

LANDSCAPES IN-FLUX

Dynamic Landscape | Productive Landscape | Religious Landscape

Journey through the Dynamic Floodplains of Holy river Ganga at Prayagraj, India

LANDSCAPES IN-FLUX

Dynamic Landscape | Productive Landscape | Religious Landscape

Journey through the Dynamic Floodplains of Holy river Ganga at Prayagraj, India



Tanvi Gupta

Graduation Report

Msc Thesis in Landscape Architecture - Graduation Report Landscapes in-flux: Journey through the dynamic floodplains of holy river Ganga at Prayagraj in India

Tanvi Gupta [4809394] tanvigupta094@gmail.com

1st Mentor: Dr.ir. GA Verschuure-Stuip 2nd Mentor: Dr.ir. M. (Marjolein) Spaans

Delegate: Dr. LGAJ Reinders

Delft University of Technology
Faculty of Architecture and Built Environment
Msc Architecture, Urbanism and Building Sciences
Department of Urbanism

Graduation Studio: Flowscapes Lab: Circular Water Stories

Delft, The Netherlands July 2020

Copyright © Author









[4809394] | Msc Landscape Architecture | TU Delft 2019-2020

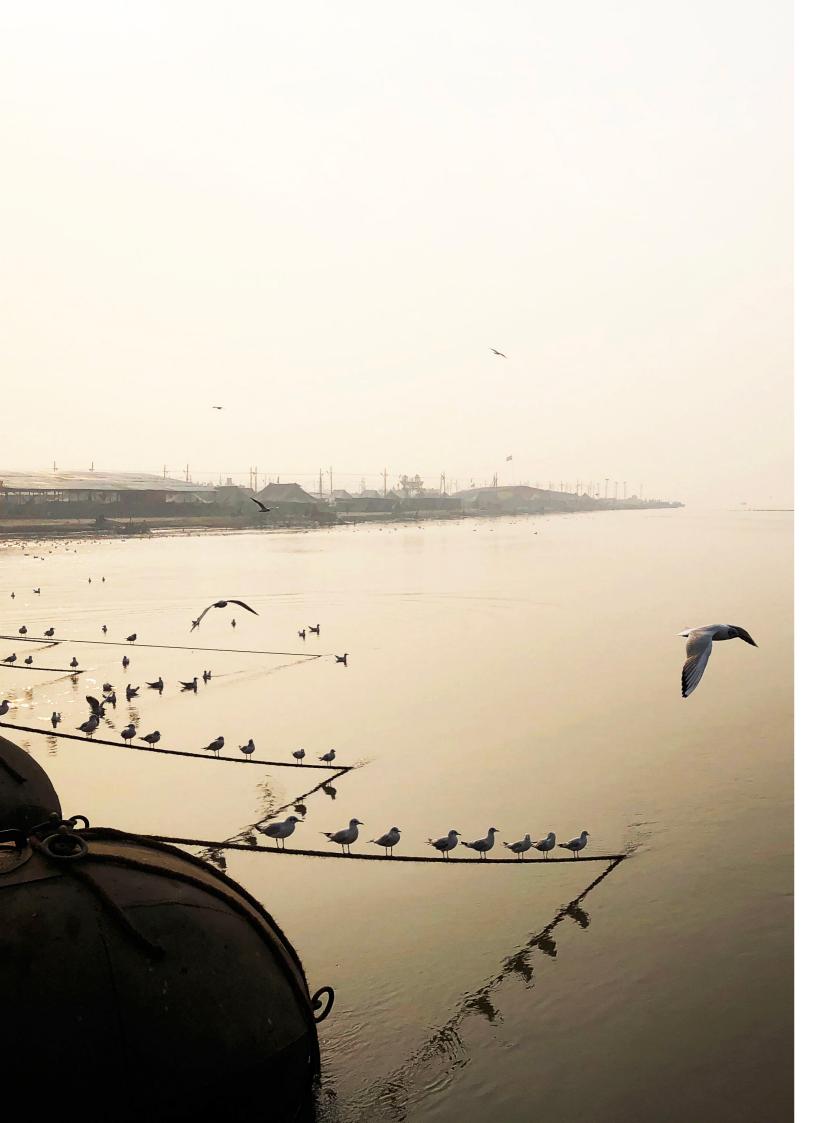


TABLE OF CONTENTS

ACKNOWLEDGEMENT

ABSTRACT	11
1. INTRODUCTION 1.1 Context 1.2 Fascination	
2. RESEARCH OUTLINE 2.01 Future Challenges 2.02 Dynamic Landscape Challenges 2.03 Voices from the site 2.04 Problem Statement 2.05 Research Objective and main question 2.06 Scope and Relevance	23
3. METHODOLOGY 3.01 Theoretical background 3.02 Research Approach 3.03 Research outline 3.04 Time framework	47
4. Analysis - Physical landscape 4.01 Annual Dynamic cycle - floodplains 4.02 Site layering (Micro) 4.03 Shifting of river course (Meso) 4.04 Geomorphology (Meso) 4.05 Floodplain topography 4.06 Conclusion (Meso)	67
5. Analysis - Use 5.01 Land-use (Macro) 5.02 Urban use (Meso) 5.03 Pilgrimage procession (Meso, micro) 5.04 Conclusion	81
6. Analysis - Meaning 6.01 Holy festival - "Kumbh mela" 6.02 History 6.03 Sangam - Holy Confluence 6.04 Snan: Mass Bathing 6.05 Holy floodplains (Meso) 6.06 Conclusion (Meso)	91

7. VISION	101
7.01 Introduction	
7.02 Vision	
7.03 Spatial Strategies	
7.04 Design with nature	
7.05 Phasing Interventions	
7.06 Use as per festival cycle	
7.07 Stakeholder management	
3. DESIGN - MACRO SCALE	121
8.01 Macro- Site Planning	
8.02 Water retention	
8.03 Plans as per phases	
8.04 Sections	
D. DESIGN - MESO SCALE	135
9.01 Holy confluence	133
9.02 Planning	
9.03 Confluence Plan	
9.04 Sectional view	
IO. DESIGN DETAILS - MICRO SCALE	157
10.01Chosen locations	
10.02 Marsh island	
10.03 Northern fringe	
10.04 Route transformation	
10.05 Terrace edge treatment	
10.06 Multifunctional infrastructure	
10.07 Floating infrastructure	
10.08 User experience (Existing vs proposed)	
11. CONCLUSION & FUTURE RECOMMENDATIONS	211
12. REFLECTION	219
REFERENCES	226



ACKNOWLEDGEMENT.

The thesis is a result of my Master graduation project in Landscape Architecture track in the Faculty of Architecture and the Built Environment at Delft University of Technology, Netherlands. The project would not have been possible without the support and input of many people along the course of this year long explorative journey.

Foremost, I would like to express my gratitude for my mentors. To my first mentor Gerdy for your insightful comments which steered me in the right direction whenever I lost track. To my second mentor Marjolein, you guided me at every stage to strive for more, your critical and constructive advice helped me immensely in the writing process of this thesis. Thank you both for your shared knowledge, patience and sharing my passion, excitement for this holy landscape and how to develop it.

Further on I would like to thank all the officials and people of Prayagraj I consulted and asked questions for this project, who showed me around the site during my field trip.

I am grateful to all my friends in Delft and India who were my support system along this relentless journey. To my housemates and our morning tea sessions which were a driving force specially during restless days of the Corona-crisis. Special thanks to Shubhonil Chatterjee for all the chocolate, laughter and being my constant support.

At last, most importantly I would like to thank my parents and siblings back home in India. To my dad for always believing in me and my mom who went the extra mile by accompanying me for the site visit. This is for you!

Figure b

Migratory birds sitting on a make shift pontoon bridge, Prayagraj, India Figure source: Author, 2020



ABSTRACT

River Ganga is sacred to Hindus along every fragment of its length and serves as a lifeline to millions who live along its course (Acciavatti, Bierig & Corrigall, 2015). It flows through one of the most sacred pilgrimage spots in the city of Prayagraj, Uttar Pradesh where it meets its largest tributary Yamuna. The site at the confluence of these rivers hosts the Hindu festival — "Kumbh Mela" where myriads of pilgrims bathe in river Ganga. Pilgrims believe this will abolish them of their sins. An intense flow of people is a defining feature for this event which demands the deployment of a temporary city

The festival of 'Kumbh mela' generates conditions for constantly changing phases of festival, agriculture, deluge and preparation landscapes which frames the 'Genius Loci' of this dynamic floodplain landscape. The floodplains face several challenges due to their inability to adapt to changing functions of pilgrimage, agriculture, river swelling. In addition, advancing trends like climate change, unregulated urban sprawl and growing number of pilgrims threatens the dynamic nature and pristine aura of the holy floodplains and district of Prayagraj.

Foremost, the research aims at reading the floodplains of river Ganga at Prayagraj in India as more than just a physical landscape but a landscape with use and meaning attached to it. The festival of 'Kumbh mela' acts as an external force of human disturbance which renders the dynamic floodplain landscape in a constant state of flux. Thus, for the landscape to adapt to its changing nature resilience approach is chosen. This approach is essential for maintaining natural functions of the floodplains along with satisfying its local livelihoods and cultural values of festival and pilgrimage. Furthermore, the dynamic floodplain landscape is analysed and explored as per the threefold approach parameters of physical landscape, use and meaning in coherence with the inter-scale approach of macro, meso and micro scale.

Educating and bringing awareness among users about the dynamic nature of the floodplains of river Ganga at Prayagraj plays a crucial role to enhance the spatial and experiential value of the floodplain landscape. The intention is to spread awareness among people about the threatened state of their surrounding environment.

Thus, the project proposes a multi scalar approach integrated with the threefold approach parameters to create a multi-functional landscape framework to preserve the sanctity, identity of constantly changing floodplains of river Ganga at Prayagraj in India. This is implemented by assisting activities like crop cultivation, animal husbandry, fishery and tourism to co-exist with pilgrimage. The spatial strategies are envisioned as per the threefold parameters and executed by concept of ecological planning and designing with nature. These strategies are used to formulate a multi-functional landscape framework for the dynamic floodplains of river Ganga to provide resilience to the floodplains which helps them adapt to its constantly changing phases of festival, agriculture, deluge and preparation landscapes.

Figure c

Plan showing the existing holy confluence of river Ganga and Yamuna

Figure source: Google earth



AIM

The project seeks to achieve a balance between challenges faced by the dynamic floodplains of holy river Ganga at Prayagraj in India. These challenges arise due to the inability of floodplains to transition efficiently from different phases it acquires due to its constantly changing nature. Furthermore, future trends with respect to climate change, urban growth and increasing pilgrimage are intensifying these challenges which threaten the identity of this dynamic floodplain landscape. Thus, the project aims to show future spatial transformation of the floodplains to integrate different phases of pilgrimage, agriculture, monsoon and preparation to guide development in the region. Since the river is seen as holy, it is necessary to raise awareness among people about the surrounding dynamic nature of the holy floodplain landscape for a constructive future. The idea of intervening with this floodplain landscape will be challenging keeping in mind it represents constant change which forms the genius loci of the site. The project will also aim to create opportunity for local and seasonal workers to engage with this dynamic, constantly changing floodplain landscape of holy river Ganga at Prayagraj in India.

Figure d

Pilgrims travel across the pontoon bridge to access the holy confluence Figure source: Author, 2020

| INTRODUCTION |

1.1 CONTEXT

CHAPTER GUIDELINE

The chapters starts with the concept of holy nature of rivers in India followed by the site context and the festival of 'Kumbh mela' in India. It concludes with the starting point of fascination along holy flood-plains of river Ganga at Prayagraj, India for this graduation thesis project.

1.1.1 SACRED WATERS

In ancient Hindu mythology (800 BC) water is described as the foundation of whole world, the basis of life and elixir of immortality. In India, water has been an object of worship since centuries. It has diverse socio-religious uses and plays a central role in many religious ceremonies, festivals and rituals (Singh, 1994). Water in India is held sacred for the following reasons:

- •Indian rivers are believed to be divine manifestations and are worshipped as goddesses since ancient times shown in figure 1.01.
- •Water plays a vital role in religious ceremonies as it is considered a symbol of purification due to its ability to cleanse our body.
- Polluting water is a great sin according to various Sanskrit texts. (Narayanan, 2001)

1.1.2 HOLINESS OF RIVER GANGA

While all rivers are sacred in India, river Ganga is particularly seen as a physical embodiment of goddess Ganga shown in figure 1.02. It was believed that Ganga descended from the heaven from the hair-locks of Lord Shiva shown in figure 1.03. Since river waters have self-purification properties pilgrims bathe, drink and leave offerings in them and give their physical remains to them. It is believed to clarify the soul of negative Karma. At sunrise along Ganga, pilgrims descend into the river to drink its water, bathe themselves and perform rituals where they submerge their entire bodies in the river.



Figure 1.01
A statue of Ganga from Uttar
Pradesh, India, 5th century CE
Figure source: Wikimedia commons



Figure 1.02
Goddess of purity and purification, personification of river Ganga
Figure source: Wikipedia

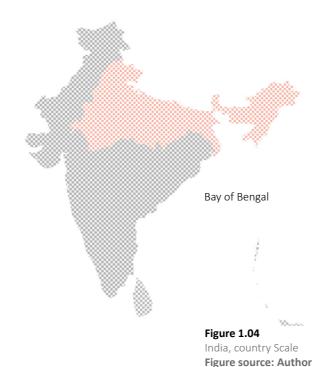
16



Figure 1.03
Shiva bearing the descent of Ganga river
Figure source: Wikimedia commons

1.1.3 SITE CONTEXT

River Ganga is the most sacred river in Northern India. It originates in the Himalayan mountains at Gaumukh, the terminus of the Gangotri glacier and empties into the Bay of Bengal. Its watershed supports one of the most fertile and densely populated regions on the planet. It covers an area of 1,016,104 sq. km. where more than 400 million people live in India shown in figure 1.04. River Ganga carries nutrient rich sediment as it flows depositing fertile soil along its banks allowing civilizations to develop and thrive along it for centuries (Acciavatti, 2015).



Its catchment lies in the Indian states of Uttar Pradesh (shown in figure 1.05), Madhya Pradesh, Bihar, Rajasthan, Haryana, West Bengal, Himachal Pradesh, Delhi and Arunachal Pradesh.

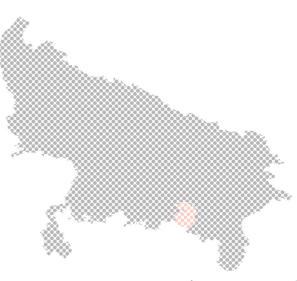


Surface area: 1,016,104 sq km Population density: 375 people per sq km

Figure 1.05
River Ganga watershed scale
Figure source: Author

Uttar Pradesh is the most densely populated state in Northern India. Two major rivers of the state are Ganga and Yamuna which join at Prayagraj. Since its location in the rich, fertile Indo-Gangetic plain agriculture is the largest employment generator in the state (Acciavatti, 2015).

Tourism is an important sector of Uttar Pradesh economy. The holy cities of Prayagraj, Varanasi, Mathura and Ayodhaya attract pilgrims from all over the world.

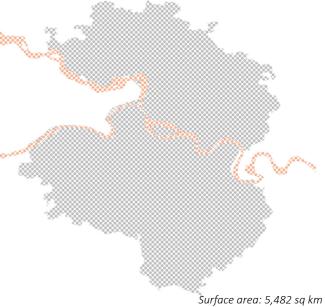


Surface area: 243,286 sq km Population density: 828 people per sq km

Figure 1.06
Uttar Pradesh, India, State Scale
Figure source: Author

Prayagraj lies at the confluence of rivers Ganga, Yamuna and mythological river Saraswati whose water is worshipped by the followers of Hindu religion (Acciavatti, 2015). *Triveni Sangam* or the three-river confluence lies in this district which is a holy site where millions of pilgrims gather every year to take a dip in the holy water of river Ganga shown in figure 1.07. It is a site of religious, historical and touristic importance and hosts the largest mass gathering 'Kumbh mela'.

The primary economic sectors of the district are religious tourism and agriculture.



Population density: 1,087 people per sq km gure 1.07

Prayagraj, Uttar Pradesh, India, district Scale
Figure source: Author

1.2 FASCINATION

The fascination towards the project commences from the constantly changing nature of the floodplain landscape. The floodplains of holy river Ganga at Prayagraj in India are in a state of constant flux as they transition from a festival to an agricultural to a deluged further into a preparatory landscape and back into a festival landscape all within the course of a year which forms the annual cycle of the landscape. This change is depicted in figure 1.08 below. The transformation makes the floodplains dynamic not just in terms of their function but also the user groups related to each function- pilgrims, agricultural workers, local communities, festival authorities etc.

Thus, the dynamic floodplain landscape of river Ganga at Prayagraj in India is not just a physical landscape but a social landscape with an inherent meaning and symbolism attached to it.

Different Phases of the constantly changing landscape

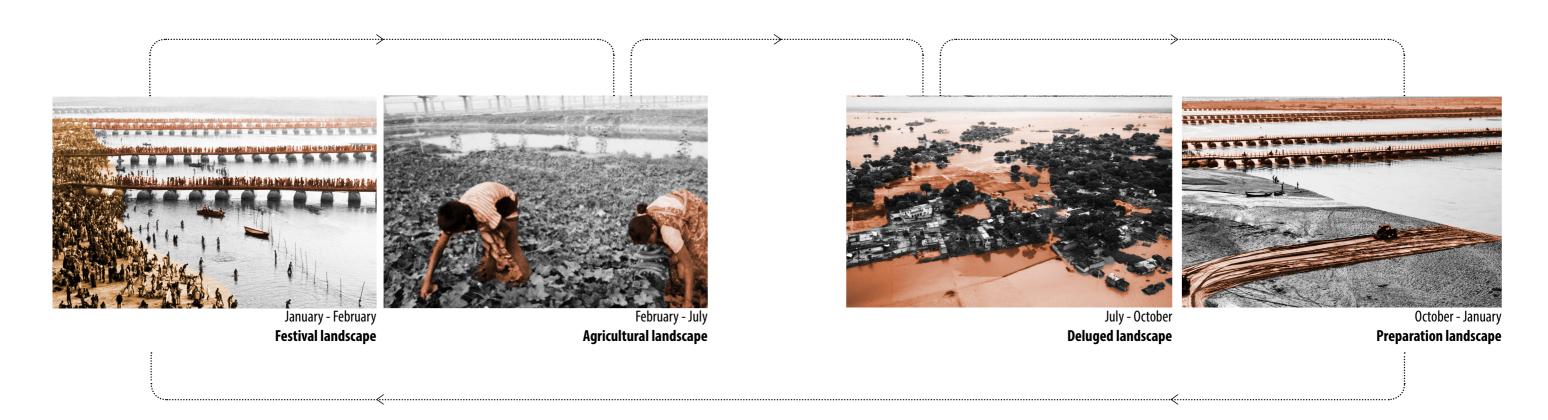


Figure 1.08
Phases of the dynamic floodplains
Figure source: Author

| RESEARCH OUTLINE |

CHAPTER GUIDELINE

The chapter gives an insight into the future hazards faced by the dynamic floodplain landscape of river Ganga at Prayagraj with respect to climate change vulnerability, urban growth and increasing pilgrimage trends. With the current challenges faced by the dynamic cycle, the problem statement is formulated followed by the research objective and main question for the graduation project. This chapter also demonstrates excerpts from the field trip with the voices and opinions of people from the site.

2.1 FUTURE CHALLENGES

2.1.1 Climate Change Vulnerability

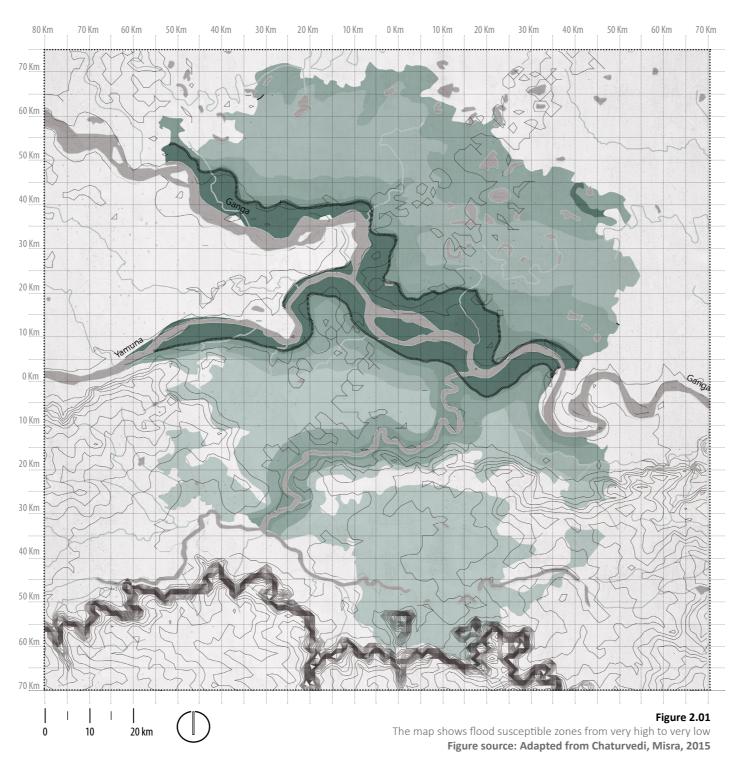
The climate of the region is an overlap between humid subtropical and semi-arid. The region experiences conditions of cyclic droughts and flooding due to this extreme climate condition.

ANNUAL TEMPERATURE : 25.7 OC AVERAGE ANNUAL RAINFALL: 981 MM

Very high flood susceptibility zones lie near river Ganga and Yamuna. The average height of these zones is less than 88m. The high flooding zones represent the old course of river. Moderate zones are relatively marshy and saline surfaces as shown in figure 2.01. (Chaturvedi, Mishra, 2015)

According to flood forecast information, India the very high flood susceptible zones experiences three levels of flooding - low to moderate flooding (occurs annually, water levels exceed normal river level), severe flooding (every 5-10 years water level slightly below highest flood level) and extreme flooding (10-15 years, water level equal to or above HFL- highest flood level.)

Very High flood susceptibility
High flood susceptibility
Moderate flood susceptibility
Low flood susceptibility
Very low flood susceptibility
Flood free zone



Cyclic Flooding and Drought Conditions

2010-2013 Floods



Inundated low lying areas near river Ganga
Figure source: NDTV India

Flooding is the main issue of low-lying areas near the floodplains which is caused by swelling up of river Ganga during periods of extreme rainfall as seen in figure 2.02. During the 2010 floods 135 villages faced harsh conditions, 7000 people were displaced to different relief camps.

Droughts

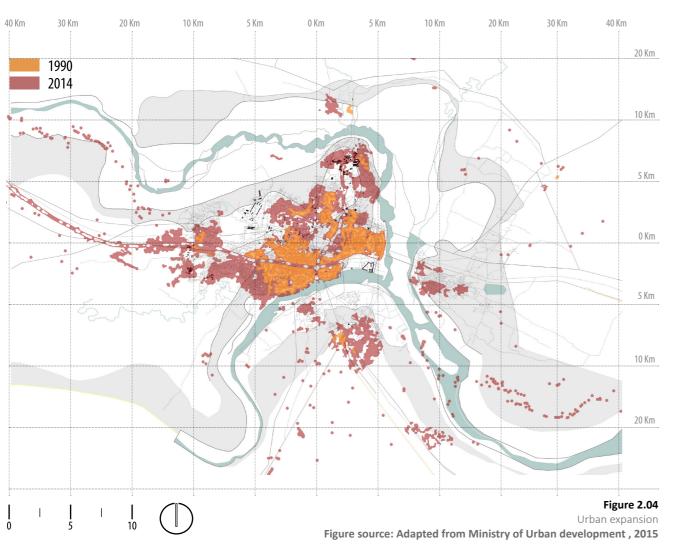


Drought hit floodplains of river Ganga at Prayagraj, Inda
Figure source: NDTV India

25

Severe drought conditions decimate crops, killed livestock and left millions without water for their daily needs. Water of Ganga is not only necessary to sustain human life but also required for sectors of religion, tourism, agriculture. Summer monsoon contributes to 70-90% of rainfall in the Ganga basin.

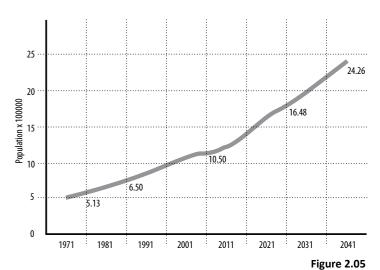
2.1.2 Rapid Urban Growth



The urban population of Prayagraj is on a constant rise due to livelihood opportunities the city offers. We see an increasing population trend as seen in figure 2.04 and 2.05.

Rural to urban immigration has contributed much to the city's population growth. Many migrants are male agricultural workers who are from low income groups (Misra, 1988) These people constitute a part of the population living near Ganga who are dependent on river related activities for their livelihood. This migration has various impacts on the landscape of the region which is shaped by its people as shown in figure 2.07. People no longer directly depend on the river which leads to river exploitation as seen in many parts of India like Delhi where the state of Yamuna is miserable due to its urban exploitation as shown in figure 2.06. Thus, it is important to provide permanent opportunities for people dependant on the river to protect its river landscape as well as livelihood of its people.

Therefore, urban expansion due to rural to urban migration leading to loss of livelihood and dependance of local communities on floodplains of river Ganga threaten its holy nature and dynamic identity.



Population trend and projection 1971 to 2041

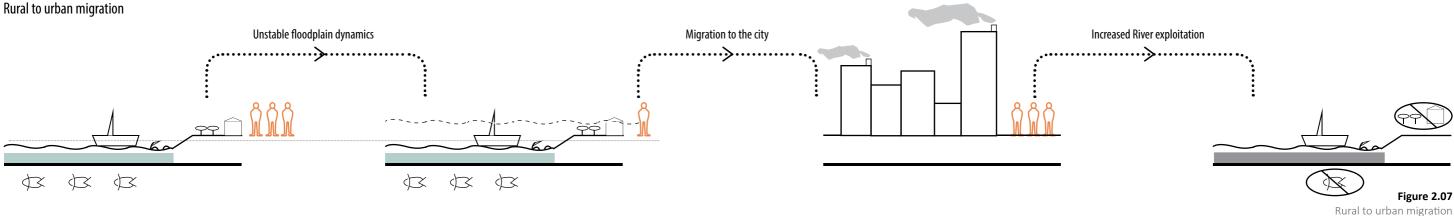
Figure source: City delevlopment plan for Prayagraj 2041, 2015

Extreme Scenario



Urban pollution of river Yamuna in Delhi Figure source:NDTV India

We already see river Yamuna in Delhi reduced to a dirty drain where all the untreated urban waste from the city is dumped into the river seen in figure 2.06.



26

Figure source:Author

2.1.3 Increasing Pilgrimage

Every year the district of Prayagraj experiences an increased number of visitors who visit the state for the purpose of pilgrimage as seen in figure 2.09.

Every year the festival authorities prepare a blue print for the temporary city. Even though water of river Ganga has a similar receding pattern, there is uncertainty among authorities due to prolonged time creating planning problems. With every 'Kumbh mela' festival more land is required to accommodate the growing number of pilgrims. This had led to the increase in 'Kumbh mela' grounds for the 2019 festival by 25% from 19.63 sq. km in 2013 to more than 25 sq. km in 2019 increasing the number of sectors (Dwivedi, Cariappa, 2015).

Growing number of pilgrims and uncertainty in festival ground availability add to the management problems of the authorities (Dwivedi, Cariappa, 2015).

Thus, increasing pilgrimage and prolongation in ground availability causes problems for the authorities to plan the festival for its large number of people. The authorities get a very limited number of days to prepare for the festival as the floodplain ground is ready for their access much later after the monsoon is over.

