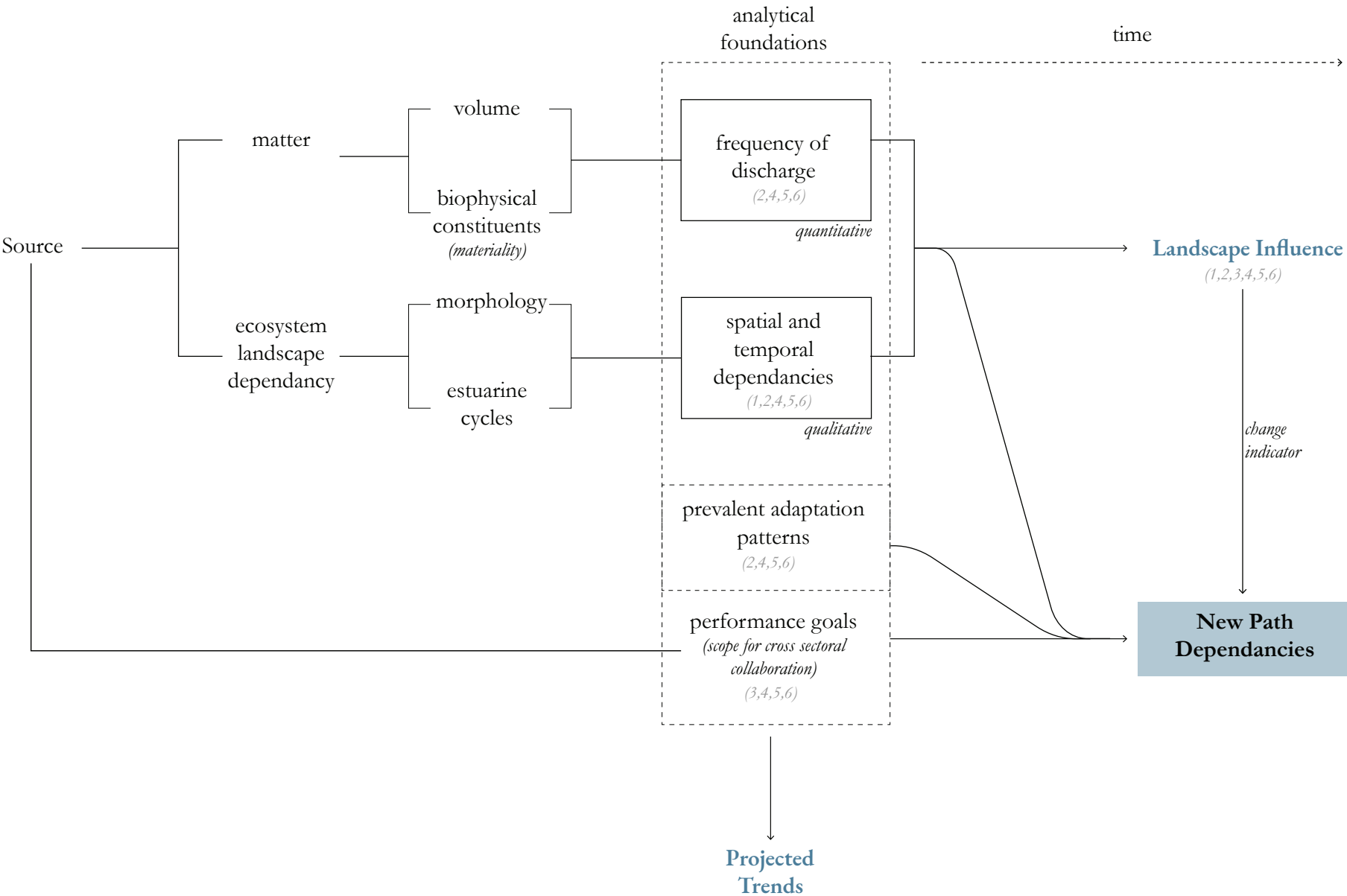
III. Implementation



pathway for alternative scenario development ----->

Figure 27. Project approach

Research by Design
methodology



1. Prevalent functioning

2. Speculate Alternative Conditions/ Forms Of Functioning

Synthetic Outcomes

- Methodology :
- 1) Geo spatial data
 - 2) Research report
 - 2) Satellite imagery
 - 3) News and mass media
 - 4) Site Survey and observations
 - 5) Interviews
 - 6) Audio-visual documentary
- Figure 28.research by design methodology

Matter Source

Sewage and Greywater

Each day the thane creek receives sewage outfall from Mumbai and Navi Mumbai.

Mumbai generates 2,700-3,000 million liters of sewage everyday. Which is distributed across 7 treatment plants situated geographically along the entire coastline of the city. Of which the Bhandup and Ghatkopar plants discharge their outfall into the Thane creek. Whereas Navimumbai generates 1139 mld. of sewage, of which the eastern part of the creek receives 473 mld. from Koparkhairane, Nerul, Belapur, Vashi and Airoli. Taking into account the anthropogenic fluxes of pollutants emanating from domestic wastewater and industries located along its eastern and western shores, the creek cumulatively recieves about 1260 mld. of sewage.

However this number varies during monsoon and dry season. Since the tidal clearance rate of the creek is accelerated during monsoons from 3.57 days to 2.47 days, the volume of sewage discharge is also increased accordingly.

The outfall from these plants is treated until the secondary stage where the organic matter is biologically degraded using oxygen and microbes. And held in aerated lagoons before it is naturally drained into the creek.

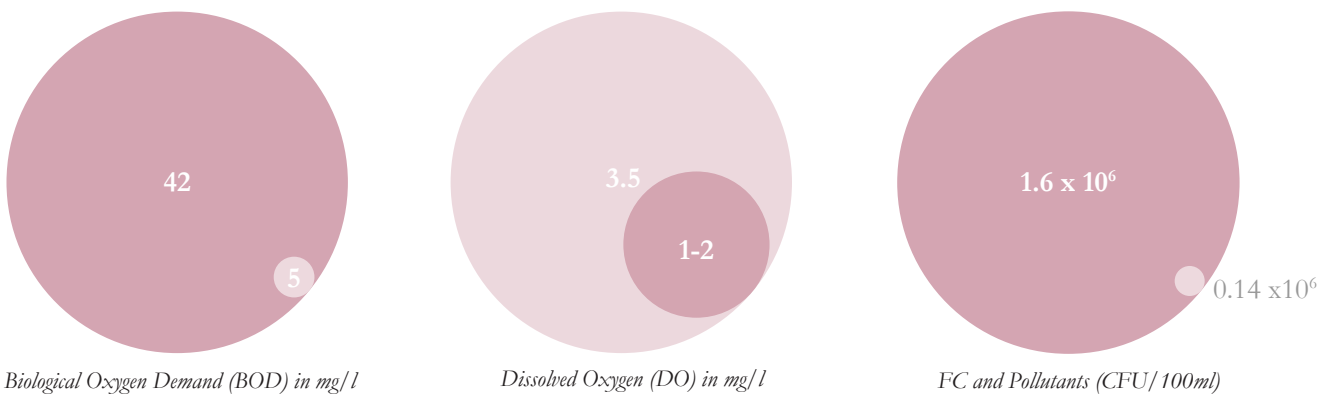
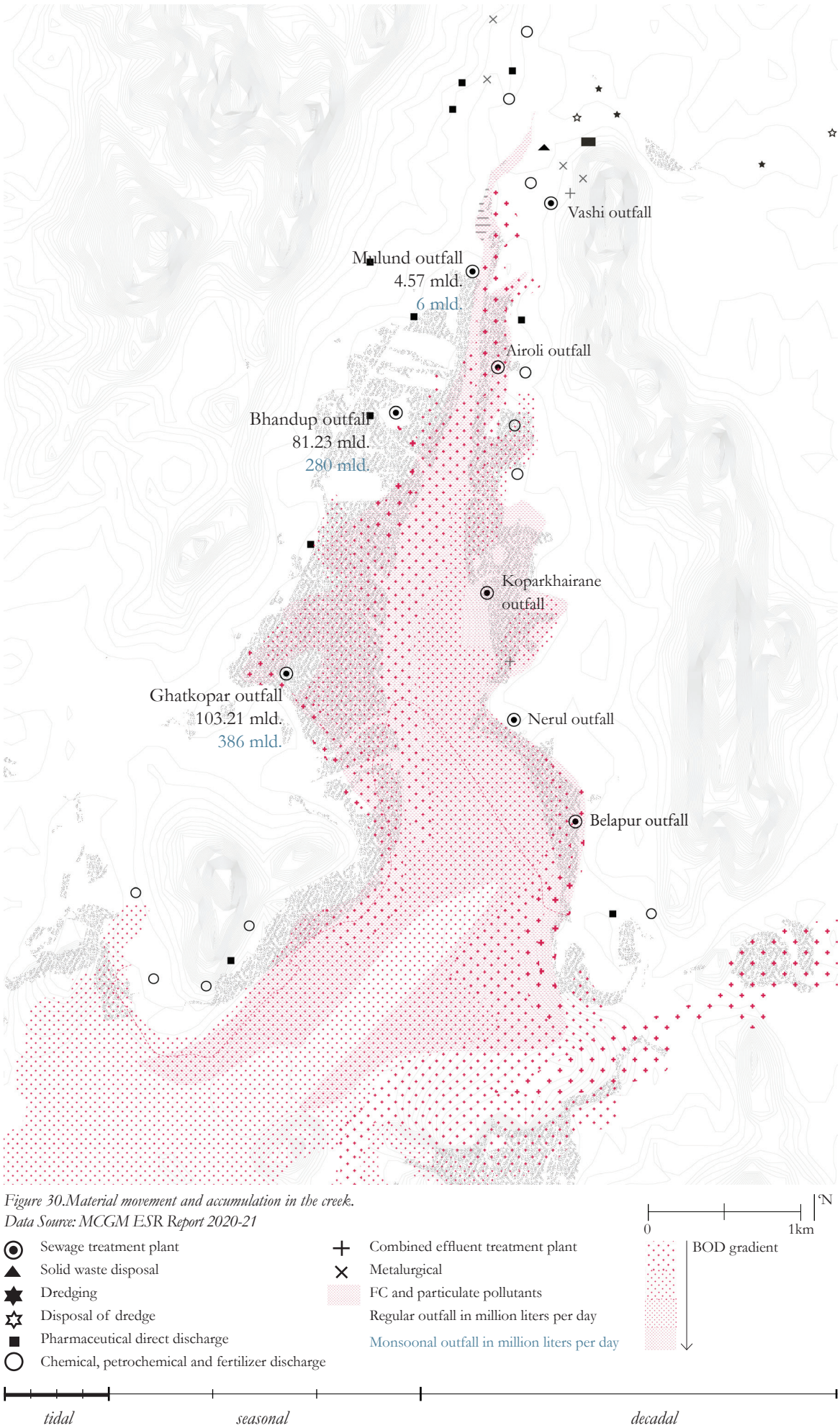


Figure 29. Water Quality Parameters

Legend: Baseline (light pink), Existing (dark pink). CFU: colony forming units



Current trend:

However, as a result of this discharge, the quality of water in the creek has significantly deteriorated in the past decade. Higher turbidity has curbed aquatic plant and animal life in the region. Additionally due to the reduced tidal influence in the creek, the water is relatively stagnant in the north and the east of the creek. Causing sedimentation of the pollutants and thereby reducing the creek and rivulets depths. Adding to the inefficiencies of water drainage in this region.

Projection: There is a projected increase in the volumes of sewage in the next 5 years because of the inclusion of more households in this system and the probable increase in population. In anticipation of which a new sewage treatment plant is due to be installed along with an upgrade in the treatment stages. However this alternative still doesn't take into account the influence of the accumulated matter on the landscape ,how the waterbody is saturated and unable to clear out the pollutants anymore. Which has already resulted in parts of the estuary being rendered dead (eutrophied) ,having altered mangrove productivity or has resulted in the backflow of sewage during monsoons or hightide.

Intent:

The project aims to manage the volumes of matter

Scope:

In reality, there are several gaps in the sewage management system of Mumbai where atleast 23% of the sewage is discharged without treatment. However due to the informality of this condition it is rather difficult to situate the outfall points under such conditions and hence has been acknowledged but not quantified in the project.



Figure 31. Formal sewage discharge path and changes in its materiality as it interacts with the landscape

Matter Source

Storm water drainage

The current Storm water drainage system in Mumbai dates in parts back to 150 years. A highly mechanized system that culminates into the surrounding water bodies through 186 outfall points along the coast of the city. Of which 46 are below the mean sea level and 140 above M.S.L of which 134 are below high tide level and only 6 outfalls are above high tide. And all of the 14 outfall points that discharge into the the thane creek are below hightide level. Makign it extremely probable to clogging due to silt deposition in the dry season and flooding due to clogging or back flow during monsoons.

Trend:

Originally, the SWD system was designed with rainfall intensity of 25 mm (1”) per hour with run- off co-efficient as 0.5 i.e. 50% water is absorbed/retained over the land and balance finally flow offhsore. However due to increased urbanisation and consequently impermeable area, the system was proposed to be upgraded to a design capacity of 50 mm/hr rainfall intensity and run off co-efficient of 1.0, where a significant part of this upgrade still hasn’t been implemented. Additionally, dueto the morphology of the channelized systems, they tend to accumulate large volumes of silt , sediments and pollutants during the dry seasons. Caused by both anthropogenic as well as natural tidal processes. Thus mandating the need for a continuous cycle of dredgind , desilting and thus clearing the accumulated matter(premonsoon and post monsoon) to make room for the precipitated volumes of monsoonal water.

Projection:

However much of these mechanised pumping solutions are proving to be ineffective in mitigating flooding as they are designed to be regionally functional. They operate on a centralised scale that entirely disregards the local terrain, surface and subsurface materiality. Resulting in extremely dry landscape conditions during summer and inundated surfaces during monsoon. Additionally Mumbai receives about 6 heavy , 5 very heavy ad 4 extrememly heavy precipitation events, during which the SWD are rendered over capacitated due to clogging or high tide. Only accentuating the flooding crisis.

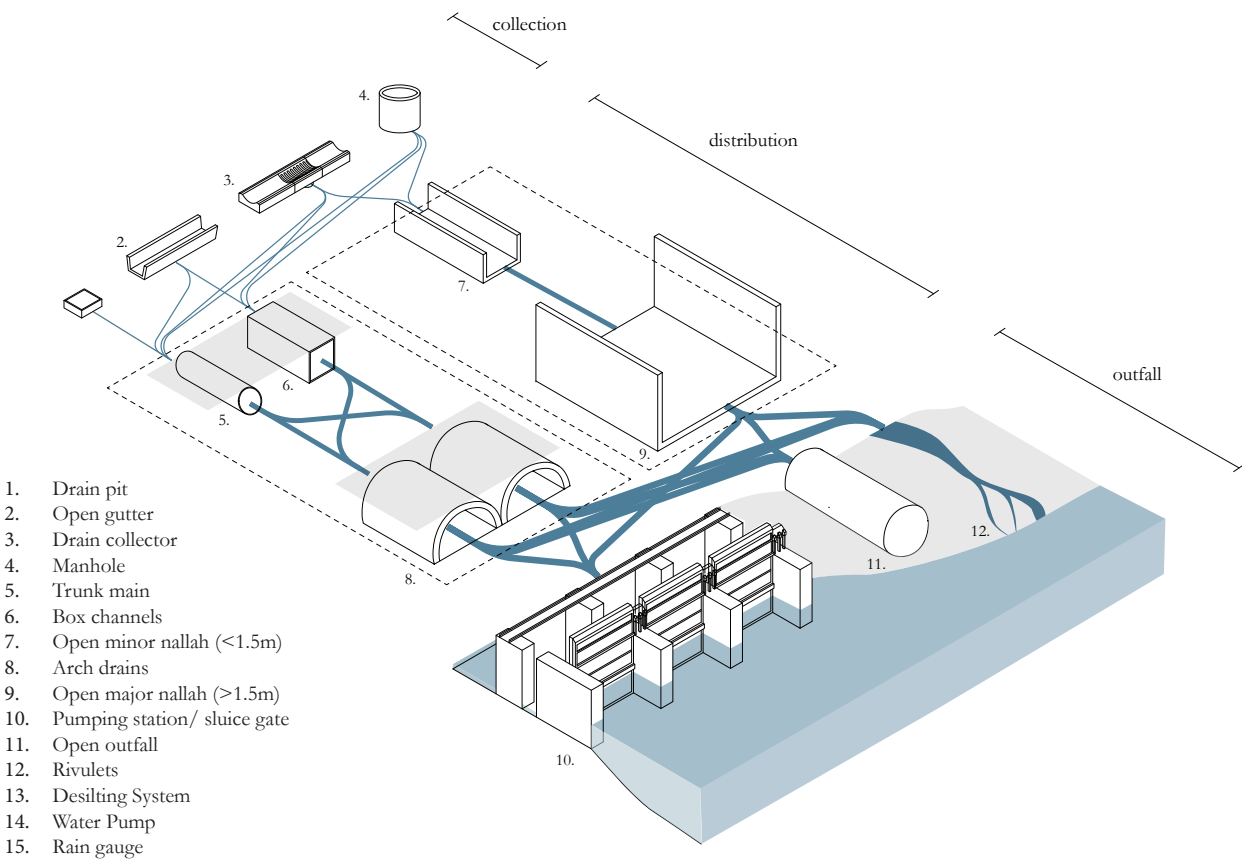


Figure 32.Existing Stormwater Management Infrastructure

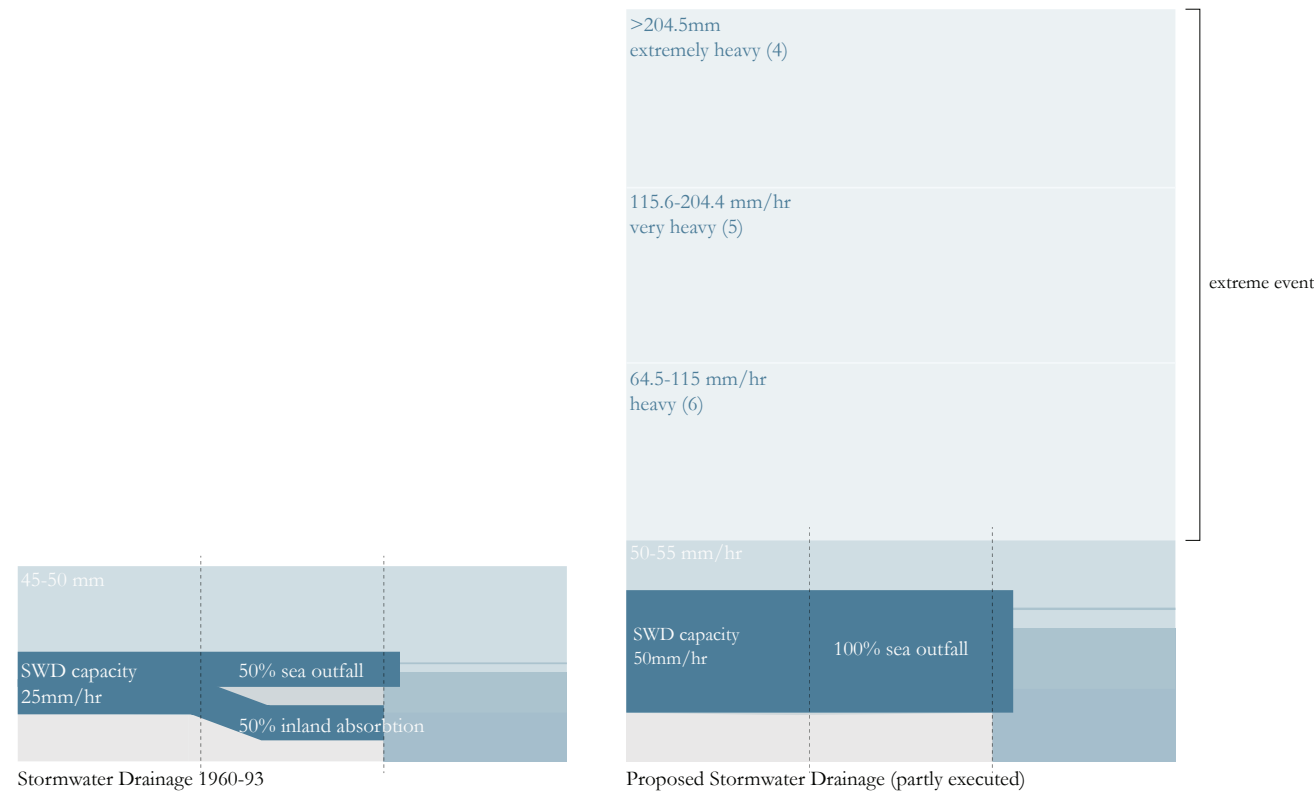


Figure 33.Capacity of the existing stormwater management system vs. the volume of water witnessed during an average monsoon season. Data Source: Mumbai Climate Action Plan 2020



Intent: There is a need for scalar integration of storm water management at the basin level, that takes into account and responds to local materiality and its innate capacity to harness water to mitigate wetness extremities.

Image 26. Incongruently situated stormwater drainage infrastructure in the urban fabric causing accumulation of sediments and silt - creating a need for regular clearance and technocratic upgrade of the system.

Matter Source

Landfill

The site also constitutes two prominent landfills embedded in the estuarine landscape- Deonar dumpyard, Kanjurmarg dumpyard, and Mulund Landfill. While the latter has been shut in the recent past, its presence in the form of monsoonal runoff into the creek is still witnessed till today.

Deonar Dumping Ground is still very functional extending over 1.32 km.sq. and approximately 40 mts tall the mountain of waste is known to accumulate about 9,000 metric tonnes of silt everyday between March and June (pre-monsoon) as a result of cleaning out the storm water drains in the city. While the context of the landfills in the site weaves into the scope of waste management in the city, the project acknowledges the presence of this dumping ground as a permanent scar in the landscape, that will perpetuate in the near future. Whilst incorporating ways of regulating, mitigating, and curbing the impact of wastewater and silt discharge from these dumping grounds.

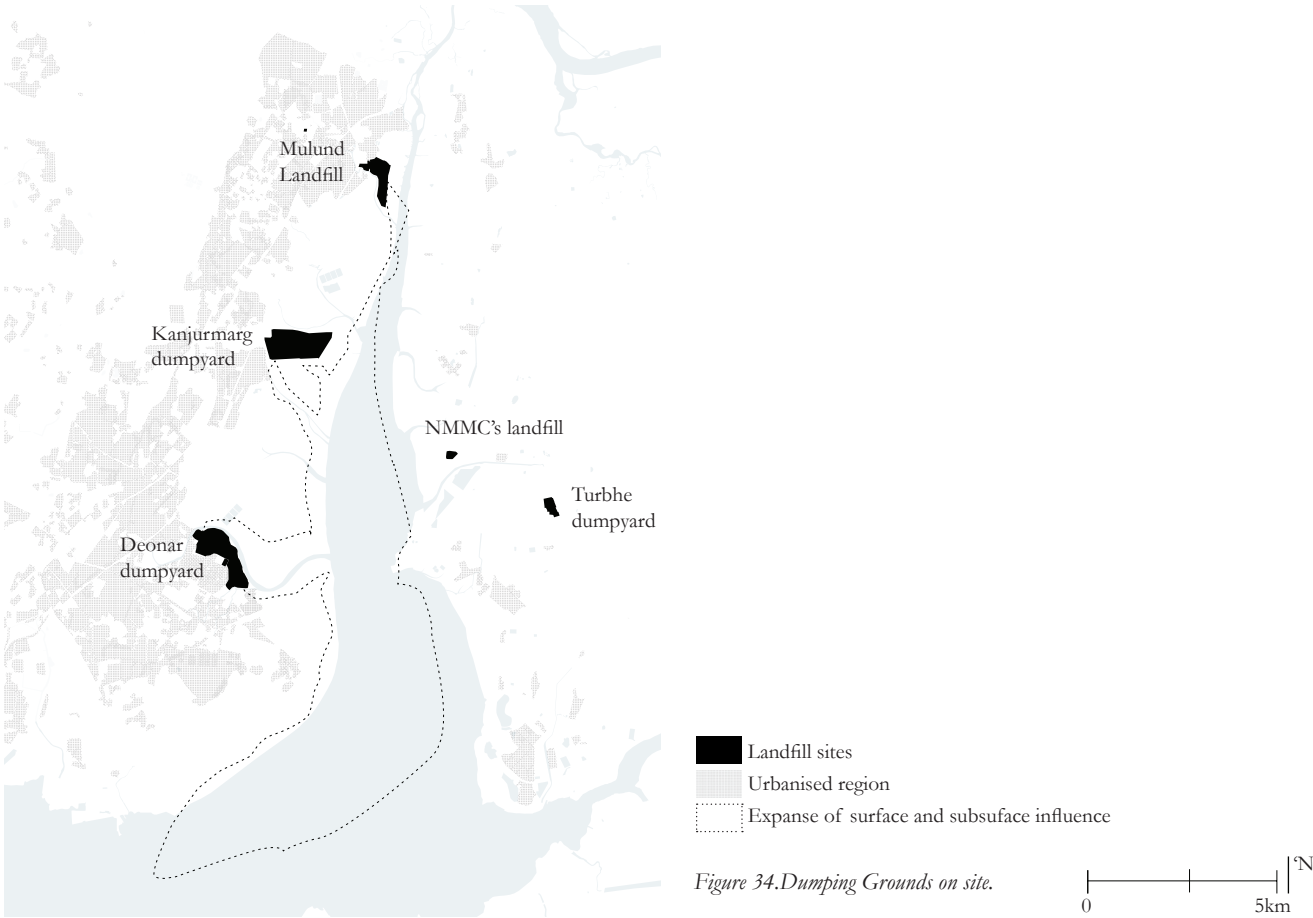
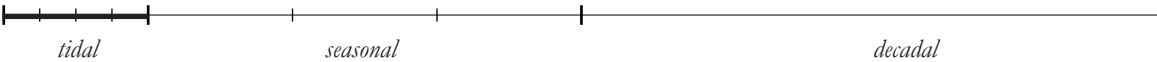


Figure 34.Dumping Grounds on site.



Image 27.Kanjurmarg Dumpyard . Image source : <https://vikbroliipost.wordpress.com>



Matter Source

Unfettered sources: socio-cultural practices

Several religious and socio-cultural rituals in the country revolve around water bodies, regarded as an embodiment of a higher power. These practices involve praying as well as making material offerings to the water body during fesitivities. However, with the expansion and commercialization of these practices, the aftermath of prominent festivals has a terrible impact on the ecology of the water bodies. Like the Ganesh Chaturthi festival marked by the immersion of idols into the sea or creek. Traditionally made from soluble ‘shadu’- a local riverine clay, has today been replaced with the insoluble Plaster of Paris. (insert shadu image, vs pop idol collection).

However, even with the clay idols and biodegradable offerings, it takes about 15 days to dissolve and disintegrate in the creek. During which the DO (dissolved oxygen) of water goes down & suspended solid increases, making it highly turbid and a predominant cause of fish mortality due to the clogged gypsum particles. Lastly, although as these particulates disintegrate, their sedimentation at the base of the creek significantly reduces its depth and clogs freshwater intrusion from the upstream Ulhas river.

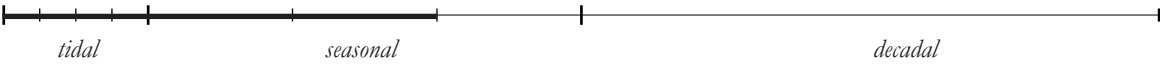
Trend: In response to the externalities of this practice, there is a dedicated period of clearance followed by the festive season. Besides the prospects of effectively clearing out all the accumulated matter is low due to limited creek access from the littoral edge, there is not much done about the effective quality of the water. The alleviation of which solely depends on the flushing rates of the monsoon and tidal currents.

In light of the detoriating creek condition, measures are being actively pursued to create artificial inland water bodies that can be maintained to absorb this scale of accumulation.

Projection: The continuance if not extrapolation of this practice is rather implicit as it is deeply embedded in the society. While the project does not delve very deeply into the real of water pollution due to this source, it does account for its existence for which it proposes mitigation methods and frameworks in support of the larger design strategy.



(top to down)
Image 28. Accumulated offerings in the water body.
Image 29. Weekly offerings to the water body.
Image 30. Annual festival of Ganesh Chaturthi.