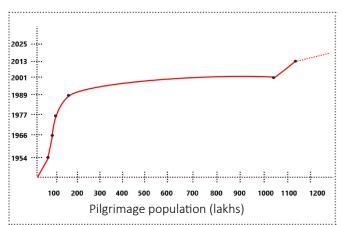


Figure 2.09

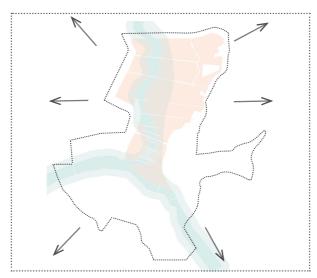


Figure 2.08
Ground expansion for the festival of 'Kumbh mela'
Figure source:Author



igure 2 10

Pilgrims waiting for their turn to bathe in water of Ganga Figure source: Author, 2020



2.2 DYNAMIC FLOODPLAIN CHALLENGES

Floodplains of river Ganga at Prayagraj undergo a series of challenges while transitioning from one phase into another as shown in figure 2.11. Each of these phases faces several challenges due to their inability to adapt to constantly changing functions. These challenges risk the dynamic identity of the landscape which contributes to the identity or genius loci of the site. Following are the challenges this dynamic floodplain landscape of river Ganga faces:

2.2.1 Challenges

(1 to 2) Festival to Agricultural Landscape

The festival of 'Kumbh mela' leads to the construction of a temporary city on an ecologically sensitive area which are the floodplains of river Ganga near the city of Prayagraj, India. This festival has adverse effects on the floodplains as well as its natural functions. After the festival is over, land is used for agricultural production. The festival leads to compaction of the floodplain due to which nutrient content of the soil is lost making the land unsuitable for agriculture. Thus, daily income of various communities like farmers, cattle herders and fishermen is affected, risking their livelihood.

(2 to 3) Agricultural to Deluged Landscape

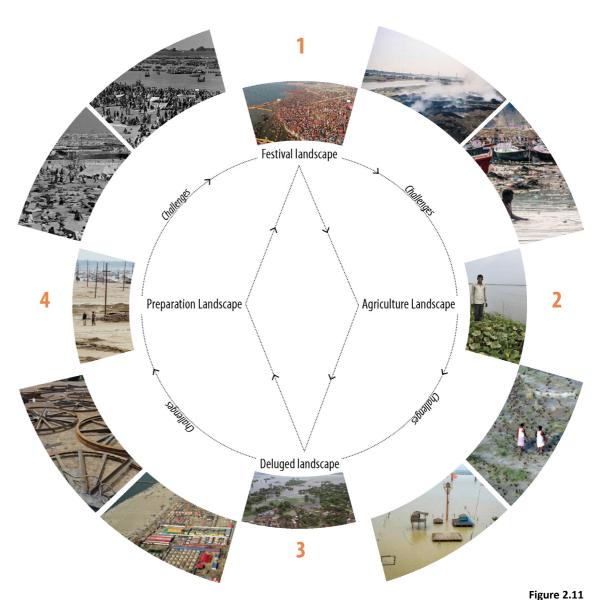
During the rainy season which usually lasts from July to October the river swells and the floodplains along with the nearby low lying areas are flooded and submerged in water. In 2013 the region experienced flooding of low lying areas due to which many people migrated away to the city of Prayagraj. Early onset of monsoon destroys agricultural produce leading to crop loss and land loss.

(3 to 4) Deluged to Preparation Landscape

Post monsoon the festival authorities wait for the water of Ganga to recede in order to plan for the festival and construction for the temporary city supporting millions of pilgrims. Even though the water of river Ganga has similar receding pattern, the prolonged time taken creates planning problems for mela authorities due to which they are unable to access the floodplains post monsoon.

(4 to 1) Preparation to Festival Landscape

Delays in construction for the festival leads to incomplete infrastructure provisions due to time constraints adding to the existing management problems for the authorities. The festival has already witnessed various threats in the form of stampedes and disease outbreaks in the past due to mismanagement.



Challenges faced by the phases of dynamic floodplain of river Ganga, Prayagraj, India

Figure source: Author, 2020

2.3 VOICES FROM THE SITE - ONSITE INTERVIEWS



Figure 2.12

Differet usergroups of the floodplain landscape Figure source: Author, 2020

For the purpose of evaluating and percieving the site, a set of onsite interviews were conducted where different users of the landscape were interviewed. These user groups included boatsman, fishermen, local residents, personal from the 'Kumbh mela' authority, priests, pilgrims etc as shown in figure 2.12. These people individually affiliate to the dynamic floodplain landscape and conveyed their hardships and connection with the floodplains and how its dynamic nature directly affects them.

The interactions were based on threefold approach parameters used for the analysis which are - physical landscape, use and meaning. These were relevant to understand the findings and problems directly from the people shaping the use, function and meaning of this physical landscape in order to drive conclusions for the vision and devise spatial strategies used for intervening with the dynamic floodplains of river Ganga at Prayagraj in India.

The interviews were taken on a one to one basis personally in the period of February 2020.



THE MAIN CONCERNS FOR THE AUTHORITY IS INACCESS TO THE FLOOD-PLAINS POST THE MONSOON WHICH DELAYS PREPARATION FOR THE FESTI-VAL.

- 29 year old festival authority, Manish Dubey, Prayagraj, Uttar Pradesh



I LIVE IN THE DARAGANJ VILLAGE, EVERY FEW YEARS MY HOUSE GETS FLOODED DURING THE MONSOON SEASON AND I RELOCATE TO THE CITY WITH MY FAMILY.

- 36 year old fruit seller, Narayani, Prayagraj, Uttar Pradesh



THE GROUNDS FOR THE FESTIVAL OF 'KUMBH MELA' HAVE TO BE LEVELLED EVERY YEAR, WE EXCAVATE THE ELEVATED GROUNDS DUE TO SILT DEPOSITS BROUGHT BY RIVER GANGA AFTER IT FLOODS THE FLOODPLAINS TO MAKE IT EVEN FOR THE CONSTRUCTION OF THE TEMPORARY CITY.

49 year old Kumbh ground levelling worker, Sadhvir



MY HOUSE GETS FLOODED ONCE EVERY 2-5 YEARS AND WE LIVE WITH FLOODWATER IN OUR HOUSES TILL THE WATER RECEDES.

70 year old inhabitant of Govindpur village, Sushma Devi



I START WORKING AT 6 AM IN THE MORNING UPTO 6 PM. DUE TO LESSER BOATS DURING OFF SEASON I SOMETIMES PRACTICE AGRICULTURE NEAR SHASTRI PULL.

- 20 year old boatsman, Anil Kumar, Prayagraj, Uttar Pradesh





MY LIVELIHOOD AND INCOME CAME TO A STANDSTILL DURING THE MON-SOON SEASON WHEN BOATING WAS PROHIBITED DUE TO INACCESS TO THE FLOODPLAINS.

- 19 year old boatsman, Jagdish, Prayagraj, Uttar Pradesh



THE 2019 KUMBH FESTIVAL LED TO A LOT OF INFRASTRUCTURE DEVELOP-MENT IN THE CITY OF PRAYAGRAJ DUE TO LARGE INFLUX OF PEOPLE AND TOURISTS. WE CAN NOW PROUDLY SHOW OUR CITY TO THE OUTSIDERS AND VISITORS.

- 63 year old resident, Prayagraj, Uttar Pradesh



THE FLOODPLAINS FURTHER FROM TRIVENI SANGAM AREA INACCESSIBLE AFTER THE FESTIVAL IS OVER (6 YEAR CYCLE).

- E-rickshaw driver, day 2, Prayagraj, Uttar Pradesh



MY FATHER AND GRANDFATHER PRACTICED AGRICULTURE ON THE FLOOD-PLAINS. HOWEVER THEY SUFFERED HUGE LOSSES DUE TO FLOODS. SEEING THIS I DECIDED TO START MY OWN SHOP AND BUSINESS.

- 40 year old local ,Dilip Tiwari, Prayagraj, Uttar Pradesh



THERE IS NO WAY TO ACCESS THE FLOODPLAINS AFTER THE FESTIVAL IS OVER. THERE IS NO ROUTE FOR THE BIKES OR E-RICKSHAWS TO ENTER THE AREA. IT IS ONLY ACCESSIBLE DURING THE FESTIVAL OF 'KUMBH MELA' WHEN TEMPORARY ROADS AND BRIDGES ARE CONSTRUCTED.

E-Rickshaw driver, day 3

Figure 2.13
Boatsman rowing to reach the holy confluence at Prayagraj, India
Figure source: Author, 2020





I OWN A SHOP AND ONLY WORK DURING THE KUMBH FESTIVAL FOR 2 MONTHS, POST THE FESTIVAL I AM UNEMPLOYED FOR REST OF THE YEAR.

32 year old shop vendor, Preeti Nissad



I WANT TO MIGRATE TO THE CITY IN SEARCH OF A STABLE JOB OPPORTUNITY.
MY WIFE AND KIDS PRACTICE SMALL SCALE WHEAT FARMING.

41 year old boatsman, Rajiv Nissad



THIS PLACE IS DIVINE AND SACRED. I VISIT THE FESTIVAL OF KUMBH EVERY YEAR WITH THE DEVOTEES TO WORSHIP THE WATERS OF RIVER GANGEA AT TRIVENI SANGAM.

- 75 year old priest, Prayagraj, Uttar Pradesh



WE RARELY GO TO THE SOUTH OF YAMUNA AS IT IS LESS POPULAR AMONG PILGRIMS AND TOURISTS.

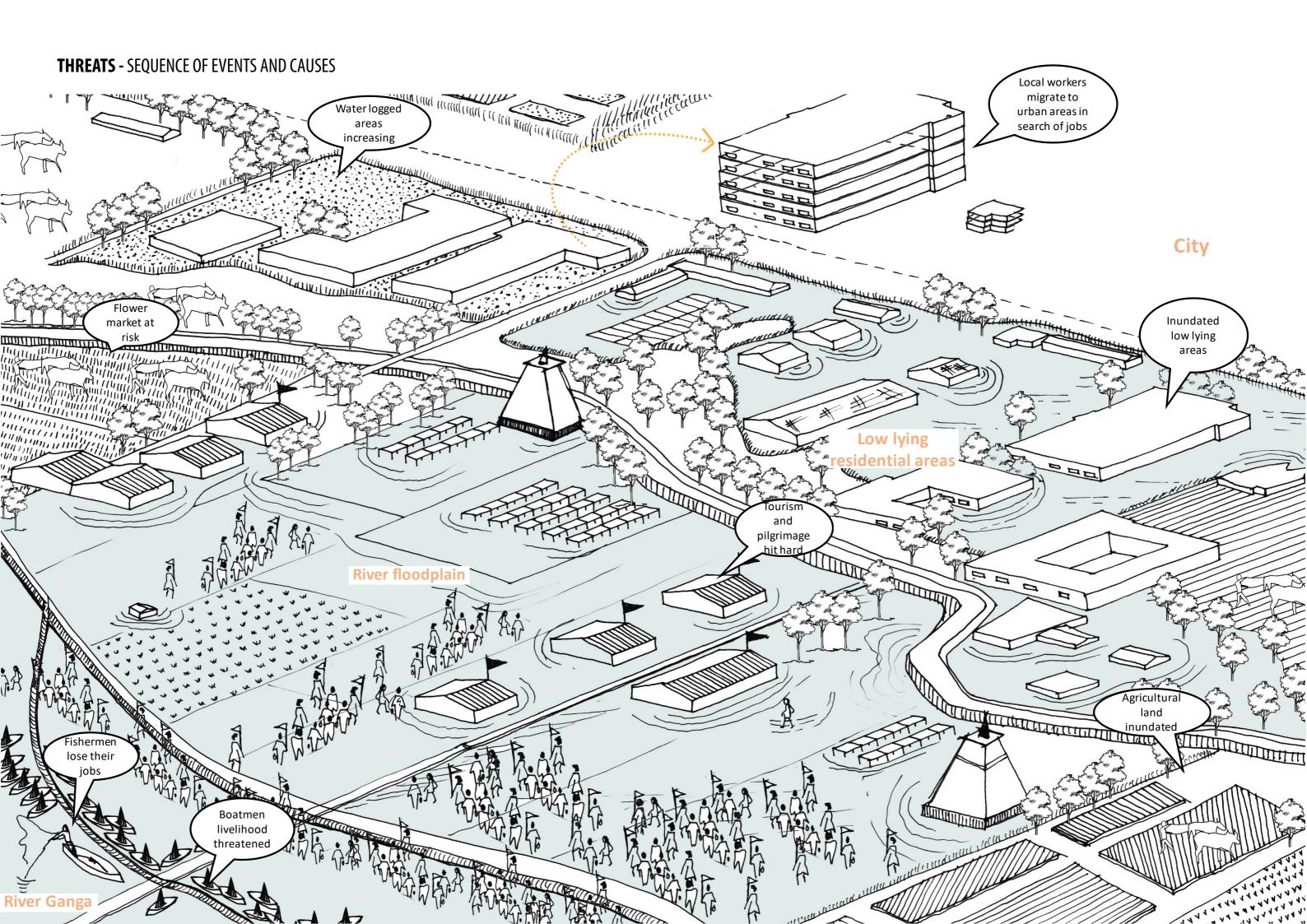
E-Rickshaw driver, day 4, Ashish



GOD AND THE WATER OF RIVER GANGA CALLS US EVERY YEAR TO THIS SACRED PLACE.

- 70 year old pilgrim, Prayagraj, Uttar Pradesh

Figure 2.14
Ground levelling workers, levelling floodplains
Figure source: Author, 2020





2.4 PROBLEM STATEMENT

SEEKING QUEST

River Ganga is a holy river whose water is worshipped by the followers of Hindu religion, it is believed taking a dip in its water will abolish one of all sins and lead them towards the path of salvation. This belief has led to various pilgrimage sites along the banks of river Ganga where pilgrims come to bathe in its holy water. One such site is the confluence of rivers Ganga, Yamuna and mythological river Saraswati near Prayagraj in India which hosts the festival of *'Kumbh mela'*, the largest mass gathering in the world where pilgrims practice the ritual of mass bathing (Acciavatti, 2015).

The floodplains of Ganga near the city of Prayagraj in India are dynamic in nature. It is under a constant process of change transforming from a temporary city during the Kumbh festival into an agropolis post festival. This process occurs every year: from a festival landscape to an agriculture landscape to a monsoonal deluge to a preparation landscape back to a festival landscape. This transformation is a slow process and does not take place instantly. The 'Kumbh mela' festival causes damage effecting the agricultural use of the floodplain making the region vulnerable to change and threatening its dynamic nature. Future challenges with respect to climate change, urban growth and increasing pilgrimage are deteriorating the landscape. The local communities directly dependent on river for their livelihood are most vulnerable due to its threatened state. Hence, the statement arises: The identity, sanctity of constantly transitioning floodplains of Ganga are threatened due to its inability to adapt to functions of pilgrimage, cultivation and river swelling making it vulnerable to its dynamic nature. This deprives the local community a sustainable relationship with their surrounding environment.

Cultivation of mustard plant and disassembled pontoon bridge on the dynamic floodplains of river Ganga at Prayagraj, India
Figure source: Author, 2020



2.5 RESEARCH OBJECTIVE & MAIN QUESTION

+ SUB QUESTIONS

RESEARCH OBJECTIVE

The project seeks to achieve a balance between dynamic floodplains of the holy river Ganga at Prayagraj in India and the challenges intensified with climate change, urban growth and increasing pilgrimage patterns.

MAIN QUESTION

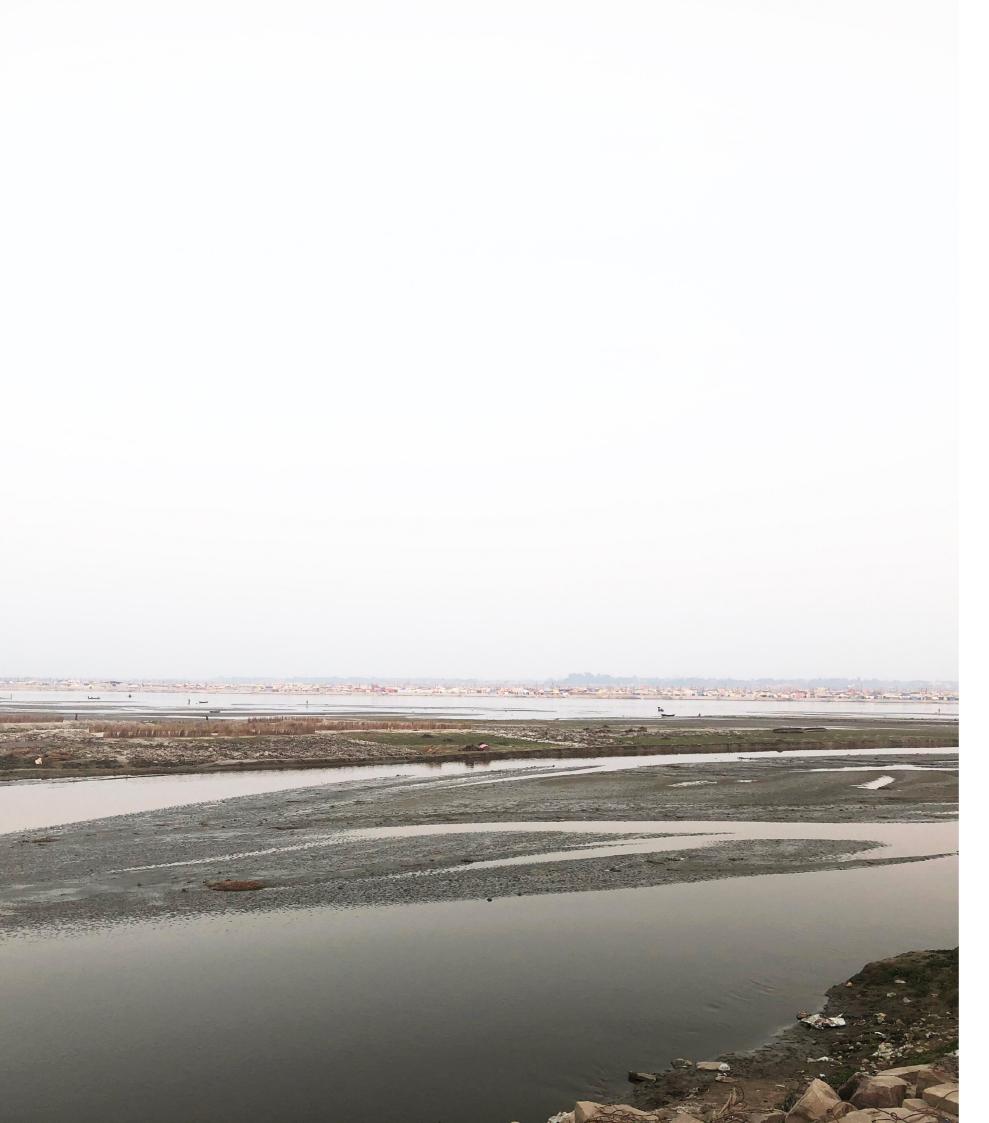
How can the dynamic floodplains of holy river Ganga at Prayagraj in India be designed in order to adapt to its changing nature and diverse phases of festival, agriculture, monsoon and preparation landscapes?

SUB QUESTIONS/ ADDITIONAL QUESTIONS

- SQ 1. How has the festival of pilgrimage "'Kumbh mela'" impacted the floodplains and its natural processes?
- SQ 2. What effect does the constantly changing nature of the floodplains have on its local communities?
- SQ 3. How to create a landscape framework where activities like crop cultivation, animal husbandry, fishery and tourism co-exist with pilgrimage?
- SQ 4. What are the different possibilities of using changing cycles of festival to make the dynamic floodplains self sustainable?
- SQ 5. How can landscape and ecology be used to improve relationship between changing phases of floodplain landscape with its users?

Figure 2.16

Temporary tent infrastructure on the dynamic floodplains of river Ganga at Prayagraj, India
Figure source: Author, 2020



2.6 SCOPE AND RELEVANCE

This graduation project will focus on the dynamic floodplain landscape of river Ganga at Prayagraj, Uttar Pradesh in India. The region supports various sectors of the economy - religious tourism, crop cultivation, animal husbandry and fishery directly dependent on the holy river. Floodplains are the most dynamic part of the system undergoing extreme changes within span of a year, every six years and twelve years. These changes bring with them a set of challenges which renders the floodplains vulnerable and unstable hindering their natural process and functions.

The relevance of this graduation project is also meant to study the potential of landscape design to provide strategies for creating stabilized conditions for dynamic floodplains which can help to preserve the holy character of the landscape in coherence with its physical setting and usage.

Figure 2.17
Okra cultivation and submerged land on floodplains of river Ganga at Prayagraj, India
Figure source: Author, 2020

| METHODOLOGY |

CHAPTER GUIDELINE

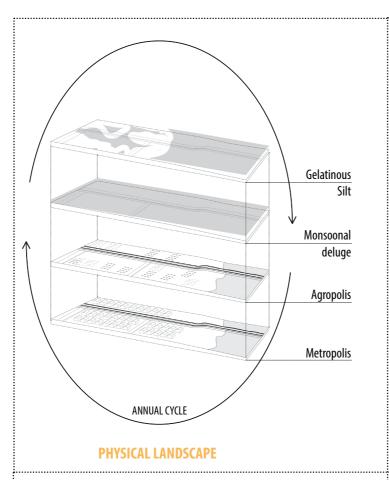
This chapter starts with theoretical background of 'Dynamic landscape theory', 'Landscape resilience' and 'Designing with Nature'. It covers the 'threefold' approach research method utilized along with the interscale mapping mapping approach, concluding with the research outline and time framework for the graduation thesis.

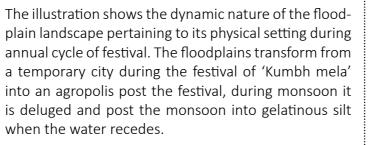
3.1 THEORETICAL BACKGROUND

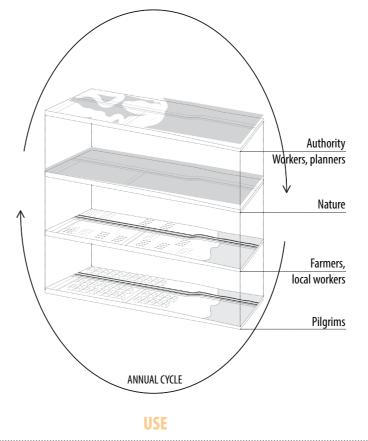
The principal aspiration to purse this graduation thesis was the dynamic nature of the floodplains of river Ganga at Prayagraj in India. The notion was to finding solutions for the challenges faced by this dynamic landscape which would lead to preserving and enhancing its 'Genius of the loci'. For achieving this, it is essential to read the landscape and understand the different types of the dynamic processes the floodplains encounter. For instance, the 'threefold' research approach adopted simplifies the dynamic nature of the site with respect to its physical landscape, use and meaning as depicted in figure 3.01.

This chapter starts with theoretical backup on the existing data with respect to Dynamic landscapes which helps in conceptualizing this project in a broader context and defining the broad term 'Dynamic' pertaining to the chosen site of floodplains of river Ganga at Prayagraj in India. 'Landscape resilience' and 'Design with Nature' are other key concepts which help to equip the floodplains to their constantly changing nature, thereby making them adaptive to its changing phases and resilient to existing as well as future challenges.

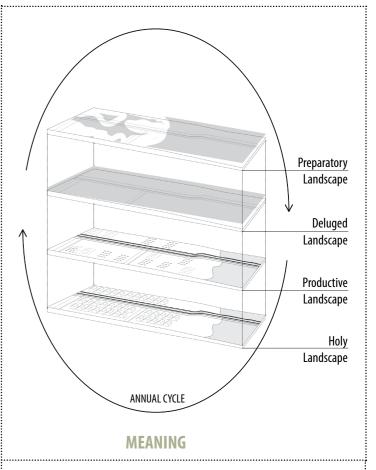
The threefold research methodology adopted as explained in section 3.2 along with the inter-scale mapping technique helps in guiding the design vision and spatial strategies for the dynamic flood-plains of river Ganga at Prayagraj in India.







The dynamic nature of the landscape pertaining to its usage function is shown in the above illustration. The primary user group of the floodplain's changes from pilgrims during the festival, to agricultural workers post the festival. It is taken over by nature during the monsoon deluge and later by the authorities and local workers post the monsoon when they start preparing for the festival.



The floodplains are dynamic also pertaining to its meaning. Their meaning changes as they shift from one phase to another. During the festival it is primarily looked at as holy post which it transforms into a productive landscape. During monsoon it is seen as a deluged landscape and post the monsoon into a preparatory landscape.

Figure 3.01

Dynamic parameters of floodplains of river Ganga as per the threefold approach

Figure source: Author, 2020

3.1.1 DYNAMIC LANDSCAPE THEORY

"Dynamic Landscapes" refers to every change that occurs in the physical, biological and cognitive assets of a landscape (Farina, 2017). Dynamic nature of the landscape can be driven by external forces of sedimentation, erosion, extreme climate events as well as human intrusions. The internal influences which make the landscape dynamic being — physical flow of matter, population fluctuation and changes in the user groups. Dynamic landscapes entail properties like landscape resilience, stability and adaptive landscapes.

Dynamic landscapes inevitably predict the need for new modalities of practice that rethink the static nature of the built environment. Intertwined with direct implications for planning, policies and development, dynamic landscapes are vital for a new landscape architectural paradigm (Abudayyeh, 2019).

Thus, acquiring knowledge on landscape dynamics and the reason behind its dynamic nature is important to understand and manage our surrounding environment.

The floodplains of river Ganga at Prayagraj in India constitute changing phases in the landscape as it changes from festival, agriculture, deluged to a preparation landscape within the span of a year. The primary reason behind this change is the external influence or human intrusion of the festival of 'Kumbh mela'. However, it is essential to understand apart from these changing phases this landscape is also sensitive to its ecological, cultural and functional changes. These changes are characterized with respect to evolving relationship among the floodplain's physical setting, use and meaning. These parameters form a structure which have varying levels of activity and impact on the floodplain landscape as shown in figure 3.02.

The festival of 'Kumbh mela' is an important religious Hindu festival which occurs on the floodplains of holy river Ganga at Prayagraj in India. The festival disrupts the natural functions of the floodplain landscape having a profound impact on the local ecosystem. Hence, it acts as a disturbance to the normally functioning landscape of river Ganga at Prayagraj in India.

"Disturbances" alter the system state and the trajectory of an ecosystem (Turner, 2010). However, the landscape may not always be resilient to its dynamic nature caused by disturbances, but disturbances are a part of ecosystem dynamics and alter landscapes across all scales. Therefore, it is essential as landscape architects to understand the dynamic nature of landscapes due to the disturbances they incur and increase their resilience in the ecological and social system to reduce their vulnerability (Turner, 2010).

Landscape multi-functionality provides a stage to unravel effects of change due to disturbances and make the landscape more adaptive to its constantly changing nature. Thus, the need for multi-functional landscapes which provide food, livelihood, security, maintenance of species, ecological functions, cultural and aesthetic functions is now recognized (Turner, 2010). Sustainable multi-functional landscapes are landscapes created and managed to integrate human production and landscape use into ecological fabric of a landscape maintaining critical ecosystem function, service flows and biodiversity retention (Farrell, Anderson, 2010).

SYSTEM'S THEORY

The main aim of the systems theory is to help landscape architects to deal with complex environments which are constantly changing. It helps in looking at landscape as a system rather than a spatial entity. It is useful in case of river Ganga due to the constantly changing nature of its floodplains which induces a constant state of flux in its floodplain landscape. The system approach helps in looking at the floodplains of river Ganga at Prayagraj in India in order to better understand the inter-relationship between its changing phases of festival, agriculture, monsoon and preparation landscapes.

SYSTEMS APPROACH FOR DYNAMIC LANDSCAPES

The systems theory helps in looking at a dynamic landscape as a system. The basic challenge of landscape architecture is to manage the dynamic interrelationships between cultural and environmental systems (Senge, 1990). Thus, this theory is important to simplify this inter-relationship and manage changes associated with dynamic landscapes on a holistic scale.

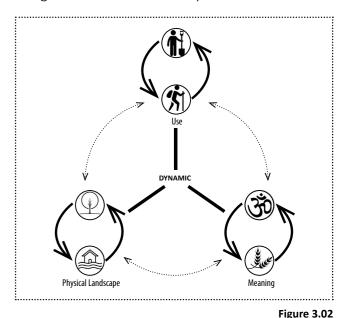
Following reasons substantiate the importance of this theory which are essential for this graduation project:

- The environment is highly complex and requires a systems approach to understand it.
- The dynamic nature of the environment leads to constant change and requires continuous learning about the inter-relationships for a successful design process.
- Design problem is an unending process because problems and solutions are in a constant flux.

CONCLUSION

The festival of 'Kumbh mela' is an external human influence or 'disturbance' which renders the floodplains dynamic. This dynamic nature of the floodplains can also be constituted with respect to external influences of sedimentation, erosion and internal influences of changing functions, community functions etc. These are crucial to understand the patterns and process occurring in a landscape. Thus, it is vital to preserve this dynamic nature and make landscapes adaptive to change increasing their resilience to disturbances.

A systems approach includes understanding and managing integral features pilgrimage, monsoon, agriculture etc. with their supporting landscape to improve their inter-relationship. The design ideas or interventions which result in changed environments should be evaluated keeping in mind their integration with the whole system.



Dynamic Aspects of floodplains of river Ganga as per the threefold approach

Figure source: Author, 2020

51

3.1.2 LANDSCAPE RESILIENCE

'Resilience' refers to the system's ability to absorb change in response to disturbance and to return to its former state through learning and renewal (Folke, 2002). An ecosystems ability to recover from disturbance and return quickly to its prior state is a measure of its stability (Folke, 2002). Ecological landscape resilience is a powerful tool for landscapes to recover from constant change they are subjected to. Hence, the study of this theory was an important step in the process of this project as it offers a solution approach towards this dynamic floodplain landscape of river Ganga at Prayagraj in India.

The floodplains of river Ganga are a dynamic land-scape having a multitude of dynamic components. This highly influenced landscape has the potential to support biodiversity, livelihood functions of its people, connect people with nature along with hosting the massive religious Hindu festival of 'Kumbh mela' on its floodplains. However, all these functions of this dynamic floodplain land-scape present a challenge to resilient based ecosystem management. In this context, an understanding of the landscape attributes is essential to understand resilience-based designing strategies in order to envision an adaptive, resilient framework for this dynamic floodplain landscape of river Ganga at Prayagraj in India.

Hence, it is important to understand behavior of complex ecosystems and their human interactions. This is captured in the model of ecosystem dynamics developed by Holling where periods of gradual change are disrupted by rapid transformation as shown in figure 3.03. During the reorganization of the back loop the system may develop according to a different trajectory (Holling, 1986).

Resilience approach of a socio-ecological system is further related to the degree of which the system is capable of self-organization and its capacity to adaptation. The floodplains of river Ganga at Prayagraj in India are subjected to overuse and exploitation during the festival of 'Kumbh mela', post which the floodplain landscape attempts to heal itself before it is given back to nature where a series of natural processes lead to its reorganization to prepare it again for the festival as shown in figure 3.03.

MECHANISMS OF LANDSCAPE RESILIENCE

Ecosystems are complex and adaptive with non-linear dynamics and thresholds between qualitatively different states of landscapes (Levin, 1999). Human interactions with landscapes in the form of pilgrimage or agriculture is affecting the underlying capacity of ecosystems to generate services at different scales.

'Landscape resilience' is defined as the ability of a landscape to sustain desired biodiversity and ecological functions over time in the face of climate change and other influences (Beller, 2018).

Many landscape attributes widely contribute to landscape resilience, with supporting empirical studies – diversity, functional redundancy, connectivity between habitats etc. Other attributes which are relevant in managing ecological resilience include – setting, processes, scale, people etc

1. SETTING: The geo-physical elements of soil, geology, topography etc. form the setting attribute

of landscape resilience. The influence of land use and history in shaping the landscape is essential along with locally adapted populations as they may offer areas of high resilience.

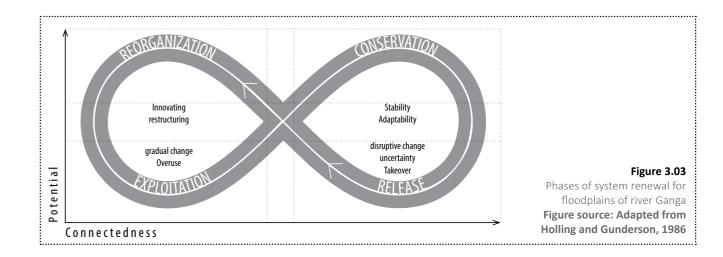
- 2. PROCESS: This includes the movement of materials, energy and processes of sedimentation and erosion which create and sustain landscapes enabling recovery and persistence of habitats, for instance, sediment-vegetation interactions.
- 3. CONNECTIVITY: Linking habitats and processes with locals, inhabitants and users of the landscape to enable migration of material and species.
- 4. DIVERSITY: Including diversity of habitat types that creates conditions for variety of flora and fauna to exist.
- 5. PEOPLE: This attribute refers to the people, users, inhabitants of the landscape which help in shaping the landscape. Public participation and guiding local communities facilitate integration of ecological functions.

It is essential to keep in mind the above-mentioned attributes while aiming a design to achieve landscape resilience.

Thus, resilience approach is important for this thesis as it addresses capacity of local ecosystems to adapt to human domination as they are essential for satisfying local livelihoods through agricultural and forested ecosystems but also to meet its cultural values of festival and pilgrimage.

CONCLUSION

In this research the approach of resilience with respect to complex adaptive systems based on ecosystem development is used. The local management practice including local customs, social norms and conventions and procedures for decision making are kept in mind. This helps in setting conditions for human interaction with the ecosystem improving socio-ecological resilience.



3.1.3 DESIGN WITH NATURE, Ian McHarg

One of the first designers who chartered a comprehensive way of multi-functional landscape design and planning was Ian Mcharg, 1969 in his book "Design with Nature" as shown in figure 3.04. He presents an ecological design concept that is based on ecosystem services, and he lays the foundation for using ecological science as the base for design and decision making.

In his book he mentions eight natural processes which have been measured and each described with an eye to permissiveness and prohibition to certain land use. These processes are as follows:

SURFACE WATER

Land uses that are integral to waterfront locations should occupy them and they should be limited to those which do not decrease the value of surface water for supply, recreation or amenity. In the cases of water usage that do not damage these water resources fall agriculture, forestry, recreation.

MARSHES

Land use policy for marshes should reflect the roles of flood and water storage, wildlife habitat and fish spawning grounds. Land uses that do not diminish the operation of the primary roles include recreation, certain types of agriculture and isolated urban development.

FLOODPLAINS

Floodplains should be accepted as those areas from which all development should be excluded except for functions which are unharmed by flooding or for uses that are inseparable from floodplains. For instance, in the dynamic floodplains of river Ganga the religious rituals are inseparable from its floodplain due to the holy nature of its water and a regarding for people's beliefs in it.

AQUIFERS

An aquifer is a water bearing stratum of rock, gravel or sand. This valuable resource should be managed and protected well. Development that includes disposal of toxic waste, biological discharges or sewage should be prohibited. Agriculture, forestry, recreation and low-density development pose no danger to this resource while industry and urbanization in general do.

AQUIFER RECHARGE AREAS

Such areas are the point of intersection between surface water and aquifers. These points of intersection are critical for management and protection of ground water. It is the movement of ground to surface water that contributes water to river and streams during periods of low flows.

PRIME AGRICULTURAL LAND

Prime agricultural soils represent the highest level of agricultural productivity, they are uniquely suitable for intensive cultivation. It is extremely important to defend agricultural lands from cheap housing or development. We need to recognize the long-term value of agricultural lands or the irreplaceable nature of these living soils.

FORESTS AND WOODLAND

Forests and woodlands improve the micro-climate and exercise a major balancing effect upon the water regimen diminishing erosion, sedimentation, flood and drought. The scenic role of woodlands is apparent as is their role as habitats for recreation. In addition, forests are low maintenance, self-perpetuating landscapes.

Forests can be employed for timber production, water management, wildlife habitats, recreation or for any combination of these uses.

STEEP LANDS

Steep lands and its ridges are central to the problems of flood control and erosion. The reasons for erosion these lands are unsuitable for development. Steep slopes should be majorly forested, and their cultivation should be abandoned.

The land use compatible with this role would be mainly forestry and recreation with low density housing permitted on occasion.

CONCLUSION

The holy floodplains of river Ganga at Prayagraj in India are an ecologically sensitive area whose natural functions are disrupted by the festival of 'Kumbh mela'. To make the floodplains resilient to this disturbance and adapt them to their changing phases of festival, agriculture, deluged and preparation it is essential to keep in mind these natural functions as basis for designing.

For instance, the festival of 'Kumbh mela' is inseparable from the dynamic floodplains due to the holy nature of river Ganga. Thus, designing with keeping ecosystem functions as foundation is crucial for landscape regeneration following the festival as an external disturbance.

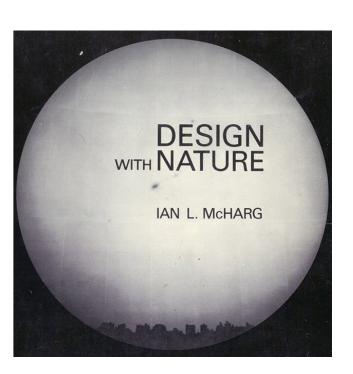


Figure 3.04 lan Mcharg's book ' Design with nature', 1969 Figure source: Architectural archives of the University of Pennsylvania

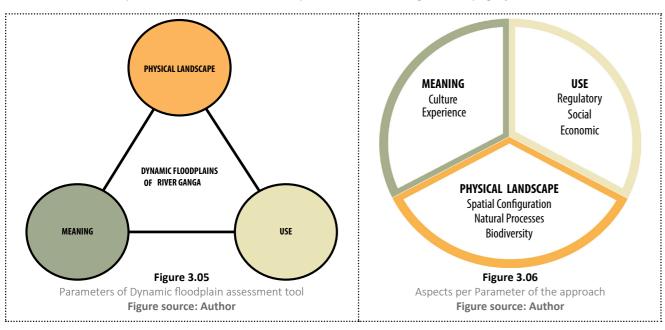
3.2 RESEARCH METHOD - THREEFOLD APPROACH

Three parameters which play an important role in shaping the landscape of the region are - physical landscape, use and meaning which constitute the three parameters of research methodology adopted – 'Threefold approach', by (Taverne and Verschuure-Stuip, 2019). The approach seeks in reading the landscape as per the three parameters of - physical landscape pertaining to tangible aspect of the ecosystem, use which pertains to different functions which are supported by it and meaning associated with the symbolic value and inherent character of landscapes.

The inter-relationship of these three parameters is directly impacting the floodplains of river Ganga at Prayagraj in India as depicted in figure 3.05. This approach is a perfect blend of the threefold approach by Taverne and Verschuure-Stuip, 2019 where spatial integration compares to physical landscape, so-cio-economic value compares to functional utility of the landscape and the user's experience compares to meaning of the landscape or its holiness.

To come up with a resilient, nature-based vision for the site and to develop a landscape framework, a combination of - social development, economic development and environmental development needs to be considered. In this project it is important to engage pilgrims and local communities with the dynamic floodplain landscape of Ganga river by creating awareness and educating them. Sectors of religious tourism, agriculture, fishery and animal industry need to be preserved to facilitate economic development in the region. In addition, resilient based design strategies need to be used to adapt to the changing conditions of floodplains and preserve its dynamic identity leading to advancement of the environment.

Therefore, the threefold research approach offers three essential parameters which are used to understand all aspects of the dynamic floodplain landscape and then used to formulate a vision in order to establish a landscape framework for the floodplains of river Ganga at Prayagraj in India.



3.2.1 PHYSICAL LANDSCAPE

Physical landscape is used as one of the parameters to understand the material content or tangible aspects of the landscape which include- spatial configuration, natural processes and biodiversity as shown in figure 3.06. These aspects are tactile and objectively measurable constituting the actual space. This parameter is a combination of physical aspects of the floodplain like dimensions, materiality, processes etc. This method is used for the characterization of the floodplain landscape aiming at identification and classification of floodplains as per its physical setting.

There are two major processes involved in the natural development of floodplains: erosion and sedimentation, these form the geology of the floodplain which are important to understand the natural processes it undergoes over a period. One of the most important geologic features of a floodplain are its fluvial terraces which mark the varying levels of floodplain elevation. Floodplains have rich biodiversity; they boast greater biodiversity than the river themselves. As this research is done from a landscape architectonic point of view biodiversity is an important aspect. In order to effectively operate our environment, we need to effectively read the natural environment in order to facilitate our goals. The physical aspect of the urban environment helps us in understanding spatial integration of the landscape. It also helps in analyzing the extent of impact the religious festival of 'Kumbh mela' has on the floodplains and its natural processes.

3.2.2. MEANING

"A sacred landscape is a temporal and spatial fabric spread over a geographic region unifying all the rituals conducted at the various sacred places within a framework." (Taylor, 2012)

The meaning of a landscape is created and transformed by human symbolic actions. The symbolism of a place is the reality which communicates an intangible notion with respect to the space. Thus, a place can be termed 'symbolic' whenever it means something to a group of individuals. In this case, the floodplains of river Ganga at Prayagraj in India has an inherent symbolic value attached to it due to its holy nature pertaining to the concept of river worship in India. Symbolism also endows a landscape with a name, identity, permanence and reason for existing as per the value and meaning it holds (Monnet, 2011). Thus, the aim of this parameter is to demonstrate the symbolic issues of the floodplains of river Ganga at Prayagraj in India by identifying places in the landscape with respect to their symbolic load. The aspects of this parameter include cultural and experiential value of the landscape which are highlighted in figure 3.06.

SYMBOLIC MEANING

Traditional cultural geographical approaches to the study of religion mainly seek to determine religions impact on landscape. A more contemporary approach highlights the role of religion in affecting landscape changes and in assigning sacred meanings to specific places (Lily, 1990). Religious experiences and the belief in religious meanings transforms physical spaces into sacred spaces.

These perceptions and meanings influence the way such spaces are used, and the personal spiritual meanings developed in using such sacred spaces.

Landscapes convey symbolic meaning If they represent objects, ideas, beliefs etc. related to specific locations, these place based features function as symbols and establish a sense of meaning to the landscape. This distinctiveness or parameter of the landscape doesn't lie in its physical forms, use and arrangement, but the meaning accorded to it by community, user groups of concerned people (Monnet, 2011).

Therefore, in the dynamic floodplain landscape of river Ganga at Prayagraj the symbolic meaning of the landscape is defined by the holiness of river Ganga and its floodplains which determines the religious significance of the 'Kumbh mela' festival on its floodplains.

CONCLUSION

A landscape is that which is experienced and lived in, it is laden with meanings. How a landscape is experienced depends on factors related to the individual and cultural background of the community. Meanings are attributed to a landscape based on how and why we are familiar with it. For instance, the same floodplain can be an everyday workplace for one person, while for another it can evoke a memory of the religious beliefs and rituals associated with it.

The way in which the landscape is experienced is affected not only by that which is seen and sensed, but also that which is experienced emotionally or imagined through knowledge or memory (Fairclough, 2006). This approach is thus essential for this research as it looks at the floodplains of river Ganga a landscape embedded with meaning and created out of an individual's experience. It helps us in understanding the dialectical relationship between landscape and culture.

3.2.3. USE

The meanings and feelings associated with landscapes change not only with the different user groups of the landscape but also through various activities that takes place in it. In case of dynamic floodplains of river Ganga at Prayagraj in India this approach is essential as it helps us in seeing how meaning or identity of the floodplain landscape changes with its variety of uses during the annual cycle, six year cycle and twelve year cycle of the festival of 'Kumbh mela'. It is the ability of floodplains to support the functions of religious festival as well as securing people's livelihood through activities like crop cultivation, fishing, boating, cattle rearing, tourism etc. Christopher Tilley sees the landscape as a space for activity or specific usage which renders it dynamic by changing events, actions and people experiencing them (Tilley, 1974). Thus, the usage attributed to a landscape changes according to its changing function which initiates its dynamic nature with respect to the threefold parameter of use.

LANDSCAPE FUNCTIONS

According to the concept of landscape functions, landscape has the following functions - production, regulatory functions, social functions and recreational functions (Scholz, 2016). According to this concept, the typology of landscape functions includes four categories: cultural functions, provisioning functions, habitat functions and regulation functions as shown in figure 3.07.

Ecosystem functions	Description	Biophysical Indicators	Goods and service	Users/ determinants
Cultural function	Non material benefits	Ecosystem properties with historic, religious and spiritual values	Religious & spiritual sites recreation education	Pilgrims
Provisioning Production function	Resources, Livelihood from ecosystems	Soil stability and fertility, Air and water quality, Topography, geology	Food Raw materials	Local workers
Habitat function	Maintenance of biodiversity & Evolution processes	Habitat for diversity of species	Refuge for species Nursery function	Nature
Regulation function	Benefits from ecosystem processes	Properties of land cover	Maintenance of soil fertility flood prevention erosion prevention	Authorities

Figure 3.07

Typology of landscape functions and uses
Figure source: Adapted from De groot, Hein, 2007

Cultural functions relate to benefits people obtain from landscapes through religious rituals, recreation and cognitive development. This may involve actual visits to the area or cultural monuments in the area. For instance, people visit the waters of holy Ganga to take a dip in it during the festival of 'Kumbh mela' also the presence of religious symbols like bathing Ghats and temples along the floodplain indicate the cultural and religious use of the site.

Provisioning functions are functions which supply 'physical services' in terms of resources or space. Production function reflects resources produced by natural ecosystems, for example, the harvesting of fish, pharmaceutical products from plants and animals, wood for natural forests or crop cultivation from fertile soil. In these cases, the functions offered by nature is the space for human activities like agriculture, securing livelihood etc.

Habitat functions comprises the importance of ecosystems and landscapes in maintaining natural processes to safeguard biodiversity by providing habitats to threatened flora and fauna. Regulation function originates from the capacity of ecosystems and landscapes to influence or regulate climate and hydrological cycles, surface processes and a variety of biological processes (Scholz, 2016).

A comprehensive overview of the 'threefold' research approach parameters along with aspect and their data are presented in figure 3.08. The aspects of each parameter are analyzed in chapters 4, 5 and 6 and their co-relationship with one another is used in formulating a vision for the dynamic floodplain land-scape of river Ganga at Prayagraj in India. Figure 3.08 is the representation of a valuation diagram which is used in the conclusion chapter to analyze the value added to the design as per these aspects of the threefold approach parameters. The aspects of the physical landscape parameter are studied pertaining to the river course, dynamic cycle, topography and geomorphology of the floodplain landscape. Use parameter is explored with respect to regulatory, social and economic functions where land-use and urban growth constitute regulatory functions, pilgrimage and holy routing constitute social functions and production and livelihood activities constitute economic functions as shown in figure 3.08. The festival of 'Kumbh mela' where the holy experience of mass bathing, river worship is essential are data aspects of the meaning parameter of this approach.

Therefore, this approach helps in unveiling and reading the landscape with respect to the mentioned aspects of the three parameters whose value inclusions are essential in achieving a landscape which is resilient to external forces and adaptive to its constantly changing nature.

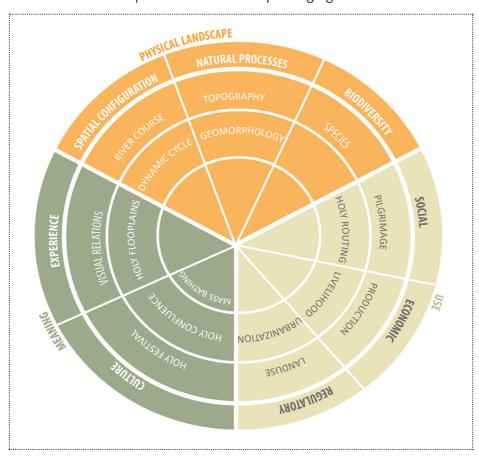
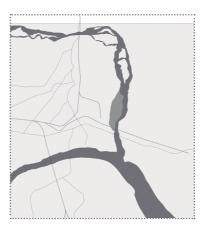


Figure 3.08

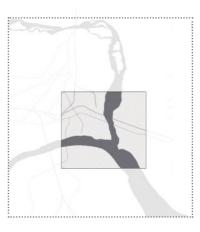
Valuation diagram along with data per aspect of the parameters

Figure source: Adapted from De groot, Hein, 2007

The parameters are analyzed on a combination of macro, meso and micro scales as shown in figure 3.09 (A,B,C). Where macro includes the floodplains of river Ganga along with the surrounding city of Prayagraj, meso scale pertains to the entire floodplain of river Ganga and Yamuna which host the festival of 'Kumbh mela' and micro scale only constitutes the location of the holy confluence which is the holiest destination for pilgrims where they bathe in the holy water of river Ganga at Prayagraj in India. The inter-scale analysis is also used for designing across different scales in chapters 8, 9 and 10. The conclusion is based on the value observance of each of the parameters on this analysis approach in the following chapters.







Macro

This scale is primarily used to study the land use pattern of the district of Prayagraj and its influences on the existing dynamic floodplain landscape and vice versa.

Figure 3.09(A)

Inter-scale analysis: Macro scale
Figure source: Author

Meso

River flows, floodplain topography and geomorphology is explored at this scale along with urban use, holy nature and symbolic destinations on the dynamic floodplains with respect to the confluence of rivers Ganga and Yamuna. The mentioned aspects are in line with the parameters of the 'threefold' approach utilized.

Figure 3.09(B)

Inter-scale analysis: Meso scale

Figure source: Author

Micro

This scale is used to analyse the annual cycle of the 'Kumbh mela' festival on the floodplains of river Ganga. Changing phases of the landscape as per the physical landscape parameter and pilgrimage routing as per use parameter is studied at this scale in chapter 5.

Figure 3.09(C)

Inter-scale analysis: Micro scale Figure source: Author

PARAMETER	ASPECT	DATA	SCALE
PHYSICAL LANDSCAPE	SPATIAL CONFIGURATIONS	Dynamic cycle, River course	Meso, Micro
	PROCESSES	Topography, Geomorphology	Meso
USE	REGULATORY	Landuse, Urban growth	Macro, Meso
	SOCIAL	Pilgrimage. Procession routes	Meso, Micro
	ECONOMIC	Production, livelihood	Meso
MEANING	CULTURE	Holy festival, mass bathing, holy confluence	Meso, Micro
	EXPERIENTIAL	Holy floodplain landscape	Meso

Figure 3.10

Table with overview of all aspect parameters with analytical data at scale levels

Figure source: Adapted from De groot, Hein, 2007

A table with an overview of the three parameters of physical landscape, use and meaning along with their respective analytical data is shown in figure 3.09. Hence, the table summarizes the threefold parameter approach which is used as an analytical tool to understand the various aspects of the dynamic floodplain landscape of river Ganga across multiple scales. These parameters are used to decifer a conclusion as per the value observance of each of these parameters at the end of the analysis chapters 4,5 and 6. These parameters are then utilized in generating a vision for the dynamic floodplains of river Ganga and find solution to make the landscape resilient to external disturbances and adaptive to its changing phases of festival, agriculture, deluge and preparation.

The next section emphasizes on the resultant research outline of this methodology adopted along with the theoretical back up of 'Dynamic landscape theory, 'Landscape resilience' and 'Design with Nature'.

3.3 RESEARCH OUTLINE

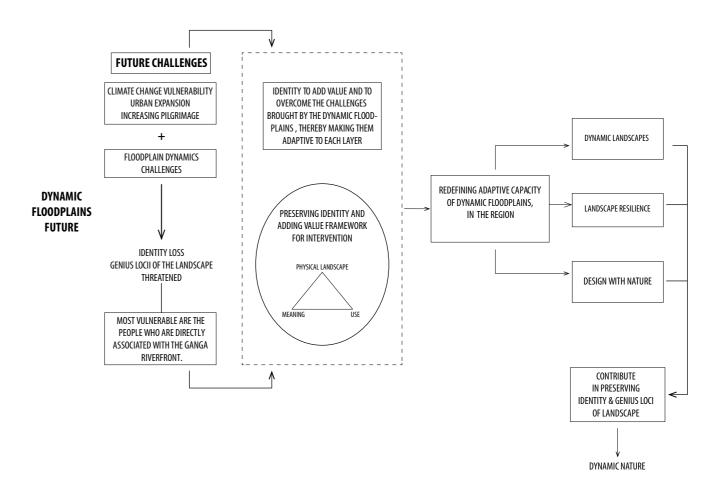


Figure 3.11
Scheme depicting line of research
Figure source: Author

The line of inquiry of this research (figure 3.11) stems from the current trends and problems faced by the dynamic floodplain landscape of river Ganga at Prayagraj in India. This results in threatened identity of the dynamic floodplain landscape which can be protected using parameters of physical landscape, use and meaning. The people directly associated with river Ganga and its floodplain are most vulnerable to this threatened state of the holy floodplain landscape. The need is to preserve and enhance the dynamic nature of these floodplains by making the floodplains resilient to external influences and adaptive to its constantly changing nature. For this the threefold research approach is used which helps in formulating a landscape framework for the dynamic floodplains.

ADDRESSING SUB QUESTIONS:

SQ 1: How has the festival of pilgrimage "'Kumbh mela'" impacted the floodplains and its natural processes?

The sub question 1 referring to the impact of 'Kumbh mela' festival on floodplains of river Ganga at Prayagraj in India is addressed in chapter 2 in the section of dynamic floodplain challenges (2.2) revealing cause-effect of the festival which impacts the floodplains creating a number of challenges for its changing phases. The second part of the question referring to its impact on the natural processes are analysed and explained in depth in chapter 4 which is analysis of the physical landscape parameter of the threefold approach.

SQ2: What effect does the constantly changing nature of the floodplains have on its local communities?

The question is first addressed in section 2.1.2 of chapter 2 where future challenge with respect to rapid urban expansion pertaining to rural to urban migration is explained. Further section 2.2 of the chapter addresses how the challenges faced by this dynamic nature of constant change effects the local communities. The sub question was further researched during the field trip by conducting various on site interviews and getting direct responses from the local communities which are depicted in section 2.3, 'Voices from the site'.

SQ 3: How to create a landscape framework where activities like crop cultivation, animal husbandry, fishery and tourism co-exist with pilgrimage?

The threefold research approach in section 3.2 of this chapter along with the theoretical backup in section 3.1 is the basis for the initiation of the landscape framework to make different activities supported by the floodplains to co-exist with pilgrimage. The framework is first addressed in chapter 7 related to the design vision. Explanation on how existing floodplain topography of fluvial terraces can be used as basis for this framework is depicted in this chapter. Furthermore, the implementation of this landscape framework at different scales is addressed in the next chapters 8, 9 and 10 in detail.

SQ 4: What are the different possibilities of using changing cycles of festival to make the floodplains self sustainable?

The festival of 'Kumbh mela' at Prayagraj, India takes place at three scales at intervals of 1, 6 and 12 years. These different cycles of the festival are addressed in section 6.1 of chapter 6 which is the analysis of the meaning parameter of the threefold research approach. How this changing cycle is used to make the dynamic floodplains self sustainable is described at the ending of the vision chapter 7 in section 7.7- 'Use as per festival cycle'. It is further illustrated in chapter 8 ,where design implementation taking into account these changing cycles at macro scale is shown.

SQ 5: How can landscape and ecology be used to improve relationship between changing phases of floodplain landscape with its users?

This question is first addressed in section 7.4 'Designing with Nature' of vision chapter 7 where it is explained how landscape and ecology can be used to create conditions for a landscape to improve its relationship with its users. Chapter 8 and 9 cover the planning at macro and meso scale which lead to chapter 10 where the question is directly addressed by showcasing the micro scale detail design.

First, location detail of the island at confluence shows how natural processes of sedimentation and erosion can be used to develop this landscape over time. Second, the use of ecology is addressed in details where specific vegetation cover is introduced and how its maintenance through different phases helps in manifesting a relationship between the different users with the dynamic floodplain landscape of river Ganga at Prayagraj, India.

3.4 TIME FRAMEWORK

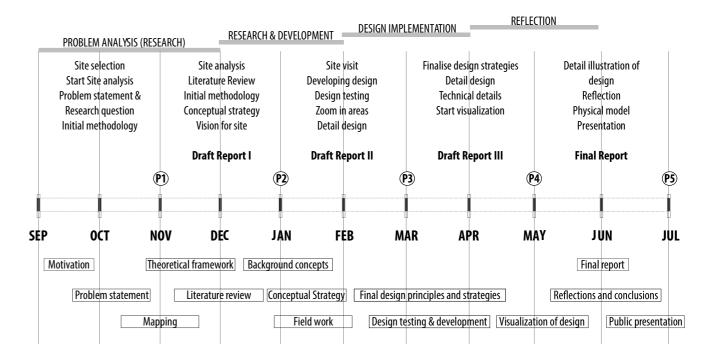


Figure 3.12
Scheme depicting timeline
Figure source: Author

04 | ANALYSIS: PHYSICAL LANDSCAPE |

The following chapter deals with reading the dynamic floodplain landscape of river Ganga at Prayagraj w.r.t to its physical landscape. The processes (dynamic cycle, shifting of the river course) and spatial configuration of the landscape pertaining to its geomorphology and topography are analysed followed by conclusion.