Matter Source

Unfettered sources: industrial activities

The deteriorating condition of the creek can also be attributed to the heavy industrialization and urbanization that has taken place along both the banks of the creek. With about 2000 industries along the creek of which 51 are large, 250 medium and 1221 small industries. That not only requires large supply of fresh water but also discharge warm water into the creek amounting to 56MLD. Thus becoming a significant cause of overnourishment and eutrophication of the water body, alongside the sedimentation of the bed.

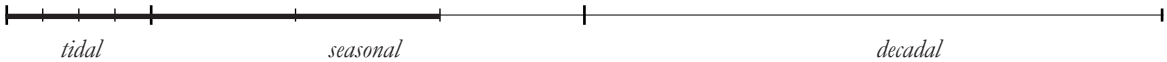
Trend:

While industrial activities in this region remain promoted, stronger norms are implemented to regulate the quality of the discharge. However, due to the lack of an integrated system for management of the outfall followed by the dissociated accountability, the prevalent approach to safeguard the creek are rather futile.



Image 31. Discharge from the concrete and quarrying industry is the most significant in terms of accumulation of matter in the creek. Along side their demand for water supply.

Thus directing the need for a circular exchange and treatment of matter between the estuary and the industrial sectors as a method to establish a sense of responsibility. Stemming from new embedded contextual landscape dependencies to maintain the quality and geomorphological characteristics of the thane creek for mutual sustenance.



Water

as a substrate

Water, plays a predominant role in shaping the site, both biophysically as well as socio-economically. Existing in various forms in the atmospheric, surface and subsurface conditions, the project tries to articulate the role and form of water on site.

Specifically analysing its role as a medium that carries matter in time, accumulates deposits and thereby continuously alters the landscape. In this context, the role of water has been researched in two ways-

As a parameterized volume to define the thresholds of the creek. Speculating upon the amount of water introduced across the hydrological cycles in time and their capacity to clear out the accumulated matter. So as to prevent morphological alterations of the estuary that manifest across the hydrological basic during peak volumes of wetness or dryness. Which the project in its larger scope aims to alleviate by managing the volumes of matter complimented by water in the creek.

The biophysical attributes of water as a method of shaping the landscape – its velocity, temperature, salinity, etc. in various parts of the creek. Which further influences the manner in which it interacts and shapes the materiality of the surrounding environment.

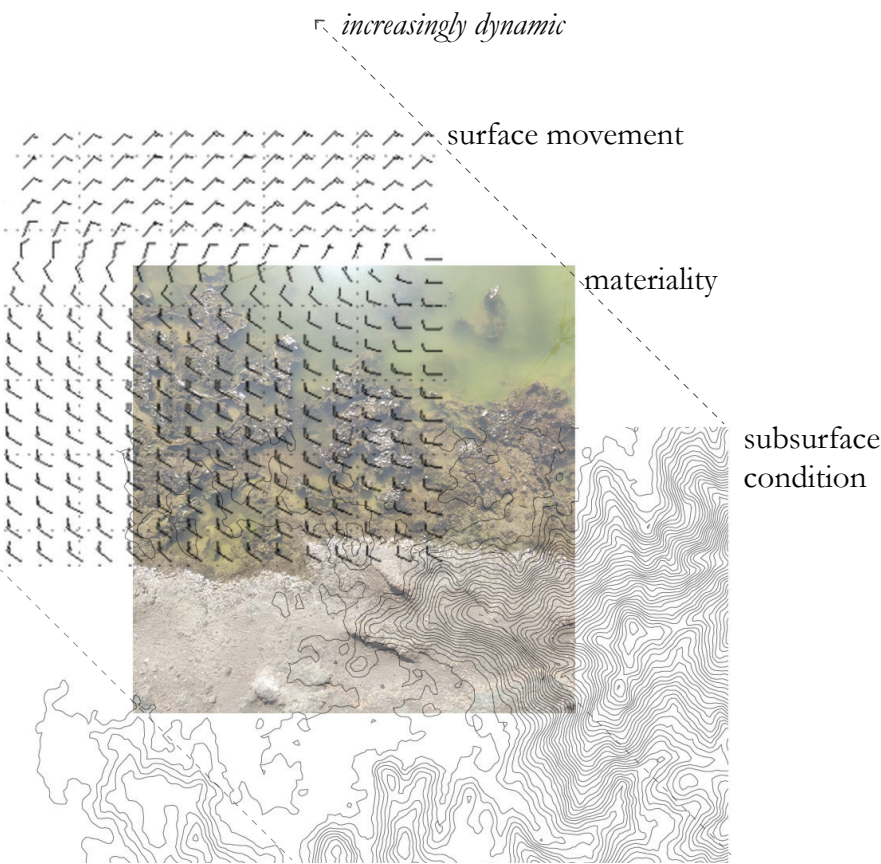


Figure 37. The scope of water for the project

Altered Landscape

as indicators of change

The project reads the site as a thick living deposition of material, resulting from the combination of anthropogenic activities enmeshed with natural ecosystem cycles giving rise to new forms of landscapes.

Manifesting as physical elements and/ cycles of varying temporality which in time compose new environmental conditions with differed functional capacities. That beyond a threshold can no longer satisfactorily support the anthropogenic activities dependent on them. Consequently, triggering a responsive amplification of anthropogenic activities and thus setting into motion a larger cycle of positive feedback that influences the morphodynamics of the estuary.

The landscape is a geosocial entity - growing, restoring, adapting, as well as transforming onto itself. And at the core of this understanding are cycles of dependencies in the Thane creek, that span across scales of time and space, feeding into one another.

Based on site interactions, theoretical and scientific analysis, certain elements and cycles have been identified as critical landscape indicators. Which can be further monitored in detail through thresholds of functioning to speculate upon their trajectory of evolution and what that means for the hydrological sustenance of the region. The project will be studying-changing creek morphology

Living matter

The estuarine landscape has been studied through the lens of its constituting materiality. Comprising of volumes of matter and its substrate that perpetuates its movement. Matter refers to as solid particulate entities of varying grain sizes- from silt to large flocculant pollutants like plastic. Which is set into motion by volumes of water as the substrate.

The constant volume of water in the estuary through out the year overlayed by daily tidal influence, annual cycles of extreme precipitation and one off events of heavy precipitation.

All of which shape the landscape at varying gradients in time. Reacting differently to the excessive volumes of matter on site manifesting in the form of an altered landscape triggering hydrological extremities in the from of flooding or dry riparian edges with different implications on the macro,meso and regional scale.

Image 32.Walking the creek



Altered landscape indicator

Mangroves

The mangrove vegetation forms a predominant part of the marshland, playing a critical role in safeguarding the eastern coast from erosion due to long shore currents and coastal flooding during monsoons. Positioned along the banks of the funneling creek, they tend to attenuate tidal currents during high tide as the saline water is covered over most of the mangroves. And when the tide recedes a small amount of the water remains in the vegetated areas due to friction and terrain slope, thereby maintaining the wetness and productivity of the marshland. Additionally the existence of prominent and growing mudflats along the creek indicates that the peripheral mangroves are getting dense and have significantly reduce erosional activity. Thus when the tidal water moves through the marshland, it reduce the maximum magnitude of the tidal currents from 100% to 20% (1 m/s to 0.2 m/s).

Trend:

An analysis of satellite images from 1990 to 2017 reveals a seaward expansion of the mangroves. Which along with the dominance of Avicennia marina(a hardy species that thrives in high salinity and pollution including heavy metals lead, mercury, and chromium conditions) particularly along the seaward edge indicates high levels of water pollution, resulting in the over productivity and consequent adaptive transformation of the mangrove species.

As a result of this over nourishment, the trees adapt to grow taller at a rampant space with low and shallow root density as the nutrients required for their growth are readily available in abundance just a few centimeters below the surface. However due to these alterations, they are inherently less tolerant to monsoonal winds and strong tides. Resulting in excessive mangrove litter that causes an increased density of propagation. And under conditions of heavy precipitation, the entire tree all together falls outs. Wherein the debris then gets sucked into the marsh, laying roots for the propagation of new saplings from it.



This rapid vertical and horizontal expansion of mangroves followed by heightened vegetation density has resulted in an increase in the rate of sediment accretion- plugging rivulets, narrowing the creek width, increasing marshlands and thus obstructing the seamless movement of water and matter in the creek.

Projection:

This thick vegetated belt has adapted to become almost as an externality to the hydrological flows in the creek, and is only projected to expand seawards due to the continued sewage nourishment and other climatic factors(temperature , salinity), further shrinking the creek. It has transformed from a buffer to a thick barrier that is now curbing the reach of tidal waters to the inland littoral edge. Causing it to dry up and permanently alter in form. While in the monsoons, this acts like a barrier restricting inland water from draining out into the sea efficiently.

Given the strong influence of mangrove overproductivity on the morphology of the creek and its functioning, there is a need to curb this excessive unhindered growth for the mutual sustenance of the creek creek width, maintenance of the hydrological cycle and perpetuate a healthier life span for the mangrove tree itself. Which narrows down to the regulation of excessive nutrients predominantly from the sewage that sets into motion the cyclic processes of estuarine alteration.

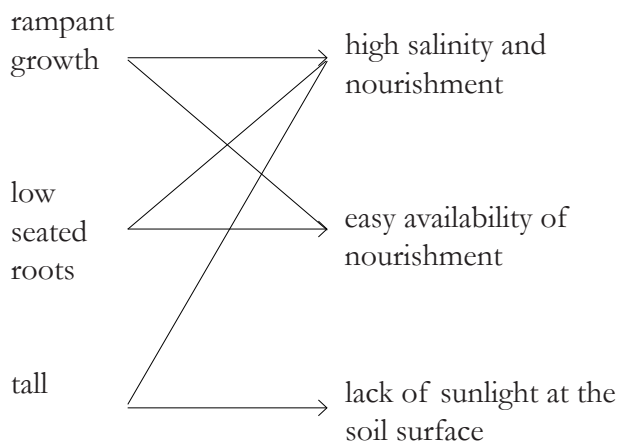


Figure 39.Positive feedback loop resulting in overproductivity

Image 33.Avecinia Marina-hardy species but have a weak structure



Image 35.Heavy litter and felling during peak monsoons



Image 34.Trapped litter, propagating new plants





Altered landscape indicators

Plugged Rivulets

Rivulets are prominent streams that cut through the vegetated marshland , which receive tidal waters through out the year as well as drain out inland stormwater during monsoons. Along side this they also constitute treated sewage outfall points. Since the discharge contains high volumes of sediments and nutrients, these either settle at the bed of the water channels or trigger vegetative growth at its priphery. Causing it the body of the channel to shrink and fuse overtime- indicated by the growth of marshland vegetation.

This not only limits the reach of tidal waters inland but also the drainage of stormwater into the creek due to silting of its bed and consequently the outfall pipes. This triggers local flooding followed by waterlogging caused by backflow of the storm water.

Projection:

With the rivulets getting narrow and shallower, the probability of a backflow through the SWD or sweage outfall point becomes accentuated. As a result of which, even with small volumes of precipitation and high tide, there will be a backflow triggering water logging.

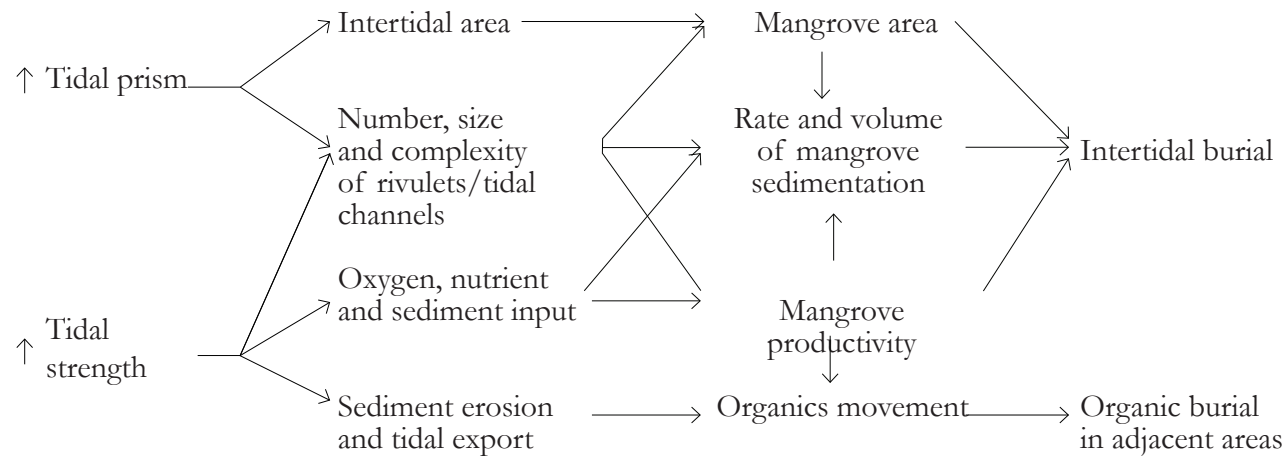


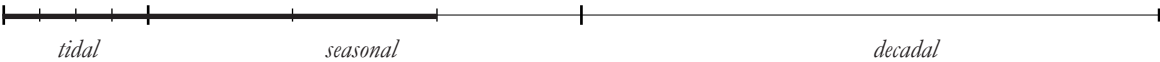
Figure 40.positive feedback loop, plugging rivulets



Image 37.Rivulets are predominantly deposited with silt and clay , condusive for wetlan vegetation to grow



Image 36.Rivulets are predominantly deposited with silt and clay , condusive for mangrove expansion.



Altered landscape indicators

Altering creek morphology

Mapping decadal changes in the creek reveals a general trend of heavy sedimentation that leads to a decreased depth and increase in the marsh land. Predominantly due to the deposition of sewage and pollutants into the creek. The accumulation of larger debris on the bed of the estuary further accentuates the sedimentation process as it traps more silt from the tidal waters. The extent of these alterations is most evident during neap ebb tides in the summer season where the creek is nothing but a large swath of mudflat with a narrow stream of water along its spine.

At the current rate of sedimentation- $2.78 \pm 0.23 \text{ kg m}^{-2} \text{ year}^{-1}$ its is estimated that the average width of the creek in the lower portion will be reduced by 2% in 2025 and by around 10% in 2050 as compared to width in 2016. In the middle portion, the predicted reduction in width is estimated to be 4% and 18% by the year 2025 and 2050, whereas in the upper portion, 14% and 64% reduction of width is estimated by the year 2025 and 2050 respectively. (Vijay. et al., 2020)

It is evident that owing to the stronger currents and flushing rate of the tides at the mouth of the creek as opposed to the upper reaches makes it less vulnerable to the expansion of the mudflats.

While on one hand the increasing mudflats support a wide range of bird and fish species like flamingoes and crabs, they reduce the stormwater draining capacity of the creek. Its stratified texture coupled with the physical properties of clay is conducive in further attracting sediments. Thereby silting the stormwater drains and raising the mean water level in the creek as its depth decreases. Consequently, increasing the tendency of a backflow and hence inland flooding during monsoons.

Thus it is essential to associate the morphology of the creek with its functional health that foremost relies on the dynamic flow of water through it. These observations mark the need for a shift in landscape management especially in the case of positive feedbacks as such where the adaptive patterns of the estuary are becoming an externality to itself- indeed transforming it into an non-estuary .

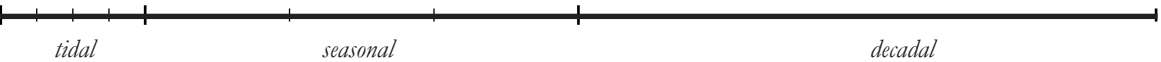


1992-2002 2002-2011

Figure 41.Decadal changes in the creek morphology



Image 38.Shrinking water stream in the creek



Altered landscape indicators

Drying Inland Riparian Edge

Desiccated patches along the interface of the creek and the urbanized inland territory can be credited to two primary causes- 1) the embanked storm water drains and 2) curbed tidal influence in the region. Which has cumulatively resulted in a landscape that is either subjected to very wet (during monsoon) or otherwise very dry (rest of the year) conditions. Making it rather unsuitable for wetland vegetation to thrive anymore.

1)Due to the hyper productive mangrove belt and its consequently increased tidal attenuation has limited the flood tides from reaching the inland interface of the creek along its western bank. This results in dry subsurface conditions for most parts of the year which also triggers salt intrusion into the region , further deteriorating its capacity to support plant life. On the other hand, during monsoons this interface gets easily inundate due to its terrain and loose un-vegetated soil which is drained out into the rivulets plugging it further.

2)Regarded as a critical landscape in draining storm water from the city, today not many of its innate biophysical characteristics are harnessed while doing so. Where the littoral edge is populated with large storm water drains situated both on the surface and subsurface.

The impact of limiting water within enclosed RCC catchments is not only evident in the adjoining landscape as it dries up but also in the performance of the engineered system in itself. That gets deposited with silt and pollutants throughout the year, reducing its depth to accommodate the storm water. While a pre-monsoon desilting is conducted is carried out every year, it only manages to temporarily mitigate the crisis of overflow as it is further deposited by more loose soil and sediments from the adjoining unvegetated surfaces through monsoonal run-off.

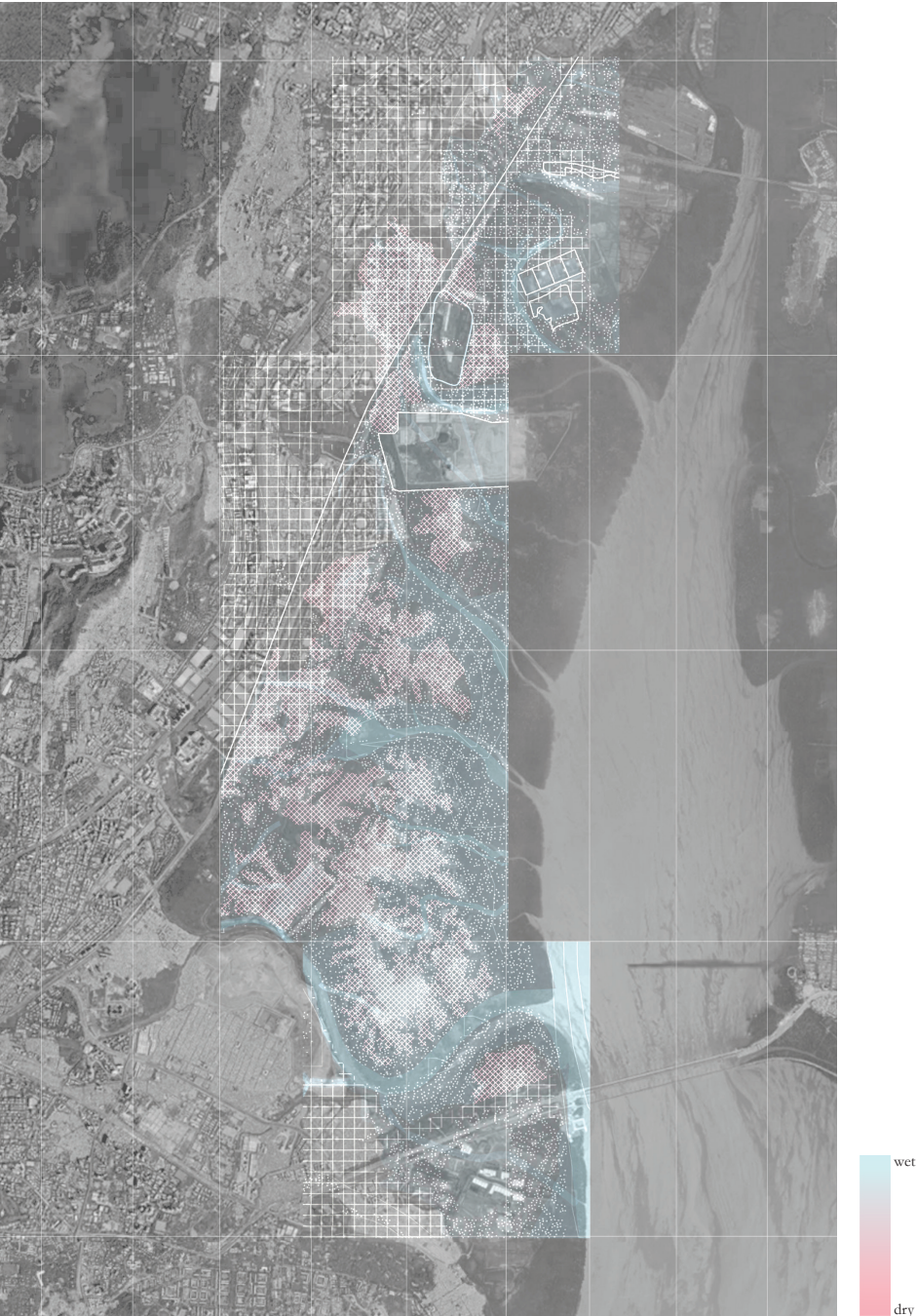


Figure 42.LandSat Color grading band 1 and 2. To determine actual variation in vegetation as an indication of surface dryness.

Additionally, as the edge continues to stay barren for years, the otherwise sinking clayey soil becomes stable (reduced capillary action of water) making it more and more suitable for infrastructural development. Given the lack of productivity in the landscape against the backdrop of land densification pressures in the city, makes it vulnerable to formal architectonic developments- encroaching and permanently curbing the estuarine territory. Some of which can already be witnessed in the current fabric.

Since the edge is composed of clayey soil which has a low permeability, there is a need to ensure wetness in these patches through ponding and storing water in the subsurface such that it can remain characteristically moist throughout the year. And on the larger scale function as a integrated system to manage the stormwater between the inland and seaward regions.



(top to down)
Image 39.Decreasing water reach within inland regions of the hyperproductive mangrove edge.
Image 40.Drying wetland landscape, particularly surrounding the storm water drains.
Figure 43.Drying clayey soil

Altered landscape indicators

aquatic & avian habitations patterns

With the creek waters becoming more and more turbid, the fish habitats are being out into the sea. With a few remaining fish that have a high tolerance to the nitrates and phosphates in the water.

However with an increase in the vegetative cover of the mangroves and longer dry soil periods, there has been an increase in the avian population in the region., typically migratory birds. Like waders, flamingoes, Grey plovers, Indian pond herons, etc. Where some like the flamingoes are not native to the region, up until around fifteen years back where they began flocking here with a marked increase in the past five years.

These birds essentially arrive during their feeding period which are the non-monsoon months. And today this thriving habitat has been preserved and celebrated through conservation efforts in the form of sanctuaries and dedicated sectors for avian research.



Image 42.Flamingoes and Grey Plovers
Information Source: local fisherman



Image 41.Mud Crabs
Information Source: local fisherman



Path dependancies

Fishing community

The Kolis are one of the few remaining indigenous communities from the archipelago of Bombay. A fishing community that lives and depends on the coastal edges of the city.

The western bank of the thane creek hosts two main Koliwadass (fishing community housing), namely Bhandup and the Mulund Koliwada.

In the recent past there has been a notable decline in the once thriving Koli community and the very practice of fishing in the city, particularly among those associated with the altering creek edge. Where the adapted estuarine landscape and fluctuating conditions of wet and dryness have made it difficult for the profession to thrive functionally and thereby economically.

The primary threat to the Koli community is the mass depletion of catch in the creeks due to poor water quality. Where of around 22 species of fish that were observed from the riverine end of the creek at the beginning of the last decade, have diminished down to just 6. While there isn't a significant reduction of species in the seaward mouth of the creek, these do not enter the creek due to its high level of pollution. Due to the reduction in clay, the mud flats did not remain hard and became silty, soft and sinking, which probably had adverse effect on the survival of the eggs affecting the breeding of prawns, crabs and fishes. The prawns got eliminated from the creek. The mud quality did not remainsuitable for the burrows of the mudskippers especially, thus eliminating them from the creek. It was observed that as the pollution and siltation in the creek increased the mudskippers moved to relatively less polluted downstream and then finally got eliminated from the creek. (Biodiversity of Thane Creek. National Conference on Biodiversity : Status and Challenges in Conservation - 'FAVEO',2013)

Instead there is an observed migration and consequent adaptation of the creek fishes to the outer sea. Since the fishing licenses are dispensed for fixed regions, the outward movement of the catch leaves the creek fishermen rather helpless. And also within their realm ,it is always more expensive to carry the boat further away from the shores.



Image 43.a),b)Thane creek and a thriving koli community. Circa 1960's .
Image Source : Sadashiv Raje 1958 from the section The Community and Their Livelihood



Image 44.Changes in the scale and nature of the Koli community and fishing practice with alterations in the landscape. a)Thane creek and a marginalised koli community. b) attempts at ponding to farm fishes. 2023

Additionally, with the sedimentation and narrowing of the creek rivulets coupled with the reduced influence of tidal waters inland has almost land lock the fishing docks. Ones that would always have sufficient water for the fishing boats to set sail most times of the year are now only limited to high tides and some to merely the periods of spring tide. Further limiting the viability of the fishing practice.

Overlaying the impacts of the altered creek morphology on fishing in terms of the duration conducive for the practice, along with other socio-cultural constraints like vegetarian months or the environmental restrictions on fishing during monsoons or breeding seasons leaves a very small window for the fishing community to operate with. Thus, making it a non-viable practice of livelihood.

While the fishermen do try to annual clear out the flocculant pollutants and solids from the water streams via nets, they are hardly successful in improving the quality of the water.

These indigenous communities indeed have a massive body of expertise about the local estuarine ecosystem. Their ability to predict rainfall, fish catch, soil potentials and tidal patterns by sheer experience, observation and a long trail of native knowledge shows promising potential to be harnessed in maintaining the creek. - Maintenance stemming from an innate sense of care, belonging, direct dependency and thus responsibility for ‘their’ waters and land. Thus, strengthening the case for a new form of habitation that generates a sense of stability that safeguards the koli community.

The onsite interaction with some of the Kolis provided a very clear and profound understanding of the local conditions of this complex interface between land and water, which can hardly be documented through satellite or geospatial data. These accounts of everyday encounters cumulatively have informed the project with more grounded findings and tangible indications that have held precedence to scientific research papers structured at a macro scale. However, because of limited power(stemming from ownership) in the bureaucratic structure of the region, the profession is indeed marginalized.



Image 45. (a,b,c)Diminishing viability of creek fishing due to the curbed reach of tidal waters in the landscape.



“These are ‘big people’ projects. Nothing is going to change. Instead, the forest department harasses us.”

कांजूरचा डम्पगिचा पण पाणी जातेला. नाहीतर आम्हाला फिशिंगमध्ये एवढा पैसा भेटायचं करायची गरज नाही. जो खराब पाणी जाताना डम्पगिचा सर्व डंपगि पडतो.

त्यामुळे वाशी पुलाच्या पलीकडे मासे येत नाहीत.

हे सर्व मांजर मासे इत्यादी चखिलात वाढतात. त्यांना कोणतीही मागणी नाही. पोमफ्रेट्स वगैरे खाडीत नाहीत.

आता पूर्वीसारखे राहिली नाही जेव्हा इथे खेकड्याच्या दोन-दोन तीन तीन टोपल्या मळियच्या. इतके की आम्हाला हे सर्व करण्याची गरज भासली नाही (अर्धवेळ पक्षी नरीक्षण फेरी सेवेचा संदर्भ).

हे सर्व लोक सांडपाणी खाडीत सोडतात. तक्रार करून थकलो आहोत. वनखाते, आमदार, एनजीओकडे तक्रार करावी लागते. हे बड्या लोकांचे प्रकल्प आहेत. काहीही बदलणार नाही. त्याऐवजी फॉरेस्टवाले आम्हाला त्रास देतात.

It is Kanjur's waste water. Otherwise we don't need other ways to make money. Fishing was more than ample. So all the bad water goes away into the sea with the currents and the fishes do not come inside beyond the Vashi Bridge. Now here, it is only these cat fishes that grow in the muck. They have no demand. Its of no use if we cannot find the prime catches like pomfrets or basa in the creek anymore.

Its no longer like before when we used to catch two to three baskets full of crabs. So much so that we did'nt need to do all this (referring to the part time birdwatching ferry service that the fishing boat is now used for). All these people(pollutants) subtly discharge dirty water into the creek and suddenly wake up once or twice a year to clean up. We are tired of complaining. We have to complaint to the forest department, MLA (local elect to the lower gov. house) , NGO. These are “big people” projects. Nothing is going to change. Instead the forest department harasses us with new regulations everytime.

excerpt from an interview with a local fisherman

Path dependancies

Salt farming community

The Agariyas or salt farming communities are the second most prominent indigenous community in the city after the Kolis. Having their largest presence along the western banks of the Thane Creek. Once marked by the circular use of the estuarine land for salt manufacturing and pisciculture, in the past few decades, this practice has commercialized in form.