Scales addressed

4.1 ANNUAL DYNAMIC CYCLE - FLOODPLAIN

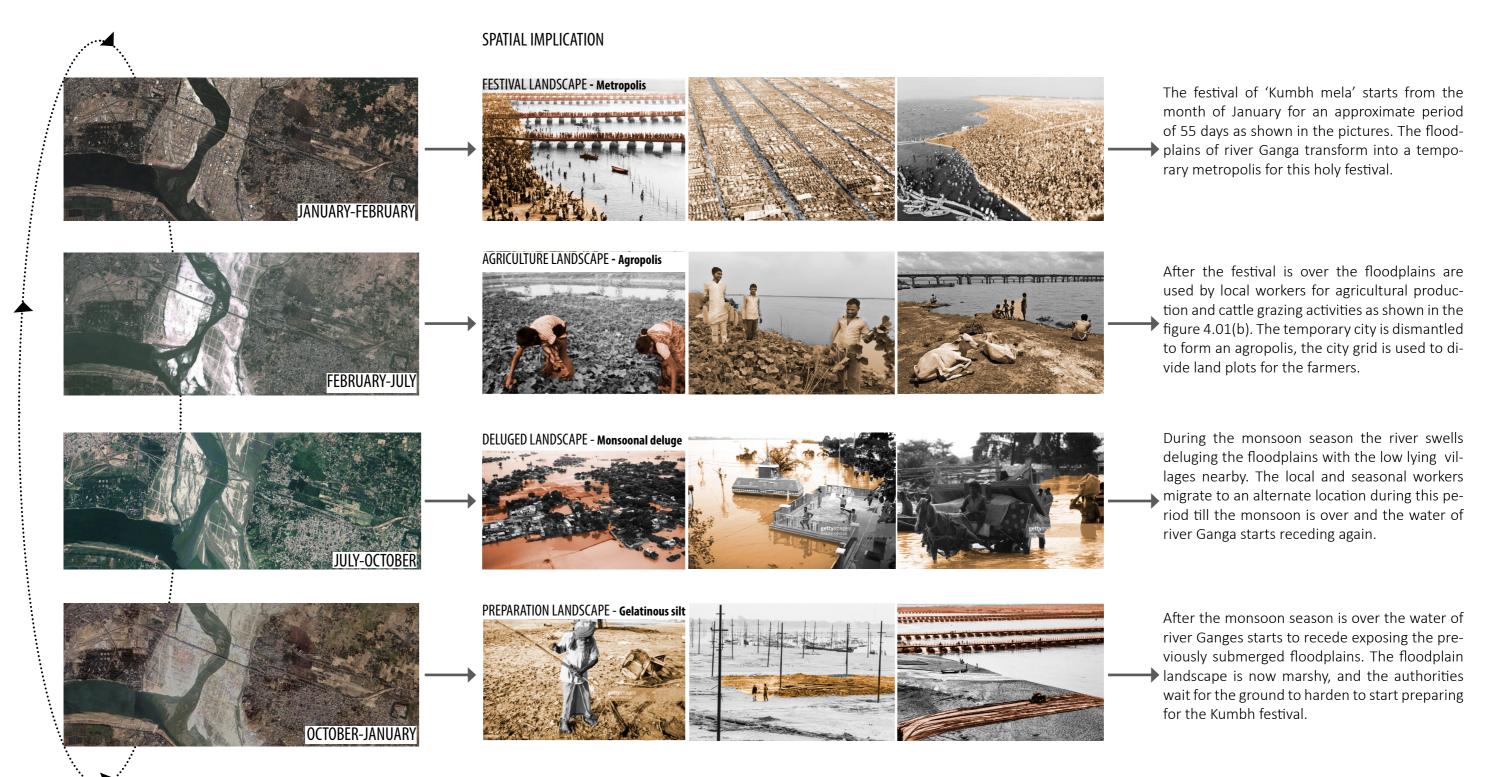


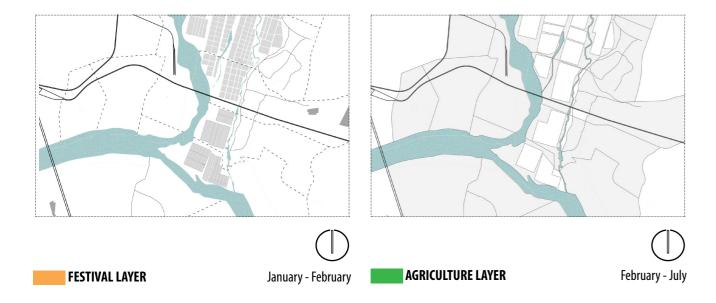
Figure 4.01

69

Dynamic cycle of the floodplain landscape

Figure source: Author

4.2 Site Layering (Scale - Micro)



The texture of the temporary city is the result of several overlapping layers of previous festival infrastructure. This is the busiest and most exploitative period for the dynamic floodplains due to their 100% ground occupation as shown in figure 4.03.

The city grid changes every year with the changing ground conditions prolonged ground hardening causing uncertainty in ground availability of the floodplain landscape of river Ganga at Prayagraj.

Post festival the land is transformed for agricultural use. The grid pattern made for the festival remains on floodplain grounds and the local communities use the floodplains for their daily activities sustaining their livelihood.

Major field crops harvested during this time are kharif crops (monsoon or autumn crops) sown at the beginning of the rainy season which include rice, maize, cereals, pulses and oil seeds.

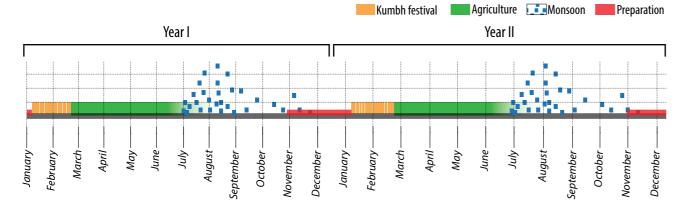
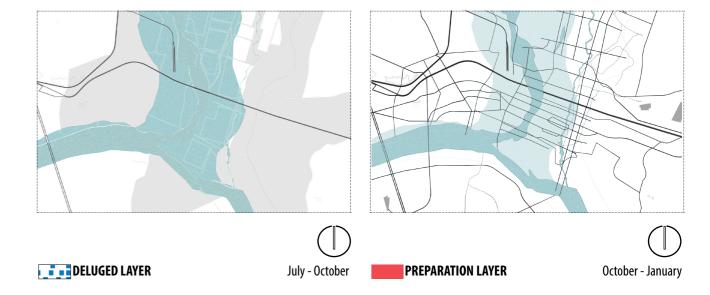


Figure 4.02
Dynamic landscape timeline
Figure source: Adapted from Mehrotra, 2015



This is the period of the monsoon season where the entire floodplains which once hosted the Kumbh festival and supported livelihood of local communities are completely submerged due to the swelling of river Ganga.

The farmers wait for the monsoon to get over so they could harvest the rabi crops (sown in winter harvested in spring) which include wheat, barley, oats, pulses and oil seeds.

The mela authorities wait for the water of Ganga to recede and ground to harden to start preparing for the construction of the temporary city for the festival. Once the river starts receding it leaves behind dampened land. The festival authorities wait for the land to set and harden to start demarcating and bulldozing major roads in preparation for metal sheets for mobility infrastructure for the festival.

Sector boundaries are outlined, and electric poles are deployed. Initial pontoon bridge construction starts for the deployment of the secondary bridges. By December all major roads are completed, and tracing of secondary roads starts (Mehrotra, Vera, 2015).

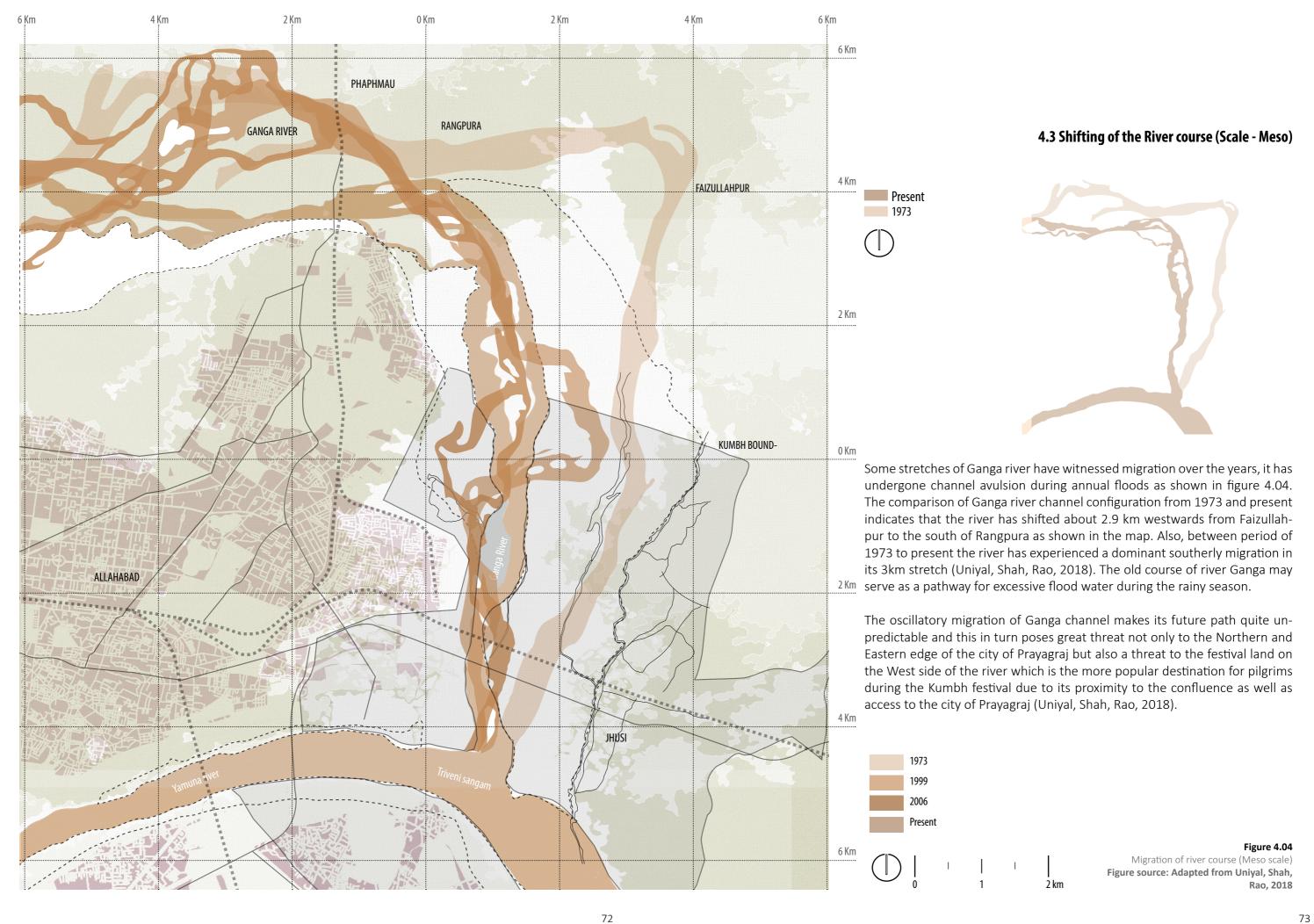
Pontoon deployment and bridge construction is 75% complete. Tent construction and occupation commences (Mehrotra, Vera, 2015).

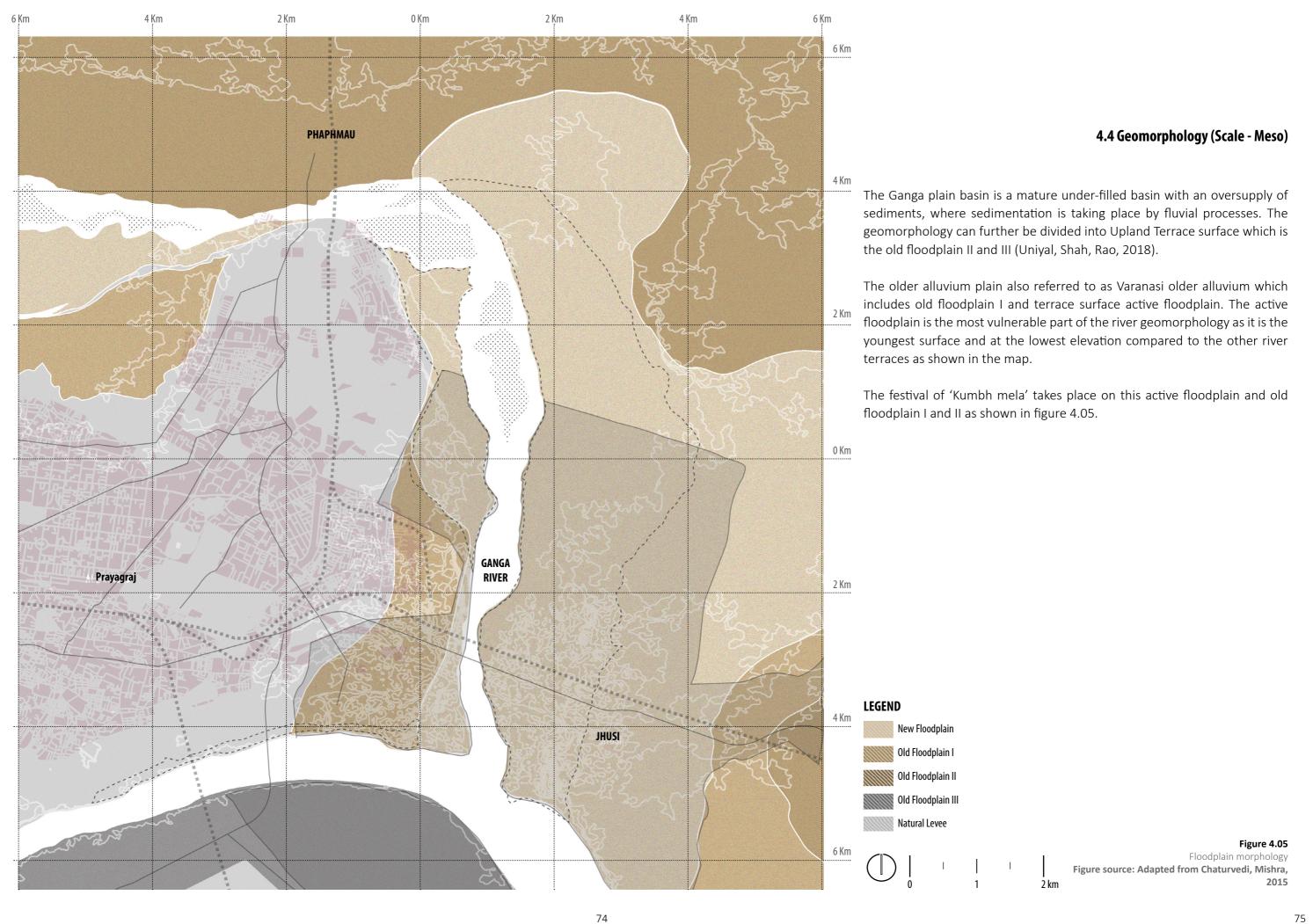
The timeline of this site layering is shown via the dynamic calender or time line as shown in figure 4.02.

Figure 4.03

Dynamic landscape layering (micro scale)

Figure source: Author





4.5 Floodplain Topography

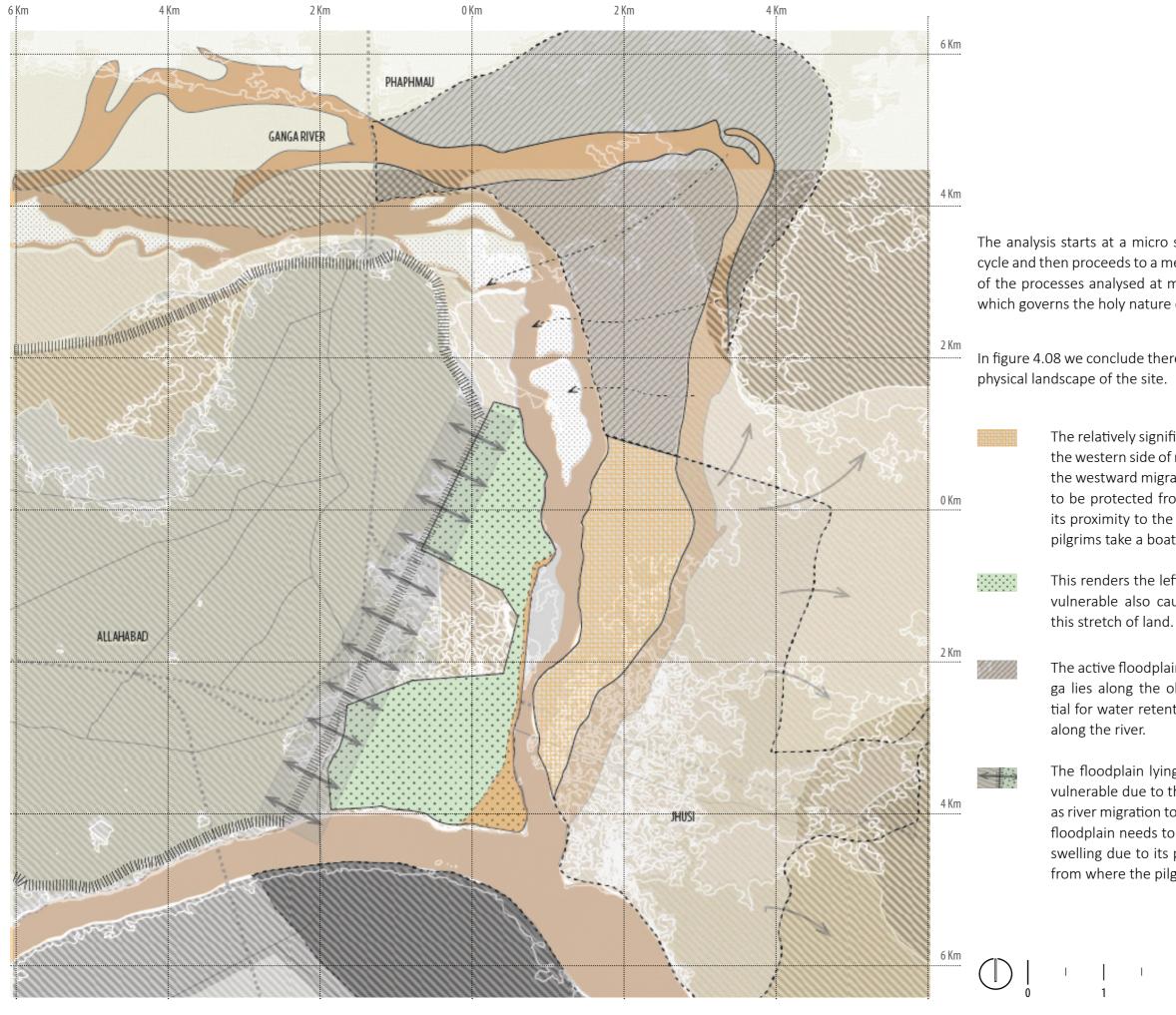
				Yamuna						Ganga			
PHYSICAL LANDSCAPE	GEOMORPHOLOGY	OLD	OLD Floodplain I	RIVER BED	NEW FLOODPLAIN	OLD FLOODPLAIN	NATURAL LEVEE	OLD FLOODPLAIN	NEW FLOODPLAIN	RIVER BED	NEW Floodplain	OLD FLOODPLAIN I	OLD FLOODPLAIN II
	SOIL (ALLUVIUM)		MEDIUM FINE GRAINED QUARTZO		SAND, SILT & Clay	MEDIUM FINE GRAINED QUARTZO		YELLOW, BROWN CLAY, SILT & FINE SAND WITH KANKAR	& CLAY		SAND, SILT & CLAY	SAND, GRAVEL & CLAY	CLAY, SILT & FINE SAND WITH KANKAR
USE	ACTIVITIES (FUNCTION/ USE)	BUSINESS, INDUSTRY, RESIDENTIAL	KUMBH, FISHING, AGRICULTURE BOATING		TOURISM, PILGRIMAGE, BOATING	KUMBH Festival, Pilgrimage	BUSINESS, INDUSTRY, RESIDENTIAL		AGRICULTURE KUMBH, PILGRIMAGE, LIVELIHOOD		AGRICULTURE KUMBH, PILGRIMAGE, LIVELIHOOD	AGRICULTUR	AL LAND
MEANING				HOLY WATER	HOLY			HOLY LAND		HOLY WATER	HOLY LAND	PRODUCTIVE LAND	
	DYNAMISM		DYNAMIC					DYNAMIC					

Figure 4.06 depicts a typical section cut across rivers Yamuna and Ganga before they meet at the *Triveni Sangam* or holy confluence. It highlights the geomorphology, soil characteristics and function of the floodplains along with its nearby areas. These aspects further fit into the three aspects of physical setting, use and meaning of the landscape as per the threefold approach. In the section we see that the floodplains along with the rivers Yamuna and Ganga constitute the dynamic nature of the landscape which is under constant change. The area with permanent settlement coming under the natural levee and the land used permanently for crop cultivation as shown in the section above constitutes the permanent landscape in the region.

Figure 4.06
Characteristics and uses of floodplain topography
Figure source: Author



Figure 4.07
Key plan
Figure source: Author



4.6 Conclusion (Scale - Meso)

MICRO TO MESO

The analysis starts at a micro scale by understanding the annual dynamic cycle and then proceeds to a meso scale. This helps in understanding impact of the processes analysed at meso scale with reference to the confluence which governs the holy nature of the dynamic floodplain landscape.

In figure 4.08 we conclude there are three major impacts with regard to the physical landscape of the site.

> The relatively significant area of the temporary city which lies on the western side of river Ganga has reduced over a period due to the westward migration of the river. Part of the floodplain needs to be protected from river migration and river swelling due to its proximity to the holy confluence or Sangam from where the pilgrims take a boat to bathe in river Ganga.

> This renders the left side of the foodplains of river Ganga more vulnerable also causing planning problems for authorities on

> The active floodplain of the river towards the North of river Ganga lies along the old course of the river, this area has potential for water retention and storage due to its strategic location

> The floodplain lying on the western side of the river are most vulnerable due to their proximity to the city of Prayagraj as well as river migration towards the western direction. This part of the floodplain needs to be protected from river migration and river swelling due to its proximity to the holy confluence or Sangam from where the pilgrims take a boat to bathe in river Ganga.

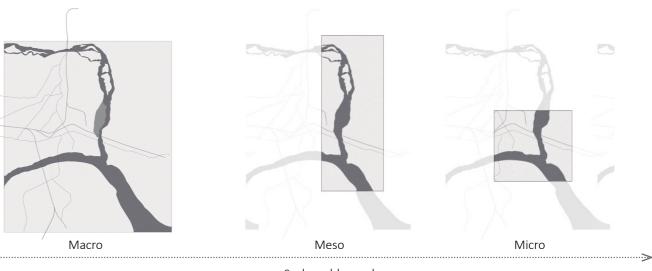


Figure 4.08 Figure source: Author

79

05 | ANALYSIS: USE |

The chapter deals with reading the dynamic floodplain landscape of river Ganga at Prayagraj w.r.t to its use or function. The landuse, urban infrastructure and routing of the floodplain landscape are analysed followed by conclusion.



Scales addressed

5.1 Land use (Scale - Macro)



AREA PRONE TO FLOODING (DYNAMIC)



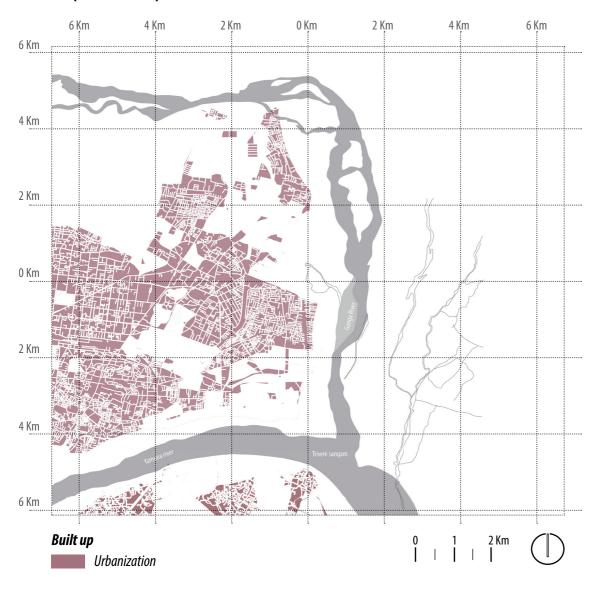
BUILT UP AREA (CITY OF PRAYAGRAJ)

The city of Prayagraj is surrounded by rivers Ganga and Yamuna on three sides and cultivated land on the fourth as shown in figure 5.01. The city is constantly expanding and the area which is most vulnerable to urban expansion is the agricultural land and the floodplains of the river Ganga where the festival of 'Kumbh mela' takes place.

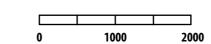




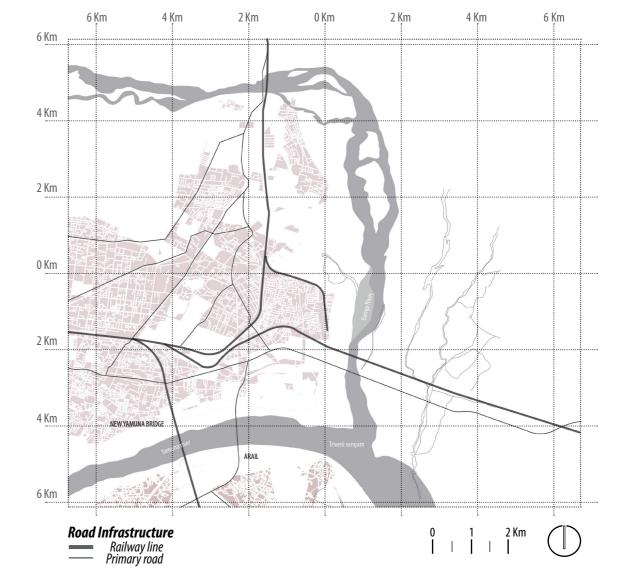
5.2 Urban Use (Scale - Meso)



The city of Prayagraj lies to the west direction of river Ganga, this makes the western floodplain land more valuable as opposed to the eastern floodplain land. The residents of the city of Prayagraj can easily access the floodplains on this side. This also renders the Western edge of the floodplains vulnerable to urban expansion and monsoonal deluge. The city of Prayagraj as seen in figure 5.02 is surrounded by rivers Ganga and Yamuna on all three sides, thus, the floodplains are critical to further urban expansion and needs to be protected from pressures of urbanization.



84



The festival of 'Kumbh mela' contributes to the development of civic infrastructure in the district of Prayagraj. Most of the existing roads are widened particularly those which lead to the *Sangam* or holy confluence as shown in figure 5.03. Connectivity from all railway, bus stations and airports has been strengthened connecting most parts of the city to its dynamic floodplain landscape. Cable stayed new Yamuna Bridge connects the city of Prayagraj to the suburb of Naini and the Arail ghat across Yamuna as shown in figure 5.03.



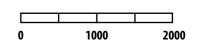
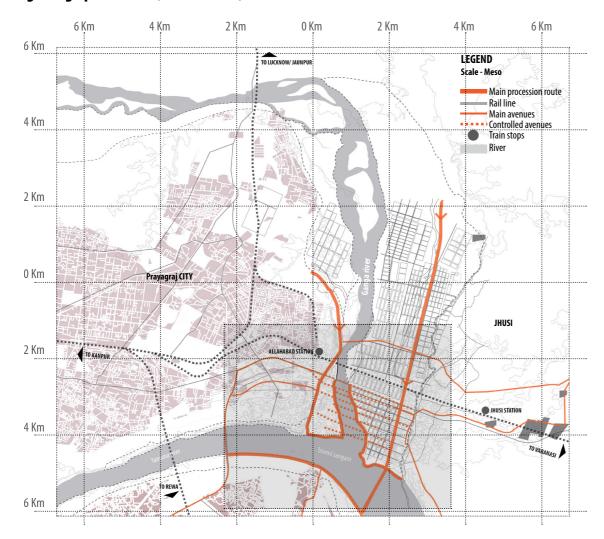


Figure source: Author, Adapted from Google maps

Figure 5.02

5.3 Pilgrimage procession (Scale - Meso)



In figure 5.04 we see the extent of land used for the festival of 'Kumbh mela', it consists of two primary procession routes on either sides of river Ganga. The pilgrims lead the procession to Sangam starting at 6 in the morning marching to reach the river shore. They march on two main procession routes barricaded along its length as shown. The procession route to the left is more popular due to its ease of access. The procession routes widen to accommodate the increasing number of pilgrims at the Sangam or holy confluence. (Mehrotra, Vera, 2015)

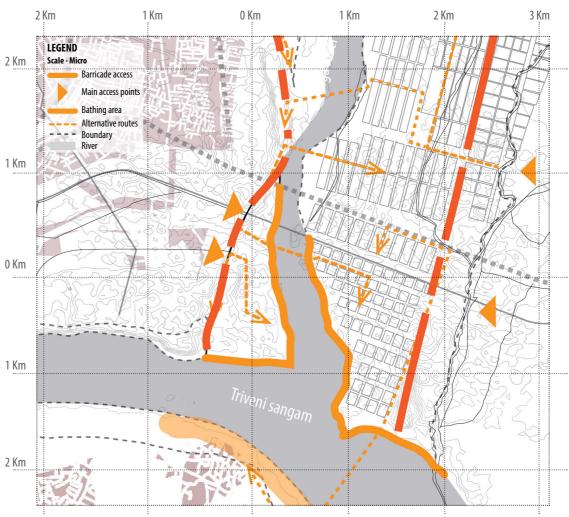
The pontoon bridges are constructed to control the pedestrian traffic during the festival. These are temporary bridges built for millions of pilgrims, vehicles and animals which arrive during the Kumbh festival, they are connected to major roads along the river. These floating bridges are built on top of a large empty metal tank which are anchored to the bottom of the river with ropes. They can accommodate weight up to 5 tons. During peak times when large crowds are crossing the pontoons are made one way to prevent stampedes (Mehrotra, Vera, 2015).

Figure 5.04

Primary Procession route (Meso scale)

Figure source: Adapted from Mehrotra, Vera, 2015

5.3.1 Potential overflow routes (Scale - Micro)



The length of Sangam shoreline is 3,700 M where millions of pilgrims are drawn to take a dip in the holy river.

Most pilgrims want to bathe on the left side of the river due to its ease of access to the holy confluence, but for crowd control reasons they are often encouraged or detoured to bathe at Ghats further to the North. At certain checkpoints, the barricades open periodically to allow the pilgrims to join the procession or reach the Sangam via an alternate routes shown in figure 5.05 (Mehrotra, Vera, 2015).

Barricades are set up to relieve congestion, forcing people to detour as well as to ensure the orderly procession of the pilgrims to the holy confluence. Police are located at intersections where bottlenecks are expected these are the locations where the barricades are opened and the pilgrims are detoured via alternate routes.

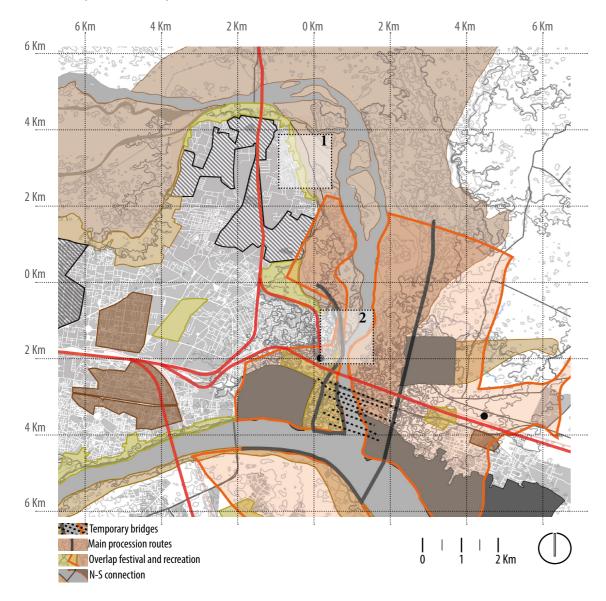
Figure 5.05

87

Potential over flow routes (micro scale)
Figure source: Adapted from Mehrotra, Vera, 2015



5.4 Conclusion (Scale - Meso)



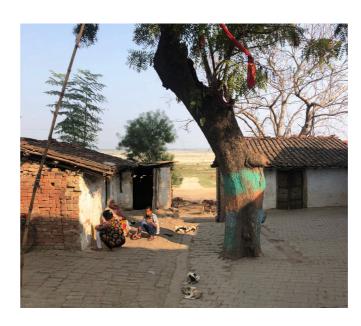
From figure 5.06 the conclusion is drawn, Prayagraj lacks recreative spaces due to less parks and open areas, the floodplains are a potential recreational space for its inhabitants.

There is sufficient connection between the West and East side of river Ganga. However, there is a lack of connectivity between the Northern and Southern side of the river. This leads to improper access to the expanded Arail ghat towards the southern direction of river.

The Daraganj and Govindpur villages flood frequently during monsoons, displacing people and ravaging their household as shown in the figure 5.06. These areas needs to be critically designed in order to protect the residents of the village from impacts of flooding.

Figure 5.06 Conclusion map (use) Figure source: Author

1 Govindpur village



The area is marked 1 in figure 5.06, it is the edge of floodplains of river Ganga and the low lying village of Govindpur as shown in figure 5.07. The inhabitants of the village practice crop cultivation, cattle rearing and fishing. Their livelihood is directly dependant on river Ganga and its floodplains. During heavy monsoon season their houses are submerged in water and they relocate inland.

Figure 5.07
View towards river floodplains from Govindpur village
Figure source: Author, 2020

2 Buxi Bund embankment - Daraganj village



Figure 5.09 depicts the view towards the buxi bund as an embankment between the dynamic floodplains of river Ganga at Prayagraj and the low lying village of Daraganj. The village faces frequent flooding during the high monsoon season and forms a vulnerable edge to the floodplain landscape.



Figure 5.08 Key Plan Figure source: Author

MACRO TO MICRO

This order was preferred to find out how the landuse pattern of the district governs the usage of the dynamic floodplains of river Ganga at Prayagraj, India.

Figure 5.09

Buxi bund embankment Figure source: Author, 2020

06 | ANALYSIS: MEANING |

The chapter deals with reading the dynamic floodplain landscape of river Ganga at Prayagraj w.r.t its meaning. The holiness of the festival, confluence, floodplains and mass bathing are explained and analysed follwed by conclusions.



Scales addressed



Mela

One must understand mela to really know the essence of India

"A mela is a great religious fair where spiritual life and the robust world of commerce, trade and entertainment come together. It is a gathering of people from all walks of life and from all over India, and it is a microcosm of India's spiritual life."

(Mehrotra, Vera, 2015)

Figure 6.01

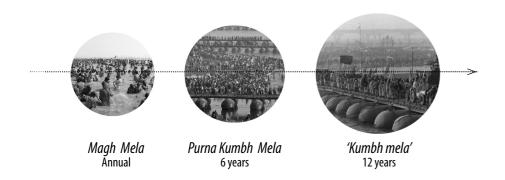
Pilgrims on a pontoon bridge
Figure source: Author, 2020

6.1 Holy festival - 'Kumbh mela'

'Kumbh mela' is a religious Hindu festival at four river bank pilgrimage sites: Prayagraj, Haridwar, Nashik and Ujjain. The largest gathering occurs at the Prayagraj 'Kumbh mela'. Since its inception, it is the largest mass gathering in the world attracting millions of pilgrims who come together to celebrate the water of river Ganga. The seekers believe that bathing in the rivers is a means to atonement for past mistakes. The ritual is part of a century-long tradition that brings devotees to this holy site from across the country. The 'Kumbh mela' festival lasts for an approximate period of 55 days starting from January until February. It happens at varying scales in three cycles as shown in figure 6.02.

The underlying structure of the festival is construction of a temporary city on the floodplain ground left by receding rivers post the monsoon season (Mehrotra, Vera, 2015).

The festival of 'Kumbh mela' has been included in UNESCO's representative list of 'Intangible Cultural Heritage of humanity' (Mehrotra, Vera, 2015).



6.1.1 Festival and the Hindu Belief

'Kumbh mela' is made up of two words 'Kumbh' and 'Mela'. The name Kumbh is derived from the immortal pot of nectar as described in ancient Vedic scripture called Puranas. Mela is a Sanskrit word meaning gathering. The fight for this immortal nectar lasted 12 days during which the drops from it fell at four locations: Prayagraj, Ujjain, Nashik and Haridwar which are considered divine, where the festival is now celebrated. These 12 days were meant to last 12 years for humans which is the reason why the largest festival is celebrated every 12 years.

There are three types of 'Kumbh mela's namely 'Magh mela', 'Purna Kumbh mela' and 'Kumbh mela' as shown in figure 6.02.

Thus, the place this festival holds in Hindu religious belief must be understood within the context of pilgrimage networks, religious fairs known as *melas*. In modern India technological advances in transportation and communications have made the practice of pilgrimage more popular.

Figure 6.02

Different cycles of the festival **Figure source: Author**

6.2 History

The first written evidence of 'Kumbh mela' can be found in accounts of Chinese, Buddhist monk Hsuan Tsang in 644 BC. He wrote about the gathering of pilgrims during the month of January- February. According to Hindu medieval theology, its origin is found in one of the most popular medieval texts, the *Bhagavat Purana*.

During the time of Mughal Emperor Akbar, the district was renamed Allahabad forfeiting its previous name 'Prayagraj'. The emperor visited the city in 1852 and asked that a fort be built at the strategic location where the rivers Ganga and Yamuna converged as shown in the figure 58 (Mehrotra, Vera, 2015). The fort is accessible to pilgrims during festival to give them access to the historic Patalpuri temple and the Saraswati koop inside the fort.

6.3 *Sangam*: Holy confluence

The confluence where rivers meet is called 'Sangam' and it is a holy location for bathing as Hindus believe taking a dip at the confluence will wash away their sins. The Ganga and Yamuna rivers both come from high in the Himalayas at Gangotri and Yamunotri, places visited by pilgrims from throughout India. The greatest of the confluences along the river course of Ganga is at Prayagraj where the rivers Ganga and Yamuna meet the invisible mythological Saraswati river shown in figure 6.03. This place where the rivers meet is called Triveni, the "triple-braid" of rivers. At this location the rivers are swollen and broaden with flood waters from the rainy season.

It is this confluence which is the reason behind the festival of 'Kumbh mela' which transforms the flood-plain landscape of river Ganga at Prayagraj dynamic in nature.

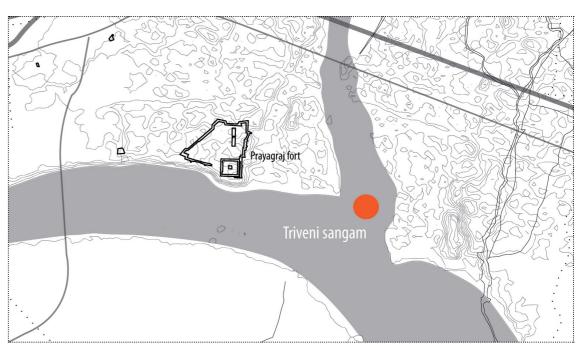


Figure 6.03
Holy confluence
Figure source: Author



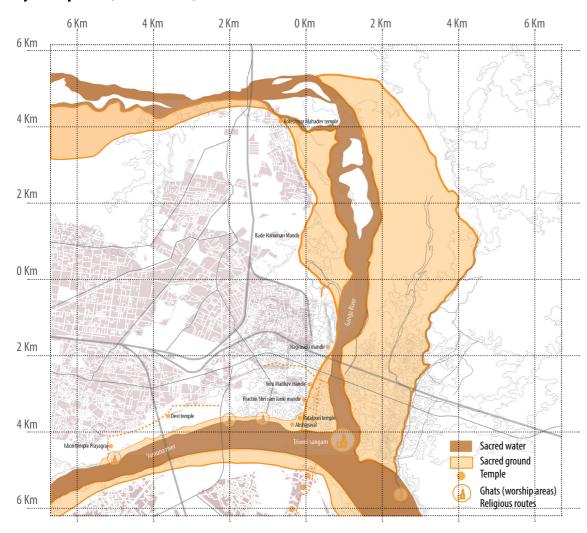
6.4 Snan: Mass bathing

For most pilgrims a dip in the holy river holds spiritual value as they believe it leads them towards the path of salvation. The pilgrims start at 6 a.m. in the morning marching towards the *Sangam* with their offerings, they dip fully into the waters once, twice, three times and then pour the water from their cupped hands back into the river as an offering to the god and the ancestors as shown in figure 6.04. They make offerings of flowers and oil lamps, floating them into the currents of holy river Ganga (Mehrotra, Vera, 2015). In figure 6.04 we see pilgrims mass bathing in river Ganga and dipping their offerings into the river.

On an ordinary day during the festival, taking a dip in the river is a constant activity along the floodplains beginning before dawn. The dynamic floodplain edges are reinforced with sandbags to allow secure footing also shown in figure 6.04. In some places bamboo guardrails and fences have been anchored in the river to protect pilgrims from crowds that might push them further into the river currents. Many pilgrims take a boat into the river where a makeshift platform enables them to bathe in the actual waters where the rivers meet (Mehrotra, Vera, 2015).

Figure 6.04
Pilgrims mass bathing in river Ganga
Figure source: Author, 2020

6.5 Holy floodplains (Scale - Meso)

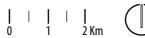


Rivers Ganga and Yamuna are one the most holy rivers in India and its water is worshipped by the followers of Hindu religion. Figure 6.05 depicts the region where these rivers meet which is considered to be of immense religious and spiritual importance. It is due to this confluence the festival of 'Kumbh mela' is held in Prayagraj on the floodplains of river Ganga which render its landscape dynamic due to its constantly changing nature. Most of the religious activities are concentrated along the floodplains which help in establishing a relationship between people and the holy water by giving them direct access to it.

Major pilgrimage spots and holy locations are located on the edge of these floodplains where pilgrims gather to worship the water of holy river Ganga and take a dip in it during the festival of 'Kumbh mela' as depicted in figure 6.05.

Figure 6.05

Holy floodplain Figure source: Author





6.6 Conclusion (Scale - Meso)

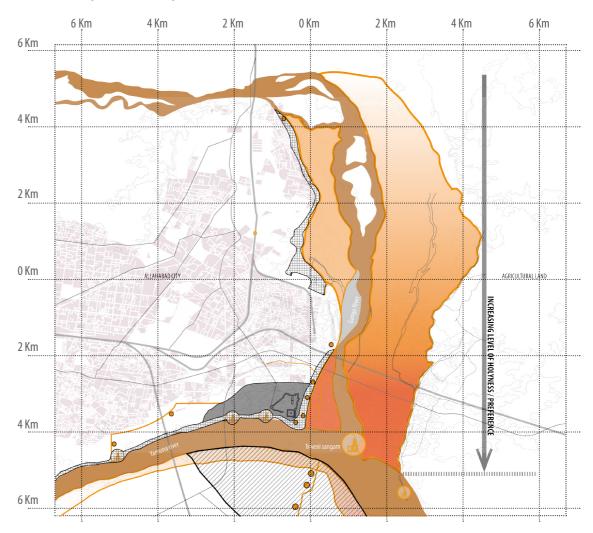


Figure 6.06 depicts the conclusions drawn from the meaning parameter of the threefold approach. It is concluded that as the distance from the confluence increases, the holy character of the floodplain decreases and they are more susceptible to other functions and uses of crop cultivation, animal husbandry etc. The confluence is the most essential location in the region with respect to people's religious affiliation. It governs the holy character of the dynamic floodplain landscape.

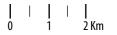
The holy confluence or Sangam is the main location of gathering for the people during the festival of 'Kumbh mela', it is because of its presence that the rest of the floodplains host the temporary city during the festival. Moreover, river Ganga is considered holy along its course but its confluence with river Yamuna is one of the most religious and holy locations along its entire length which hosts the festival of 'Kumbh mela' making its surrounding floodplain landscape dynamic in nature.

MESO

The entire floodplain stretch are believed to be holy in nature. The city of Prayagraj is an urbanised area and most places of worship are situated on or near the floodplains of holy river Ganga at Payagraj in India.

Figure 6.06

Conclusion map Figure source: Author





| VISION |

VISION **DYNAMICS** SPATIAL STRATEGIES BASIS Chapter 7 DESIGN WITH LANDSCAPE DYNAMIC PHYSICAL USE MEANING RESILIENCE LANDSCAPE LANDSCAPE NATURE DESIGN PHASING ANNUAL 6 YEAR CYCLE 12 YEAR CYCLE CYCLE DESIGN IMPLEMENTATION Chapter 8, 9, 10 MACRO MESO MICRO **SCALE SCALE** SCALE CONCLUSION + RECOMMENDATIONS Chapter 11,12 REFLECTION

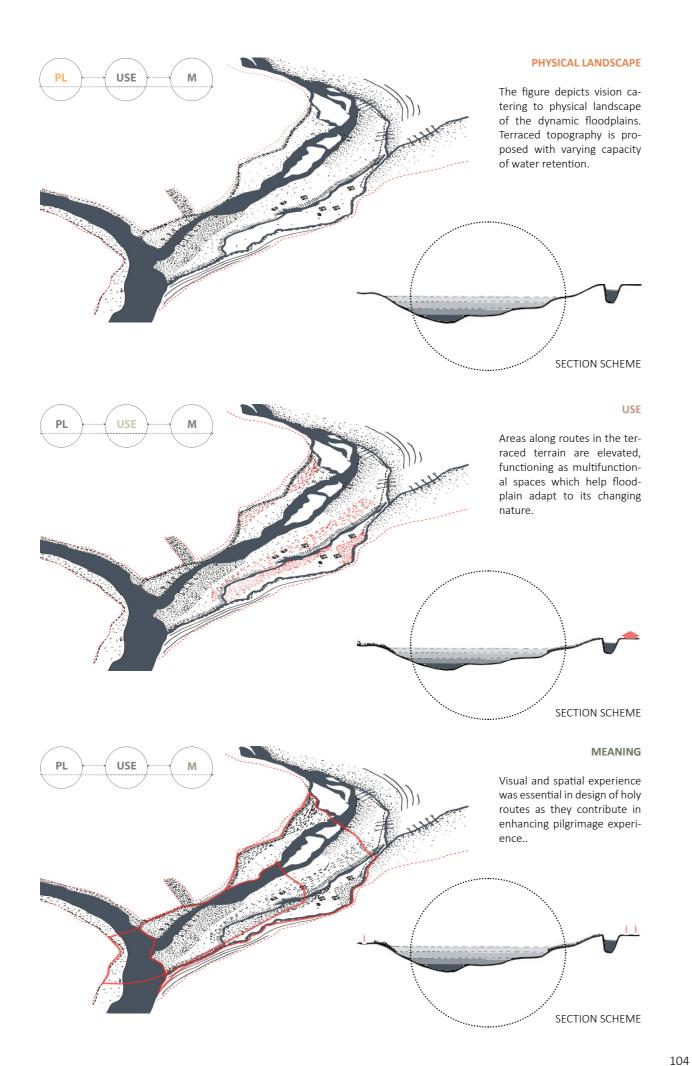
Figure 7.01
Vision framework
Figure source: Author

ANALYSIS CONCLUSION

The vision follows from the conclusion of analysis from the previous chapters as shown in figure 7.01. As per the physical landscape parameter, the floodplains are subject to immense pressure due to river swelling and flooding of essential land during the monsoon season. Important floodplain land is subjected to degradation due to accelerated erosion processes leading to vulnerable areas in this dynamic landscape. Conclusions derived from the use parameter mainly focus on the suffering of the different user groups due to the conflicting nature of the floodplains pertaining to their dynamic character making them inadept. As per meaning the confluence area where the festival of 'Kumbh mela' is held annually is the holiest of all locations on the floodplains and important in terms of its spatial experience.

CHAPTER GUIDELINE

This chapter deals with the vision for the dynamic floodplains of river Ganga at Prayagraj in India. Thus, spatial strategies are derived from the initial vision generation in coherence with the threefold research parameters of physical landscape, use and meaning which helps in preserving and enhancing the dynamic nature of the landscape thereby making it adaptive to constant change and resilient to existing and future disturbances. This follows how concepts of 'Design with Nature' is integrated in generating a multi-functional framework for this landscape followed by stakeholder involvement and phasing of the design interventions as shown in figure 7.01.



7.2 VISION

The idea is to breed a permanent connection among parameters of physical landscape, use and meaning (figure 7.03) using resilient approach to make the floodplain landscape adaptive to existing and future challenges. This strategy helps to restructure as well as reveals opportunities within this dynamic landscape for a constructive future. River flows, water retention are essential components of the physical landscape, multi-functional infrastructure and making spaces adaptive to changing functions add to designing with the use parameter along with keeping in mind the pilgrimage experience where holy routes contribute to the meaning of the site as shown in 7.02. All these aspects of the threefold approach parameters contribute in enhancing and preserving the dynamic identity of the floodplains of river Ganga at Prayagraj in India.

Thus, the design aims to showcase transformation of dynamic floodplains to integrate phases of- festival, agriculture, deluge and preparation landscapes as shown in the next section.

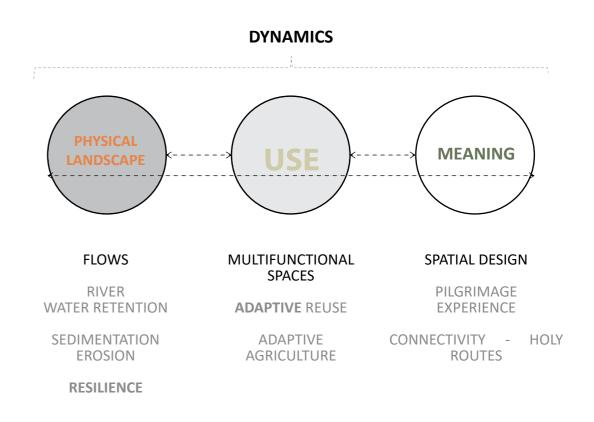
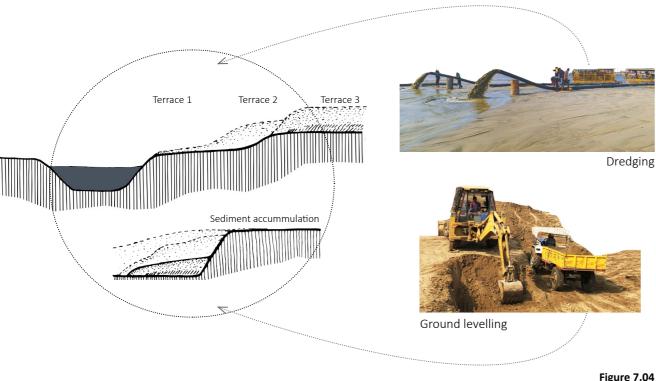
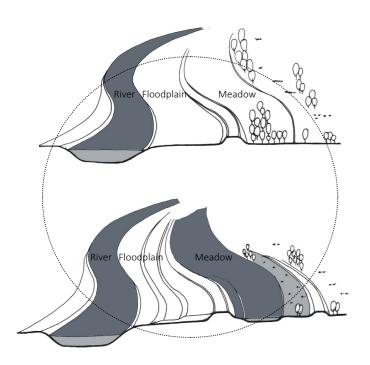


Figure 7.02
Scheme depicting vision with respect to the threefold parameters of physical landscape, use and meaning
Figure source: Author

Figure 7.03
Scheme depicting analysis conclusion
Figure source: Author



Floodplain terracing via dredging and ground levelling
Figure source: Author, 2020



In the 'Room for the river program' excess flood water from the river is diverted to reduce the risk of flooding on natural river stream or key point of interest. In the case of river Ganga it is used to divert excess flood water from valuable floodplain land to untouched fields and meadows. This can be achieved in the following three ways:

- 1. Embankment removement
- 2. Water routed to lake beds or other areas for temporary storage.
- 3. Flood bypass- high water channel is designed to route water away from river.

Figure 7.05

106

Room for the river, excess water routed away from floodplains

Figure source: Author

7.3 SPATIAL STRATEGIES - CONCEPT PHYSICAL LANDSCAPE

ELEVATE

The idea is to elevate floodplain land and widen the existing embankments to protect low-lying areas from flooding. These elevated landfill sites function as widened and heightened embankments creating sloping terraces where each terrace supports different variety of flora and fauna forming varied ecosystem zones. The elevation is achieved using natural process of sedimentation which occurs while the water recedes post monsoon season. The land which is usually extracted to level the plains is left on site, to elevate it as shown in figure 7.04.

ROOM FOR THE RIVER

In Netherlands, "Room for the river" is a government design plan intended to address flood protection, master landscaping and the improvement of environmental conditions in the areas surrounding Netherlands rivers (Buuren, Warner, 2011). The aim of the program was to provide more space for the major rivers as a way of managing high water levels in the delta area as shown in figure 7.05. Likewise, in the case of river Ganga at Prayagraj, elevating floodplain land to create terraces effects the ability of this dynamic landscape to contain high volumes of water from the river during monsoon season. Thus, 'Room for the river' approach is applied, where water of Ganga is directed towards the existing fields and vast meadows towards the eastern bank of river to compensate for the elevated land which reduces its capacity to retain water.

WATER RETENTION

In periods of drought which the region experiences due to its hybrid climate, users can use water stored in retention areas like- ponds, lakes on elevated floodplain terraces as shown in figure 7.06. This technique facilitates the storage of water in these elevated floodplain terraces and can be used by different user groups as per the changing functions and phases of the floodplain landscape of river Ganga at Prayagraj in India.

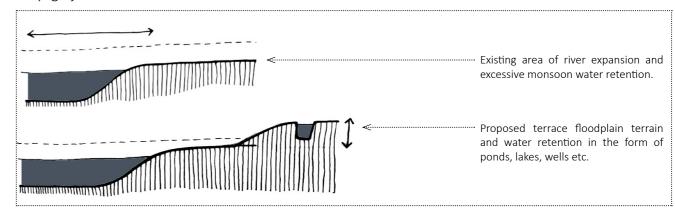


Figure 7.06

Scheme depicting existing vs proposed water retention Figure source: Author

River Route River **DURING FESTIVAL** Access to river Ganga Route POST FESTIVAL Access to agriculture River Route **DURING MONSOON** Functional landscape River Route

Figure 7.07
Proposed dynamic nature of the multi-functional access routes
Figure source: Author

PREPARATION

TERRACES

The strategy to elevate floodplain land to enable a terraced topography is to initiate the envisioned multi-functional landscape framework. The terraces fabricate a productive and functional floodplain landscape throughout the year. For instance, during the festival season these terraces are used by the pilgrims, post festival they are used by the farmers to access the floodplains, during the monsoon season the terraces at high levels are protected from high flood waters of the river making the dynamic floodplain landscape functional and accessible. The highest floodplain terrace retains the festival infrastructure which can be used for other functions like religious tourism, agriculture, recreation etc. The lower terraces are used by the agricultural workers for crop cultivation and the lowest terrace which is the most popular location for the temporary city is converted into a marshland post festival. These terraces inhabit the multi-functional dynamic routing which changes with the changing conditions of the floodplain landscape as shown in figure 7.07.

MULTI-FUNCTIONALITY

Multi-functionality is a crucial strategy for the intervention on the dynamic floodplains as it considers the ability of spaces to provide multiple benefits. The idea is to create spaces which can be adaptively re-used during each phase of the dynamic floodplain landscape making it adaptive to its changing state as shown in figure 7.08. For instance, the infrastructure provisions on higher floodplain terraces are retained to be used for other functions. These spaces with permanent infrastructure provision function as dynamic spaces enhancing and contributing to the dynamic identity of the floodplain landscape of river Ganga.

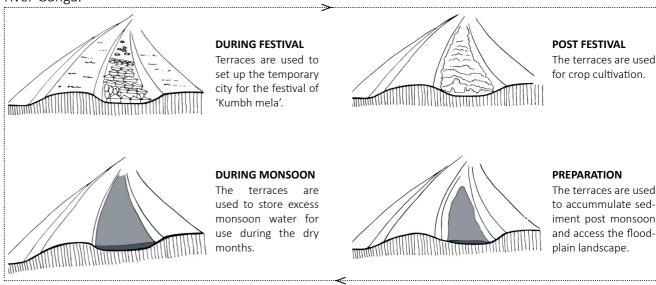


Figure 7.08

Scheme depicting multifnctionality of the floodplain terrace Figure source: Author

Figure 7.09 Conceptual sketches illustrating existing and proposed holy access Figure source: Author, 2020

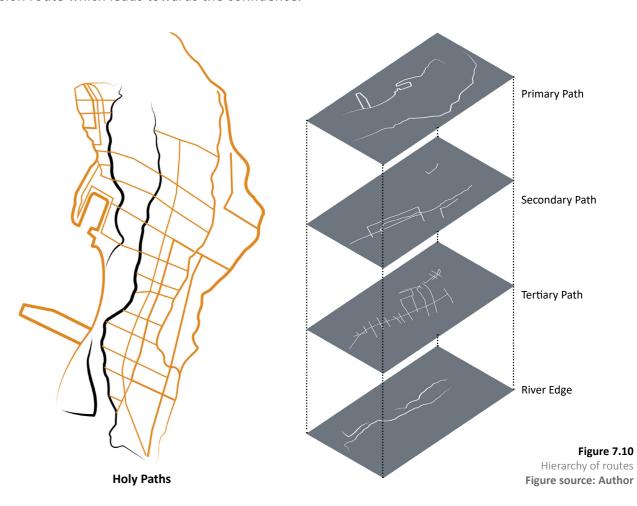
7.3 SPATIAL STRATEGIES - CONCEPT MEANING

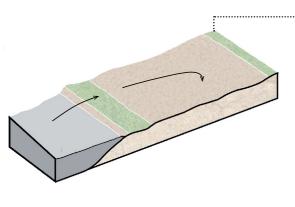
PILGRIMAGE EXPERIENCE

For pilgrims, the experience to the holy confluence is as important as bathing at the confluence of rivers Ganga and Yamuna at Prayagraj. This journey is enhanced by re-orienting their connectivity and accessibility to river Ganga by improving the spatial and visual experience of these holy religious routes designed along the dynamic floodplain landscape. These routes function as dynamic features similar to the dynamic nature of the landscape they are embedded in. They are elevated, opening views towards holy river Ganga.