The salt pan lands fall under the ownership and legislation of the central government. Which in coordination with the state government are leased out to salt manufacturing companies for a varying period of 5-20 years. These companies have fixed laborers for the different tasks in the annual cycle of salt farming. Different men for bunding, ponding and harvesting which are deployed in rotation for periods of 3-4 months across different salt farms between adjoining states. After the salt is harvested in peak summer (May), the land is left unused for the whole of monsoon and is only re-bunded for a fresh salt cycle in around October.

Based on the prevalent status of salt farming in the city, it can be very well concluded that it is no longer the indigenous community but the indigenous practice that exists today. Practiced by individuals with very limited regard for the landscape or the viability of the region. Additionally with the decreasing demand for cultivated sea salt and high leasing rates, the demand for the industry is fading. In response to which the government has already opened some of these salt pan lands for development in 2019 (cite). This brings forth the urgency of addressing the fading salt farming practice. Not only its heritage relevance but more importantly the impact of vacating this practice on the surrounding landscape, which is rendered vulnerable to infrastructural development.



Primitive practices unable to accomodate extreme conditions of wetness or dryness. Mulund Salt farm(top to bottom)
Image 46.Rebunding and soil draining after an untimely rainfall.
Image 47.A silted and choked water channel in the bunds.
Image 48.And yet very dry soil conditions questioning the viability of the Agariyas.

In face of the grim reality of diminishing of salt farms, there is a need to stimulate the evolution of an alternative landscape that not only compliments the adjoining creek but also supports the territorial goals of maintaining the ecosystem. As a critical step towards restructuring the functional relevance of the landscape in the estuarine region such that it holds precedence over the ever-increasing infrastructural demand for more land.



Image 49. opening of salt lands for infrastructural development



“ *Yes, the rainfall ruined all the salt. But that is not my problem.* ”

हाँ, बारिश ने एकत्रित सारा नमक नष्ट कर दिया। यह मट्टी में मलिन कर खराब हो जाता है। लेकिन यह मेरी समस्या नहीं है। मैं यहां केवल मार्च से अप्रैल तक हूँ और मेरा काम नमक की कटाई करना है। तो मैं वापस जा रहा हूँ। मैं रहता हूँ यह छोटी सी झोपड़ी है जो साहब ने प्रदान की है। इसके बाद मैं वहां नमक की फसल के लिए सूरत जाऊंगा और फिर निर्माण के लिए घर वापस आऊंगा। जून के बाद इस जमीन का कोई उपयोग नहीं होने वाला है। दवाली के बाद ही नए लोग आएंगे।

... नहीं मुझे नहीं लगता कि यह लंबे समय तक चलने वाला है, मैंने नमक कारखाने के साथ काम करना तब शुरू किया जब उन्होंने मुझे बिहार से मुंबई आने का प्रस्ताव दिया। लेकिन नहीं तो बिना रोजगार के मैं यहां कैसे रह सकता हूँ। और कंपनी हमें चार से पांच महीने के लिए स्थानांतरित करती है लेकिन अगर वह बंद हो जाता है तो उनके पास अभी भी निर्माण कार्य है इसलिए मैं वहां काम करना जारी रख सकता हूँ।

नहीं, मुझे नहीं पता कि नमक कहाँ जाता है, लेकिन इसे खाने में इस्तेमाल नहीं किया जाता। यह बहुत अशुद्ध होता है, इसका उपयोग कारखानों में या मछलियों के भंडारण के लिए किया जाता है।

Yes, the rainfall ruined all the salt gathered. It is mixed with soil and spoilt. But that is not my problem. I am here only from March till April and my work is to harvest the salt. Then I go back. I live in this small hutment that sir has provided. After this I will go to Surat for salt harvest there and then back home for construction. This land is not going to be used after June. Only after Diwali (October-November) will new people come.

... No I don't think this is going to last long, I started working with the salt factory when they offered me to come to Mumbai from Bihar. But otherwise how can I stay here without employment. And company moves us for four to five months but if that shuts then they still have the construction jobs so I can continue working there.

No I do not know where the salt goes, but this is not used for food. It is very impure, it is used in factories or for fish storage.

excerpt from an interview with a salt farmer

Path dependancies

Eco Tourism

In the past couple of years, with increasing awareness about marshland biodiversity, accreditation of the creek as a Ramsar Wetland and the sudden increase in the flamingo population has created a new niche for eco-tourism. Through the aid of several local, national and international NGOs, avian sanctuaries and biodiversity parks have been set up in this region, predominantly centered around the narrative of the flamingoes and mangroves. Providing an alternative source for an assured income for the fishermen who take the tourists out on their boats to witness the feeding migratory birds. However, even with this, there is still a limited time frame when the water level is sufficient for the boats to set out into the sea.

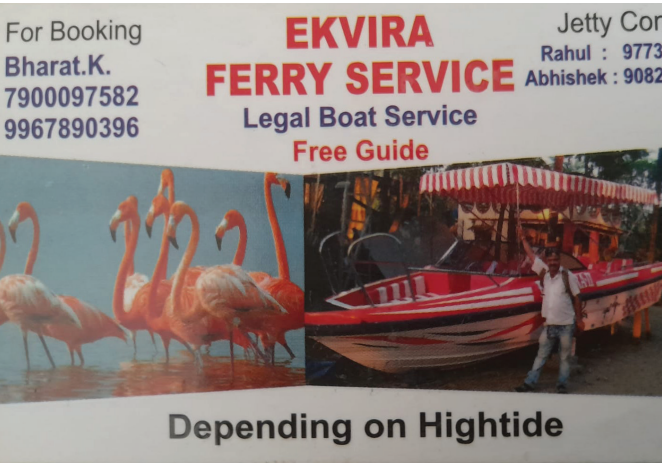
In this booming context there is a need to critically evaluate the gravitation of the Kolis to eco-tourism and what that means for the socio-cultural identity for the city . Alongside the reality of these new symbols of environmental pride and prosperity in the creek that have been introduced in the narrative of the Mumbai.



Image 50.(top to bottom)
Image 51.Sculptures
Image 52.Painting in public spaces
to revive the “pride” of being a Koli
(fisher).



(top to bottom)
Image 53.A depiction that often reflects
a valorised imagery of the past.
Figure 44.Ironically juxtaposed with
new alternatives to the fishing commu-
nity.



(top to bottom)
Flamingoes are soon becoming the new
identity for this region.
Image 54.Where not only is the land-
scape being actively shaped to accommo-
date and extrapolate this occurrence via
sanctuaries and bird parks.
Image 55.Even the local & indogenous
communities are permanently shifting
their orientation towards thisseemingly
economic alternative.



Conclusion

accumulation

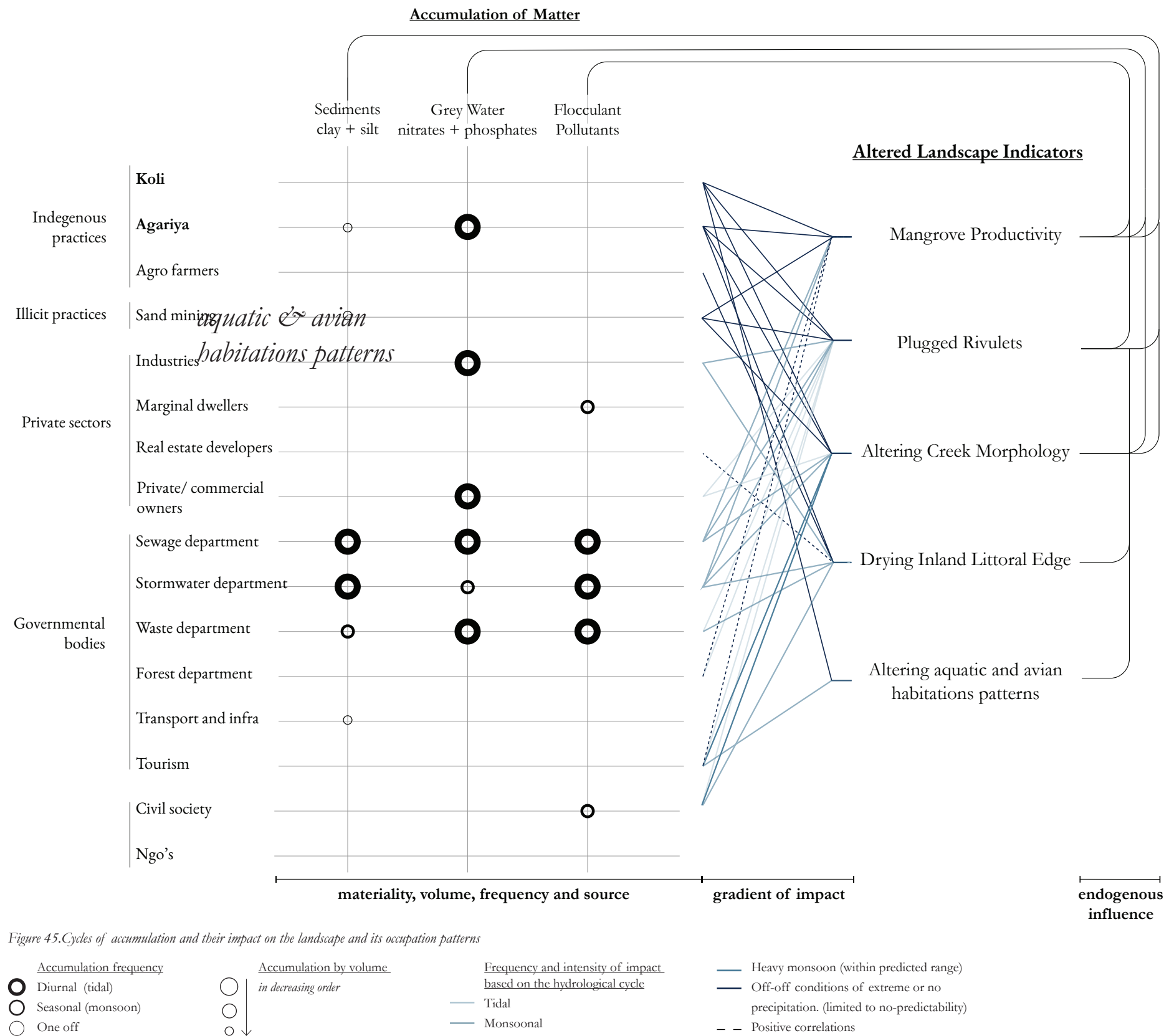
A detailed analysis of the site reveals it to be a composite of multiple local cycles (human and more than human) of dependencies that are enmeshed together in time through the hydrological cycle.

The permanance of material deposition as a manner of growth and existence is evident from the vicious self feeding cycle of landscape alterations that has been set in motion. That has not only altered the biochemistry of the landscape but at the same time subjected its constituting elements (human and more than human) and cycles to accommodate this alteration in the environment.

Where individual (elementary) adaptations occurring at varying paces, that digress from the previously congruent dependencies whilst being replaced by new open-ended synergies. A collective of multiple discordant movements that no longer amount to the collective health of the landscape – yet again altering it. **A condition where the very adaptive trends of the estuary are becoming an externality to itself.**

While the sources of the pollutants are largely constant, its externality is however witnessed by a broader and diverse spectrum of the society- in varying amounts , frequencies and formats (economic, spatial, identity- individual or as a collective) . Where their vulnerability or ability to persist the resultant hydrological instabilities can be subjectively estimated as a cummulative of their economic capacities, power and interest in the landscape *matters*.

This synthesis reveals critical segments of the society that need to be holistically addressed and actively included in this new paradigm of growth. One that is conciously shaped by the existing endogenous landscape cycles, in response to the practices of accumulation that will most likely prevail in the future of the city.



Conclusion

Clearance and the need for maintenance

While there are several process of material clearance in the estuary- human, more than human as well as via interactions between the two, they are hardly sufficient to accommodate the immense volumes of deposition that occurs annually.

Motivations for Clearance

Within the societal scope of actions, there is limited overlap between the sectors who are actively accumulating matter and those involved in its clearance. Most of which is stimulated by a systemic necessity with the exception of voluntary clean-ups of the creek by NGO's and indegenous communities stemming from the **necessity to care**. And this puts them central in ethically reconfiguring as well as implementing a new paradigm of growth- revolving around ensuring a healthy landscape.

Where does the matter go?

In reality, even if the current efforts of clearance are stream lined and extrapolated in scale to accommodate the large volume of matter, they still remain futile in addressing the core condition of an altering landscape. As the accumulated matter is merely transposed from one region to an other in the estuary. Which will yet again be accumulated under the influence of water. Bringing forth the need to productively close (as far as possible) the loops of matter within the landscape, to abait the externalities caused in their excess.

Scales of Operation:

And more importantly, these local actions operate independantly and in isolation (spatial +systemic) with little to no regard to territorial implications. Consequently, rendering these smaller measures insignificant in improving the overall health of the estuary. Necessitating the need for a scalar integration of ambition and actions on site. Where synchronised smaller actions in the landscape can alleviate and achieve local goals whilst cumulatively functioning to wards managing the volumes of matter in the estuary.

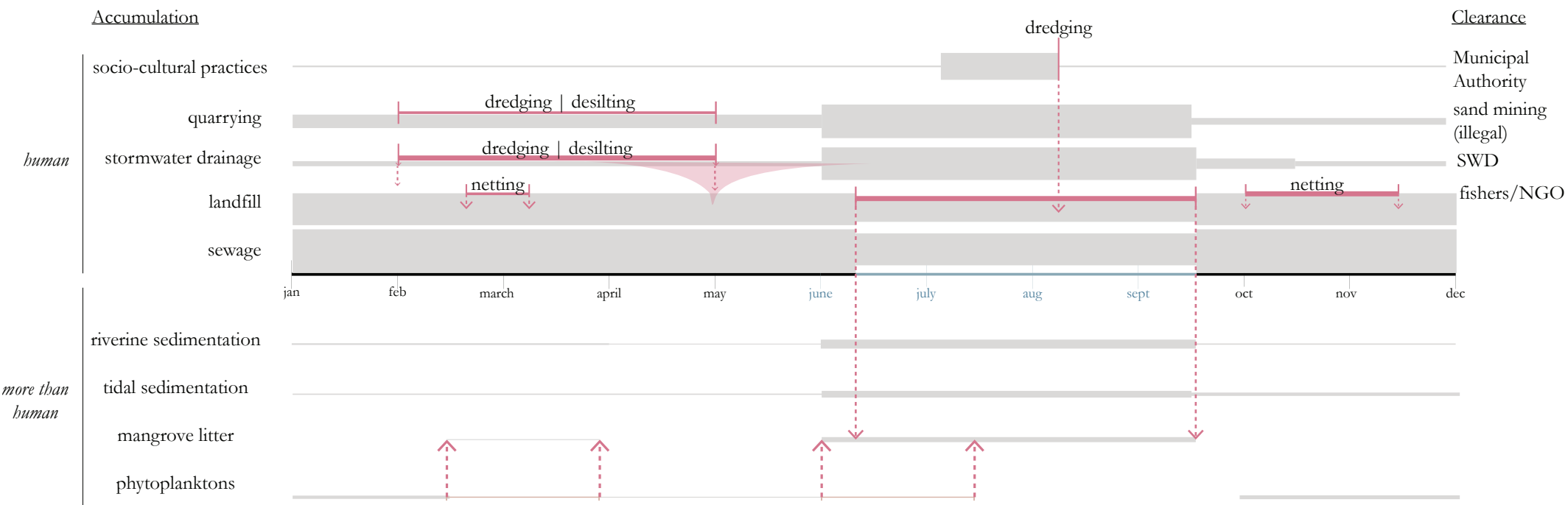
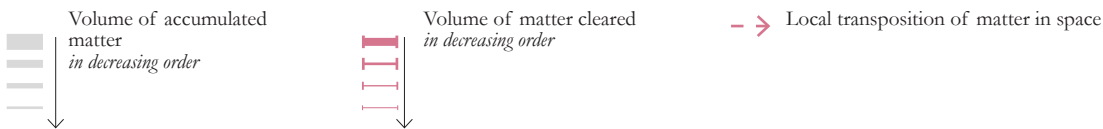


Figure 46. Annual cycles of Clearance (material removal/transposition)



The non-estuary

circa 2050

At the current rate of landscape alteration, by 2050 the estuary in its morphological sense will cease to exist. With its creek entirely landlocked and transformed to a large and yet stagnant lake.

With no source of water besides the monsoons as it will be permanently disconnected from the Ulhas river in the north and tidal waters from the Arabian Sea in the south. With curbed tidal influence, the surface and subsurface will dry up and will make available, new land for infrastructural expansion towards the water body.

The functional dependancies of the city by large will be affected by the changed hydrological cycles on site. From systemic processes like sewage expulsions and stormwater drainage that depend on the movement of water in the creek, to local indigenous practices of salt farming and fishing that will cease to exist.

Not to mention the absolute vulnerability of the entire city to flooding as the shallow stagnant pond will accentuate water logging during the monsoons. With stormwater drains embedded under layers of accreted matter, the accumulated water will be pushed backwards through the stormwater drains into the city.



Figure 47. Existing estuary - 2023



Figure 48. A non estuary- 2050

Paradigm Shift

evolution by degrowth

Acknowledging the implicit tendency of a developing city like Mumbai to perpetuate expansion as the primary strategy of growth. The project proposes the necessity for a parallel pursuit for **degrowth complementary to the evolution of the city. Envisaged as an act of maintenance** that can capacitate the territory to accommodate the externalities that stem from an accelerated functioning of the city.

These material dependencies are founded on the necessity for individual sustenance, mutual co-existence and collective maintenance of the shared environment under homeostasis .

Maintenance embedded in the processes as well as material relations within the landscape. Thereby ensuring the co-existence and secured prospects of evolution for the territorial landscape, as well as its human and more than human occupants.

Degrowth:

It suggests the politicization of accumulating practices, implying a simultaneous acceptance of certain biophysical limitations and a specific consciousness regarding the inherent characteristics of landscape.

Aimed at limiting the externalities of rampant expansionary developments to allow spaces for new connections and patterns of common life to emerge within the prevalent socio-environmental fabric.

Degrowth is not a call for reviving the past or limiting development (societal, environmental, and economic) in the city but more about cultivating a symbiotic environment. By-

1. ensuring adequate functioning of the prevalent fabric
2. whilst defining the limits to expansion based on the capacity of the landscape to withstand the consequent externalities in time and lastly,
3. internalizing the material externalities of the new occupation patterns or physical interventions.

And thus, evolution in this context is attributed to an improved health of the territory (biotic and abiotic) that reflects in its ability to thrive in time more than its spatial expansion.

Which in this context can be determine based on the performance of the territory with respect to the hydrological cycle.



Image 56. Defining growth within the dichotomy of *Altering the landscape vs an Altering landscape*

Identity crisis

moral and ethical positioning

Despite the multitude of occupation patterns, functions, and elements (biotic and abiotic) that constitute the Thane creek, in context of planning and management, it is still regarded as the service core to the city. Hosting backend functions like sewage management, stormwater drainage, waste management, port activities, industrial functions etc.

And while the primary concern of the accumulating sediments in the creek can be readily alleviated through technocratic solutions amounting to a robust storm water drainage system or via increased sewage treatment plants, these approaches manage to mitigate the crisis only temporarily. Creating the need for routine upgrades, expansions, and the integration of more mechanized solutions in response to the adjoining landscape adaptations. Indeed reducing the creek to a water filtering machine. Powered solely by engineered infrastructure, with almost negligible natural dynamics.

An identity that is already overpowering the local heterogeneity of the region, particularly that of the indigenous communities and practices that have been commemorated to the past through historical landmarks as the proposed development intents for the creek renegades them to the background.

Thus in a gentrifying condition as such there a necessity for the project to address the protocols of care in this context.

While the design approach proposes couple acts of clearance and maintenances of the estuary with economic functions, as a means to decentralize responsibility of the landscape. However, on the downside, in such a scenario there runs a possibility of commodification of the landscape based on its productive value.

And this can be effectively addressed by empowering the heterogeneous practices on site at the very local level, that function in sync with the estuarine cycles and it is from these intricate dependencies that a condition of caring can be achieved that stems from a

state of belonging and sensitivity.

One that will eventually resonate beyond the physical boundary of the creek. As in time an awareness about the strong interdependency of the city upon its estuarine features is brought to prominence and reflected its regional planning intents.

Design Approach

Project approach\ aim:

This approach of evolution aims to replace the independent elementary perspective of growth with a more collective purview. Based on an understanding of the landscape through its material and non-material dynamics, new synergies can be proposed for mutual persistence of its elements that amount to a maintained and thereby resilient landscape.

The framework of the project is nested within 2 cycles of time .-from designing for time to designing with time

- 1) The functional cycles of the estuarine ecosystem(human + more than human) as shaped by the regional hydrological cycle (figure.71)
- 2) Periods of adaptation for the estuarine elements and processes as limiting factors defining the scope of maintenance. (figure. 72.)

In this project the altered landscape elements have been studied as indicators to determine the limits of growth and scope of maintenance for this site.

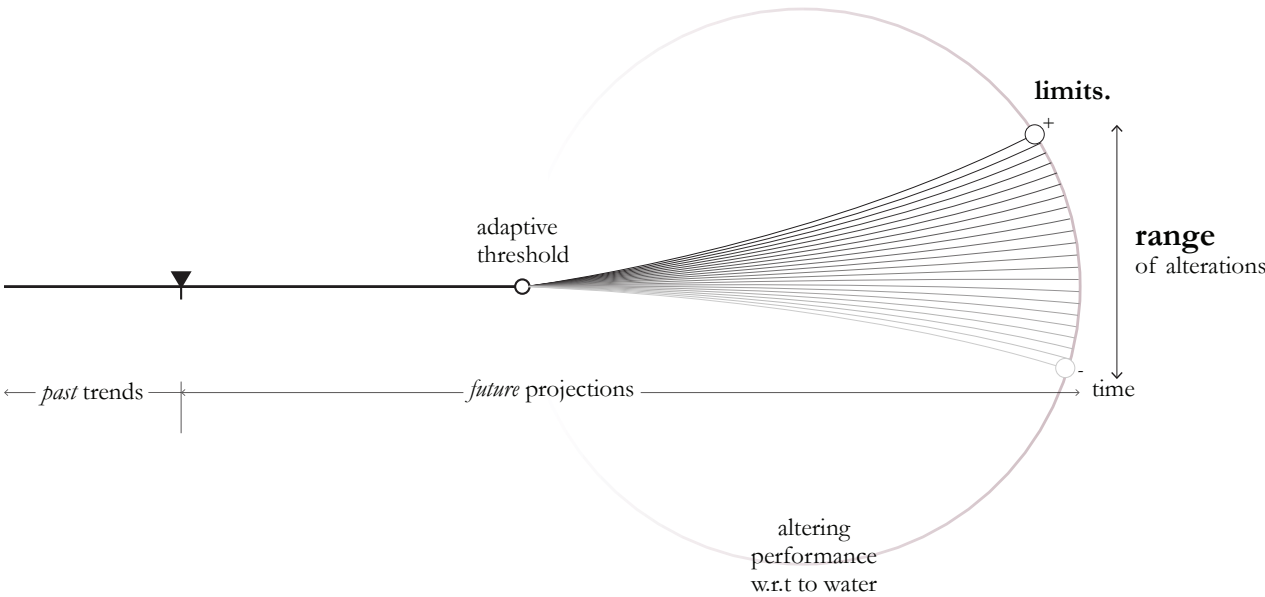


Figure 51.Macro scale of time, observed in the functional cycles of the estuarine ecosystem as a whole.

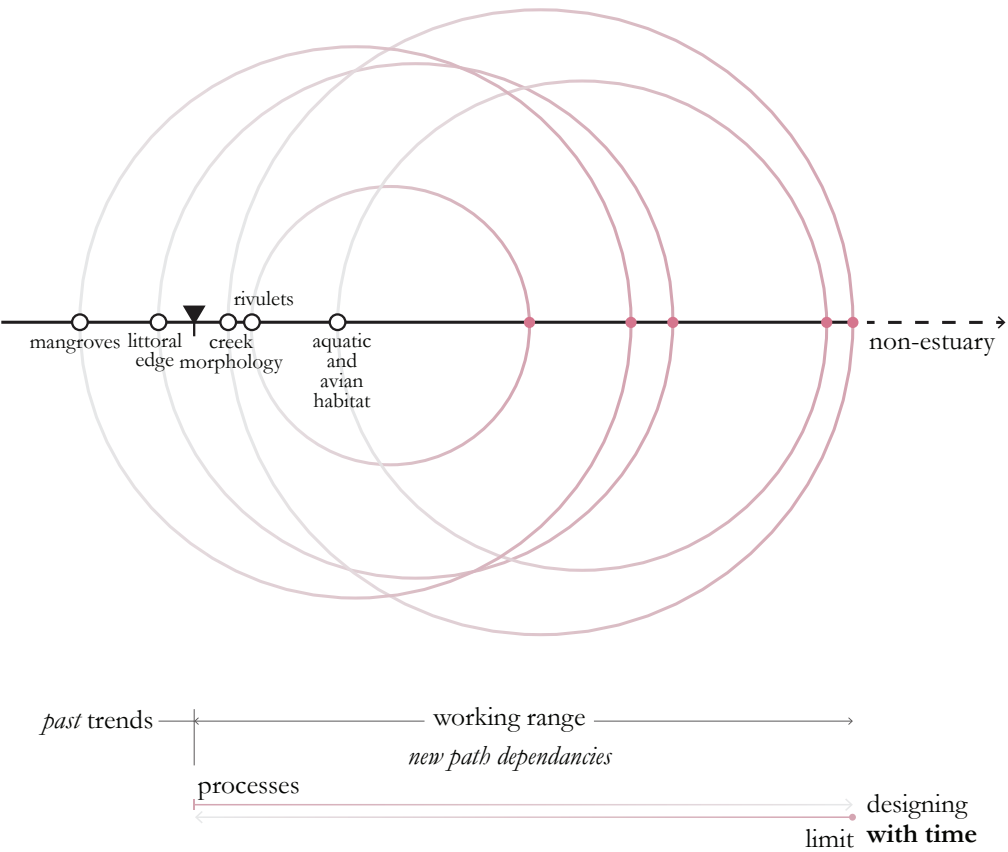


Figure 52.Meso to micro scales of time, observed in the paces of adaptation in individual estuarine elements.

The proposal aims to position calibrated landscape elements that scaling down to the very materiality of local elements and their role in the landscape cycles. The approach proposes to align processes of accumulation and clearance in the estuary based on time, spatial influence and capacity to speculate upon prospects of new local synergies.

New forms of material synergies that are informed by local societal, surface and subsurface conditions and set in motion by water. Which cumulatively with other local interventions in time ensures the management of matter and thereby the biophysical health of the estuary.

At the core of this approach is the act of maintenance stemming from the necessity for care. In the prevalent organizational structure, the estuarine landscape is regulated by the governing authority. Which is further categorized into determinants based on sectors like hydrology, mangroves, fishery, sewage, stormwater etc. Parcelling the region into disparate segment that fail to function synchronously. And given the top down management, the intent of landscape clearance or change monitoring are highly institutionalized. Resulting in forms of action that are dissociated from the onsite material realities.

Defining Maintenance:

The project thus proposes to trigger patterns of maintenance embedded in the ecosystem cycles, eliminating the need for external intervention. By closing loops of matter within the region and coupling material management practices with local economic activities, founds a new basis for maintenance of the landscape.

Thereby generating a sense of direct responsibility, care and liability for the regulation of estuarine functions as a basic necessity for perpetuating the economies of life aligned with it.