CONNECTION AND ACCESS - HOLY PATH

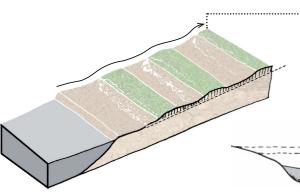
Pilgrims can access the water of holy river Ganga all year round using these elevated routes. The routings are defined as primary, secondary and tertiary routes in line with their elevation and thus ease of access after the festival as shown in figure 7.10. The hierarchial routes are inter-connected and make the waters of Ganga more accessible as opposed to the current situation of just one single primary procession route which leads towards the confluence.





····Stage 1

Initial stage of constructing terrace, strips of vegetation are planted along the contour combined with small contour ridges made up of stone.



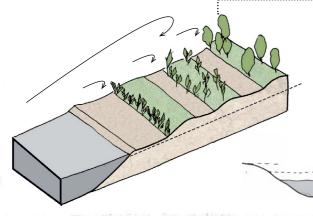
···Stage 2

These contour ridges made up of stone are planted with main crops including perennial species which act as vegetation barriers as the water of river Ganga flows on floodplains bringing with it rich alluvial deposits.





These perennial species of vegetation develop dense cover over time, capable of reducing the velocity of runoff trapping sediment leading to aggradation.





····Stage 4

Preliminary results show that contour hedgerows function effectively as soil erosion barriers from second year of planting. This process leads to the development of these terraces which function essentially in the same way as bench terraces (Dorren, Rey, 2004)

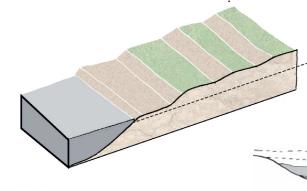




Figure 7.11

Stages of terrace formation **Figure source: Author**

7.4 DESIGN WITH NATUREUSING NATURAL PROCESSES AS BASIS FOR DESIGN IAN MCHARG, 1969

The concept of ecological planning was pioneered in the book 'Design with nature' (Mcharg, 1969). The concept is a precursor of the multi-functional landscape design where Mcharg focuses on the natural, social and cultural processes and sees design as a process shaped by human and ecosystem interactions.

Every year when the water of river Ganga recedes post the monsoon season the river leaves behind residue and rich alluvium deposits on the floodplains. These deposits make the floodplain ground irregular; Thus, ground levelling workers excavate the excess alluvium deposits to level the ground for the construction of the temporary city before the festival. This natural process of sediment accumulation is used to create terraces in this dynamic floodplain landscape of river Ganga at Prayagraj in India as shown in figure 7.11. The landscape slowly transforms as the floodplain terraces develop as an interaction of individual plants with soil, water erosion and sedimentation processes on the existing sloping terrain of the floodplains as shown in figure 7.12. The terraces are constructed using permanent vegetation barriers combined with small contour ridges made of stone or earth. The principal objective of this terracing is to reduce surface runoff, loss of soil and increase soil moisture content.

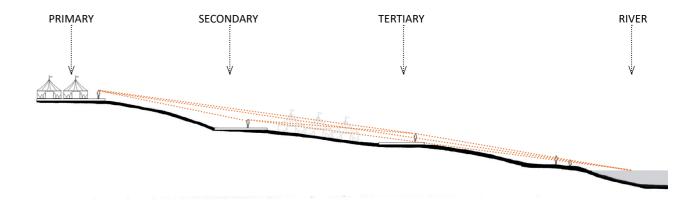


Figure 7.12 Scheme depicting resultant terrace formation

Figure source: Author

7.5 PHASING INTERVENTIONS

PHASE 1 (0 years)

PHASE 2 (+5 years)

PHASE 3 (+10 years)

STAGE - 0

ANNUAL 6 YEARS 12 YEARS

1 EXISTING FLOODPLAIN TERRAIN

STAGE - 1

- 1 TERRACE FORMATION INITIATED
- 2 WATER DIVERTED (ROOM FOR RIVER)

STAGE - 2

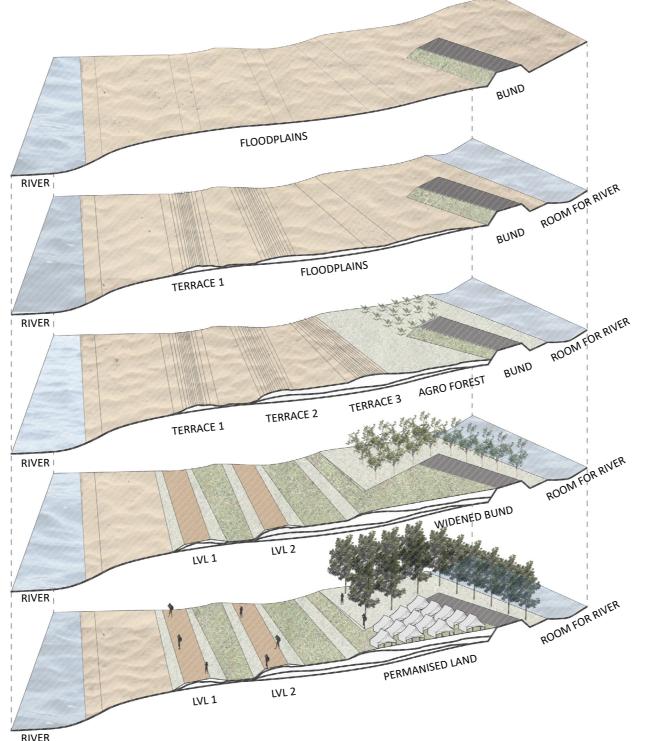
- 1 TERRACE FORMATION IN PROCESS
- 2 TREE PLANTATION IN FESTIVAL LAND (12 YEARS)

STAGE - 3

- 1 EMBANKMENT WIDEN ING
- 2 AGROFOREST MAINTE NANCE

STAGE - 4

1 TERRACED FLOODPLAIN 2 ADAPTIVE INFRASTRUC TURE INTRODUCED





LAND - ANNUAL CYCLE (0 Years)

Stage 0 and 1 is applied to land used for annual cycle of festival as shown in the figure. Terrace formation is initiated in festival land used annually and excess monsoon water is diverted as per the terrace levels.



LAND - 6 YEAR CYCLE (+5 Years)

Stage 1 now expands to land used for 6 year cycle, stage 2 and 3 begin in festival land used every 6 years. The existing bunds (buxi bund) are widened and tree plantation and maintenance starts in festival land used every 12 years.



LAND - 12 YEAR CYCLE (+10 Years)

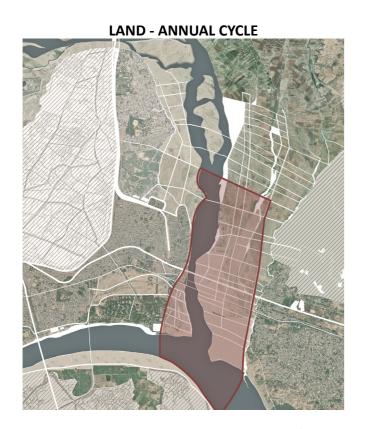
With the highest terrace formation along with the widened bunds or embankments multi-functional, adaptive infrastructure is introduced on these terraces (floating platforms, tent infrastructure for users. etc.) Parts of festival land used every 12 years is transformed into agroforests by villagers which practice controlled felling for producing raw materials (wood) for festival infrastructure.

Figure 7.13

Phasing of the different stages of design intervention on the floodplains

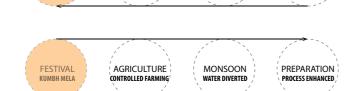
Figure source: Author

7.6 USE AS PER FESTIVAL CYCLES



1st YEAR

6th YEAR



MONSOON WATER DIVERTED

PREPARATION

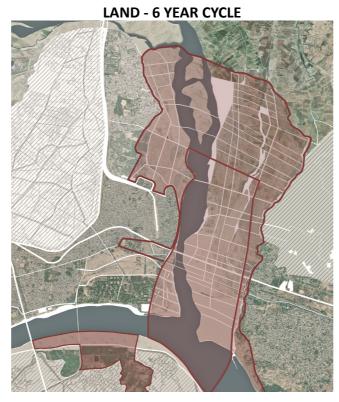
AGRICULTURE

12th YEAR



Figure 7.14 depicts the primary function or use of the festival land used every year, every 6 years and every 12 years. The land is used for the festival of 'Kumbh mela' every year. The extent of floodplain land marked in the map in figure 7.14 is used to host the festival every year.

Figure 7.14 Use of annual festival land Figure source: Author





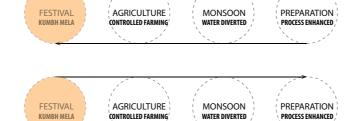
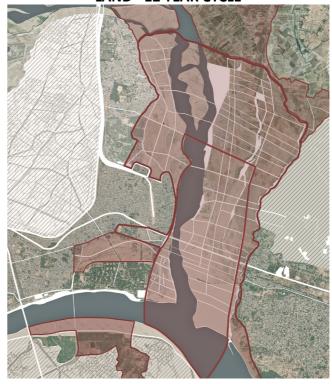


Figure 7.15 depicts use of 6 year festival land during the annual cycle, when the festival of 'kumbh mela does not take place on this part of the floodplains. The primary function of this area during the annual cycle is agriculture, water retention during the monsoon and recreation.

> Figure 7.15 Use of 6 year festival land Figure source: Author

LAND - 12 YEAR CYCLE









The primary function of the land used every 12 years for festival is agriculture, water retention during monsoons, recreation and agroforestry till the twelfth year when it hosts the festival of Kumbh mela as shown in figure 7.16.

> Figure 7.16 Use of 12 year festival land Figure source: Author

> > 117

GOVERNMENT OF INDIA CENTRAL (INDIA) **COMMUNICATIONS DEPARTMENT Environment & Forests** Railways Culture STATE (UTTAR PRADESH) STATE ADMINISTRATION CHIEF MINISTER + CHIEF SECRETARY **STATE DEPARTMENTS** Information & PR Food & supplies Urban Development 7 Cultural affairs Pollution control Ayurveda Environment Public works Irrigation Horticulture Transport Tourism Housing **Planning** Forests Finance Bridges Energy Roads Water Dairy **DISTRICT (PRAYAGRAJ) DIVISONAL COMMISSIONER** SITE **MELA ADHIKARI MUNICIPAL COMMISSIONER PLANNING ASSISSTANT CONSTRUCTION ASSISSTANT** MANAGEMENT ASSISSTANT **SECTOR MAGISTRATES**

Figure 7.17 Administrative stakeholders involved Figure source: Adapted from Mehrotra, Vera, 2015

7.7 STAKEHOLDER MANAGEMENT



Stakeholder involvement is significant for the accomplishment of the envisioned landscape framework for the dynamic floodplains of river Ganga at Prayagraj in India. Uttar Pradesh is the largest state in India and comprises a large hierarchial administrative structure depicted in figure 7.17. Each organization plays a major role in the development of the project. Hence, their aims and problems need to be addressed by stakeholder identification as shown in figure 7.18 to facilitate management of the project throughout its development over time.

The project aims to propose stakeholder involvement from planning phase. As per figure 7.18 it is shown that the local inhabitants, boatsmen, agricultural workers, tourists, researchers etc. all have high interest in the project but dont have enough power and influence. However, Prayagraj development authority, public works department and town and country planning have sufficient power but dont have that level of interest as a result of politicized decision making. Thus, the main drivers for this project would be state departments comprising of environment, tourism, food and supply, water and heritage. The eventual gainers from this project would be the students and researchers who play a crucial role in creating awareness among the local inhabitants by engaging them with the dynamic floodplain land-scape. Thus, contributing in preserving its dynamic identity and sanctity.

Figure 7.18
Interest Power graph
Figure source: Author

| DESIGN: MACRO |

8.1 MACRO SCALE: SITE PLANNING

RESILIENT LANDSCAPE TERRACES Terrace level +88.5 m Terrace level +82 m Terrace level +76 m Terrace level +72.5 m DYNAMIC SITE ROUTING Primary route Secondary route Tertiary route ECOSYSTEM FUNCTION -WATER RETENTION Proposed area Decreasing capacity

Figure 8.01
Main interventions at Macro Scale
Figure source: Author

122

CHAPTER GUIDELINE

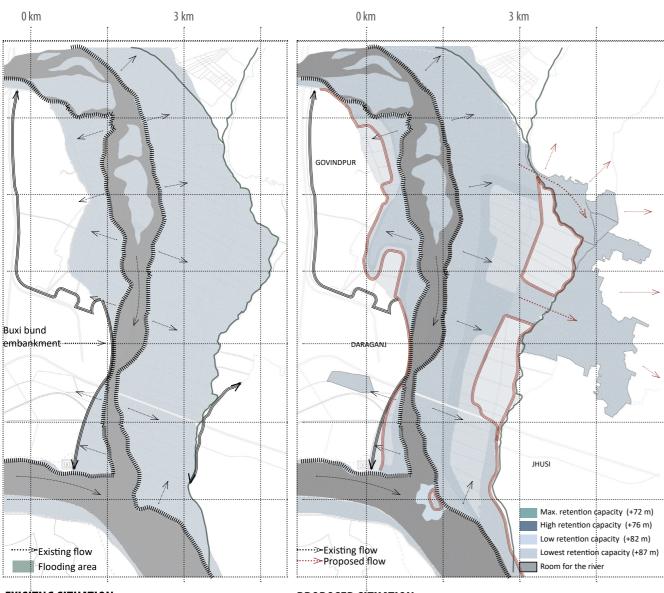
This chapter includes the design framework for floodplains of river Ganga at Prayagraj in India at a macro scale. It starts with the drawings for the main planning interventions as shown in figure 8.01. The primary function of this type of an ecosystem is to act as a buffer for the river and experience its flooding. The intervention with respect to this natural function of water retention by floodplains is explained in section 8.2 of the chapter. It is followed by the plans of changing phases in section 8.3 and part site sections in 8.4.

INTRODUCTION

The intervention is proposed on the dynamic floodplains of river Ganga in coherence with the threefold research approach utilizing parameters of physical landscape, use, meaning and the theory back up of 'Landscape resilience', 'Dynamic landscape theory' and 'Designing with Nature' as per figure 8.01. The idea is to make use of the existing floodplain topography of fluvial terraces and elevating them at varying levels to make floodplains adaptive to its changing phases of festival, agriculture, monsoon and preparation. The routing on the floodplains are proposed to function as dynamic features in the landscape which lay on the elevated terraces at different levels enhancing spatial experience for the users. They are characterized as primary, secondary and tertiary routes in accordance with their level hierarchy.

The land of the floodplains is divided as per changing cycles of the festival. Only a part of the floodplains near the confluence is used annually for the festival of 'Kumbh mela', other parts only host the festival every six years and twelve years respectively. This cycle is used to initiate primary functions to different parts of the floodplains helping it respond to its changing phases and making it self-sustainable.

8.2 WATER RETENTION



EXISITNG SITUATION

The map shows the existing extent of flood- The map shows floodplain terraces and their decreasing during the monsoon season.

Area available for water retention - 23 sq. of the floodplains as shown in the map. km.

Existing vs proposed water retention capacity of the dynamic floodplain landscape of river Ganga Figure source: Author

PROPOSED SITUATION

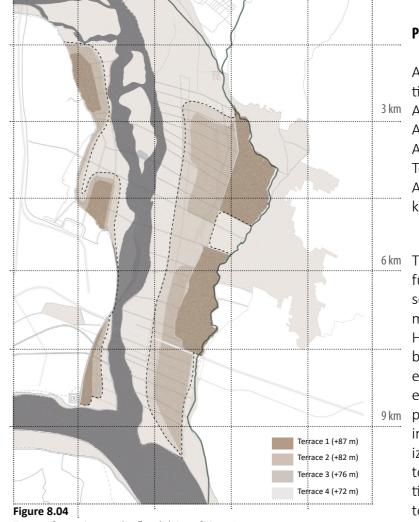
plain land of river Ganga at Prayagraj in In- capacity of retaining water. To balance the reduced redia which has the capacity to retain water tention capacity of the floodplain, water is diverted to vast unused fields and meadow land on the Eastern bank

Area available for complete water retention - 13.84 sq.

Elevated area- 9.16 sq. km

Area added for water retention- 13.23 sq. km.





3 km

Terrace formation on the floodplains of river Ganga Figure source: Author

0 km

PROPOSED TERRACES

0 km

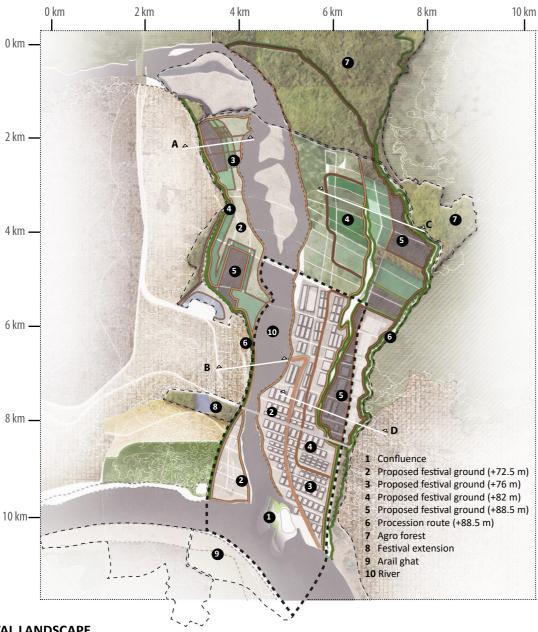
Area available for complete water retention- 13.84 sq. km 3 km Area of terrace 1 (+88.5 m)- 3.36 sq. km Area of terrace 2 (+82 m)- 3.97 sq. km Area of terrace 3 (+76 m)- 1.83 sq. km Total elevated area- 9.16 sq. km Area added (Water retention)- 13.23 sq.

6 km The terraces formed on the floodplains function as retention terraces or absorption terraces to retain water during monsoon season (Dorren, Rey, 2004). However, this strategy to create terraces by inducing permanent vegetation barriers and sediment accumulation reduces existing retention capacity of the flood-9 km plains during monsoon season as shown in figure 8.02. Thus, water is channelized to low lying fields and meadow land to compensate for the reduced retention capacity due to enhanced terraced topography of the floodplains.

Terraces with elevation of +88.5 m above sea level are provided with small ponds which increases their water retention capacity along with recharging ground water. Terraces having elevations of +76 m and +72.5 m above sea level get flooded during severe and extreme flooding situation thereby facilitating water retention by these terraces on the dynamic floodplains.

As per the Netherlands 'Room for the river' program, additional area is provided for river water to prevent valuable areas supporting livelihood activities from submerging. Likewise, in case of dynamic floodplains of river Ganga, water is channelized by existing streams towards the eastern bank of river comprising of vast fields and meadow. Flooding these areas prevents the valuable land on the western bank of river Ganga near low lying residential areas from getting flooded along with promoting livelihood functions within the dynamic floodplains of river Ganga at Prayagraj in India.

8.3 PLANS AS PER PHASING



FESTIVAL LANDSCAPE

The plan shows transformation of the dynamic floodplains during festival of 'Kumbh mela' (annual cycle). The existing water streams are naturalized, and elevated procession routes are proposed along them. The festival takes place at three levels as per the elevation of the proposed terraces. The highest level is least likely to flood and comprises of adaptive infrastructure which is proposed as per the changing phases of the floodplains. The proposed routes on either side of the floodplains function as main access routes for pilgrims during the festival. The festival land used every 12 years is converted into community managed Agro forests and water retention areas giving more room to the river during monsoon or high-water flows during the annual and 6 year cycle of the festival.

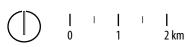
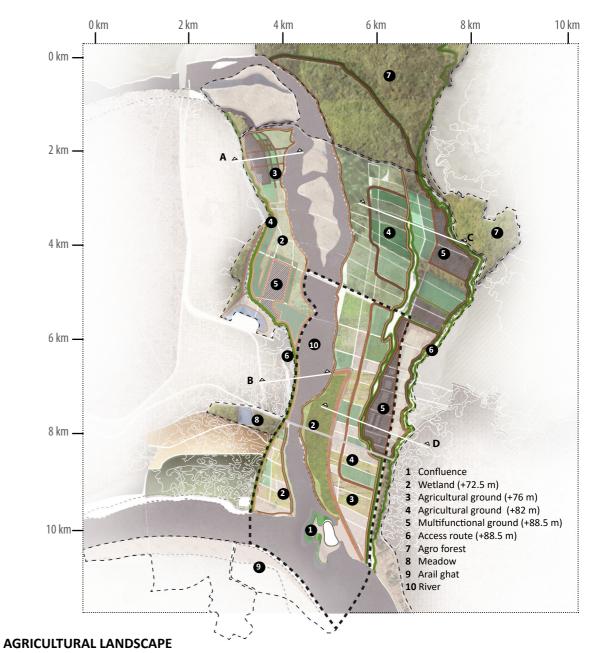


Figure 8.05
Planning- Festival phase
Figure source: Author

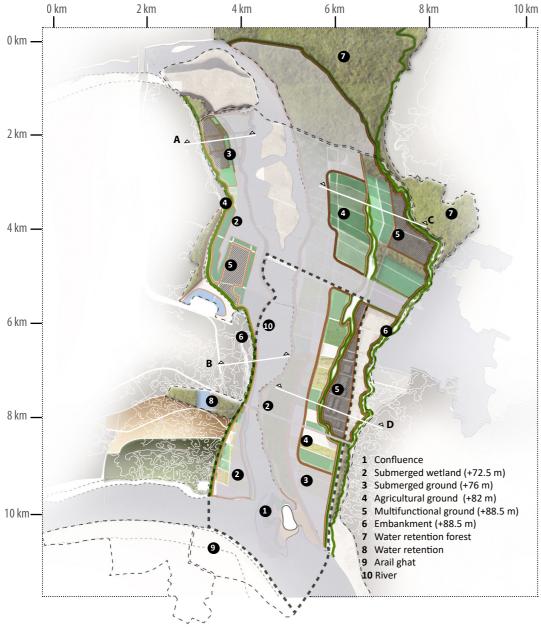
126



The plan in figure 8.06 shows transformation of the floodplains post festival of 'Kumbh mela' to adapt to its next phase of agricultural landscape. The elevated procession routes used by pilgrims during the festival are now used by the agricultural workers and local communities to access the dynamic floodplain landscape. The proposed terraces now support production and various species of flora and fauna. The terrace infrastructure at level +88.5 m above mean sea level is now adaptively re-used for storage of agricultural produce, recreation and tourism. Terrace at level +82 m is elevated for protection from annual flooding and can be used all year round to cultivate crops. The festival land used every 12 years is converted into community Agro forests to supply the excessively used raw material of wood for the festival.



Figure 8.06
Planning- Agricultural phase
Figure source: Author



DELUGED LANDSCAPE

Figure 8.07 shows how the dynamic floodplains adapt to the monsoon season post its agricultural phase. The elevated procession routes previously used as access routes now also act as embankments to protect important land supporting livelihood functions of the communities from flooding. The farmers can still cultivate crops on the upper two terraces which are protected from the annual flooding. Terrace at level +76 m above sea level can still be used for growing crops which can survive submerged conditions as the flood water on these terraces does not excess more than 2 m during annual flooding.

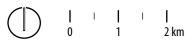
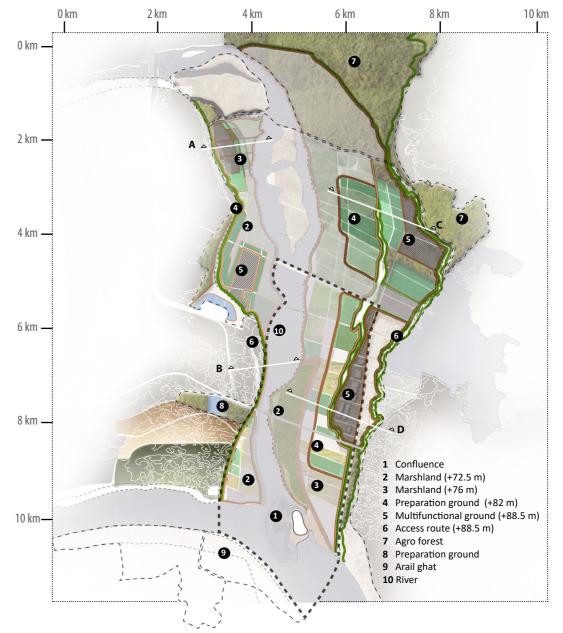


Figure 8.07
Planning- Deluged phase
Figure source: Author



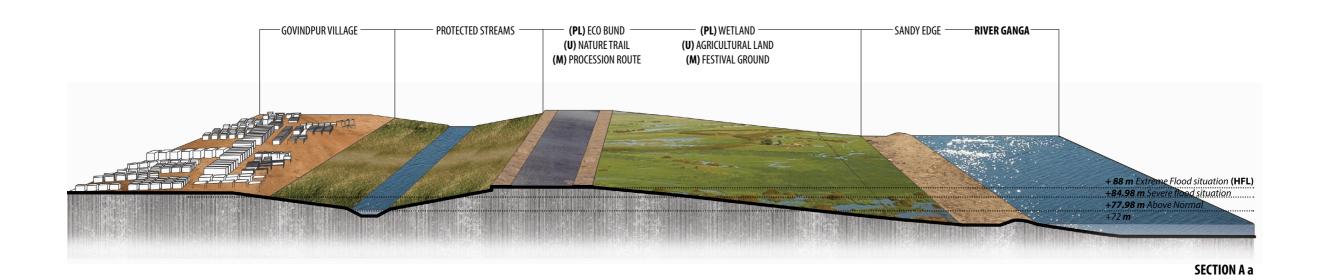
PREPARATORY LANDSCAPE

The floodplains now goes through the phase where the water of river Ganga starts to recede post the monsoon season and the water level goes back to its normal level of 72.5 m. The proposed vegetation cover and grasslands planted during the agricultural phase assist the ground hardening process by sediment accumulation. The proposed primary routes can be used by the festival authorities to access the floodplains and start preparing for the festival of 'Kumbh mela'.



Figure 8.08
Planning- Preparation phase
Figure source: Author

8.4 SECTIONSPART SITE SECTIONS



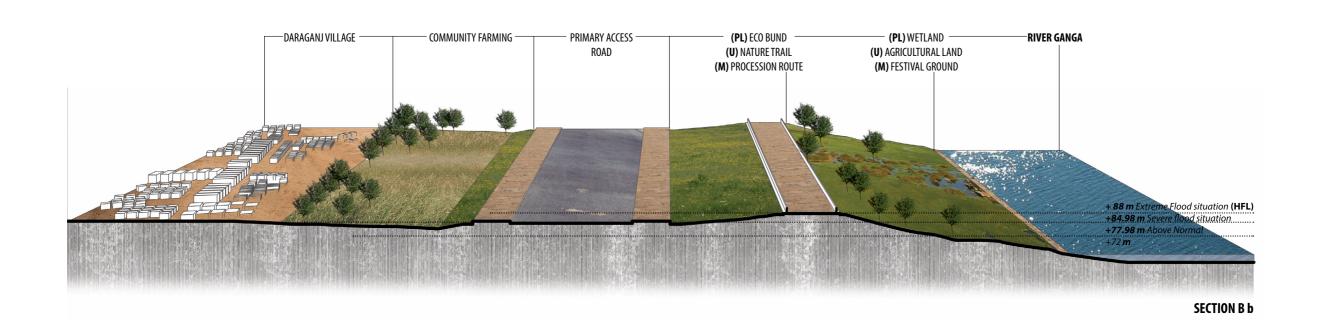
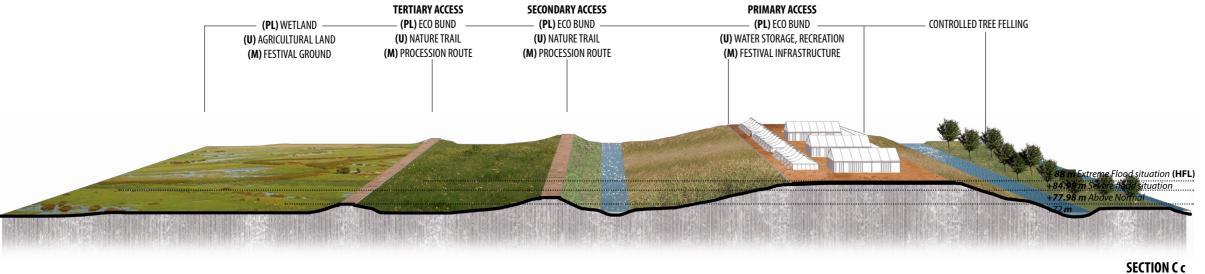
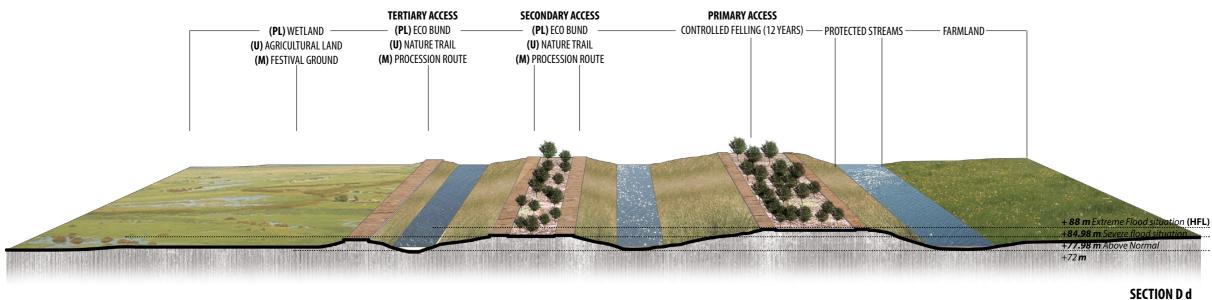


Figure 8.09

Sectional views Figure source: Author





CONCLUSION

The chapter depicts the landscape framework for the floodplains of river Ganga using the 'threefold approach' and theory back up of 'Dynamic landscapes', 'Landscape Resilience' and 'Designing with nature' at a macro scale. The fluvial terrace topography of the floodplains is utilized to achieve this. Designated areas at varying levels are proposed generating a multifunctional usage of the dynamic floodplain landscape which helps in developing a resilient landscape framework adaptive to its changing phases of festival, agriculture, deluge and preparation. The areas of the floodplains hosting festival at changing cycles have been assigned specific uses to make the floodplains self-sustainable.

The next chapter deals with this approach at a smaller meso scale at the confluence which is the holiest location along this dynamic floodplain landscape. The design of this holy confluence at meso scale shows the application of this landscape framework in a more detailed manner.

Figure 8.10

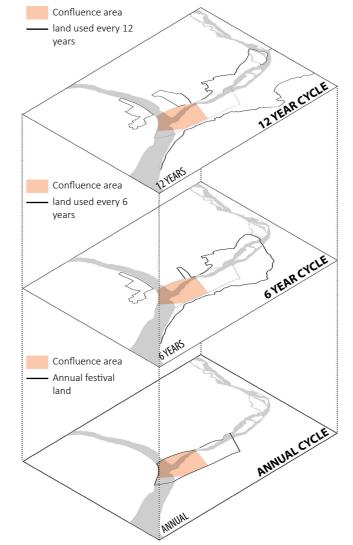
Sectional views Figure source: Author

| DESIGN: MESO |

9.1 Confluence







MOTIVATION

The confluence of rivers Ganga and Yamuna is the ultimate holy location across the entire floodplain stretch at Prayagraj in India as shown in figure 9.01. The location hosts the festival of 'Kumbh mela' and falls under the annual dynamic cycle shown in figure 9.02. Also, it is an essential location owing to its low elevation and constant water flows which makes it susceptible to change. The confluence is extensively used every year and is the main reason for pilgrimage in the region due to its holy nature.

THE INTERVENTION

The floodplains at the confluence are most heavily influenced area due to its frequency of hosting the festival of 'Kumbh mela'. The proposition is to elevate the floodplain ground at this location and enhance existing fluvial terrace morphology by the natural processes of sedimentation and erosion to achieve varying levels as shown in figure 9.03. This helps the confluence in achieving dynamic adaptability making the landscape resilient to change.

Figure 9.02 Location through phases Figure source: Author

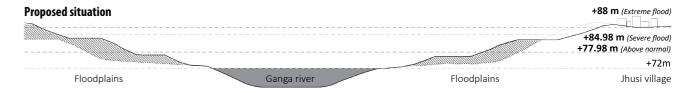
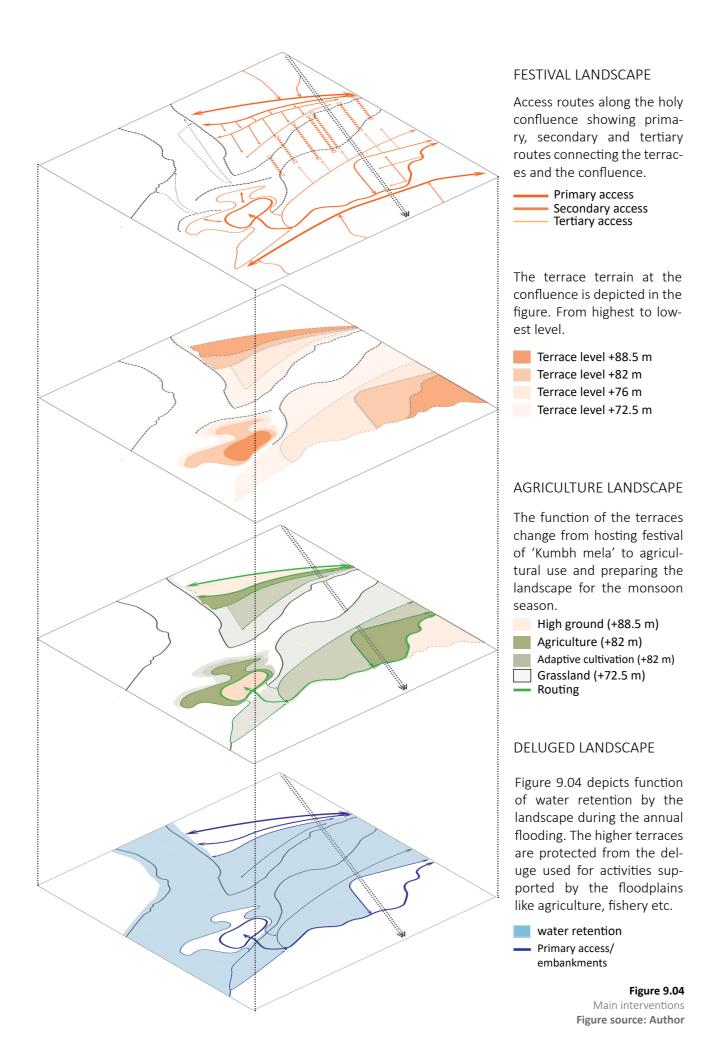


Figure 9.03
Existing vs proposed situation
Figure source: Author



9.2 PLANNING

The floodplain is elevated to form terraces which function as progressive areas which adapt to the changing functions as per each phase of the dynamic floodplain landscape as depicted in figure 9.05.

The terraces formed at levels of +88.5m, +86m and +82 m have altering functioning typologies where, primary function of terrace at level +88.5m is giving access to the floodplain landscape, terraces at level +82 m and +76 m contains fertile floodplain ground used for agricultural and other activities and terrace at level +72.5 m functions primarily as a retention terrace which contains the river discharge of Ganga during the monsoon season.

These terraces are formed to function as multifunctional areas which can adapt to the changing nature of the dynamic floodplain landscape of river Ganga at Prayagraj.

The design for the confluence primarily focuses on the above normal level flooding which occurs annually projected at level of 77.98 m above mean sea level.

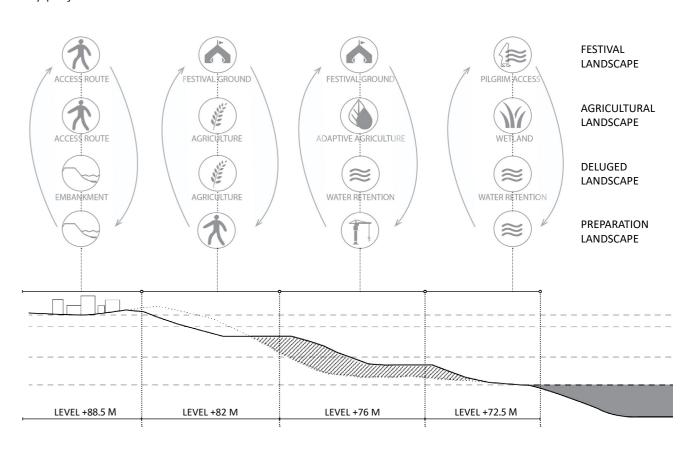
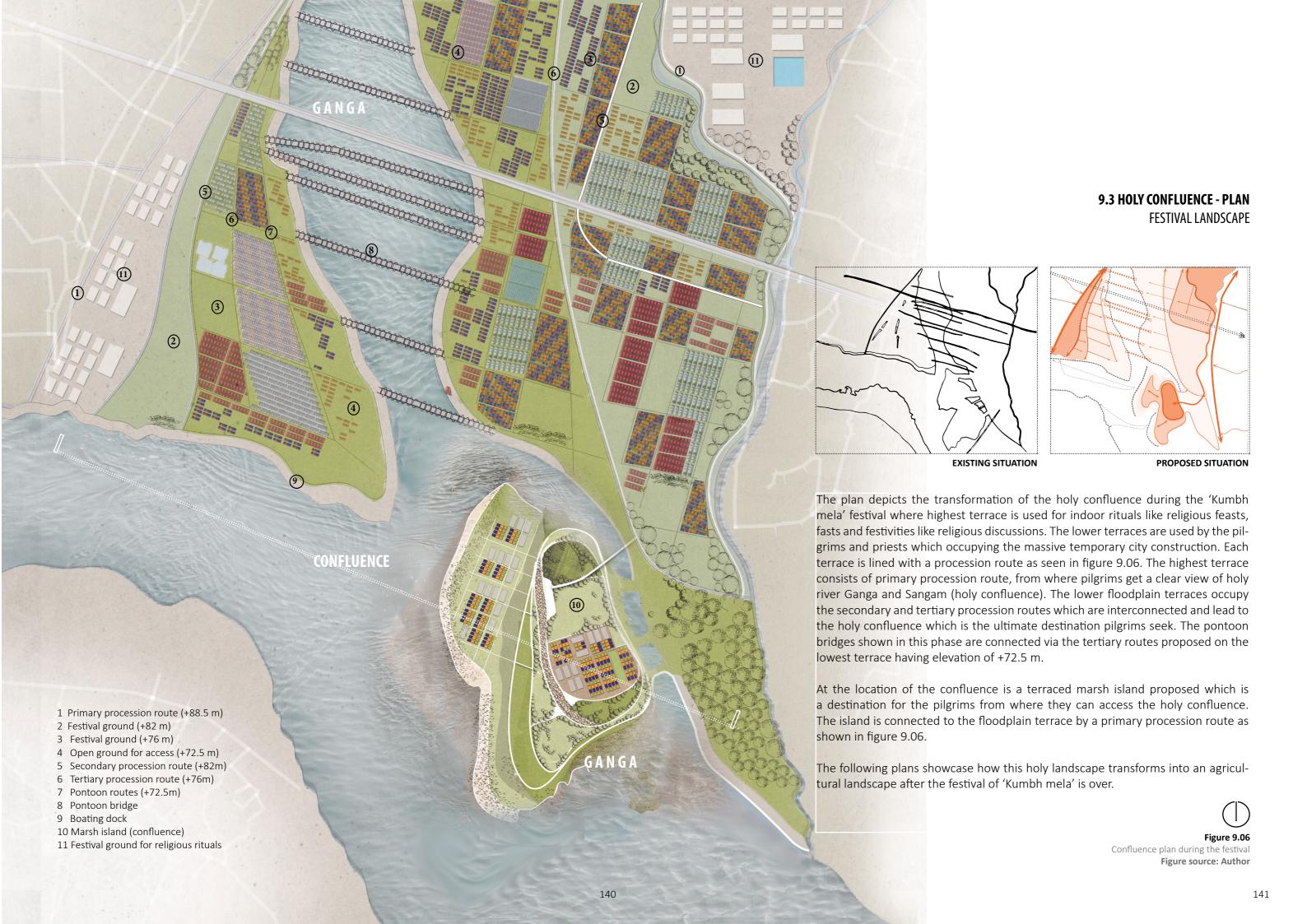


Figure 9.05
Proposed functions as per each phase
Figure source: Author



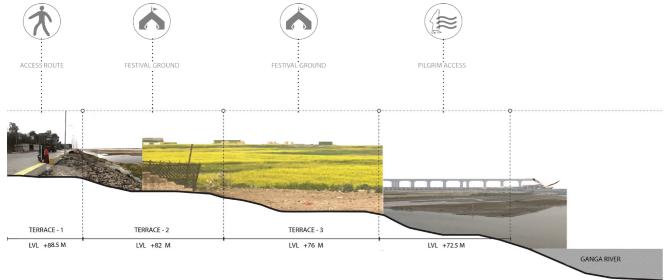


Figure 9.07
Terrace function during festival
Figure source: Author

9.4 HOLY CONFLUENCE - SECTIONAL VIEW FESTIVAL LANDSCAPE

The dynamic floodplain landscape of river Ganga at Prayagraj during the festival of 'Kumbh mela', from Januray to February is depicted in figure 9.08. The floodplains are proposed to be elevated at different levels to host the festival - terrace level 1 (+88.5 m), terrace level 2 (+82 m), terrace level 3 (+76 m) and terrace level 4 (+72.5 m) as shown in figure 9.07. The pilgrims or the devotees use the procession routes on these terraces to reach the holy confluence as shown in the section. These holy processions routes remain indented in this floodplain landscape, designed to be dynamic in nature as they change with diverse functions of the floodplains after the festival of 'Kumbh mela' is over.

We see the terraced marsh island at this location makes it easier for the pilgrims to access the confluence and descend into the water of river Ganga to bathe in it. At the highest level or terrace of the confluence island we see the festival infrastructure where the pilgrims can have religious discussions or special rituals or ceremonies which are otherwise practiced on makeshift temporary platforms through boat. The island supports a boating dock from where pilgrims can access the confluence coming from other locations along the floodplains.

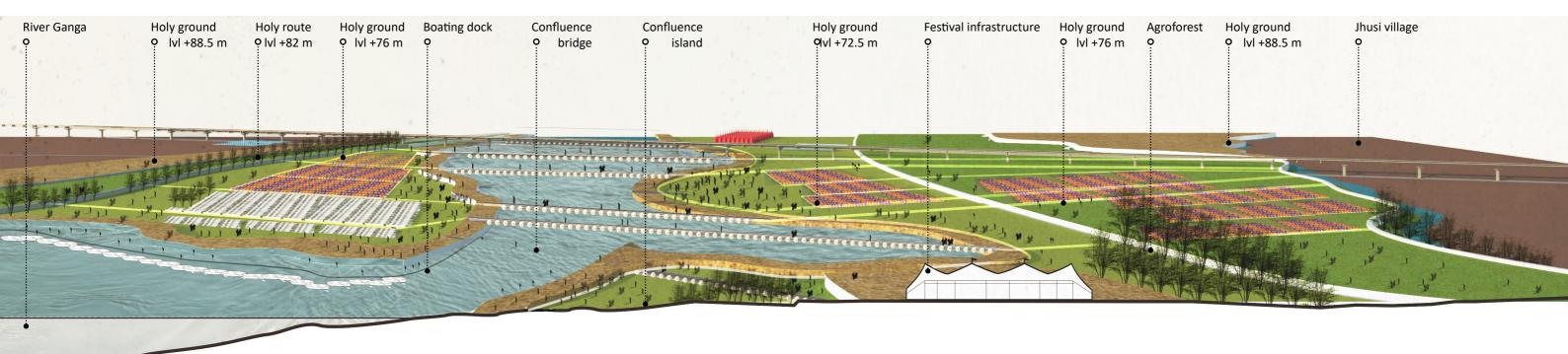


Figure 9.08
Sectional view during the festival
Figure source: Author



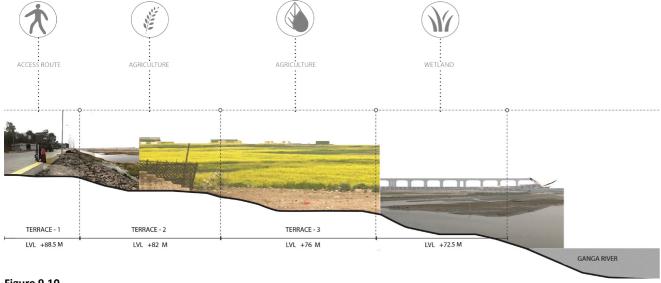


Figure 9.10
Terrace function post festival
Figure source: Author

9.4 CONFLUENCE - SECTIONAL VIEW AGRICULTURAL LANDSCAPE

The section in figure 9.11 shows view towards the confluence and the transformation of the dynamic confluence into an agricultural landscape. The terraces which previously supported the temporary city now support the agricultural workers as they cultivate crops on them. The pontoon bridges installed for the festival of 'Kumbh mela' are dismantled before the monsoon and retained for this phase of the landscape, the pontoons can be used to access either side of the floodplains by agricultural workers and visitors of the landscape after the festival is over. The provision of terraces in the dynamic floodplain terrain promotes rock weathering and eventually increases crop growth (Dorren, Rey, 2004). This also helps in maintaining a permanent soil cover over the terraces which are essential for their stability, maintenance and prevents soil from eroding.

The terrace marsh island is converted into a wetland creating conditions for various species of flora and fauna to exist. The highest point on this island functions as a viewing point for religious tourists and visitors of the landscape to experience the holiness of the landscape by visually connecting them with the holy confluence.

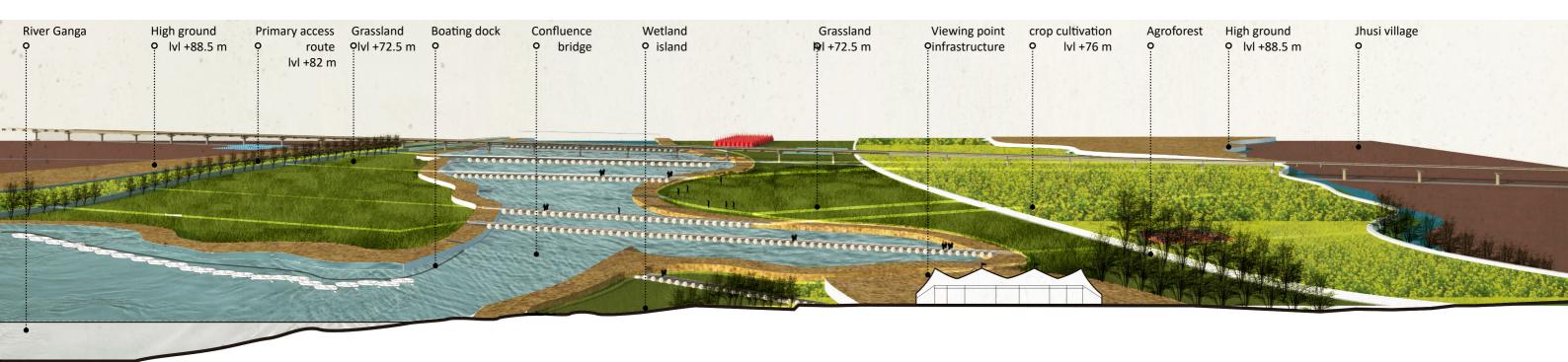


Figure 9.11
Confluence plan after the festival
Figure source: Author



EMBANIMENT AGRICULTURE WATER RETENTION WATER RETENTION TERRACE -1 LIVL +88.5 M LIVL +82 M LIVL +72.5 M GANGA RIVER Figure 9.13

Terrace function during monsoon

Figure source: Author

ain landscape during the monsoon season

9.4 CONFLUENCE - SECTIONAL VIEW

DELUGED LANDSCAPE

Figure 9.14 depicts the sectional view of dynamic floodplain landscape during the monsoon season. The swelling of the river and retention capacity of the floodplains near the location of confluence of rivers Ganga and Yamuna is illustrated. The view shows annual flooding situation when the water of river Ganga is at 77.98 m above sea level. At this level the lower terraces having elevation +72.5 m, +76 m are completely submerged in water. The higher terrace having elevation +88.5 m and +82 m is accessible by the users of the landscape during this phase of the cycle as shown.

The marsh island is completely deluged by the flows of river Ganga during monsoon season. However, like the floodplains the highest terrace level of +88.5 m on this island landscape is still accessible via the primary access route connection and boats. It is still functional and can be used by religious tourists, boatmen and fishermen for their requirements.

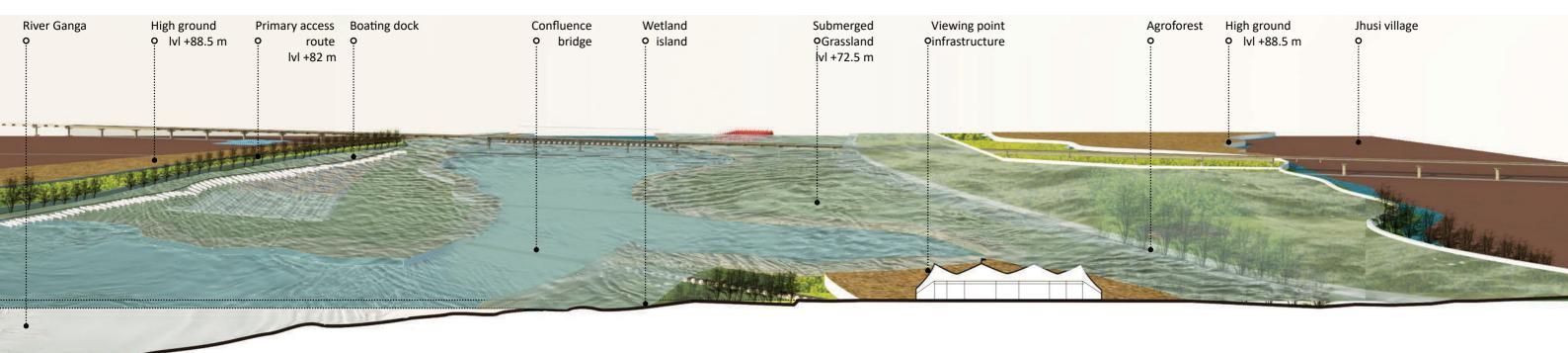


Figure 9.14
Confluence plan during the monsoon
Figure source: Author



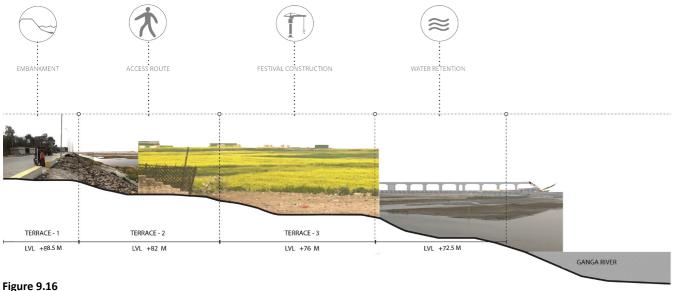


Figure 9.16
Terrace function post monsoon
Figure source: Author

9.4 CONFLUENCE - SECTIONAL VIEW PREPARATION LANDSCAPE

The section in figure 9.17 depicts view towards the confluence while the water of river Ganga at Prayagraj in India, recedes post the monsoon season and authorities start preparing for the festival. The vegetation cover like grassland and other pioneer species planted on the lower floodplain terraces reduce the ground hardening time as they maximize the process of aggradation on the dynamic floodplains. It traps sediment and prevents the soil from eroding back with the water of the river as it goes back to its normal state.

The agroforests planted on the floodplains functions similarly as they enhance sediment retention by deep soil root penetration and reducing rate of erosion as the water recedes. Eucalyptus platypus is grown in this area as it can survive submerged conditions.

CONCLUSION

The next chapter depicts this process in greater detail through the detail design illustration of the terrace marsh island which is a crucial location during the festival and post the festival owing to its strategic location which makes it the most dynamic part on the confluence of rivers Ganga and Yamuna.

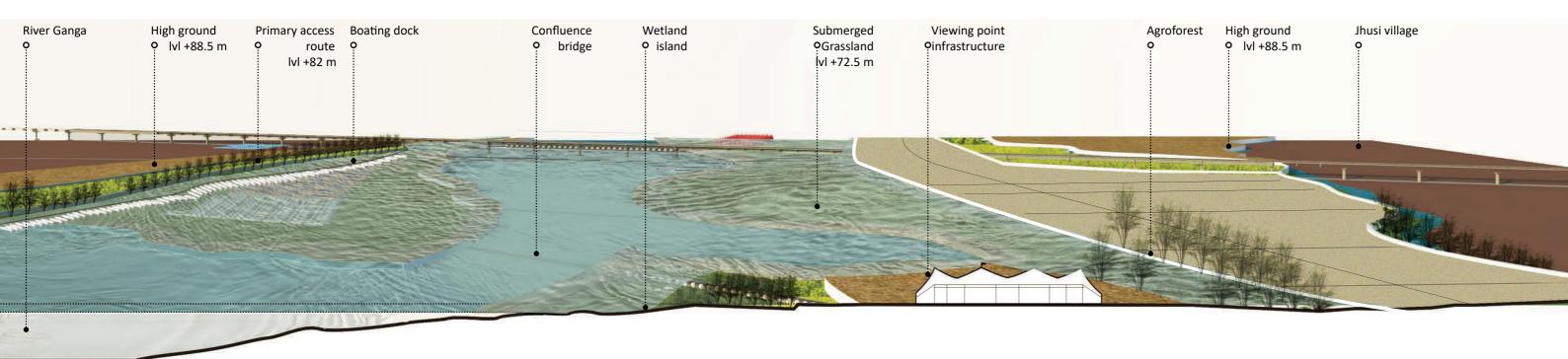
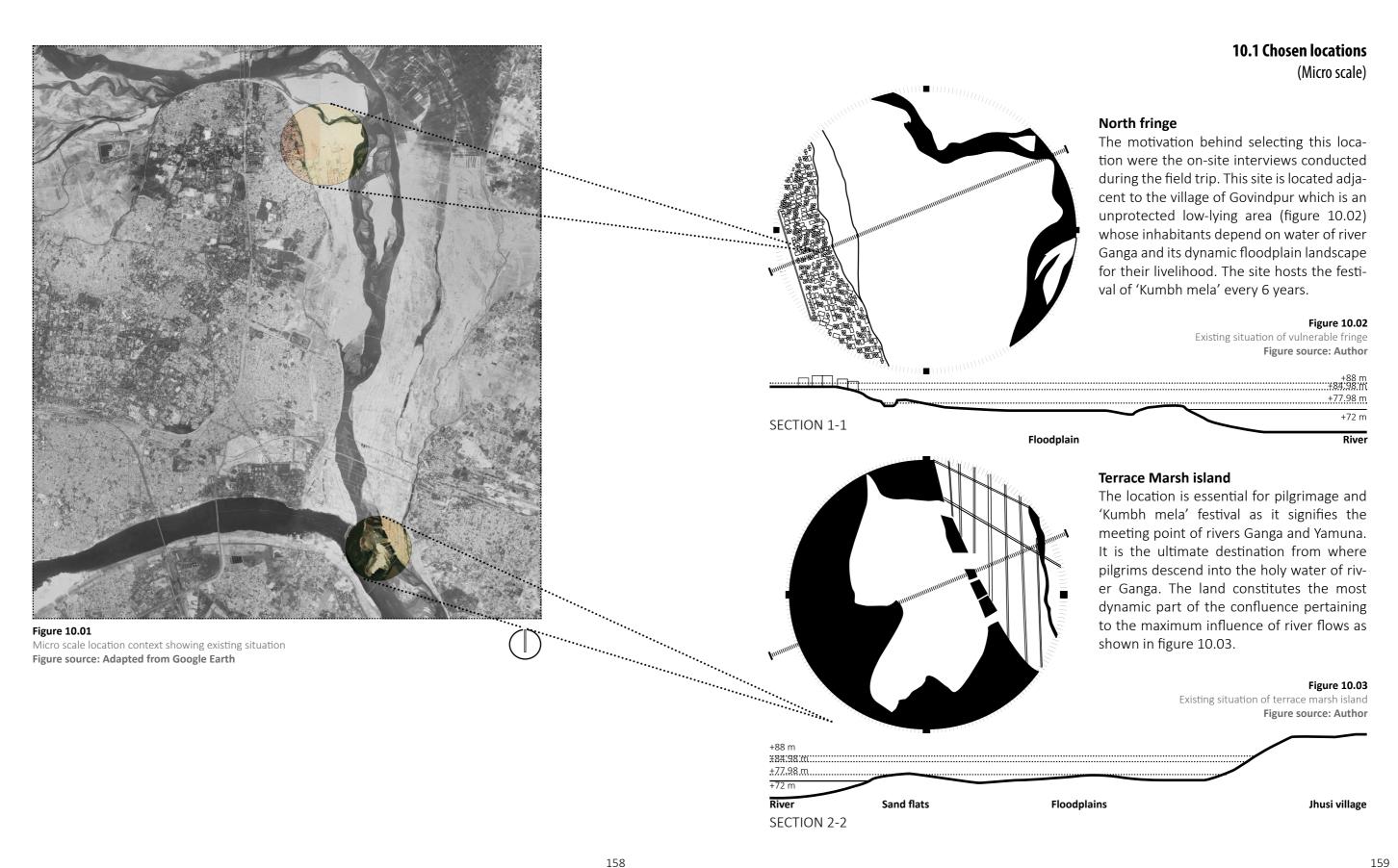
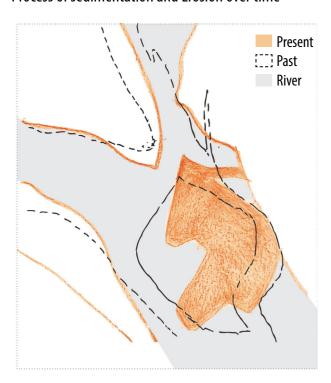


Figure 9.17
Confluence plan during the festival
Figure source: Author

| DESIGN: MICRO |



Process of sedimentation and Erosion over time



The shifting course of the island due to natural processes of sedimentation and erosion at the confluence is depicted in figure 10.04. This sand flat island is the most dynamic part of the confluence which evolves as per the flows of river Ganga and Yamuna.