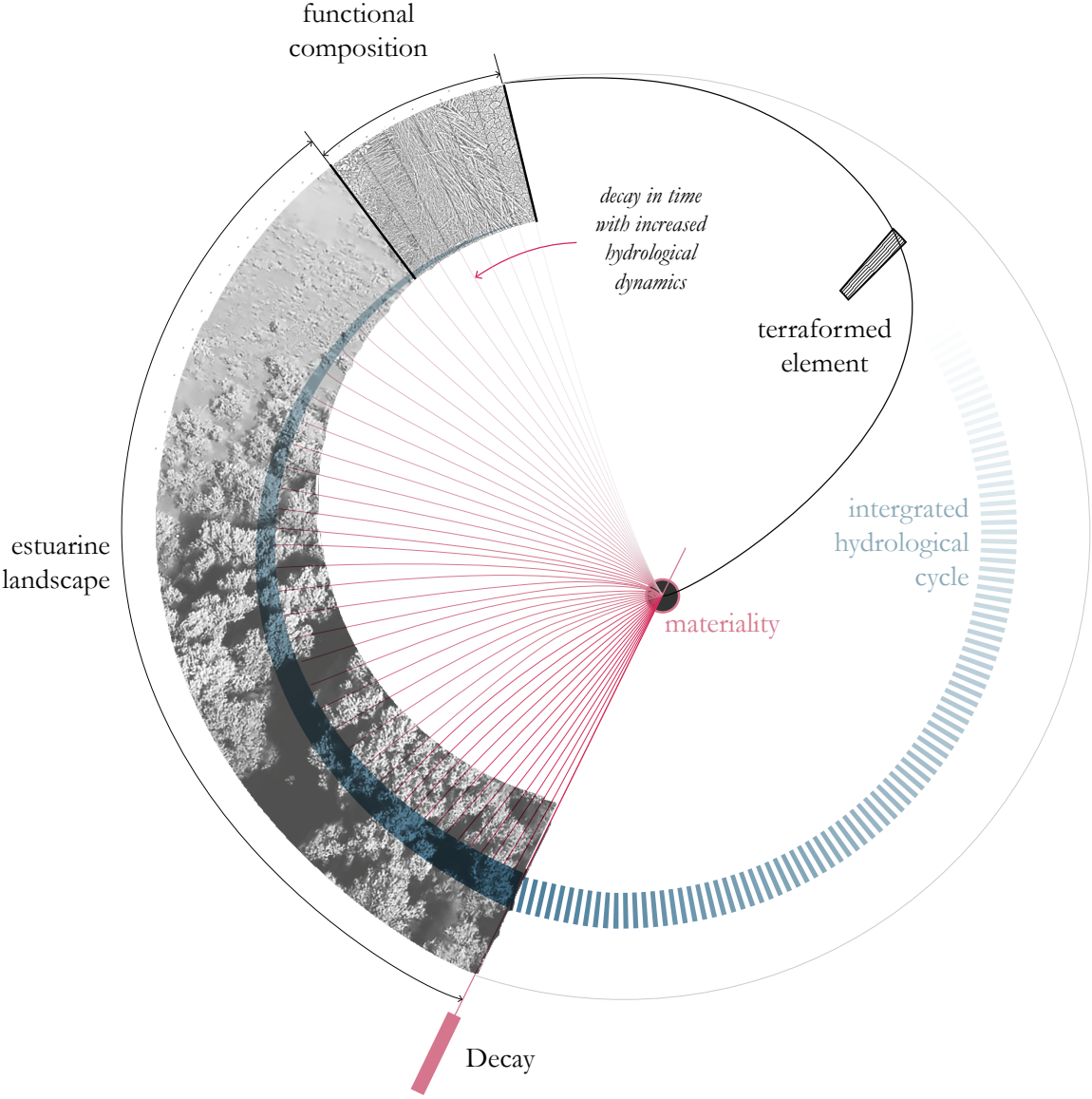


Figure 53. The approach to maintenance: Calibrating landscape elements to function across scales that through their decay restore the hydrological integrity of the territory in time

Water As A Method And Performance Determinant

1. Method:

The approach specifically takes into account the tidal and monsoonal cycles of water that have a profound impact on shaping the site at varying scales in time. Tidal being the daily and bi monthly cycles, the monsoons occur at an annual frequency (also arranged in increasing order of influence on the landscape)

Based on a critical understanding of their relations with the material environment, the prosed interventions are designed to respond and be shaped in time by these very cycles. They may be designed in time to expand, persist or decay under the influence of these water cycles in time.

2. Performance determinant:

The interventions have been designed to alleviate the overall health of the estuarine landscape. Where 'health' has been defined as the biophysical and functional capacities of the landscape along with its elements to withstand hydrological upheavals. Caused by fluctuating monsoons(too much or too little) and intensified the influence of tides. Thus as a performace goals, the design aims to accommodate or mitigate such conditions speculated in time. Which can be broadly parametricised at different scales in terms of the volumes of precipitated water (atmosphere) the landscape can accommodate (surface) and absorb (subsurface) to alleviate flooding in the short term and prevent landscape dessication/ other forms of alteration in the long term.

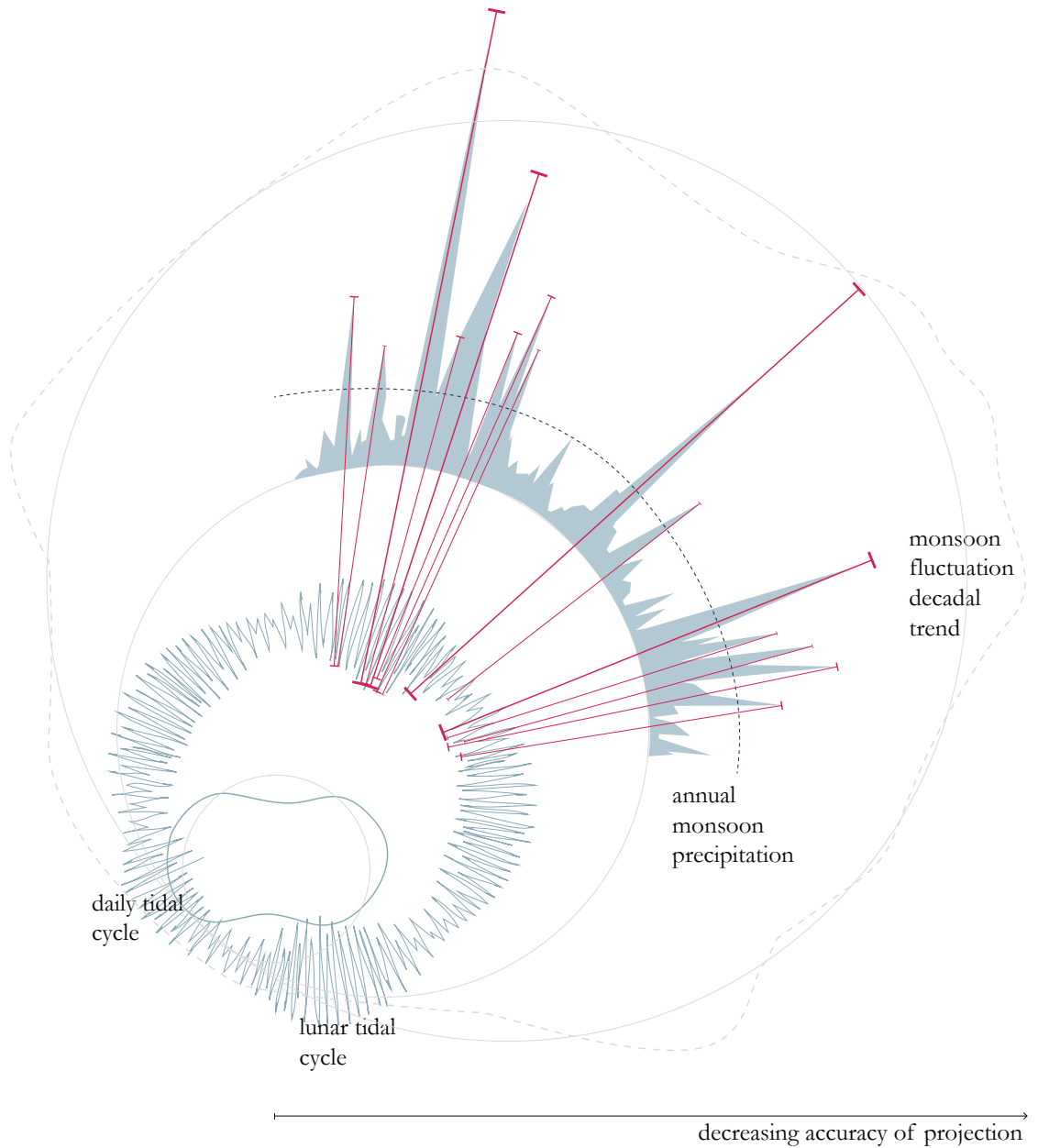


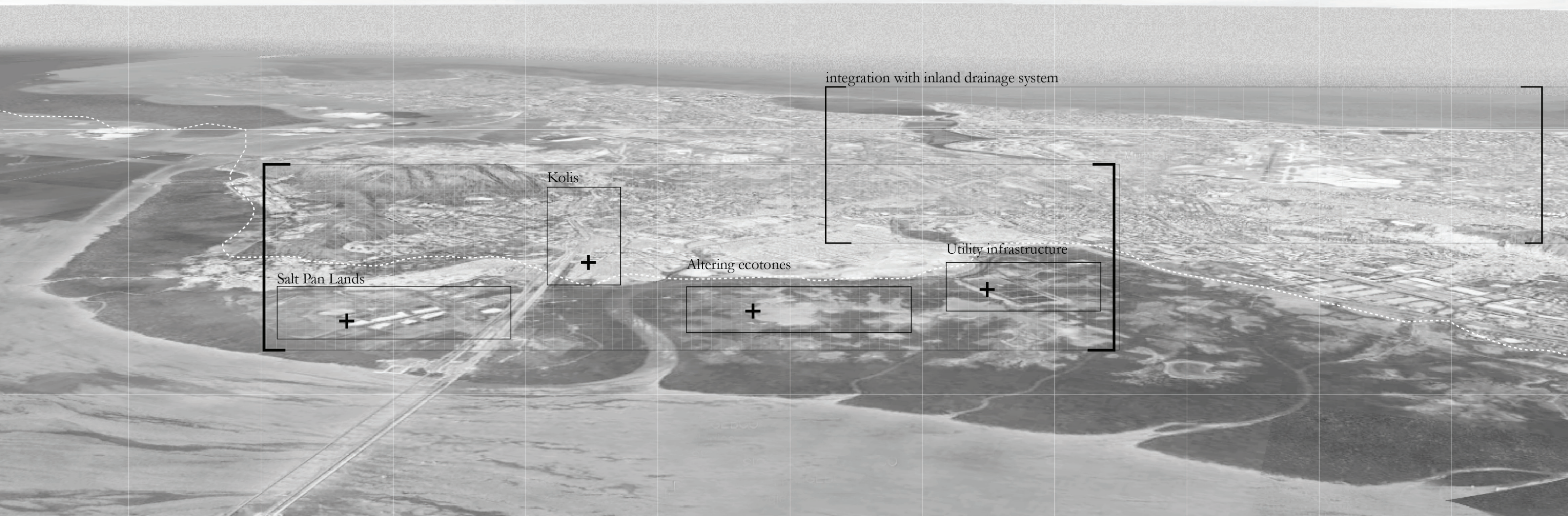
illustration based on:
tides on 3rd june, 2022
lunar tidal cycle 1 june - 3 july 2022
monsoonal data 2022

Figure 54. Hydrological cycles on site in time

The Project: a landscape intermediary

Acknowledging the discordantly shifting environments, the project thus proposes a landscape of buffer - conducting **new synergies** between the inland territorial practices/dependencies in response to the altering ecology of the estuary. Aimed at achieving a **resilient co-existence** of both human well as more than human occupants of the territory.

The proposal **breaks down the homogenous identity** of the wetland zone into smaller **local cycles of engagement with the water**. Stipulated by processes of **conscious release and clearance of the accumulated matter**, as a means of **maintaining the socio-ecological integrity** of the region. Such that it **cumulatively recalibrates** the hydrological cycle on a macro scale by harnessing the potential of the surface and subsurface to accommodate the rampant variations of water throughout the year. Thereby making it (the eastern catchment area of the city) resilient to annual flooding caused by heavy precipitation during monsoons.



Territorial Goals

Hydrological reconfiguration

As established before, the functional influence of the estuary transcends beyond its morphological boundaries and is a critical ecosystem for the sustenance of the territory by large. Which if unadress will result in a non-estuary by 2050. Symptoms of which can already be observed in the landscape.

With the fresh river water no longer reaching beyond 7kms into the creek, its hydrological flow remains disconnected for most part of the year(except for monsoons) with much of its middle body rendered stagnant. Thus accumulating heavy amounts of sediments that in time only further restrict the water flow.

Also the enhanced tidal attenuation limits its reach into the inland parts of the littoral edge which has lead to its drying up. Both of these conditions have not only deteriorated the quality of the water but further curbed its ability to absorb or drain out monsoonal precipitation, resulting in frequent flooding.

Indeed, the health of the landscape can be determine based on its performance with respect to the regional water cycles in time.

Acknowledging this , the territorial goal is based on the importance of congruent hydrological dynamics in the region and thus emphasizes the need for its integration along the lateral, horizontal as well as vertical axis across the territory. Namely,-

- 1) Lateral- Increase the influx of freshwater into the creek to stimulate mixing with the tidal waters from its mouth, that persists perennially through the year.
- 2) Horizontal- Expand the influence of tidal waters into the inland reaches of the estuary to maintain its characteristic wetness.
- 3) Vertically- Harness potentials of the surface and subsurface materiality to capacitate the territory across scales (micro, meso and macro) against fluctuating volumes of water throughout the year.
- 4) Quality- Consciously ensure an acceptable biochemistry (refer to the quality page in terms of bod as parameter) of the water in the landscape to ensure survival of the estuarine landscape as well as its dependent habitats.

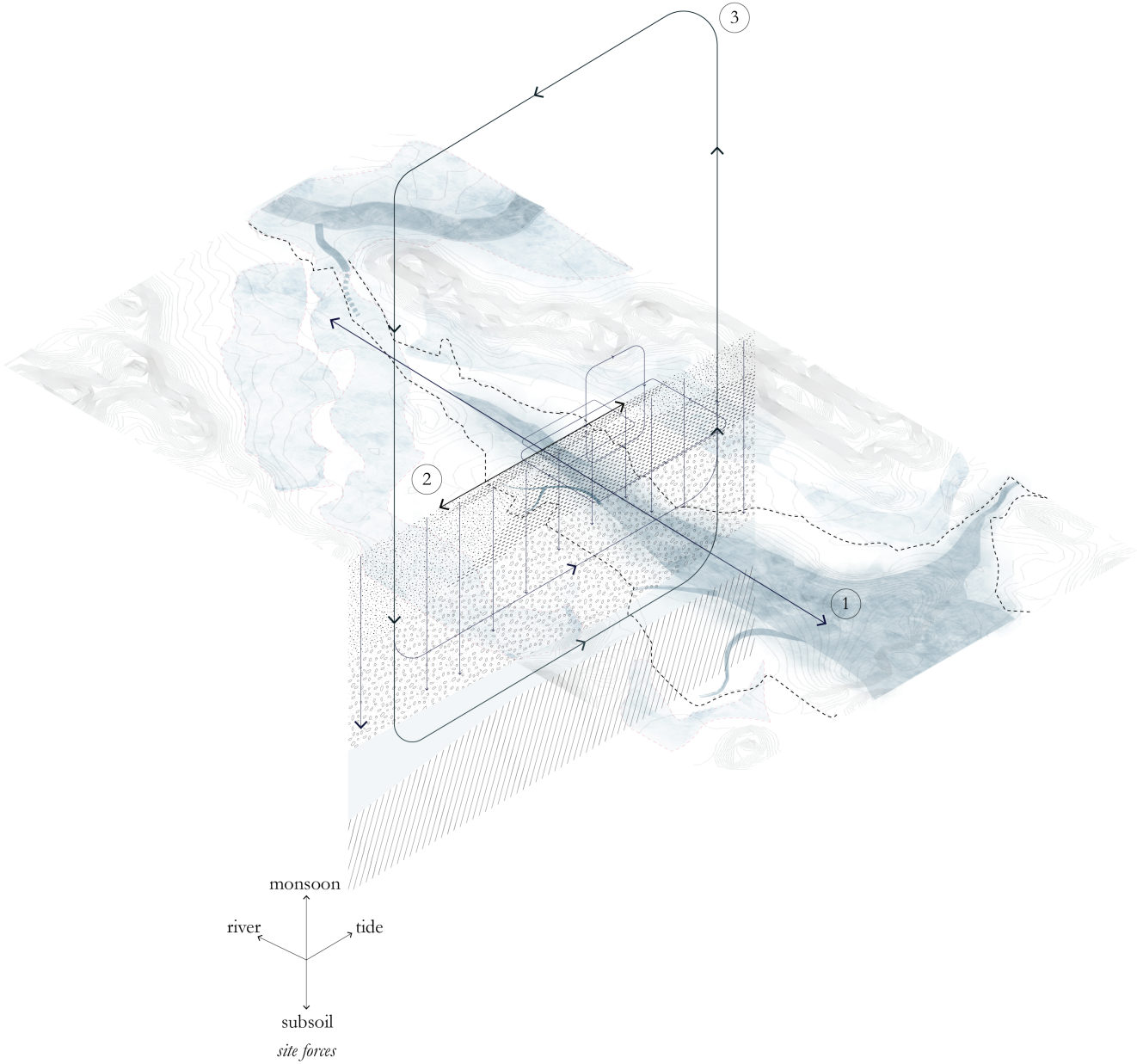


Figure 55.Hydrological reconfiguration

Local Goals

(micro and meso)

•Internalizing the management of matter (circular matter management)

Currently, the rate of accumulation of matter in the creek is much larger than the natural pace of clearance or absorption, by the landscape. Thus to balance this disparity, the project proposes new hybrid (combination of anthropogenic practices and natural systems) forms of landscape processes to curb material discharge (particularly sewage and pollutants) into the sea. Accomplished through practices like wastewater aquaculture and biomass harvesting that assimilate and close the loops of matter within the economies of production at the littoral edge. Thereby internalizing as far as possible the management of matter (production, treatment and reuse) within the landbound territory.

•Thriving ecological habitat -revive, secure and create

The biodiversity in the estuarine landscape plays a critical role in ensuring its productivity. By analyzing their shifting occupation patterns, the project aims to remediate these local environments to achieve a quality suitable for its native biodiversity to thrive. Measures like fixed dredging areas and soft landscape interventions will ensure that the prevalent avian and aquatic species remains undisturbed. And lastly the introduction of hybrid landscapes along the littoral edge will introduce new plant and animal species that would actively participate in the management of matter in the estuary.

•Safeguarding the edge

Given the disrupted distribution of water across the landscape through out the year, manifesting in extreme conditions of wetness or dryness, the estuarine landscape is shrinking as it shifts seawards. To avoid this, the approach aims to re-channelize excess volumes treated sewage water into the inland riparian edge and harness its subsurface potentials to store it. This practice will not only support closing the loops of excess water and matter in the region but the nutrients from this water will also nourish the soil and revive its ecology.

•Bolstering local heterogenous identities/ new economies

The scope of 'identities' in this context encompasses social communities, economic sectors as well as material composites of the estuarine region. The project thus proposes to align independent goals of these communities and sectors at a grassroots level to forge new relations with the altering material environment in a mutually beneficial manner. One that propagates local practices of aquaculture, salt farming or even chemical production to not only thrive but more so alter in their forms of function. Such that they can actively participate and benefit from clearing and maintaining the local environment of the creek.

•Designing for decay(growth by decay)-

Based on the formative understanding of the estuary as a living entity, the project refrains from introducing hard or permanent interventions within the landscape that refuse or evolve and respond to changes in the surrounding environment. Thus the project operates through terraforming as a primary medium of design that is shaped in time by the hydrological cycle of the territory. Laying critical focus on the materiality and thereby lifecycle of these interventions such that on serving their purpose, they either disintegrate into the landscape in time or lay foundations for the surrounding ecology to evolve, encroach, and thrive.

•Autonomous functioning (political resilience)

The administrative organization of this approach is largely de-centralized and dissociated from governmental institutions to ensure it resilience to altering political stances every five years. Operating on a scheme of negotiates resilience, it empowers local occupants to collaborate with larger commercial sectors on site to maintain the desired condition of the landscape through their daily operations on site. Thereby establishing a stronger sense of responsibility and liability for the occupied landscape. While the backend service sectors of storm sewage and waste management still prevail, their functionality is now integrated and made efficient through integration with the new local hybrid landscape practices.

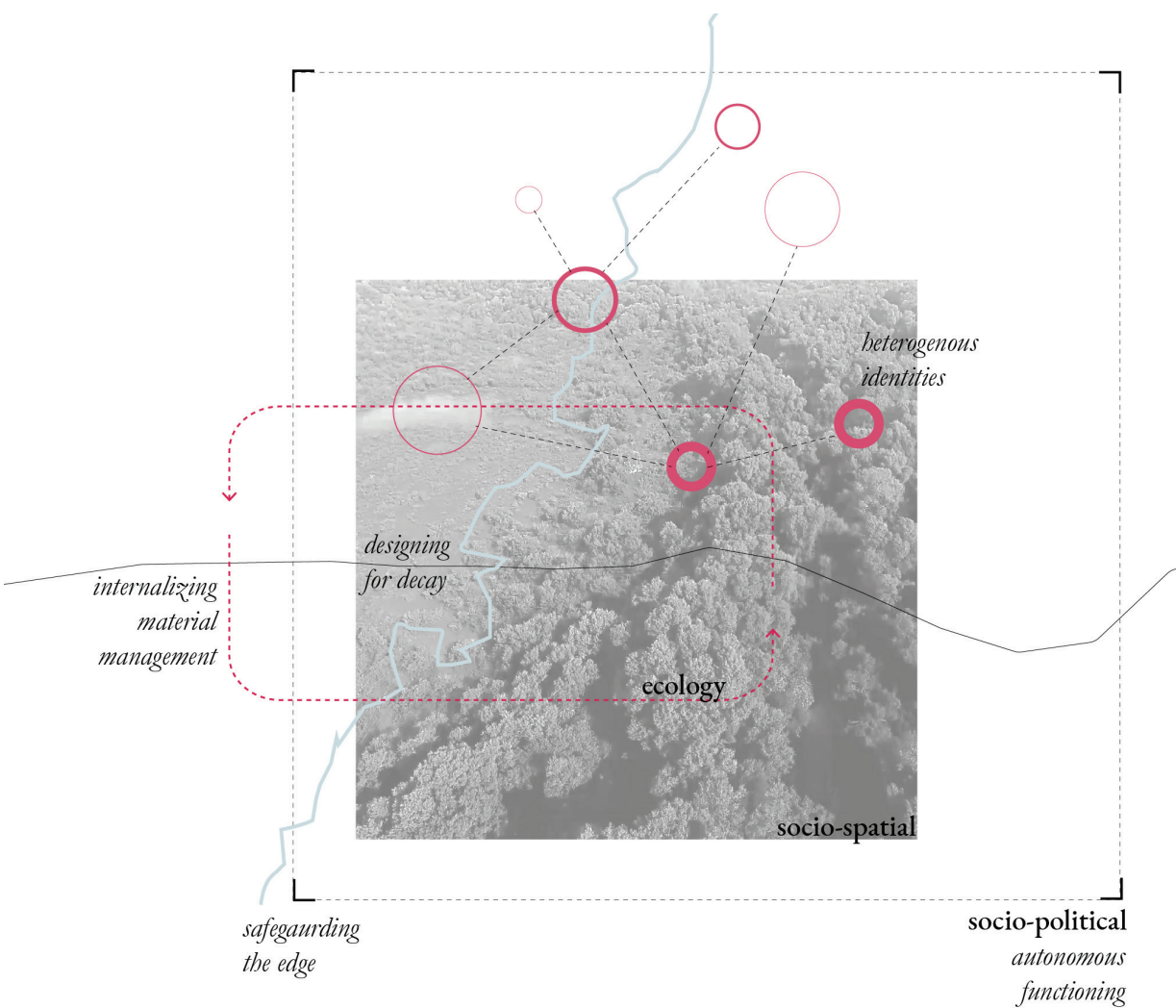


Figure 56. Meso and Micro goals

The Landscape Collage

regional intervention

By working with the natural morpho dynamic forces on site, the proposal through small, sequenced acts of terraforming- with time aims to maintain the estuarine landscape. Coarsely determined by the management of matter and water.

Much like acupuncture, 3 local strategic interventions have been introduced in the landscape to relieve some pressure off of it. That in time will either disintegrate or assimilate into the estuarine landscape, as its purpose fades out. Each of the three play different roles and yet compliment each other to develop a founding basis for the operation of a fourth intervention at the meso scale. And all of which function symbiotically in time and space to ensure the internalized management of matter and an eventually improved performance of the landscape under varying hydrological conditions.

Arranged in sequence of implementation, the interventions constitute of -

- I. Sediment traps- Placed in the tidal marshes to accumulate receding /floating sediments from the most sedimentation prone mid eastern fringe of the creek. From where through periodic cycles of dredging the traps can be cleared of the matter.
- II. River avulsion- Complementing which is the diversion of the Ulhas River into the plugged rivulets and thane creek, through naturally evolving tidal barriers in its flow. Thus ensuring its perennial flow downstream into the creek.
- III. Un-embanking the stormwater drains- to increase its run-off capacity and revive the surrounding landscape wetness.
- IV. Waste water aquaculture- Where the secondary treated sewage is filtered through ponding where specific aquatic and fish species feed on the nutrients in the water , which is then either supplied the industries, used for wetland nourishment or discharged into the creek but thi time around in a much better quality that can be cleared out by the water currents. Additionally, it also provides opportunities for new forms of bottom up community collaboration in the maintenance of the landscape, particularly ensuring the inclusion and viability of indigenous communities like the Kolis.

The goals of these interventions project to the 2034 in the short term and 2050 in the longer term.

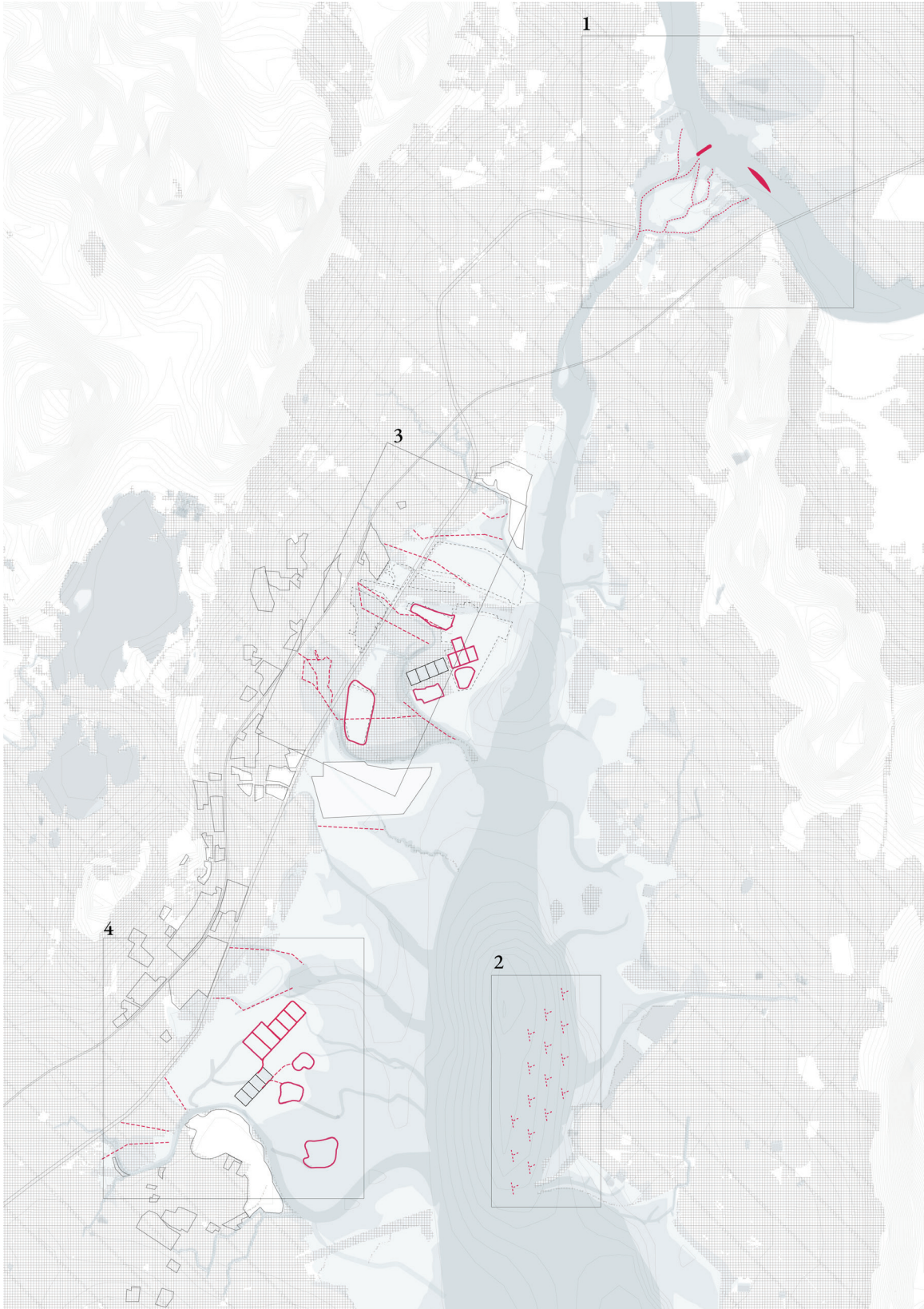
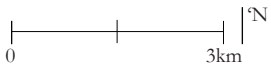


Figure 57.Regional Plan



I. River Avulsion

Strategic intervention

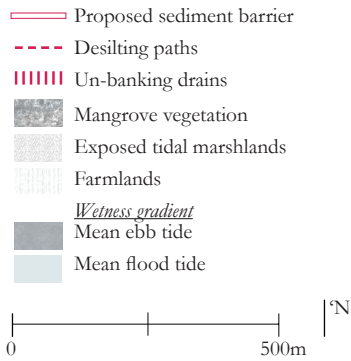
About 3 decades back the creek would receive a perennial supply of freshwater from the river fed Ulhas estuary. However, with the positive feedback loop of sedimentation, seaward movement of mangroves and reduced freshwater influx, the head of the creek has narrowed down to mere 50meters.

To revive the freshwater influx, the project proposes to divert the water flow from the Ulhas estuary to the creek as to revitalize dry channels, stimulate erosion of the creek bed and consequently expand the influence of water into the inland regions of the littoral edge. Which will in time extend the influence of fresh water uptil the regions of tidal influence.

The intervention constitutes of two primary forms of action- 1)re-earthing and 2)unearthing

2) Unearthing refers to un-embanking streams and dredging out channels to allow for the influx of fresh water. Owing to the narrow width of the streams, these paths can be dredged using small suction pumps as a formative act of clearance. Removing trapped plastics and other pollutants from the site.

1) Alongside which the water from the Ulhas river estuary will be diverted by constructing two barriers in its path. Positioned with respect to the flow of the water currents, these stone barriers will eventually grow in area and impact as they accumulate sediments to form tidal bars. The untamed growth of the tidal bars will be checked by incoming tidal waters which will cyclically erode some of the deposited sediments.



Initiation phase:
Desilting and Introducing barriers

Non-monsoonal clearance rate:
Ulhas River: 2.57days
Upper Creek: nil



2 years
Annual Desilting (pre-monsoon clearance)



5 years

Non-monsoonal clearance rate:
Ulhas River: 2.57days
Upper Creek: aprox. 4 days

As a combined effect of these two actions, the region in time will be percolated by new rivulets with stronger water flows that will continue to erode the mudflats, besides enhancing the water supply to the primary creek channel. This junction will not only be supplied by fresh water from the upstream rivers but also by tidal influx from the west (although lower in influence).

In time, the accumulated sediments will get compacted and the tidal bar stabilised further by the growth of vegetation on it. Which will strengthen it and prevent its erosion particularly during monsoons.

As the water permeates into internal niches of the littoral edge, it will meet existing channels and form a new network that will ensure inland wetness and an enhanced capacity to drain the stormwater out during monsoons. Additionally, the growth of tidal bars in Ulhas Estuary can also be seen to direct freshwater flow into the otherwise stagnant northern bank..

Maintenances and dredging-

Owing to the high discharge rate of the freshwater and the volume of sediments it brings down stream, there is a tendency of the freshly dredged channels to get plugged again. Thus, until the velocity and volume of water diverted into the creek channel does not increase, these channels will have to be dredged about twice annually. And approximately, in five years the water stream should be enhanced and consequently there will be a salinity gradient established at the head of the creek that further stimulates mixing and the downstream movement of water. Thus, ensuring a continuous yearlong flow of water in this creek.

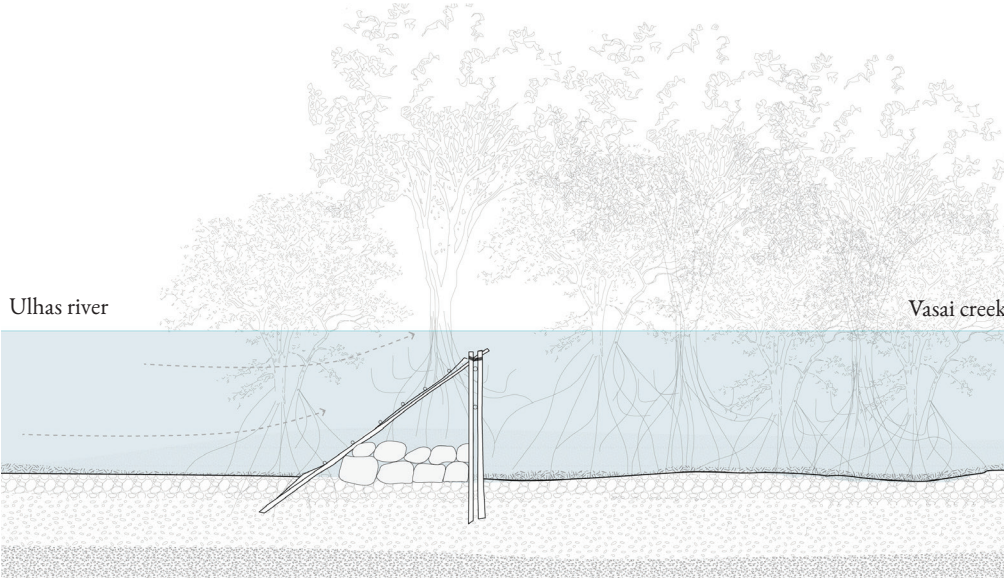


Figure 58.Initiation phase: Ebb tide. Predominance of riverine deposition

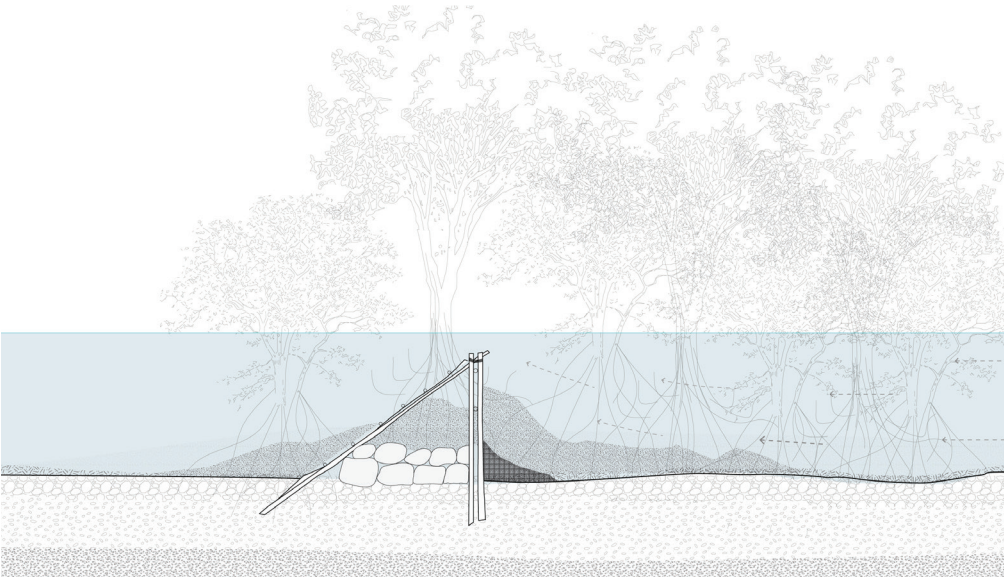


Figure 59.Initiation phase: Flood tide. Predominance of tidal deposition from Vasai creek

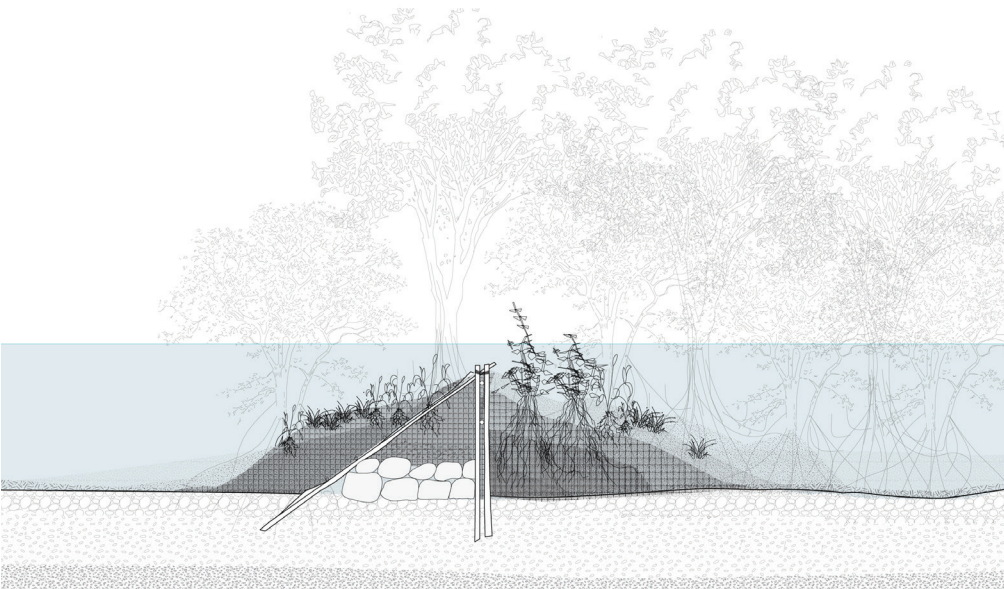


Figure 60.Stabalised tidal bar.

Figure 61. A thriving wetland by 2050 with regions of permanent wetness. New and revived rivulets flowing through the vegetated region that prospectively bring back creek fishing.



I. Sediment Traps

Strategic intervention

A founding step in this cycle of maintenance are natural entrapment structures placed in the bed of the creek to accumulate sediments in one area which can be dredged in a cyclic manner.

Owing to the direction of flow of water and the position of the primary sewage outfalls on the western banks of the creek, a significant part of the sediments from the secondary treated sewage are accumulated in the mid eastern marshland edge. Since the intensity of tidal waves in this region is very low with almost a velocity of 0.2m/s of for the ebb tides, the fecal particulates persist undisturbed in the region for long and eventually settle into the bed.

While towards the western banks along the same axis, the clearance rate of the sediments is higher as the velocity of water column is much greater which is also reflected in the deeper creek bed.

While dredging all of the mid eastern mudflats is an ecologically disastrous and a very expensive cyclic task of maintenance, there is a need for regular clearance of matter from this region.

The project thus proposes the placement of 16 sediment entrapments at specific intervals to localize the regions of accumulation which can be systematically cleaned out at scheduled periods without disturbing the surrounding environment.

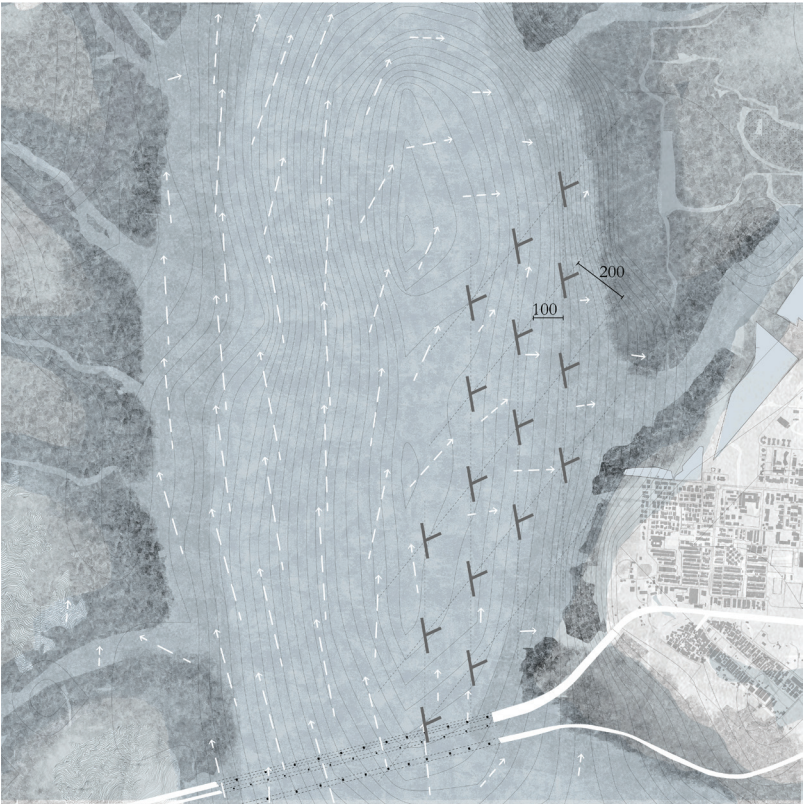


Figure 62.Sediment deposition in flood tide

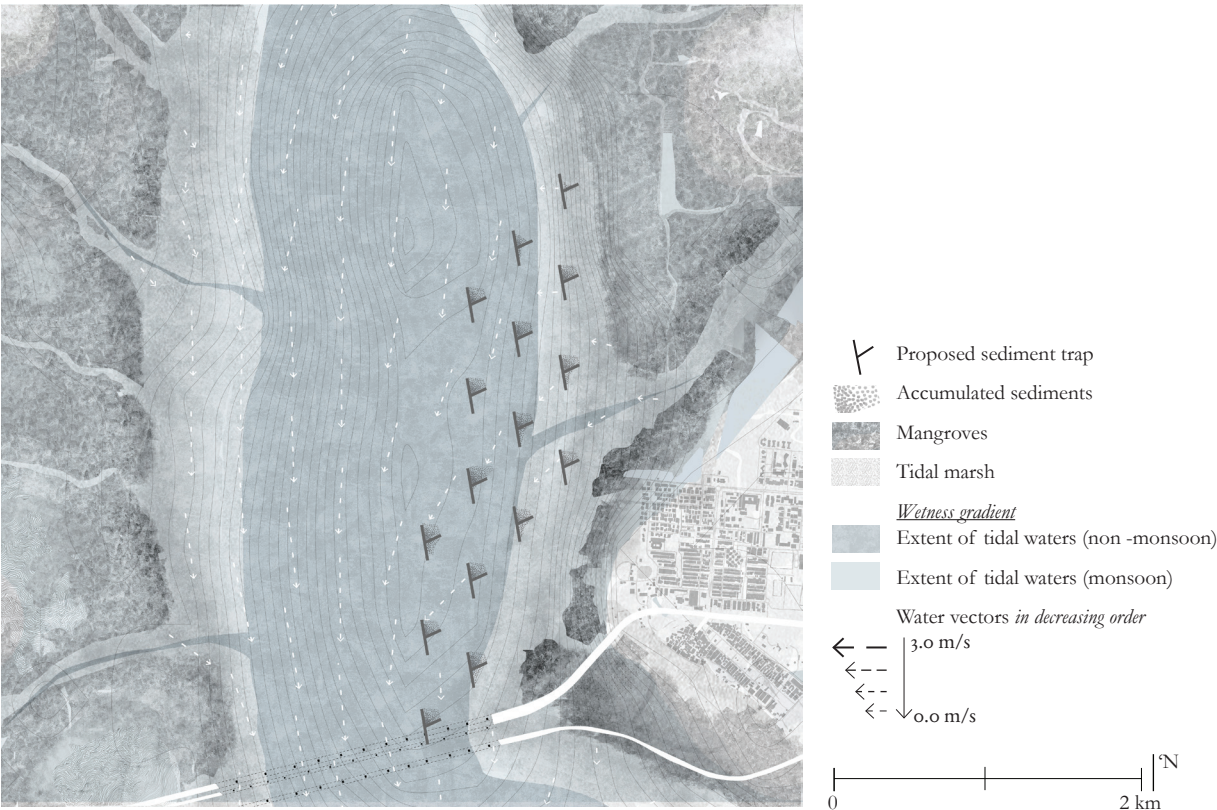


Figure 63.Sediment trapping in ebb tide

Hydrological performance:

Assembled from a local stone called cheera (a laterite composite speculated with basalt), these structures are located just below the mean sea level such that they partly surface during a mean lowtide . Oriented with their mouth (larger surface area) in the direction of the receding tide, the traps should be able to trap most of the suspended sediments before it settles.

Critical to its function is the materiality of these entrapments. Where the coarse texture and colloidal properties of cheera are particularly effective in attracting the sediments in the tides. And once a basic bulk is accumulated within the mouth of these entrapments, it only attracts and becomes more efficient in trapping sediments due to the cohesion and friction angle of clayey particles. Thereby also reducing the resuspension of the accumulated sediments during flood tides.



Cheera stone
Image source adobe stock

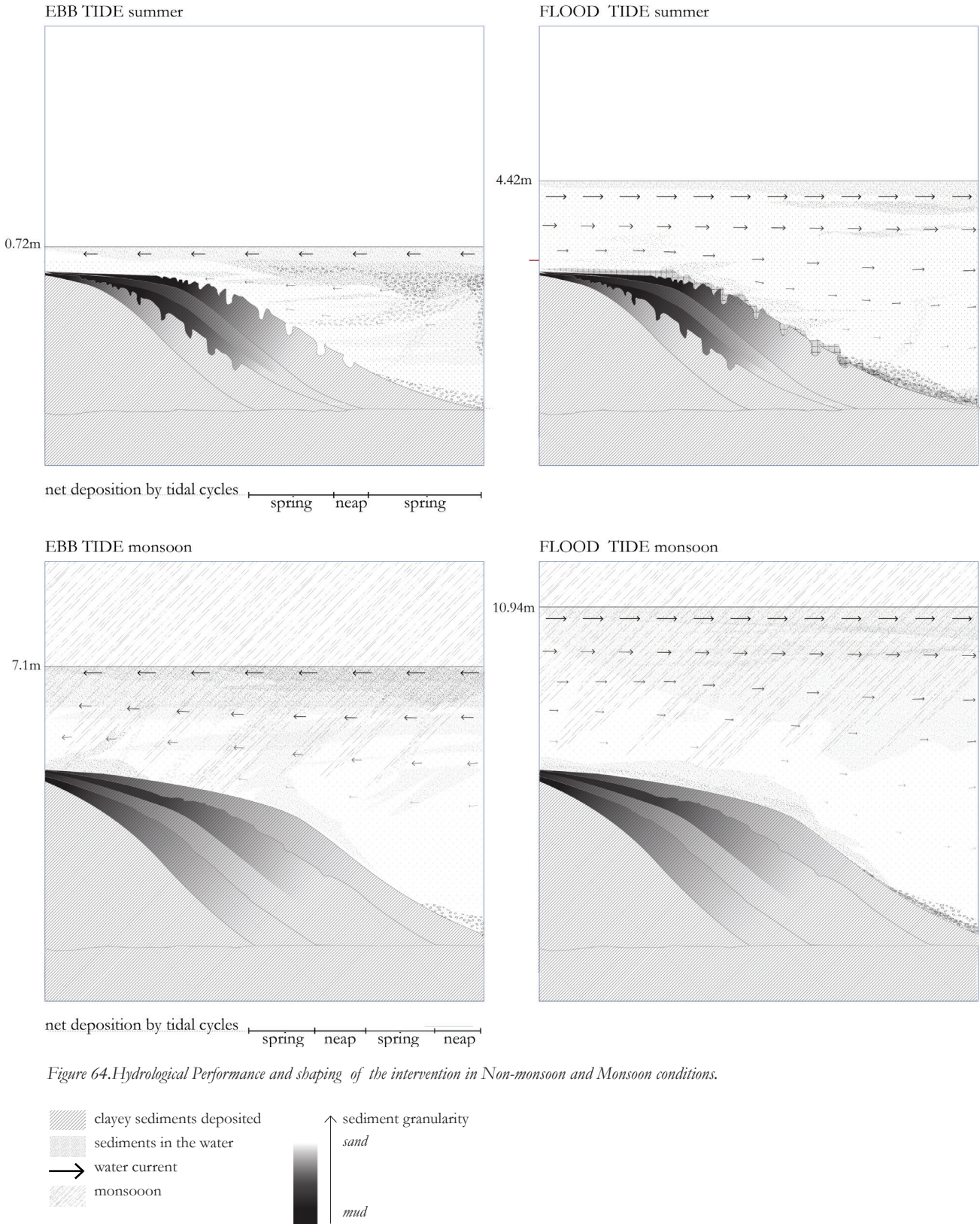
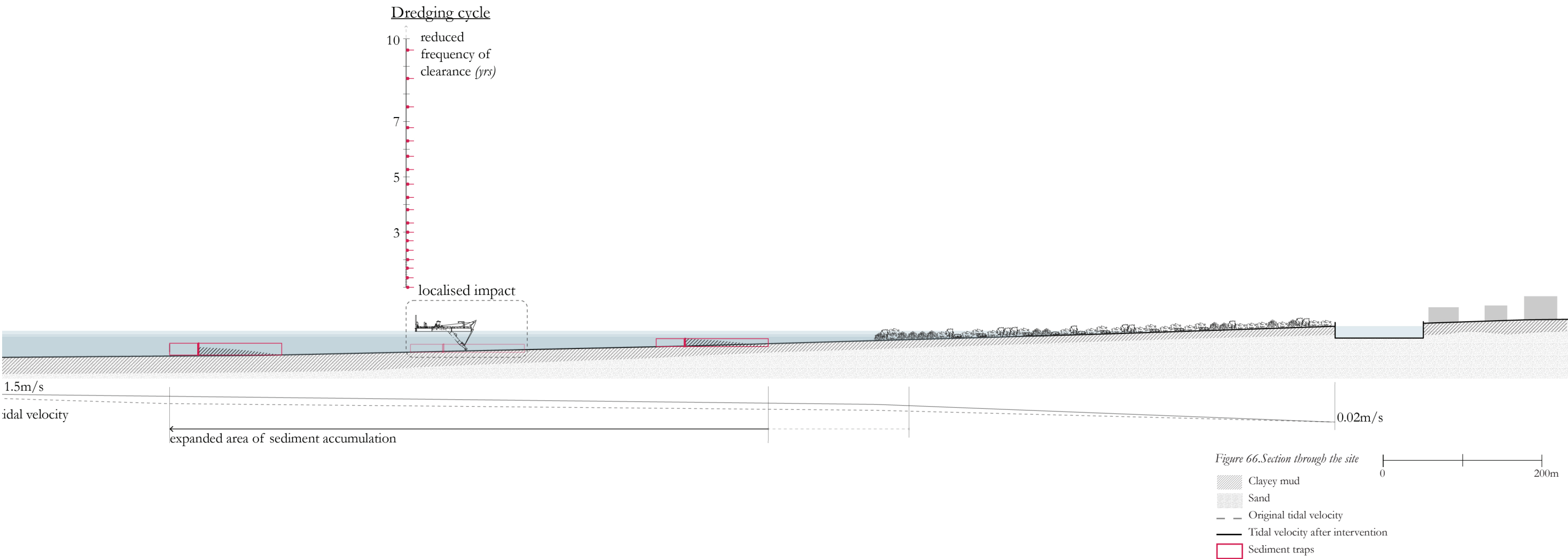


Figure 64.Hydrological Performance and shaping of the intervention in Non-monsoon and Monsoon conditions.

Dredging

Working with the clearance rate of the creek at 3.75 days, that reduces to approximately 3 days during the monsoons, the capacity of the sediment traps along with the volume and frequency of sediment discharge into the creek- a periodic dredging cycle can be scheduled. At the current rate of sediment load in the water body ,it will have to be cleared out 3 times annual around the months of - Jan , May (premonsoon) and October (postmonsoon).

However in about 3 years of time when other interventions aimed at maintaining the creek will be set in motion, this frequency of dredging can eventually recede to twice a year. Which will completely fade out with the full-fledged functioning of the waste-water aquaculture system.



Designed for decay:

Upholding the values of this approach to refrain from the introduction of permanent entities in the landscape, the sediment traps are designed to decay in time as the hydrological dynamics of the landscape are revived and over power it.

As an intervention itself, its is assembled as a stone masonry wall, which owing to its self weight will eventually in the first year sink significantly in to the marshland, that will hold it firmly in place. And in the consecutive years will experience some amount of subsidence in the ground.

Being a porous stone with high permeability, Cheera has an elevated tendency of absorbing but at the same time losing water easily as it is exposed to the sun. Thus due to the daily flood and ebb tides, along with the annual temperature extremities, the stone will eventually become brittle and disintegrate onto itself.

In its consolidated state, the high iron content of the rock makes it rather unsuitable to host fish or aquatic plant species. However, it is very effective in absorbing phosphorous from the water in the form of granular ferric oxide (GFO), thereby improving its quality.

Additionally, its chemical composition also supports the growth of micro- algae which serve as a bird feed particularly for the flamingoes that migrate to this area during their feeding season. At the same time play a vital role in absorbing nutrients from the water.

In time (approximately 5 years) due to the tidal and seasonal fluctuations of wetness , algal colonization as well as abrasive impact of water currents, will lead to the disintegration and erosion of the rock. With it pores and surface altered and overlayed with depositions of silt and clay, its reduced acidity will allow for the growth of native corals and aquatic plants, that feed the fish. To this effect, the intervention is thus imagined decaying into the landscape, that will with time host an active estuarine ecosystem.

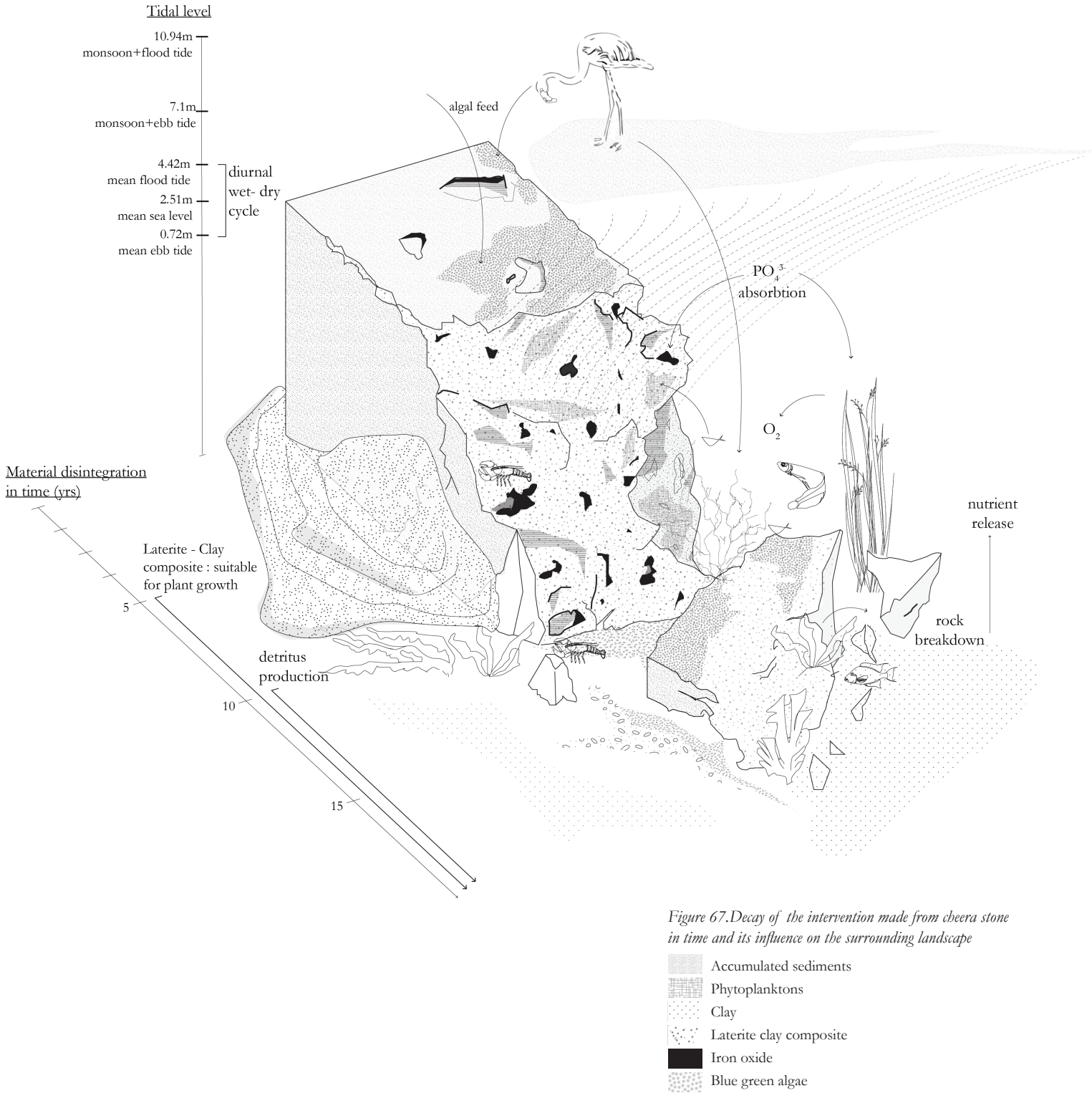


Figure 67. Decay of the intervention made from cheera stone in time and its influence on the surrounding landscape

III. Unbanking drains

Strategic intervention

This phase essentially involves de-engineering the storm water drains as they open into the littoral edge. Focusing on the water extremities experienced along this interface through the year, the intervention aims to redistribute the gradient of wetness to not only safeguard the boundary of the estuarine landscape but also capacitate it against monsoonal upheavals. Which will symbiotically improve the performance of the seaward as well as the inland regions of the basin during such events.

Flooding in the city occurs at three scaled stages, listed in order of increasing volume of precipitation. The first is local (inland) waterlogging due to clogged roadside drains, that have a modest impact on the surroundings. Second, are the low-lying areas (along the inland littoral edge) populated with large storm water drains, that witness flooding due to limited run off or overflowing. And lastly, this crisis is further exacerbated by the backflow of water due to enhanced rainfall, high tide, or both, from the storm drains that open deep within the creek (below high tide level).

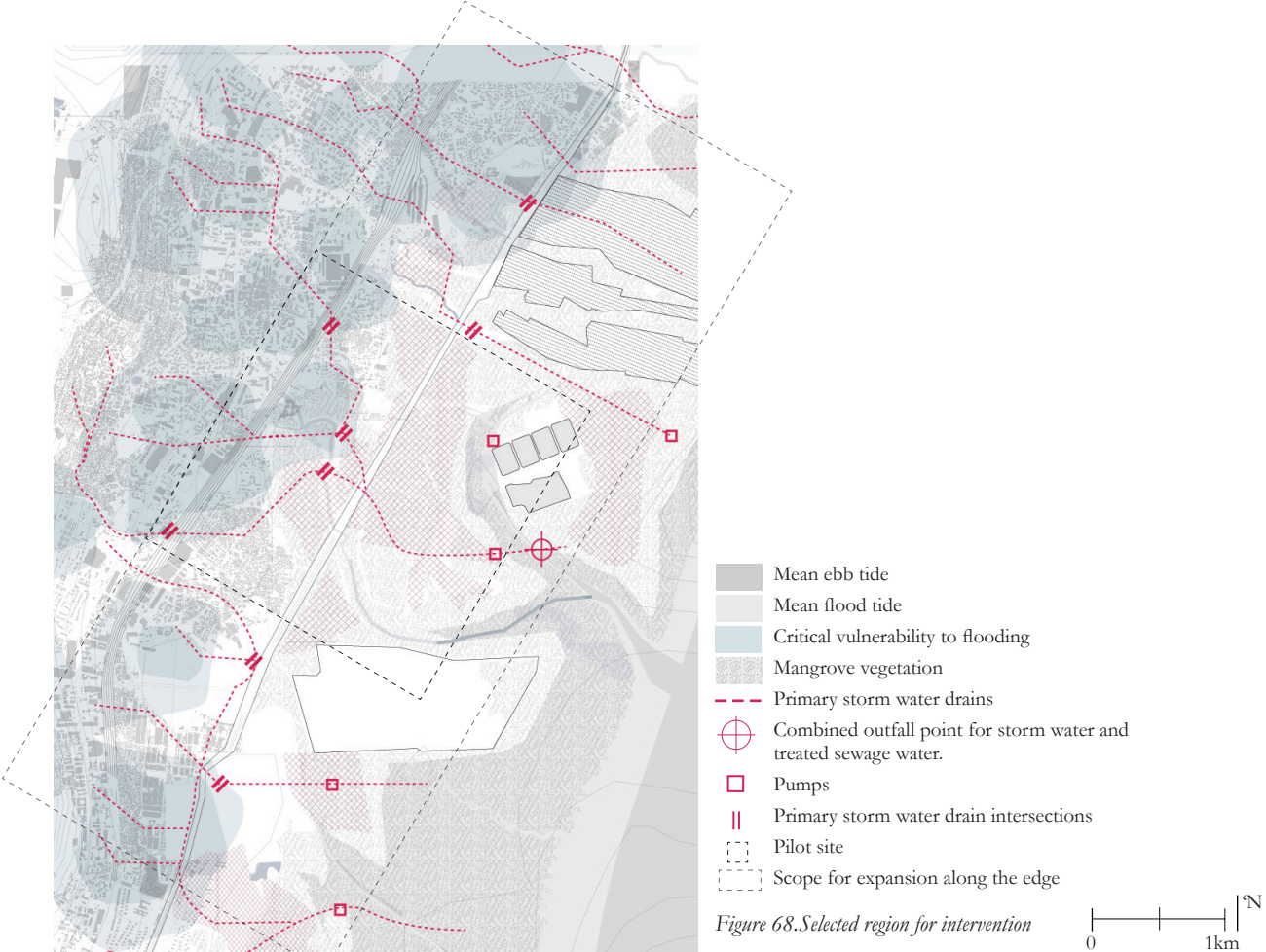


Figure 68. Selected region for intervention



Figure 69. Existing site condition

This approach is piloted in a flooding hotspot (determined by flow simulation) housing some of the most prominent (in terms of capacity) storm water drains in the basin. Based on a hydrological analysis of the terrain overlayed on the existing rivulets and the dry patches on site, paths have been traced that will lead the storm water into the creek upon deconstructing the storm water drains.

The removal of the banks, and its replacement with stone gabions will ensure a permeable interface between the water carrying stream and the surrounding landscape (vertical and horizontal). Furthermore, it will be effective in trapping sediments from the discharge and ensuring relatively filtered water as it exits into the creek. As the alluvium and silt deposits accumulate on the banks, they are compacted with the surrounding clayey soil will increase its otherwise poor water permeability. Which along with the percolation of water into the surrounding landscape, will be once again able to support plant life. Where based on the salinity tolerance of the plant species, the region will be populated with marshland vegetation that will further increase water absorption into the soil, filter (particulate and chemical) the runoff and ultimately stabilize the estuarine environment.

While the recharged ground water cannot be used for potable purposes unless it is encapsulate in artificial subsurface reservoirs due to salt intrusion. I still plays an important role in ensuring the biophysical expanded consistency of the soil thereby maintaining its productivity in the landscape function.

However, because of the level of flocculant pollution in the open storm water drains of the city, the inflowing water into the wetlands will have to be sieved out of plastics and pollutants to maintain the biophysical and functional integrity of the region.

Besides prolonging and permeating the runoff during monsoons, this transition space will not only protect the littoral edge from encroachment but also in parts can transform into a public space for the community. Stimulating a sense of belonging and awareness about this productive landscape.

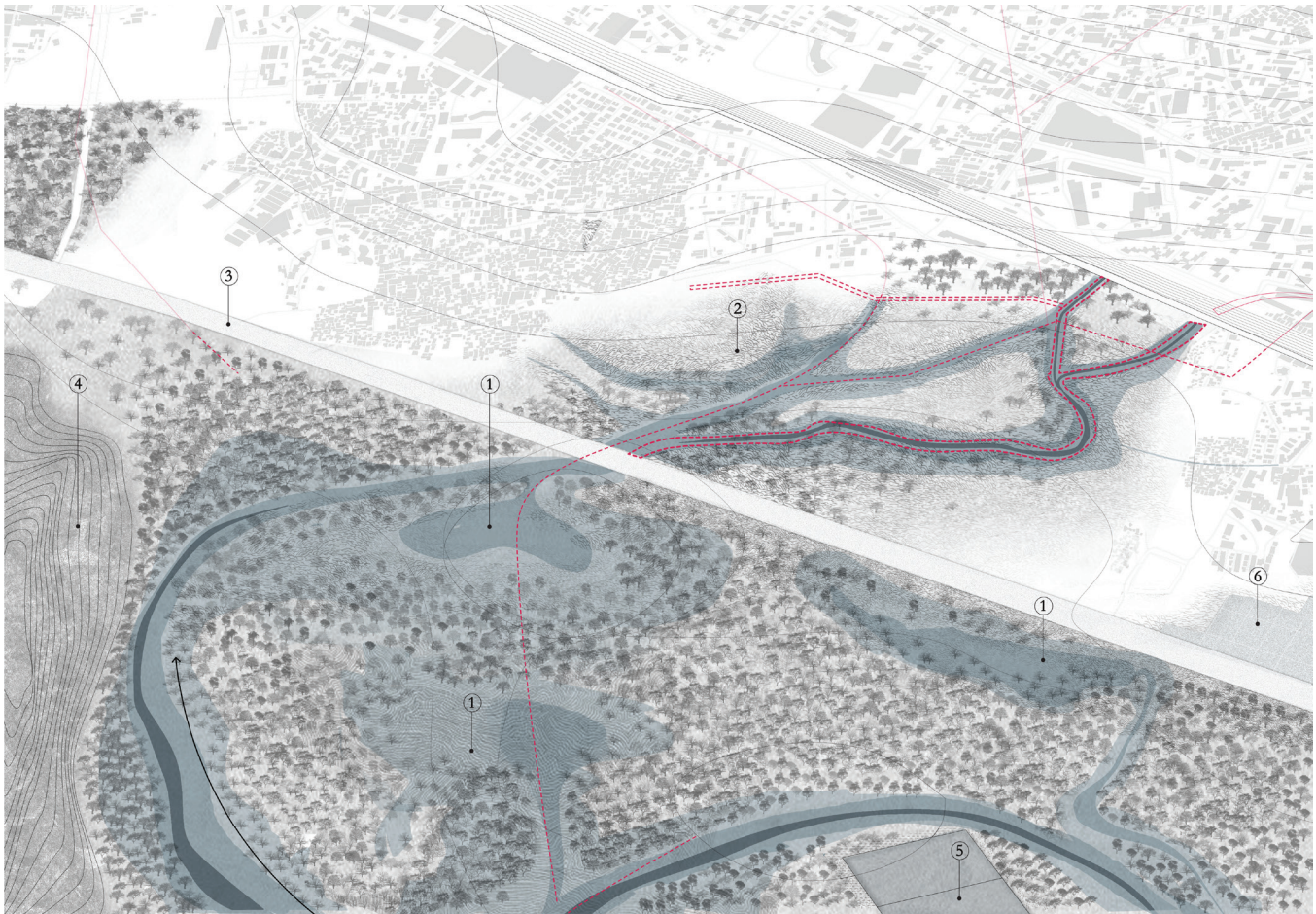
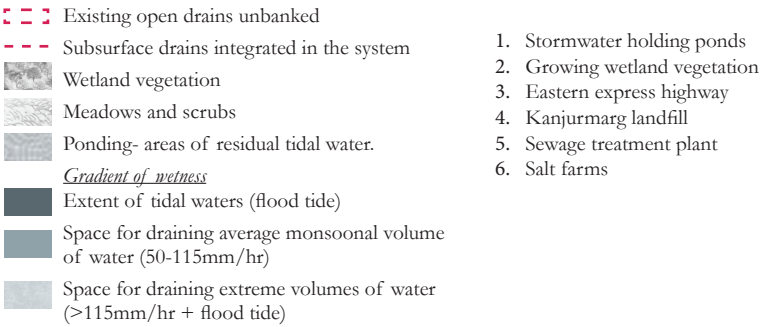


Figure 70. Unbanking drains, to create more room to capacitate excessive volumes of water and its influence on the surrounding landscape.



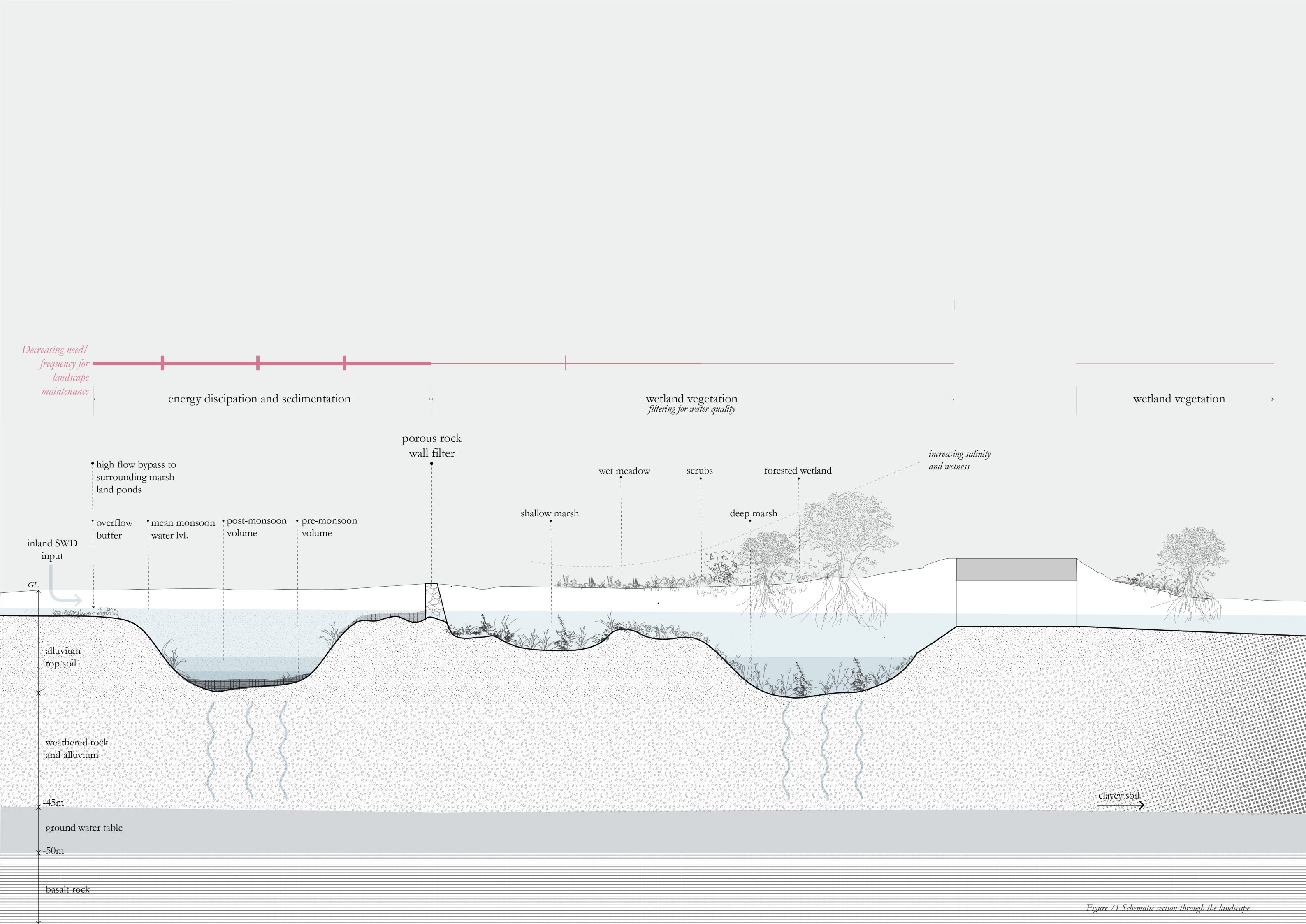




Figure 72.Landscape in the summer



Figure 73.Landscape in the monsoon

IV. Wastewater Aquaculture

Strategic intervention

This proposal is inspired from the indigenous Bheri system practiced in the wetlands of Kolkata²,India. It is a waste water aquaculture system where the city’s sewage is filtered through a series of bunded shallow ponds , where it is progressively cleaned through various natural aerobic and anerobic processes.

The excessive deposition of nutrients from the sewage discharge is a primary source of pollution in the creek, where despite being treated upto the secondary stage , it has a significant impact on the quality of water and consequently the habitat it supports. Particularly the fish species and the indigenous communities whole lively hood depends on it.

Bringing to front the alarming need to improve the quality of the sewage discharge thus curbing the massive volume of matter deposited in the estuary on a daily basis.

Given the present context, the final intervention proposes the implementation of a wastewater aquaculture system within the littoral region. Complimenting the prevalent sewage treatment plants, this wetland landscape will further filter the effluents to reduce its nutrients (fecal colli, phosphates and nitrogen) to a baseline amount (insert citation to the quality parameter) required for maintaining the health of the estuarine landscape. The system can be further integrated to meet the water supply requirements of the industrial sectors in this region. Thereby curbing the volume of deposition in the estuary all together.

¹ Spanning over an area of 12,500 hectares, the wetland system manages to clean out 700 million tonnes of raw sewage per day.

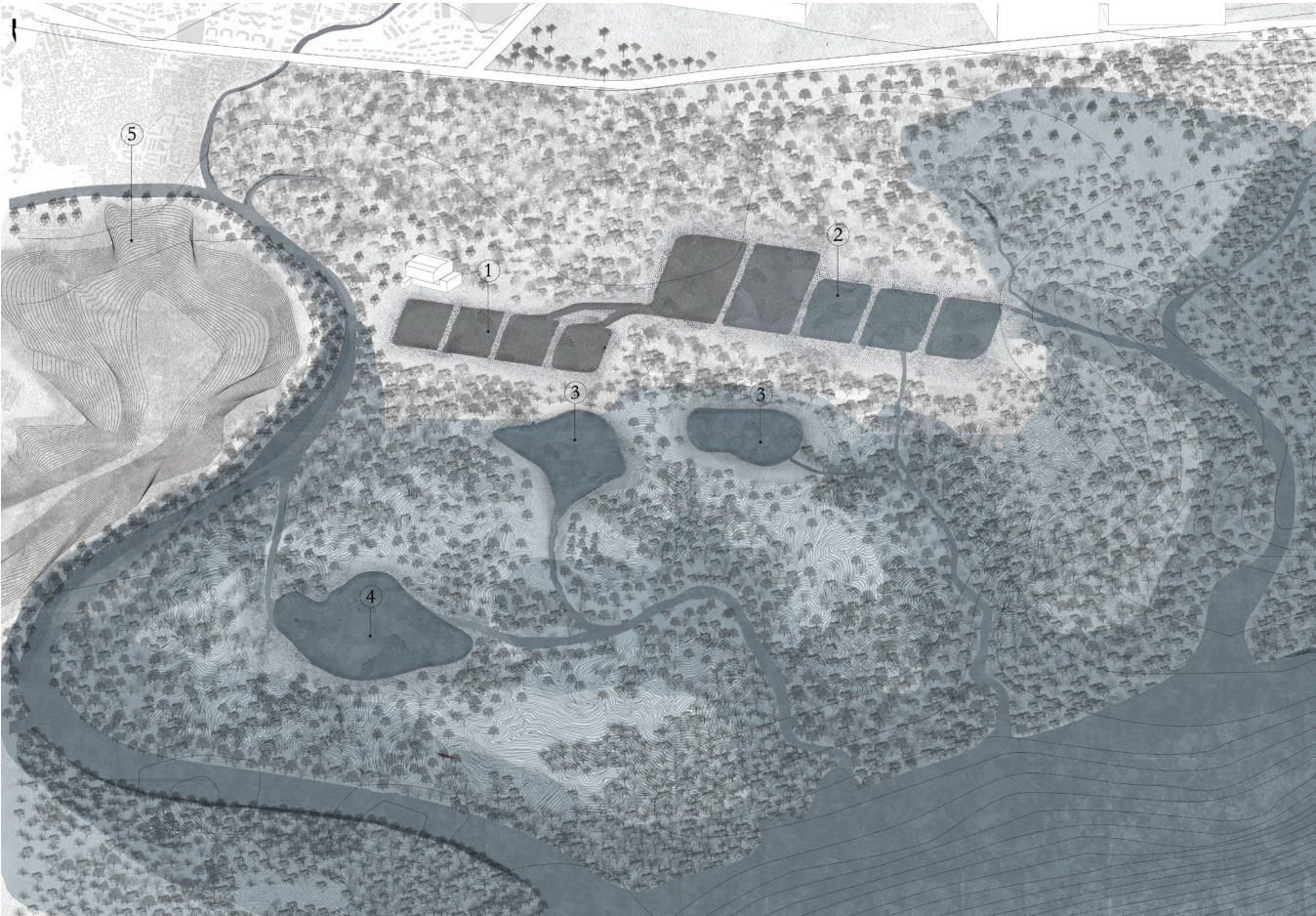


Figure 74.Wastewater aquaculture embedded in the wetlands.

- | | |
|---|--|
|  Ponding- areas of residual tidal waters. | 1. Existing sewage treatment ponds (secondary) |
|  Mangrove vegetation | 2. Waste water aquaculture ponds (fish farms) |
|  <i>Gradient of wetness</i> | 3. Higher salinity ponds (crustacean farming) |
|  Mean ebb tide | 4. Higher turbidity pond (mussel farming) |
|  Mean flood tide | 5. Deonar Landfill |
|  Mean tidal extent in extreme monsoon events | |

Capacity

Currently the 2 outfall points of Mumbai discharge about 18.44 MLD of sewage which increases to 666 MLD during the monsoons (MPCB report, 2022). Thus to accommodate this volume about 1,350,000 m3 of pond capacity would be required(taking into account an approximate 25% increase in the discharge volume in the next decade). Which can be optimally positioned within the drying landscape adjoining the Ghatkopar STP.

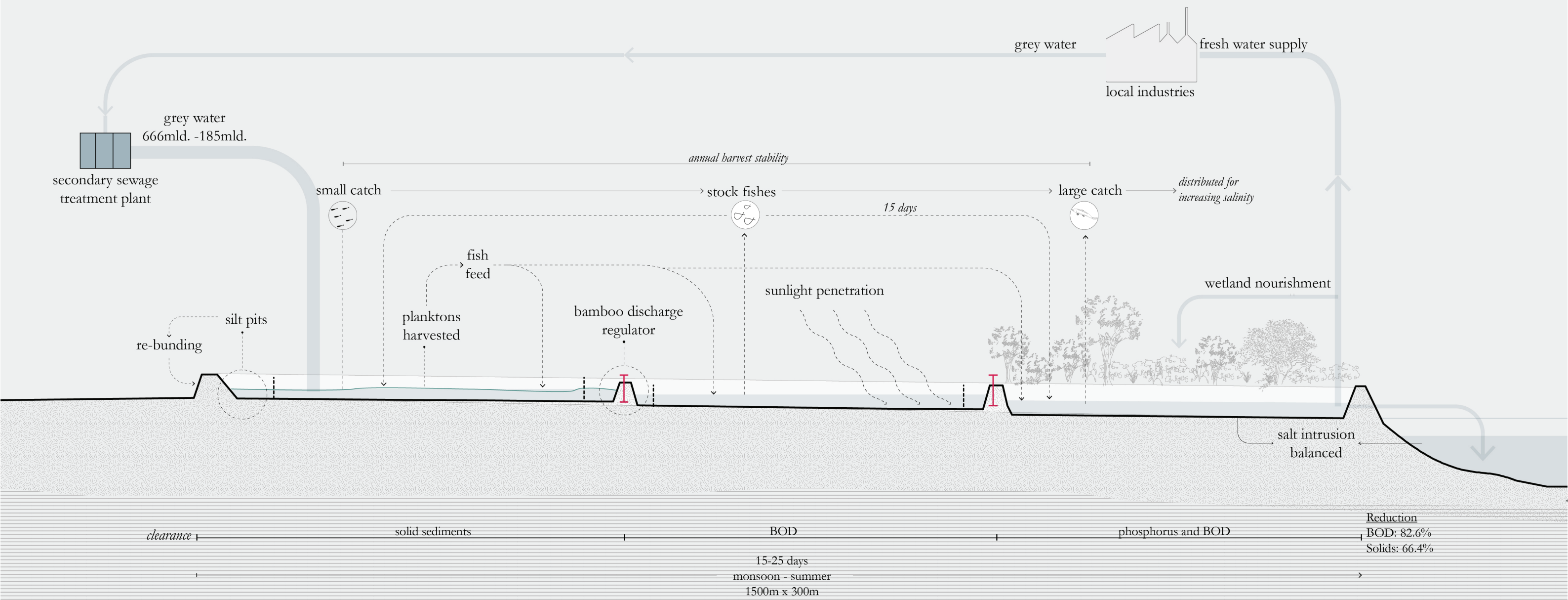
Although stemming from the Bheri system, this waste water aquaculture system will only constitute of maturation ponds – about 1-3 meters deep which are consistently aerobic and remove phosphorous and BOD in 10-25 days. The accumulated sewage, triggers the growth of aquatic plants and phytoplankton species that absorbs the nutrients from the water and

serves as fish food. While the quality of the water must be monitored by the fishermen to prevent eutrophication, these ponds can remain productive through out the year, where compatible fish species can be farmed in different ponds in rotation throughout the year such that a consistency of harvest can be achieved.

The filtered water can thereafter be used for -

- 1)Surrounding Industries- to meet their water supply demand
- 2)Nourish the landscape and recharge the ground water around the sites. Thereby maintaining its wetness and supporting the growth of wetland vegetation.
- 3)Discharge into the sea.

Figure 75.Systemic Section for the proposed wastewater aqua culture practice on site. Circular movement of matter and water at a macro and meso scale.



Through the meticulous selection of suitable plantations within this landscape can also ensure the stability and enhanced productivity of the landscape. Like the use of water hyacinths to border the edges of the water ponds. Which not only provides fish feed but can also provide shade during harsh sunlight. And these plants eventually can also embed their roots into the dykes, further strengthening it to resist erosion during monsoons. Fishes are matured in specific combinations and ponds based on the weather conditions, and salinity and turbidity levels of the water.

Advantages

Besides ensuring security for the Koli communities, in approximately 5 years upon implementation, this system should be able to bring down the turbidity levels in the creek water within the permissible range which can be efficiently cleared out by the tidal waters. Thus reducing sedimentation as well as restoring the fish and avian habitat in this region. Impacts of decreased nourishment should also be visible in the mangrove adaptations as their will alter in form and species with the curbed nutrition, making them less prone to felling. Along with the reduced sediment deposition that have been currently plugging the rivulets, that are essential for draining out the inland storm water.

With wetness reinstated in the inland edges, the area will also become better equipped in absorbing and retaining the stormwater discharge.

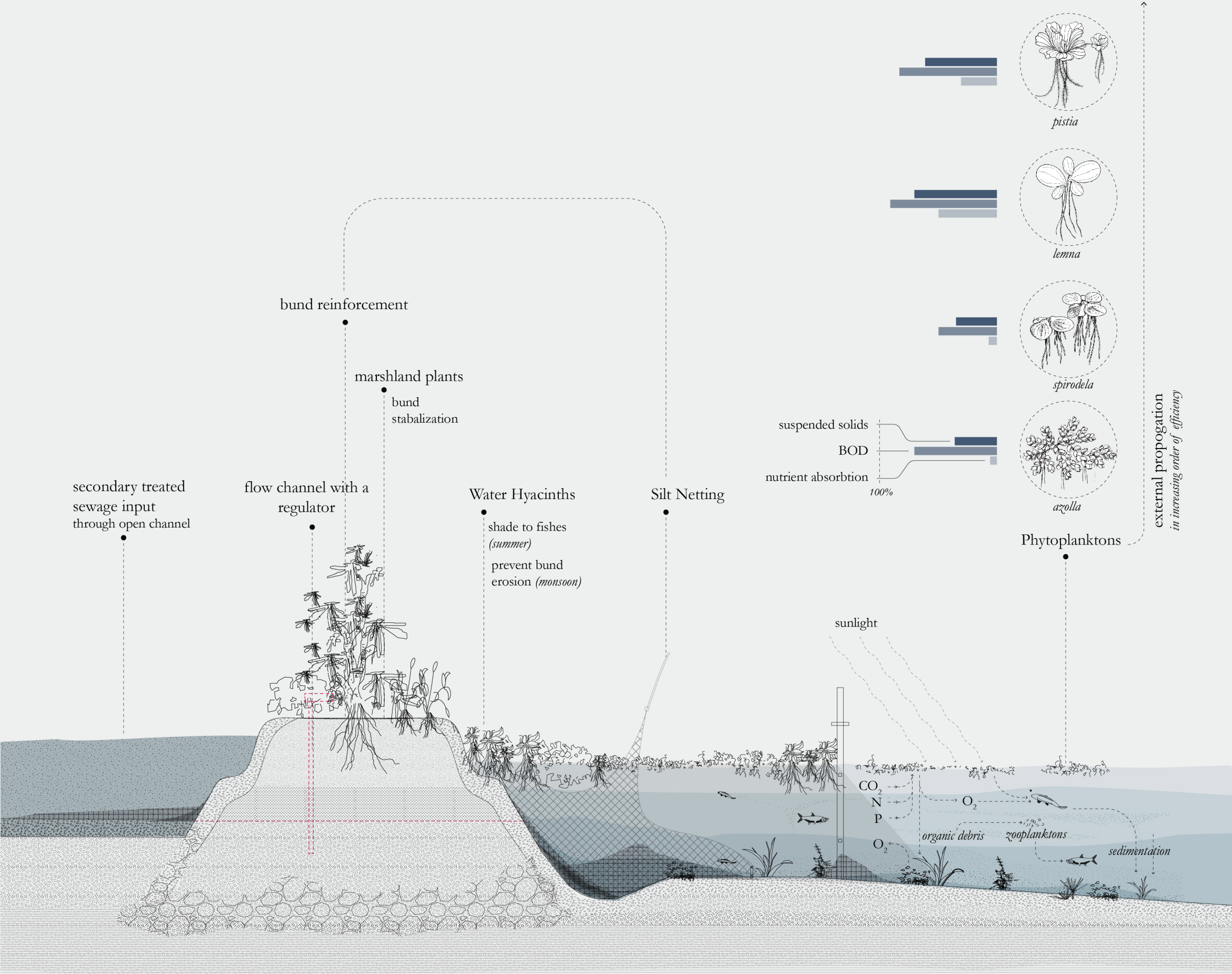


Figure 76. Circular processes observed at a micro scale by harnessing potentials of its local environment (biotic and abiotic). Its materials, micro-climate, water conditions, plant species, etc. to operate this systemic setup that is embedded in the act of maintaining the adjoining landscape.

Maintenance

After each cycle of fish harvest, the pond has to be desilted which can be done by the fishers itself by dragging their nets across the pond so that the silt is trapped together and stored in the silt traps. Which can be later used to reinforce the dykes of that very pond.

While the entire landscape can maintain itself with minimal human assistance, every 3-4 years, in the colder seasons , the ponds need to dry out in rotation through natural process of evaporation. Which is when the dikes and boundaries can be repaired. The ground is also tilled and scattered with lime to decrease the acidity of the soil before it can receive fresh influx of sewage discharge.

Community collaboration

The execution of this system is based on a mutually beneficial collaboration between the public works department (sewage), private sector (Godrej and Boyce. Co.) and the indigenous community of Kolis. Where the private institution is involved nominally as the land is under their ownership and can gain economic subsidy from it . The governmental organisation will supply the raw material and will be able to not only upgrade its sewage treatment system at minimal costs but also improve and maintain the creek. And lastly this system will be managed and maintained solely by the kolis with almost negligible economic input but higher and consistent produce. The local autonomy of this system from the top down governmental organisation will ensure an intimate system of landscape maintenance stemming from a sense of belonging, ownership and care.

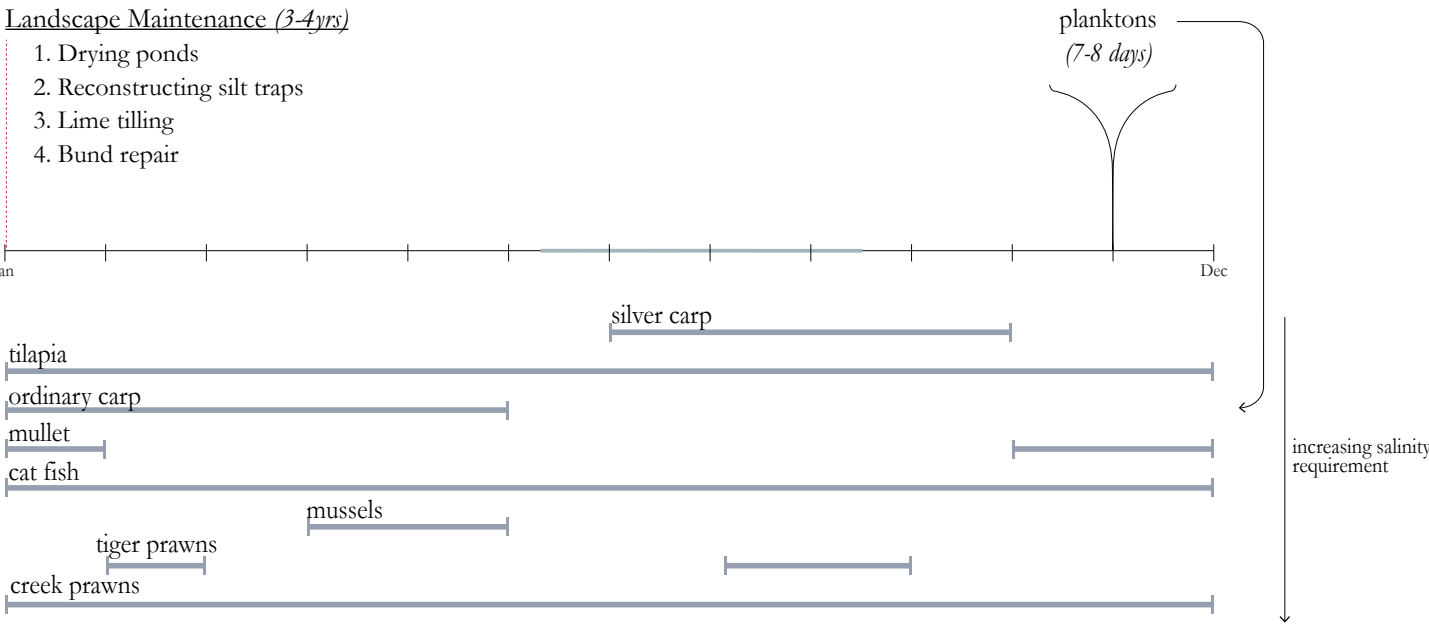


Figure 77.Functions and periods of landscape maintenance required to be done by the fishing community, thereby having a stable year round scope for fish harvest.

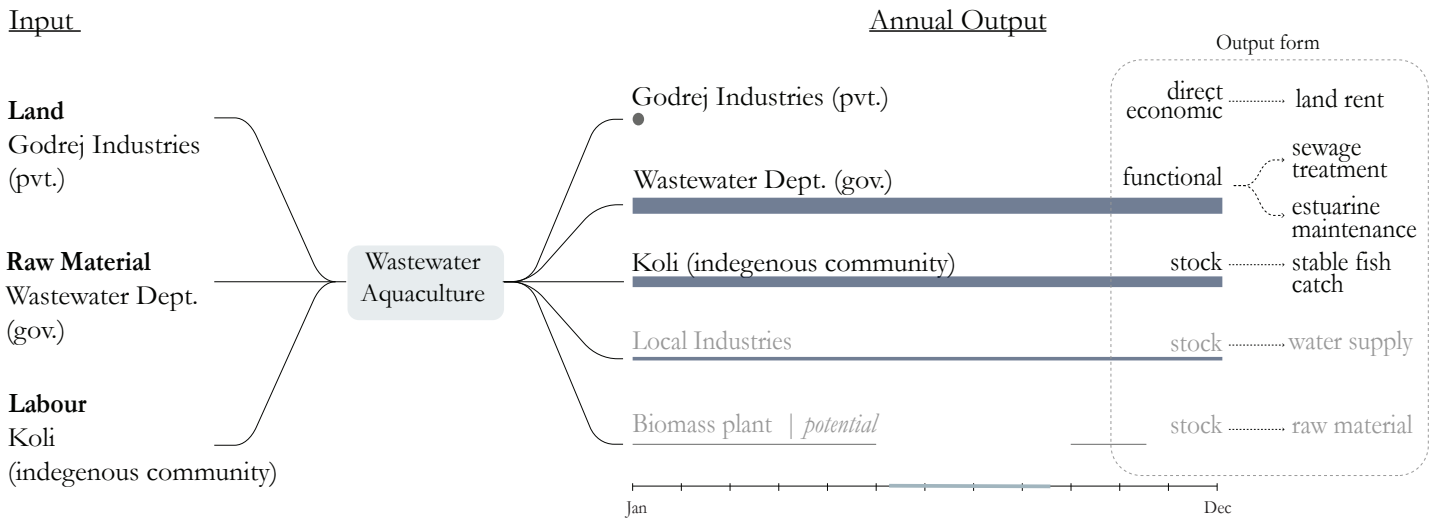


Figure 78.Involvement and collaboration between the sectors on site required to implement the proposal and resultant incentives as an output.

Landing

phasing and implementation

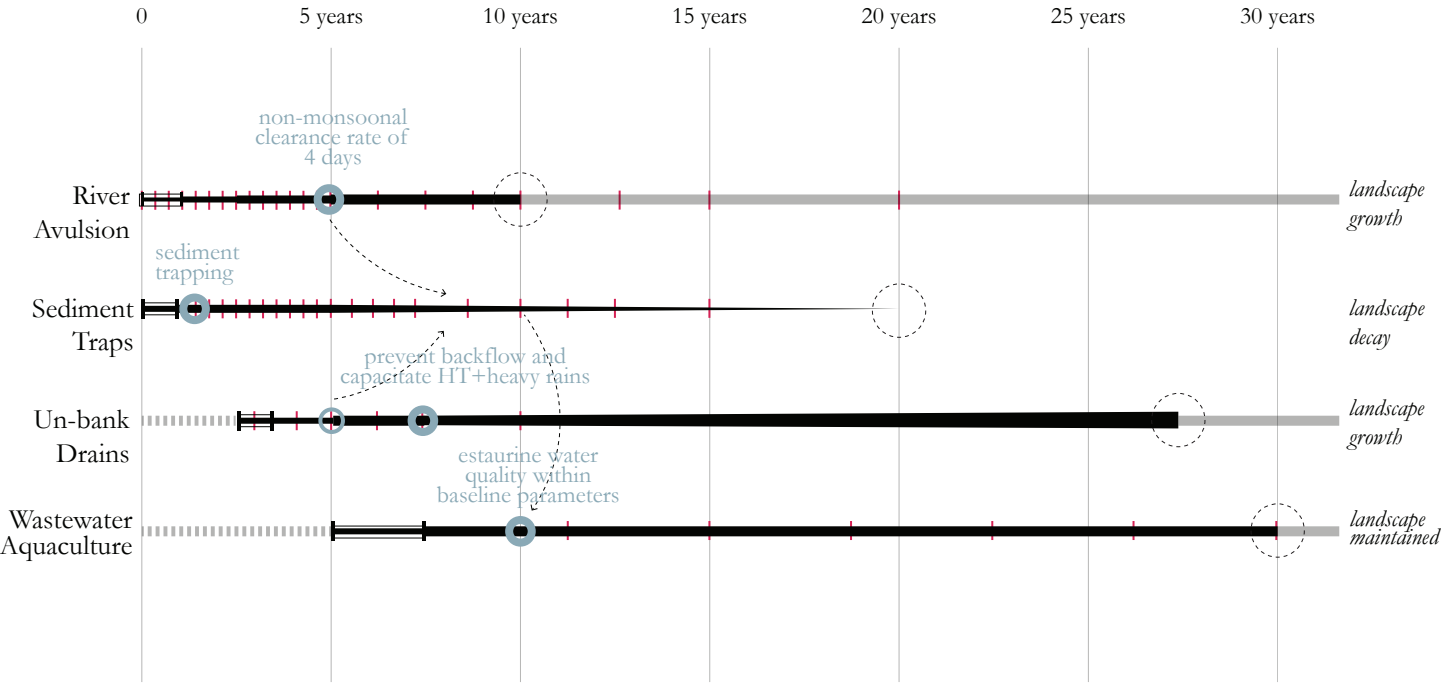
Each of these interventions are contextualised to the local environment as well as designed to complement each other in ensuring the hydrological integrity of the estuarine landscape. Thus, critical in this synchronic functioning is their phasing. Which in the annual time scale is defined individually is based on the tidal and monsoonal cycle while in the longer period is positioned with respect to other interventions based on their hydrological performance goals.

For instance, the sediment traps operate based on the tidal movements on site and in the long run are designed to eventually decay as the wastewater aquaculture system becomes fully operational. Around which time the vegetation surrounding the de-engineered storm water drains will also begin to regenerate just enough to play a definitive role in curbing sediment discharge or overflow into the creek during the monsoon.

Given the dependant positioning (in time and space) of these interventions , the illustrated timeline is to be interpreted as a relative approximation and not as an absolute cut-off. Where the duration operation for every insert has been determined by overlaying the cycles of alteration of its constituting landscape elements as well as their adaptive thresholds shaped by the tidal and monsoonal water cycles. While their initiation period is approximated based on the fixed bureaucratic cycles of decision making and approvals along with the non-definitive time needed to further research, locally discuss and arrive at a grounding consensus.

The incubation period is essentially marked by a greater frequency of anthropogenic maintenance up until the landscape has matured to its hydrological goal. After which it the need for tending either reduces significantly or ceases all together as the intervention itself evolves, much like a living form. Expanding as an integrated part of the landscape, decaying or adapting to resist through periodic human conditioning.

Under the overarching redefinition of growth as a moving target,an integral part of the project framework is stage of re-evaluation. Marked by the synthesis of changes that have been monitored in the landscape indicators along with the changes in the water cycle to speculate upon the health of the estuarine ecosystem. Founding basis to restructure, the scope and physical necessity of the prevalent landscape acupuncture in this new cycle of maintenance.



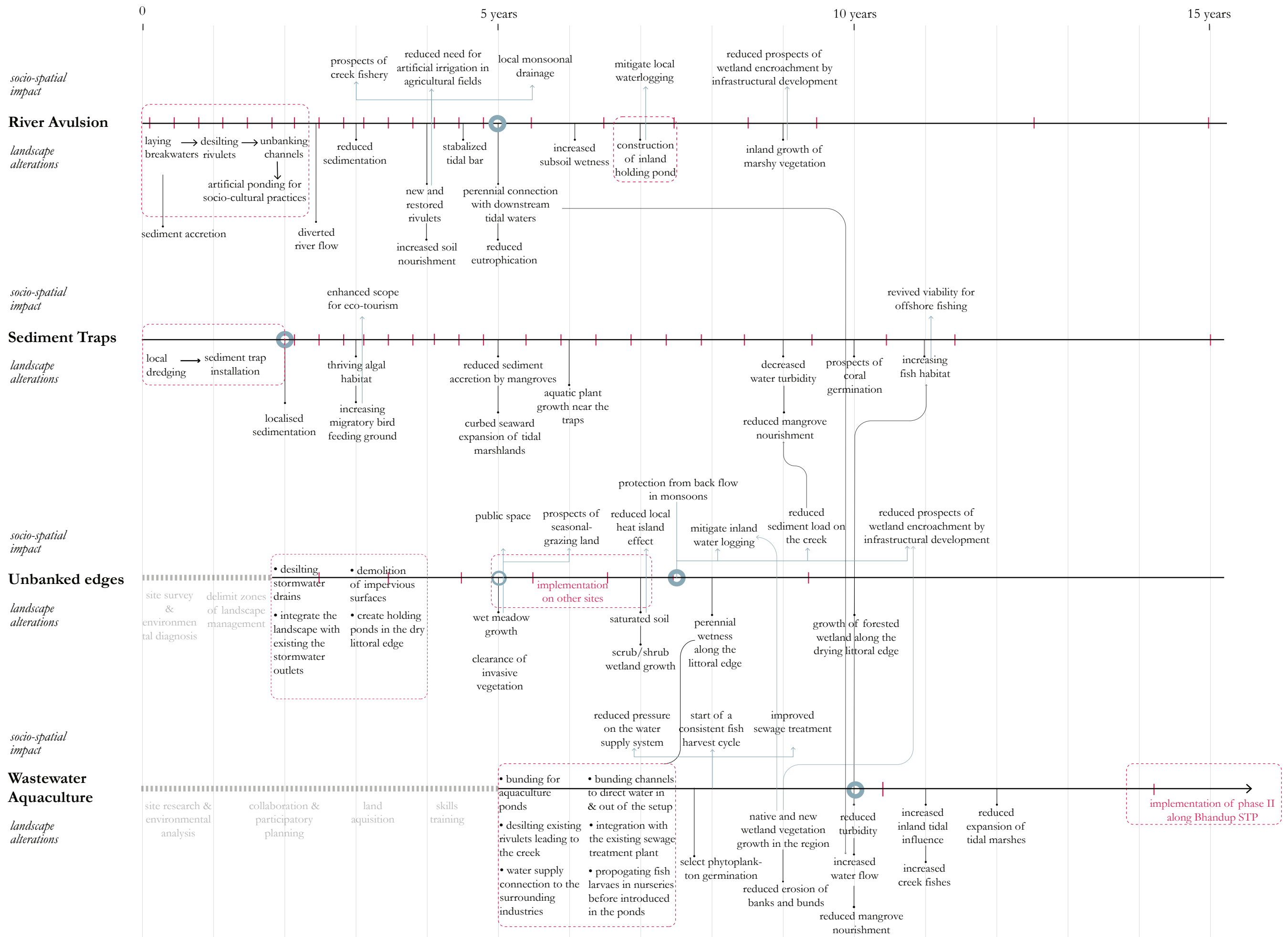


Figure 81. Landscape evolution in time

Landing

ambitions and power (governance)

In the current scenario, *development* and management of the landscape (site) is determined by the Regional Plan which is revised every 20 years. This plan sets goals and ambitions across the regional (territorial), meso (municipal administrative unit) and local (ward scale) through the involvement of specialised governmental sectors. Ones that operate parellelly with limited overlap interms of ambitions, scales of operation or even periods of implementation or restructuring. For instance the environmental plan is revised every 7 years while the coastal regulation plan is ammended almost every year.

Given the beauracracic complexity coupled with the top down structure of the urban planning realm, landscape maintenance takes a back seat. With most of it involving infrastructural maintenance and upgrade, dissociated from the landscape it exists in.

The entire structure functions systemically influenced by political, economic and individualistic propogandas. With little to no grassroots involvement in the form of research institutes or local communities.

In the prevalent reality of an altered landscape, there is a need for a critical understanding and emphasis on maintenance as a method of growth.

Even if the project aims to separate itself from this hierarchy via bottom up planning and design strategies, the involvement of governmental organisations is inevitable as it must evetually be grounded in the contextual realities. And this has been achieved by creating different forms of incentives for maintenance based on the different sectors involved. That instigate an active necessity to care for the landscape.

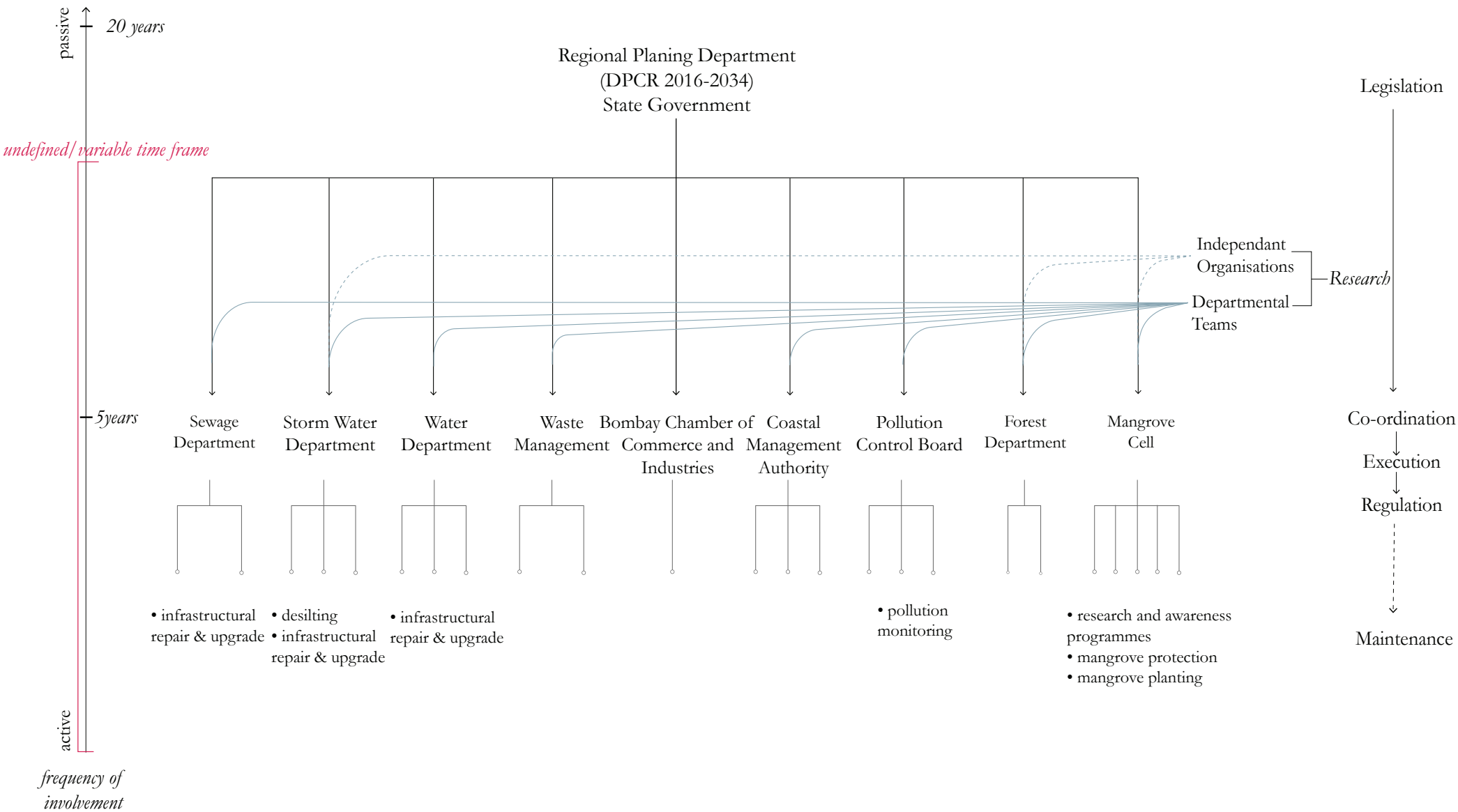


Figure 82.Existing governance structure for urban planning in the city applicable to the site context

Landing

ambitions and power (governance)

This restuctured format for growth is centred around acts of maintenance involving active participation of local communities, research organisations and governmental service departments. This transcalar collaboration between societal, scientific and beuraucratic bodies of knowledge that can forge new path dependancies at a pace that can respond to the landscape dynamics and be strongly contextualised to the alterations on site.-through research and monitoring.

Which in definite periodic involvement with NGOs, Unions, governmental portfolios and other private entities can scale up and re-structure larger landscape goals. (feedback loops/ re-evaluation)

Goals that will still operate under the larger legislative frameworks set by the regional plan but will be a lot more nuanced and sensitive to the site conditions.

Realistically, in this organisation - the necessity for maintenance stemming from care is reduced with the outward transition from a personal /communal involvement to systemic and political inclusion.

In light of which the bottom up roles, involvement and powers of action are defined based on prospects of collaboration and overlapping incentives. That inturn create a sense of urgency and necessity to take action.

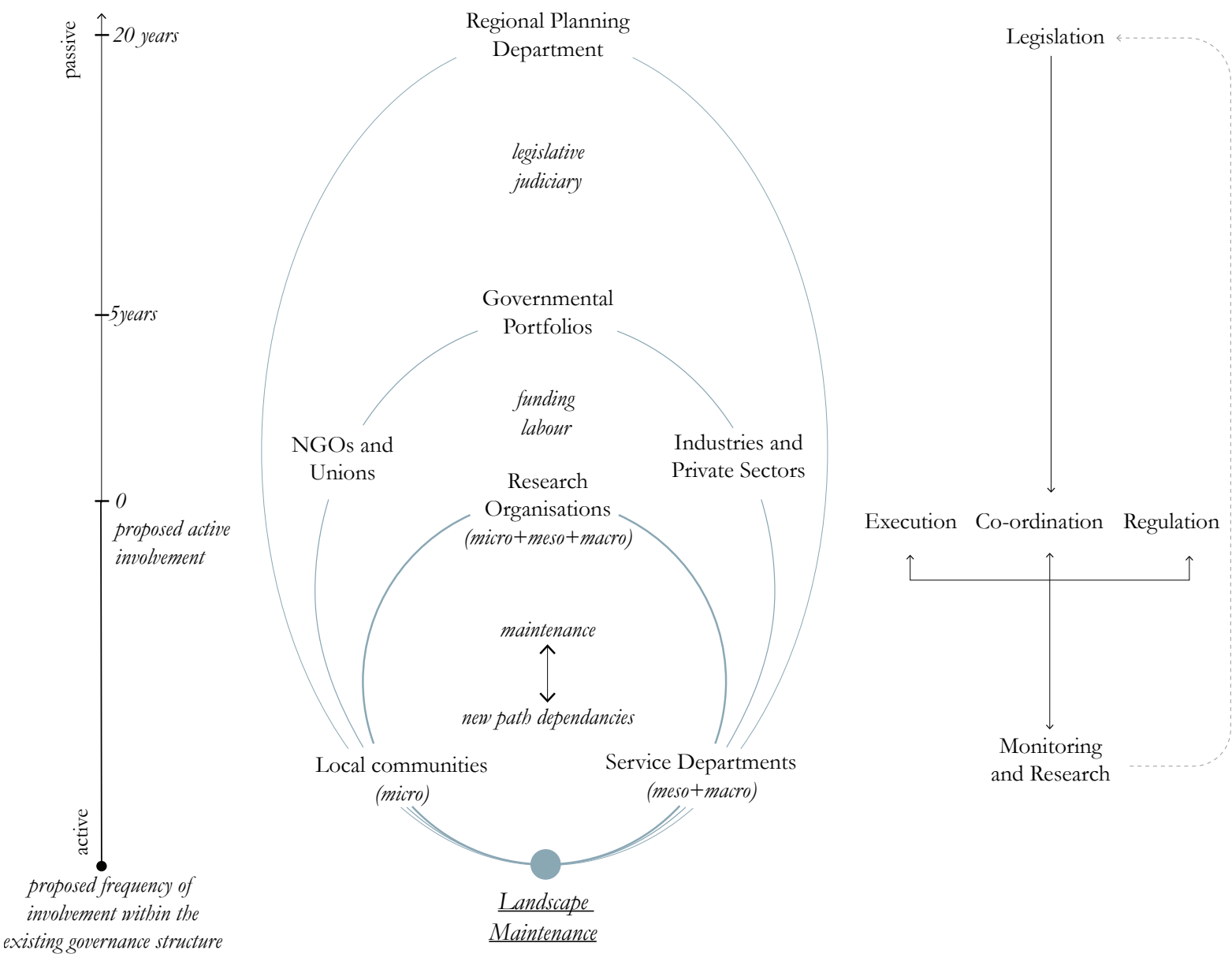


Figure 83. Proposed bottom up organisation for landscape maintenance within the existing governmental frameworks of urban planning and design.

Critique and project limitations

While the approach of the design recognises the necessity of growth as a moving target for a landscape that is perpetually changing, the proposed interventions are simply its manifestation/implementation in the prevalent context of space and time. As a result of which there are two primary challenges that the interventions would face as they are being grounded-

1. Parametric limitations – The proposed collage of interventions have been shaped by parametrising processes of accumulation and clearance on site. Primarily, capacitated to handle the projected volumes of matter (based on past trends of deposition) as moved by the prevalent hydrological forces, whilst accommodating the predicted scope of hydrological fluctuations as a performance parameter in the near and distant future. Which means that the design may not be able to function effectively in case of an abrupt fluctuation (beyond its scope) in one of the above parameters.
2. Unforeseen hydrological upheavals- The water cycles on site play a critical role in shaping and testing the health of the estuarine landscape. And it is according to this data that the alterations/adaptations in the landscape have been projected, which it will take a predicted period of 5-10 years for to evolve before it can capacitate the hydrological extremities. However, a water calamity in this incubation period, could lead to alterations (maybe even permanent) in the landscape that have not been accounted for in the project. Possibly needing a re-evaluation of the landscape indicators and consequently restricting the acupuncture points.
3. Uncurbed increase in matter – Upon the success of the pilot project of wastewater aquaculture, there could be a tendency of expanding the capacity of this landscape intervention by multiple folds under the pretext of a growing city. Yet again altering the estuarine edge, into a machinic service landscape. Although by multiplying or integrating

any of these interventions the growing volumes could possibly be mitigated, unfortunately at this scale the project will be dissociated from its ethics of care and maintenance that motivate it. Thus while the Approach of the design is transferable and can be expanded, **the design intervention stands as a hard limit to itself.** As it does not intend to perpetuate an attitude of normalising land reclamation or other accumulation practices as implicit to growth yet again. Based on the intensity of the change and its permanence in the landscape the path dependencies on site will change and consequently would impact the efficiency of the interventions.

4. The urgency of implementation- Against the backdrop of an urgency to maintain the estuarine nature of the landscape, is also the need to implement the proposed interventions within the stipulated time frame. Beyond which not only would the landscape conditions have altered significantly but also the socio-economic goals and their path dependencies would be shifted, thereby curbing the efficiency of the proposal. Additionally, as we move ahead in time, the changes in societal and environmental conditions become more difficult to predict and work with particularly in terms of grounding the project in a geography as complex as Mumbai. Having said that, the proposal does incorporate a leeway of 5-7 years as a period to accommodate possible latencies (bureaucratic or socio-economic) towards implementation.

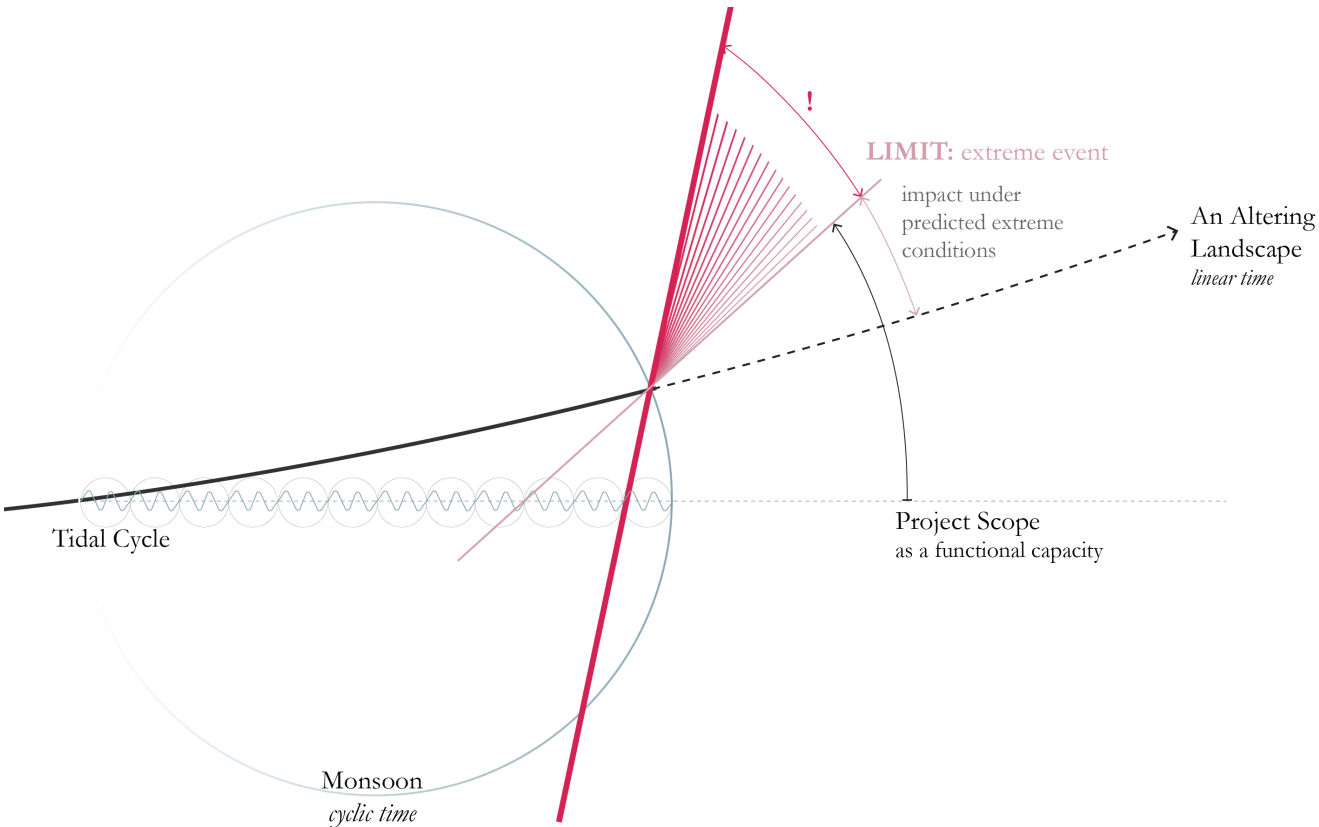


Figure 84.Limited capacity of the project to accommodate extreme or unforeseen hydrological upheaval beyond the projected scope. (1,2)

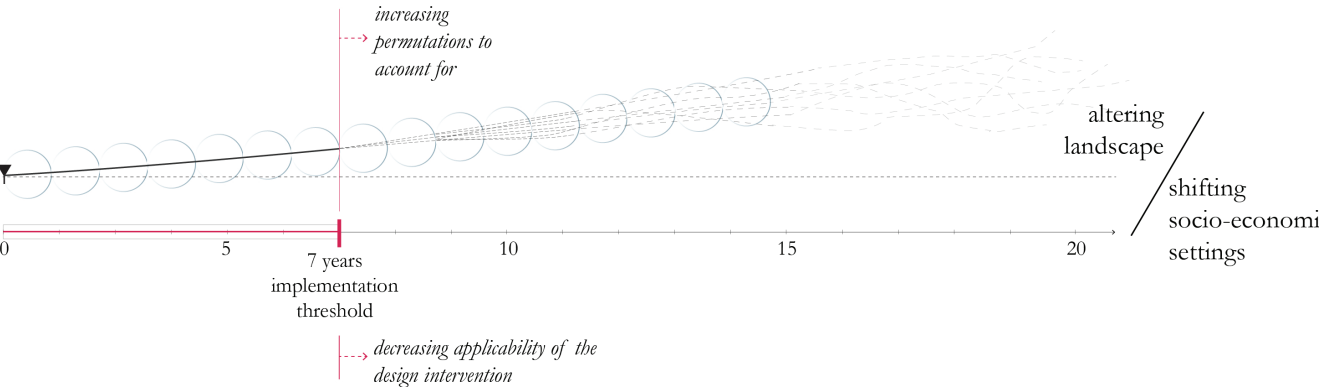


Figure 85.Necessity of initiating the project within the stipulated timeframe (4)

New material reading

With the proposed landscape intermediary being an act of grounding, the key transferable takeaway of this dissertation remains to the Approach. Which besides being founded on a material understanding of the dynamic landscape being shaped by systems of care, presents a new perspective into territorial planning. Away from the prevalent top down and static material additions to the landscape.

Commencing from a fluid reading of the territory.- the shifting water matter relations have been mapped through a transect of its materiality at a given point in time.

Behaviour (motion) attributed to its bio-physical properties ,their relation to the surrounding environmental conditions (natural or anthropogenic), thereby adding to or being cleared out of the region.

A process that leaves traces in the territory, some more permanent than others. Traces that define changes in the landscape across scales- in its phyciality, composition, functionality, habitability and ultimately accretes in the longer term as a more evident morphing of the “land”.

This material cartography of the landscape aims to present an alternative purview in the study of territories that are in state of constant formation. A method that not only presents material study as an analytical and monitoring tool but can also be used to trace the implications of external interventions placed incongruently in the landscape dynamics.

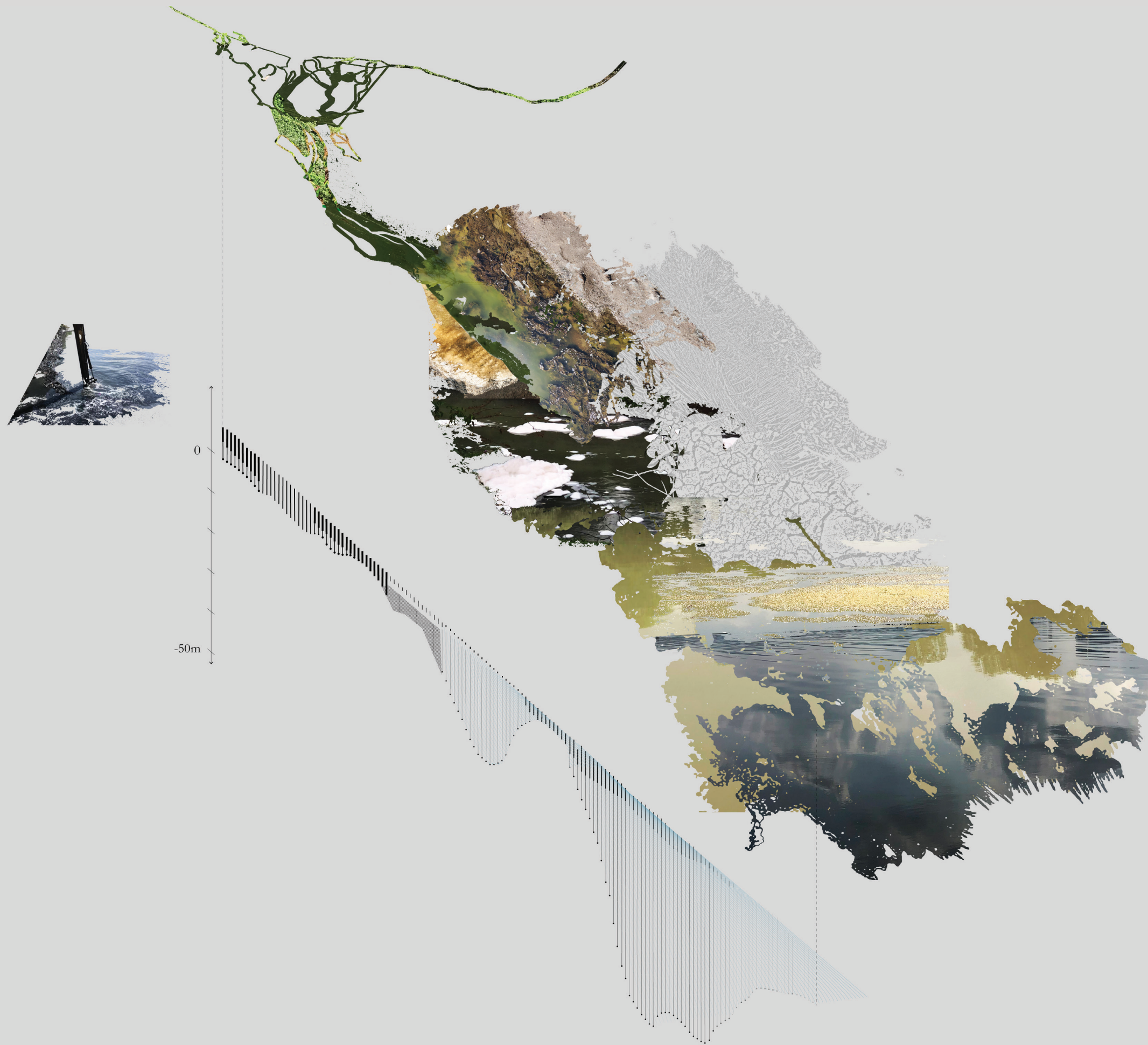
A visual that brings to prominence the reality and urgency of an adapting estuarine landscape that occurs at the cost of its hydrological integrity. That is further accelerated by anthropogenic interventions of building more, which may not necessarily be direct of acts of land reclamation but simply situating elements in the landscape dynamics as such invariable triggers new cycles of accumulation. Which in the case of the Thane creek will in time lead to somewhat of a land-locked water body. A non-estuary.



Figure 86. A render of the proposed Trans-Harbour link in the Thane Creek.
Image Source: ARUP rapid environmental assesment report.



Figure 87. An actual visual of the bridge under construction captured in September, 2022. Showing its material impact on the landscape. Bridge due for completion in November 2023.
Image Source : @cbdbhage/ Twitter



- Tidal Water Vectors
in order of decreasing current speed
- Materiality
 stratified extent (vertically in meters)
- Density
in descending order
- Settlement in a tidal clearance cycle

Figure 88. *A new material reading*

Conclusion

Reflection

What is the relation between your graduation project topic, your master track (Ar, Ur, BT, LA, MBE), and your master programme (MSc AUBS)?

The project is centred around exploring alternative prospects of territorial growth that respond to urgent as well as insurgent socio-ecological crisis in Mumbai. As the project deals with the conflicts and incongruencies between anthropogenic habitation practices and the hydrological system, evolving it under the Transitional Territories studio is the most fitting. Aligning not only with the general scale of its approach but also its very theme “Inland Seawards”.

Where through a series of methods like critical cartography, peer-review, crossover feedbacks, lecture series, abstract model making and open learning in the studio has allowed me to systematically unpack the complexities of the subject-its processes, systems, occupants as well as their co-relations. Especially through the intensives that introduced and encouraged alternative methods for analysis that broadened and further enriched my dissertation topic. Something that I believe was crucial in my case as picking a site with extreme familiarity came with the burdens of preconceived notions that would have been conforming in the following stages of the project.

The emphasis on design as a system of care and negotiation between the human and more than humans on site resonates strongly with the ethics I envisioned for the project, as I stepped into it. The ethical and theoretical inputs from the studio presented me with a guiding plane to manifest my seemingly utopian project goals as a pragmatic design output. Which in equal measures is based on a thorough parametric analysis that focus on the domains of urban planning and design, landscape, geology, hydrology, water management as well as humanities.

Tapping into these array of domains reveals a challenge of prioritization, where the layered method of synthesis and the approach of research by design introduced by the Urbanism program has helped streamline the project. Leading to a systematic and yet interdisciplinary hierarchy across the varying scales of the project that very rightly fits within the Msc Urbanism programme.

2. How did your research influence your design/ recommendations and how did the design/ recommendations influence your research?

I strived for this graduation project to be a confluence of my technical background and ethical values, matured over time. And thus, viewed this as an opportunity to investigate the positioning of emergent ecological crisis amid the prevalent socio-spatial predicaments in hyperdense environments like Mumbai. With a scope this broad, and the sheer intricacy of its fabric made it rather overwhelming to step into research and analysis. Grappling with loads of information and acquainting myself with the multitude of urban domains that this topic encompassed.

And overarching this ambiguity was the determination to not develop yet another project of flooding in Mumbai, -resolved by engineered water management solutions. At which point the studio methods along with the graduation intensives helped immensely in streamlining my thoughts and thereby the scope of the project. While the different layers of the ecology, society, economy, and geo-politics were analyzed separately, the necessity to synthesize this information as a graphical output was very difficult but forced me to make essential decisions in narrowing the project down. Particularly, thought provoking were conclusionary drawings of ‘clearance’ that regularly encouraged the speculation of possible urban solutions to the problem field charted through my analytical research. Marking primitive but essential points of a back and forth between analysis and design, further filtering variables or establishing constants and limitations that the project would operate within. A collective of these rough interventions, although presented more critique than answers, helped define narrative. Where the project was more focused on a landscape understanding of the city as a resultant of land- water negotiations in time

However even at the mid term stage (P2) the project still lacked the novelty I seek for in my graduation dissertation. While more site-specific analysis was carried out through critical cartography, it tended toward a linear solutionist approach to a context so plural in time and space. Thus, alternative methods of analysis like interviews, montages and documentary making (as a part of the site visit) were used to enrich

the project. Not only as a method of research but also a step towards synthesis as a design recommendation. Post the site interaction, most of my preconceived linear frameworks for design were debunked. An essential step necessary to pace the project in terms of its output, whom it catered to and the motivations for it. Developing a strong basis to structure the design approach and envision its implementation.

Yet again restructuring the goals and aim of the project to become more articulate and conscious to the dynamics of the context across scales and time. Establish the grim reality of having to deal with an altered landscape and the need for its maintenance. Thereby dubbing the prevalent notions of growth, bolstered through a design approach, that essentially addressed landscape limitations in time and space as a means of design for maintenance. At which stage, periodic analysis into the materialities on site and its relationship with the landscape forces on site, have informed forms of action aimed at maintenance of the landscape. Ultimately amounting to a new transcalar approach for landscape design founded on the principals of research by design, with time.

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3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?

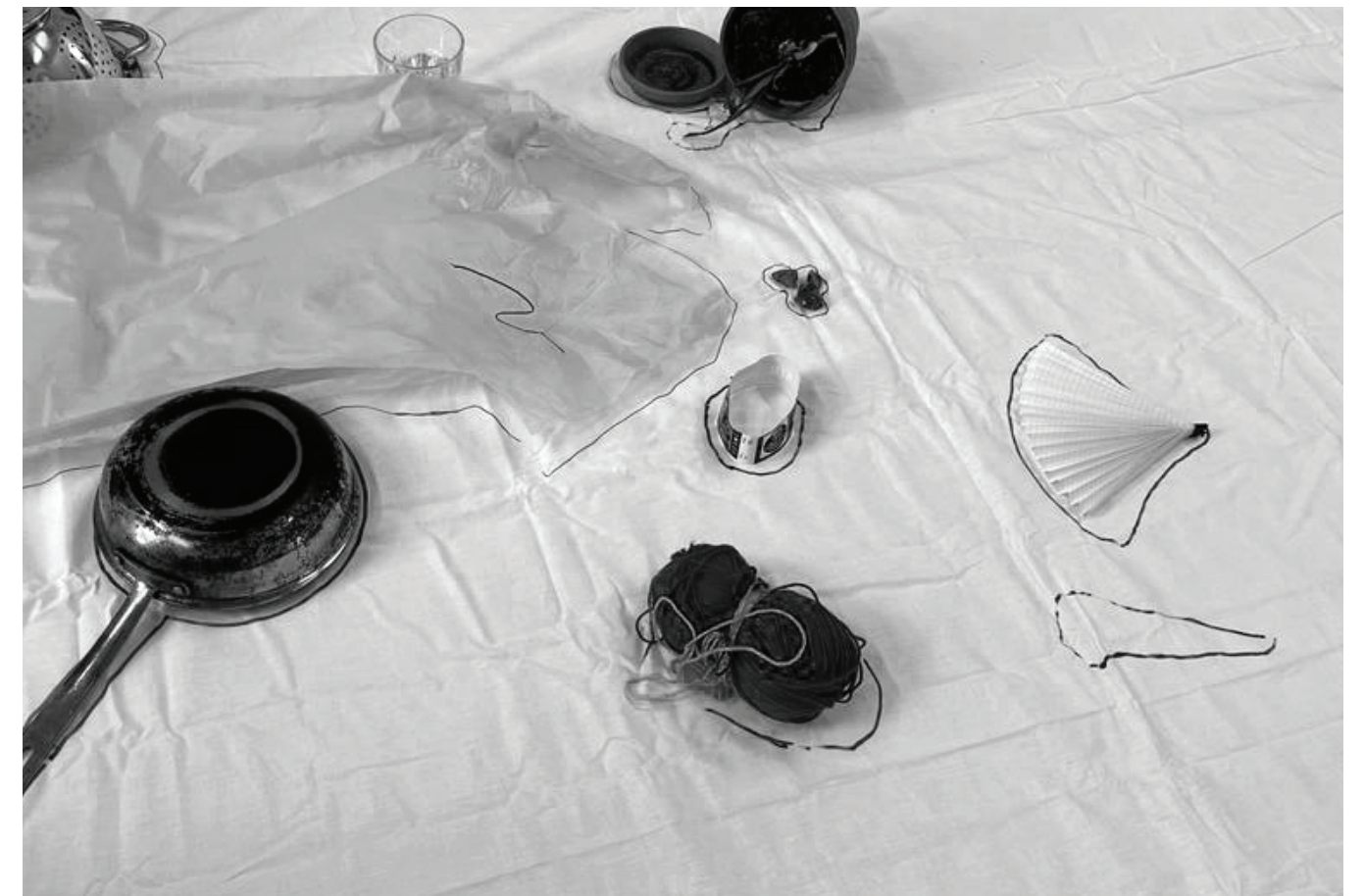
Addressing a subject contextualized in a rather personal and familiar site has its impediments as much

as its upsides of commencing with a solid foundation based on scientific and more importantly, lived encounters. Despite being consciously aware of a possible polarized approach to synthesizing the layered problem field, it was easier said than done. The lines of inquiry as a method of research by design played a key role in directing the project. This systematic addressal of the diverse physical, social, economic and geo-political across scales in the territory presented new points of approach to the subject. While being overwhelmed by the sheer volume of actants and intricacies within the project scope, the necessity to synthesize via “critical cartography” helped establish a hierarchy and narrative for the project. A method which has been further pursued as vital outcome to represent the incongruencies on site as a new and nascent body of knowledge.

While scientific research papers, geospatial other remote sources of data provided a plethora of information on the topic, it still was unable to satisfactorily encapsulate the complex human and more than human interactions at a local scale. To address this gap, the ‘journalistic’ approach was furthered through local and professional interviews. At which stage the site visit played a defining role in documenting native knowledge, experiences, values, and motivations as a core element that altered the project from speculating prospects of territorial growth to the realization of simply maintaining it. Which has been video documented as a landscape biography, focusing on contradictions and claims that try to encapsulate the complexities on site.

Thus, debunking a linear solutionist approach to the problem field, the project proposes a method of analysis and implementation which can be tested as a design intervention. Essentially working with the scales of time in space as well as the materiality of the site. While the framework of tis approach encapsulates a vast array of tangible and intangible dynamics/ movements on site, it is grounded and bound together by it’s overarch aim of landscape maintenance arising from the ethics of care.

Lastly, the project proposes the intervention itself as an active act of implementation situated within the socio-economic landscape of Mumbai. Backed by an analysis of the prevalent societal organization (based on power and interest) as a basis to forge mutually beneficial collaborations to executing this project



Expanding the scope of the research beyond the condition studied (complexities of flood mitigation represented by the yarn mesh) to its relation with other elements around it. Image Credit: Emilie Stecher

of care within an otherwise economically oriented society. A particularly essential step in grounding and justifying this dissertation in a context as Mumbai.

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

Professional Relavance

The project presents an opportunity to critically position research, design, and planning of urban environments within the dichotomy of society vs nature. Something that is particularly prevalent in the profession today as the urban environment is no long restricted to buildings and infrastructure but is heavily influenced by the surrounding exosystemic processes that inform it. Thus, the approach of the project transcends from an elementary or functional study of the landscape to its ephemeral dependencies that collectively sustain the environment. Emphasizing the need for urbanism to respond to the ever-altering landscape dynamics by proposing non-linear alternative approaches to the otherwise static urban interventions. Methods that can be transposed contextually or systemically to adapt to future uncertainties, whilst holding true our core ethical and technical responsibilities as Urbanists.

Social

A critical value central to the project has been achieving maximum social inclusivity at all stages of the project, namely research and analysis, designing and implementation, thus achieving a just transition. Inclusivity in this context was particularly emphasized upon as the site in itself is extremely diverse with varying anthropogenic habitation patterns directly aligned with their socio-economic capacities, which goes on to defining their vulnerability to the altering landscape and the consequent impacts of the disrupted hydrological cycle.

Most acts of disaster management in developing cities like Mumbai are often nascent in their impacts. Where owing to the politics of the urban environment, goals of adaptation are narrowly framed so as to protect near-term interests of a select few and more superficially framed in an attempt to homogenously sustain the interests of society, in the longer frame of time.

Thus social inclusion in this project has been incorporated via three broad ways-

- 1)by accounting for their vulnerability to extreme conditions of wetness or dryness based on a holistic accounting of social, and economic parameters.
- 2) By incorporating their concerns, knowledge and ambitions at the research by design stage
- 3) Evolving a framework that asserts independent power and viability to the critically vulnerable communities and yet respecting and maintaining their innate relation with the surrounding ecosystem (natural and man-made).

Scientific and Academic Relavance

While there is a large and growing body of research and technoscientific knowledge that addresses the crisis of flooding, there is serious knowledge gap in contextualising it to a dense developing region. Where limited resources, globalisation ambitions, socio-cultural values, complex political or economic constructs, limited land and inadequate disaster awareness makes it a lot more tedious to effectively implement the available knowledge onto the site. While several engineered steps have been taken to address these hydrological disruptions, they have failed to prevail in time due to the continuously evolving estuarine landscape along side the city's developmental pressures. The project thus presents a new angle of research into the subject through the lens of landscape urbanism positioned within the prevalent socio-economic structures. The multimedia approach of researching and synthesising the problem field presents the scope for an interdisciplinary collaboration of urbanism with other fields like humanities, environmental philosophers, conservation photographers, etc. Generating a wider, mutually accessible body of knowledge that can potentially present new avenues for investigation into the hydro morphology of the site, estuarine dynamics or simply even the symbiotic existence biotic and abiotic elements on site. The resultant methodological framework presents a transcalar method of accommodating time in designing for dynamic environments, considering and working with certain constants. Wicked problems that will unfortunately prevail in time and how those can be internalised in the territory and yet as an externality dissociated from the ecological landscape .



Artwork by Mauro Staccioli, Anello (1997-2005; locality Poggio di San Martino). Image Source: Windows on Art

The concept of this artwork closely represents my understanding of urbanism today. One that frames the territory with all its constituents, highlighting aspects of concern and consequently enhances the condition of the region . And yet much like the ring set in a vast untamed landscape, presents the reality of territorial environment that can never truly be regulated. In which case it is these red bounds help determine a niche in this vastness that not only defines the extent of landscape alterations but also meanings, values that essentially govern it.

Ethical Aspects

The project is not only nested between the human and more than human contrarities in the territory but even within the human realm the sheer plurality of the context poses several ethical questions regarding the stance of the project. To whom it is addressed, who it caters to and more importantly what are the values that motivate it.

These rather sticky decisions have been made based on two aspects-the theoretical frameworks and grounding realities addressed at different stages of the project. Theoretical frameworks of care and maintenance have heavily influenced the project delving into the need and prospects of bottom up localised addressal of the problem field. Thereby ethically defining the agency of the project and its design proposals in the wider framework of the urbanism field.

However as the project recommendations became more tangible and articulate, there was need to contextualise these theoretical ideals as a critical step in grounding the project. Balancing contrasting societal needs, values, ambitions whilst incentivising a non-humanist approach to urban design. Which is particularly tedious in a context like Mumbai, defined by cutthroat ambitions of unbridled growth and monetary progress. It is this economy and growth centric attitude that has been channelized to forge a mutually beneficial system that can maintain the estuarine landscape. Although this approach loosens on some of the theoretical values previously established, it does however ensure a non-naïve outcome.

Thus in this project, design is not only motivated by ethical values of inclusivity and symbiosis but also presents a plane for negotiating the assertion of various sectors (biotic and abiotic) that constitute the landscape. While a hierarchy of their importance has been determined by the urbanist based on scientific as well as local inputs, there still persists values of equity, democracy, mutual care and sustenance that inform all stages and iterations of the project development.

5. How do you assess the value of the transferability of your project results?

As a transferable outcome, the project proposes alternative methods of analyzing, mapping and intervening in complex urban environments.

Critical cartography as a method of research through design has presented a new way of aligning the otherwise disparate parcels of information (which is often the case in regions with overlapping institutions monitoring a single landscape.)

Putting forth a visually strong method of problematization that can be furthered to formulate a narrative. Which, when combined with the on-site audio visual documentation, presents a strong medium of communication. A rich body of parallels, synthesized and scaled across scientific and local domains of knowledge that is presented in a largely accessible format. Enabling cross pollination of information across the varying sectors and expanding the process of research by design beyond the academic realm(inclusive).

At the core of the final design inserts is the intent to propose dynamic interventions that eventually become one with the surrounding landscape. Marking a shift from the typical nature-based solutions, that have a definitive goal set in the morphology of the landscape. Given the bottom-up collaborative approach of execution based on care and symbiotic cohabitation, it is rather unusual take and yet very feasible to be tested in developing regions like Mumbai where urban projects as such are often dismissed because of their demanding economics or the organizational bureaucracy on site.

The resultant approach lays enhanced focus on the materiality of the region and its relationship with the surrounding environmental forces, presenting a new purview into addressing and designing with the movements in the landscape especially in the dynamic estuarine environments. Providing a deeper understanding into ways of harnessing and working in congruency with the forces on site, as a means of ensuring a healthy landscape.

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