The figure shows overlapping of the past landform with respect to the current landform which has evolved due to the natural process of river flows over time.



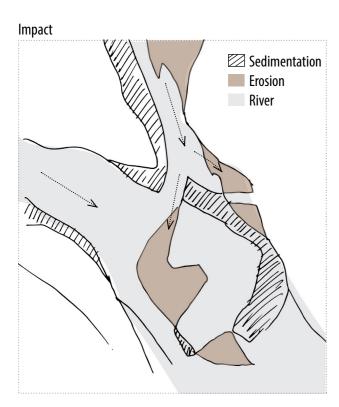


Figure 10.05 shows the consequence of the powerful forces of nature pertaining to sedimentation and erosion brought in by the flow of river Ganga and Yamuna across this vulnerable fragment of land. The land at the western part of the island has undergone erosion and eastern side has encountered sedimentation as depicted. Thus, it can be concluded that this fragment of landmass lying at the confluence is under a constant process of change due to the direct impact by natural flows of the river.



160

10.2 Marsh Island Designing with Natural processes

Shaping the fragment of sand flat island at this confluence location was a crucial part of the designing process. The landform is envisioned to evolve considering, the ecosystem functions of the dynamic floodplains and using natural forces of sedimentation and erosion existing on site. The sand flat is transformed into an elevated dynamic landform which adapts to the constant change it experiences. The land fragment having lower elevation is left to act as a barrier for this elevated landform and is dynamic with respect to the physical parameters of river flows.

Figure 10.06 and 10.05 shows the impact of sedimentation and erosion over a period on this dynamic island landscape lying at the confluence of river Ganga and Yamuna. It is observed the outer edge of the island exposed to direct flow of river Ganga and Yamuna has undergone erosion over a period as opposed to the inside edge, towards the floodplains which has undergone sedimentation.

Past situation

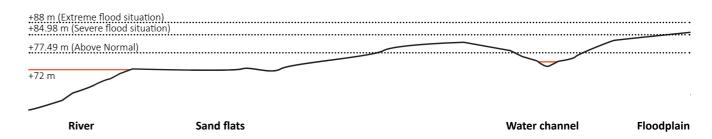


Figure 10.06

Past situation

Figure source: Author

Existing situation

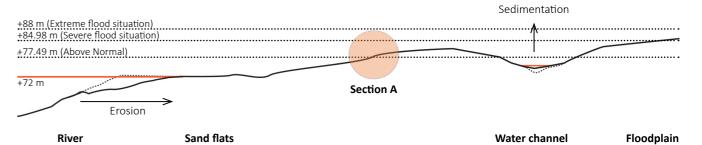
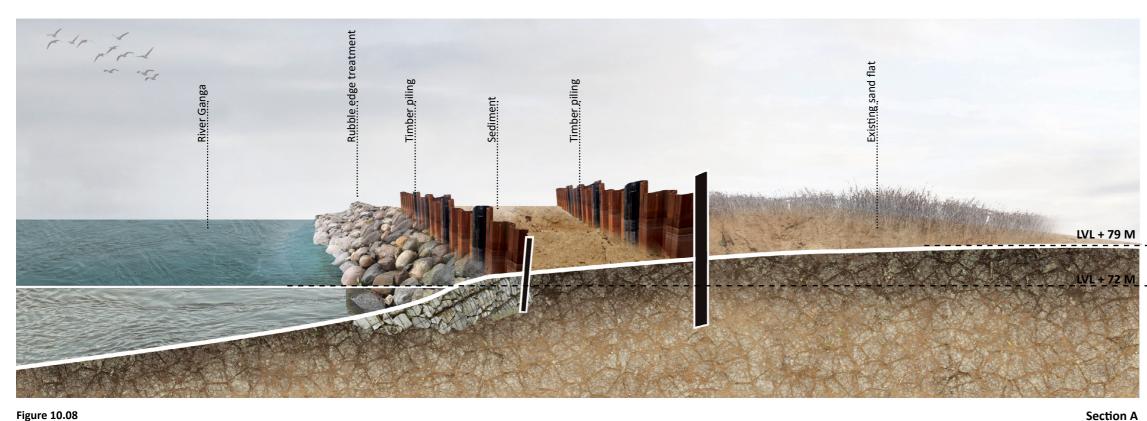


Figure 10.07
Existing situation
Figure source: Author

10.2.1 Development over time

(Terrace formation)



EXISTING SITUATION

Figure 10.08 depicts the existing condition of sand flat at the confluence which is temporarily converted into a *ghat* for the festival of 'Kumbh mela' from where pilgrims access the holy confluence water.

At this location a part of the sand flat is elevated to make it more adaptive to its dynamic nature returning the site to its ecological and community function depicted in figure 10.10. The edge is inserted with timber sheet piling to help in the retention of soil and the sediment brought in by river during monsoon season.

The edge is also treated with rubble to protect soil from erosion when the water recedes and stabilize the sediment deposit within the island.

Figure 10.08
Intervention in the existing situation
Figure source: Author

Existing situation

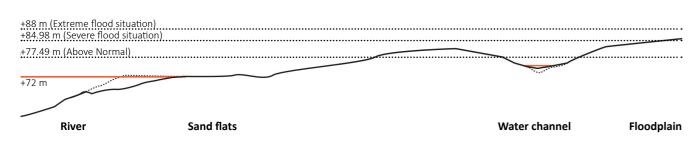


Figure 10.09

Existing situation of terrace marsh island **Figure source: Author**

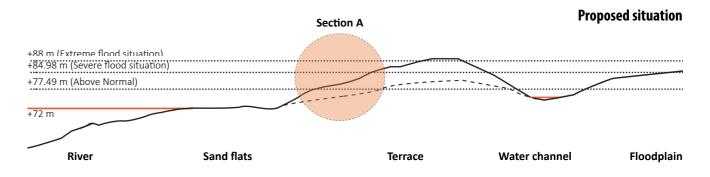
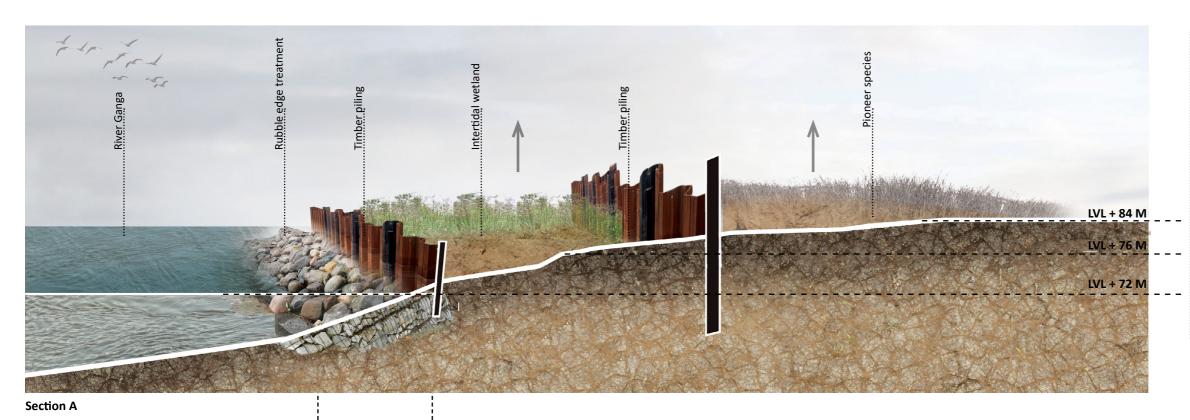


Figure 10.10
Proposed situation
Figure source: Author

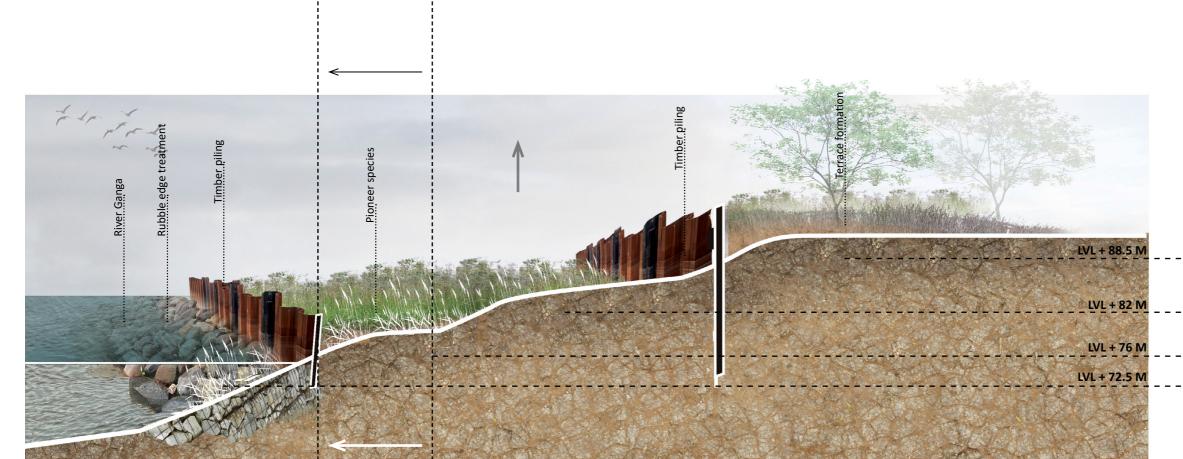


+ 6 YEARS

Initial layering of timber sheet piling is removed towards the river allowing sediment to deposit at this location as shown in figure 10.11. As sediment layers, raising the levels, pioneer species are introduced which trapmore sediment gradually leading to the increase in elevation of the sand flats island.

This initiates the development of terraces which are further elevated and stabilized as the pioneer species form a dense cover over time.

Figure 10.11
Landform after 6 years
Figure source: Author



164

Section A

+ 12 YEARS

Over time pioneer species form a dense cover stabilizing the trapped sediment depicted in figure 10.12. The new layers of sediment trapping protect the elevated land behind it from deluging river flows during the monsoon season.

The island can now be accessed during all phases of the landscape by different users as per their requirements. It is important to retain this vegetation cover on the island to maintain this land formation and prevent the island from natural forces of water flows, erosion over longer periods of time.

Figure 10.12 Landform after 12 years Figure source: Author



PHASE 1: FESTIVAL LANDSCAPE

Pilgrims access the confluence during festival of 'Kumbh mela' with the help of the temporary *ghats* (platforms) constructed on the marsh island depicted in figure 10.13. The elevation of the island surface ensures land availability during the festival period and increases ease of access of the holy confluence for the pilgrims seeking to bathe in the holy water.

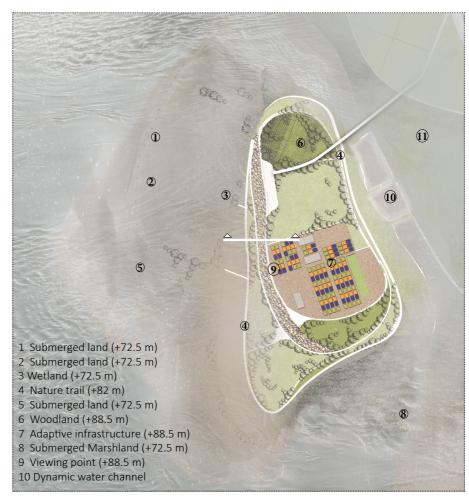
Figure 10.13
Festival landscape- Plan
Figure source: Author



PHASE 2: AGRICULTURAL LANDSCAPE

The temporary ghat and festival ground are converted into a wetland park post the festival of 'Kumbh mela' as seen in figure 10.14. The elevated landform now ensures the agricultural workers and locals can access the holy confluence after the festival is over due to its ease of access with the rest of the floodplains of river Ganga.

Figure 10.14
Agriculture landscape- Plan
Figure source: Author

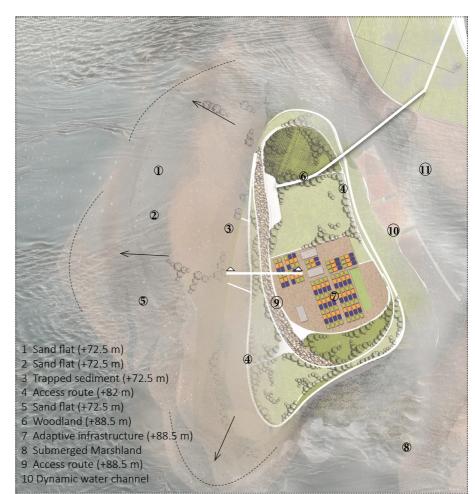


10.2.2 PLANNING

PHASE 3: DELUGED LANDSCAPE

The temporary wetlands are completely submerged in water during monsoon season, the vegetation prevents soil erosion and traps sediment making the land formation stable for the next phases of the constantly changing land-scape shown in figure 10.12. The submerged marshes and wetlands create conditions for various species of flora and fauna to exist on the island.

Figure 10.15
Deluged landscape- Plan
Figure source: Author



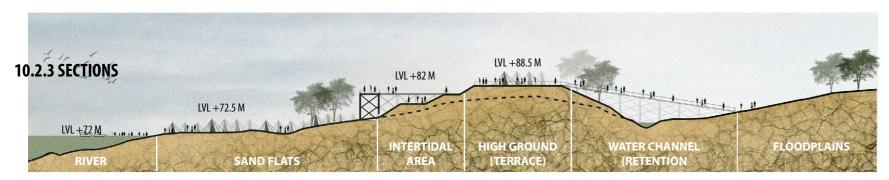
PHASE 4: PREPARATORY LANDSCAPE

During this phase the water starts receding from the submerged wetlands depicted in figure 10.16, vegetation proposed acts as barriers enhancing the rate of sedimentation and preventing land degradation. The elevated landform gives access to the festival authorities to start planning for the festival during this phase.

Figure 10.16
Preparation landscape- Plan
Figure source: Author

| | | | | 0 100 200 n





SECTION 1- FESTIVAL LANDSCAPE

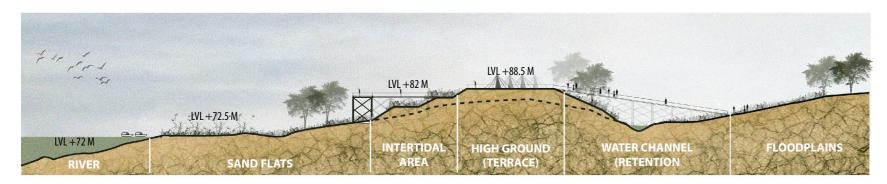






i. rnombolaea

Section shows the marsh island landscape during the festival of 'Kumbh mela'. We see the highest ground is completely occupied by the pilgrims who can access the island via a bridge from the floodplain land. The lower ground at level +82 is used by the pilgrims as a procession route. The sand flats at level +72.5 m inhabit the temporary tents and used by the pilgrims to access water of river Ganga.



SECTION 1- AGRICULTURAL LANDSCAPE







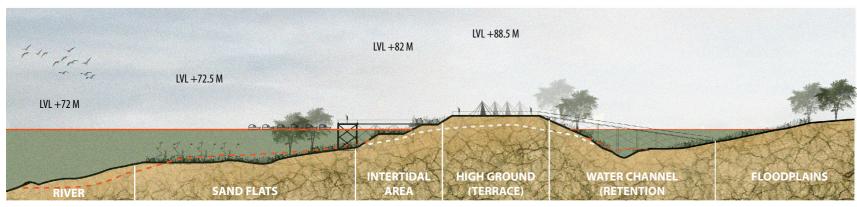
Eichhornia crassipes

Ceratophyllum demersum

labeo catlo

Sarkidiornis melanoto

The primary use of the landscape changes after the festival of 'Kumbh mela', the island now enters the agricultural phase. In this phase native pioneer species are planted on the sand flat island to prevent erosion during the monsoon season. This also creates conditions for variety of flora and fauna to exist on this land water interface.



SECTION 1- DELUGED LANDSCAPE







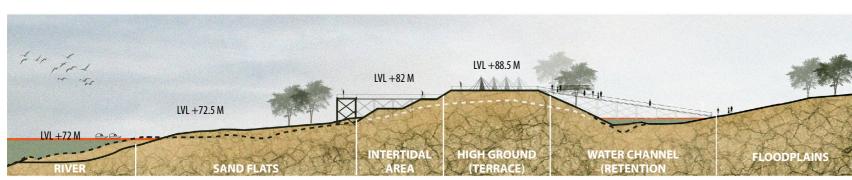


ita

cyperus iria

Coturnix ypsilophora Pavo cristatus

The island is now under the natural forces of river flows during the monsoon. The vegetation proposed can survive submerged conditions and enhances sand accretion as shown in the adjacent section. This dynamic nature of the island and the surrounding landscape can be experienced by the locals and visitors via the proposed elevated routes. The dynamic water channel is completely submerged in water and functions as a retention channel.



SECTION 1- PREPARATION LANDSCAPE

The section shows receding water of holy river Ganga and its impact on the terraced marsh island, the ground hardening time is decreased due to various terrestrial species planted which help in stabilizing the soil at a faster rate preparing the ground for the construction of temporary festival infrastructure.

Figure 10.17
Section- 1
Figure source: Author



10.2.4 SPATIAL TRANSFORMATION

VIEW TOWARDS BRIDGE

FESTIVAL LANDSCAPE

In figure 10.18, the view towards the bridge across the terraced marsh island is shown. The bridge functions as a procession route opening up views towards the festival ground as well as holy river Ganga.

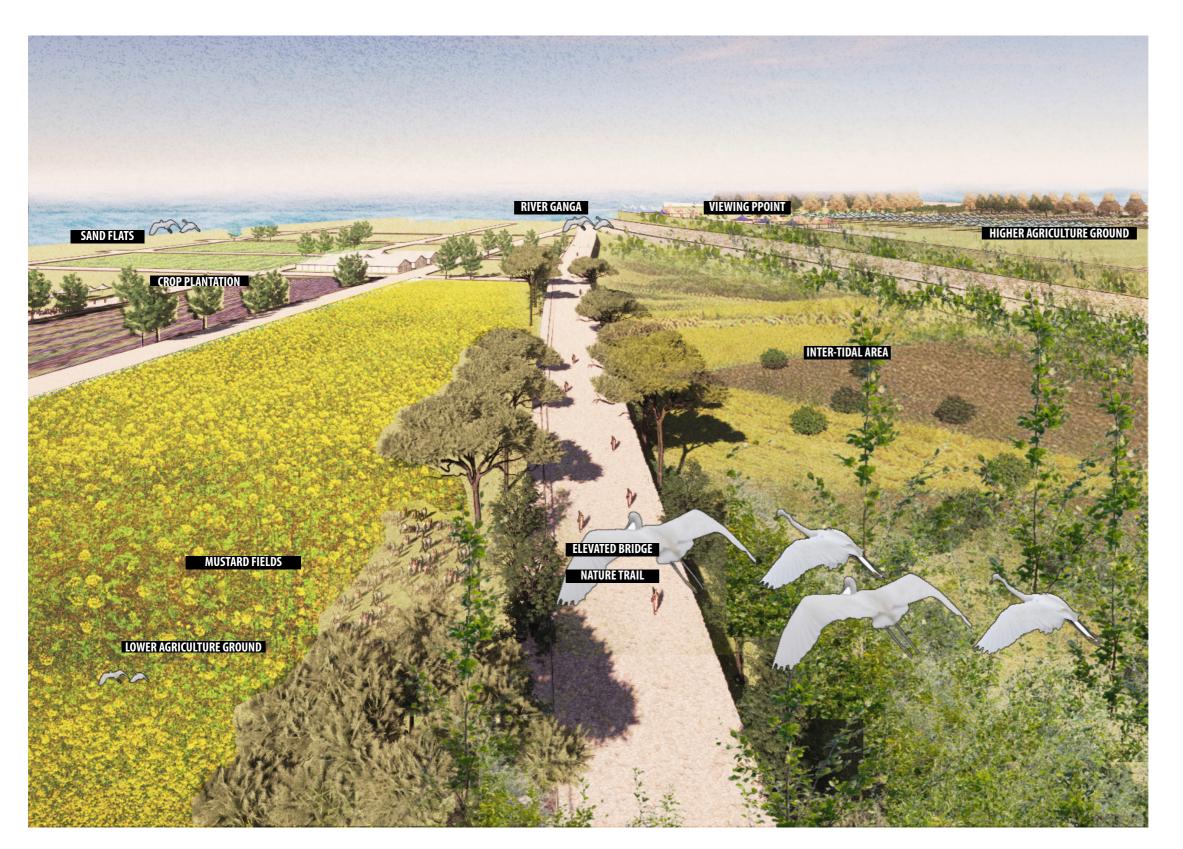
It is strategically positioned between the upper festival ground and lower festival ground to facilitate ease of access for the pilgrims visiting this terraced marsh island during the festival of 'Kumbh mela'.

The route is designed to function as a multi-functional feature which helps in manifesting a relatonship between changing phases of the dynamic floodplain landscape with its changing functions and user groups.

The following illustrations depict how this island transforms in the context of this bridge as per its changing phases of agriculute, deluge and preparation.

Figure 10.18
View towards bridge during festival

Figure source: Author



VIEW TOWARDS BRIDGE

AGRICULTURE LANDSCAPE

In figure 10.19, view towards the bridge across the terraced marsh island is shown. The bridge functions as a nature trail opening up views towards the agricultural ground as well as holy river Ganga.

It is strategically positioned between the upper terrace and lower terrace to facilitate ease of access for the locals and tourists visiting this terraced marsh island post the festival of 'Kumbh mela' during the agricultural phase of the landscape.

The route is designed to achieve the envisioned multifunctional landscape framework for the dynamic floodplains of river Ganga. It helps in making people aware of the changing nature of their surrounding environment.

The bridge is experienced in a way such that it depicts the adaptive nature of the landscape it is embedded in.

Figure 10.19
View towards bridge after festival
Figure source: Author



VIEW TOWARDS BRIDGE

DELUGED LANDSCAPE

In figure 10.20, the view towards bridge across the terraced marsh island is shown. The bridge functions as a nature trail opening up views towards the submerged floodplain landscape as well as holy river Ganga.

It is strategically positioned between the upper terrace and lower terrace to facilitate ease of access for the locals and tourists visiting this terraced marsh island post the festival of 'Kumbh mela' during the deluged phase of the landscape.

The inter-tidal area represents the species planted which now act as vegetation barriers protecting the higher terrace ground from flows of river Ganga.

Figure 10.20

View towards bridge during monsoon Figure source: Author



VIEW TOWARDS BRIDGE

PREPARATION LANDSCAPE

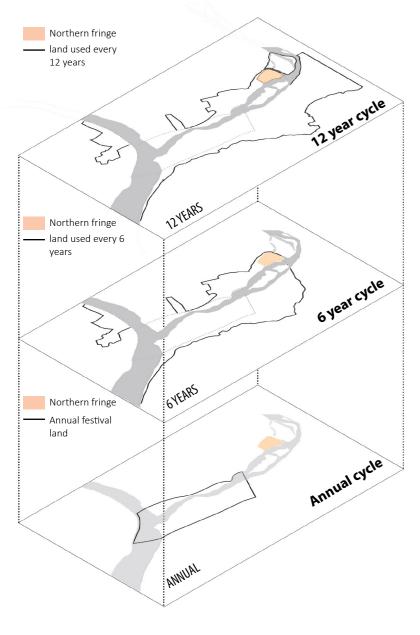
In figure 10.21, view towards the bridge across the terraced marsh island is shown. The bridge functions as an access route opening up views towards the marshy floodplain land as well as receeding water of holy river Ganga.

It is strategically positioned between the upper terrace and lower terrace to facilitate ease of access for the locals, tourists and authorities visiting this terraced marsh island post the monsoon season to experience the preparation phase of this dynamic floodplain landscape.

Authorities start preparing for the festival of 'Kumbh mela' on the higher floodplain land before moving to the lower floodplain land where the water is still receeding.

Figure 10.21 View towards bridge during monsoons

Figure source: Author

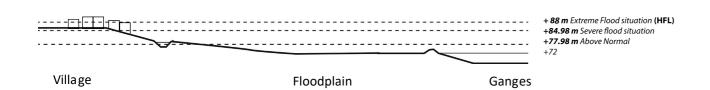


The drawings in figure 10.22 gives the context of the Northern fringe location with respect to different cycles of the festival of 'Kumbh mela' which are the annual, 6 year and 12-year cycle.

During the annual cycle, location supports livelihood activities of local communities and adapts to the changing phases in the region. The location along with its supporting communities is neglected as it is away from the holy confluence. It is prone to flooding every few years, displacing communities living adjacent to this site forcing them to temporarily relocate inland during the monsoon season.

Figure 10.22
Location through different cycles
Figure source: Author

Existing situation



10.3 North Fringe (Micro scale)

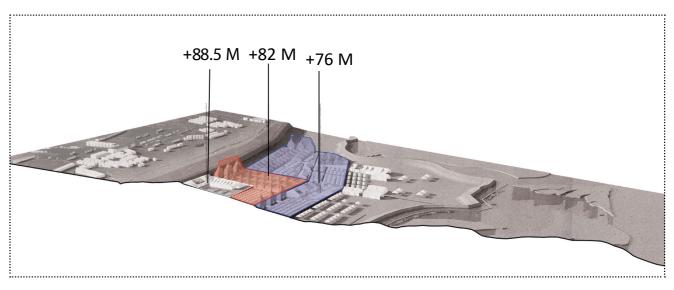


Figure 10.23
Levels scheme for the chosen site
Figure source: Author

The sectional scheme in figure 10.23 shows the different levels proposed as per the macro scale planning framework for the site- 'Northern fringe', near the low-lying village of Govindpur to adaptthe land to its changing phases as well as changing cycles of the festival. The design is shown for the six-year cycle when the area hosts the festival and region experiences severe flooding situation when water of river Ganga crosses annual flooding level of +77.98 m and reaches level of 84.98 m above mean sea level.

Proposed situation

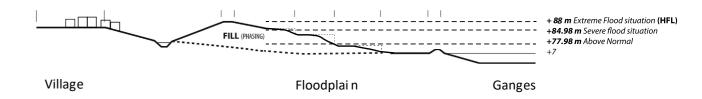
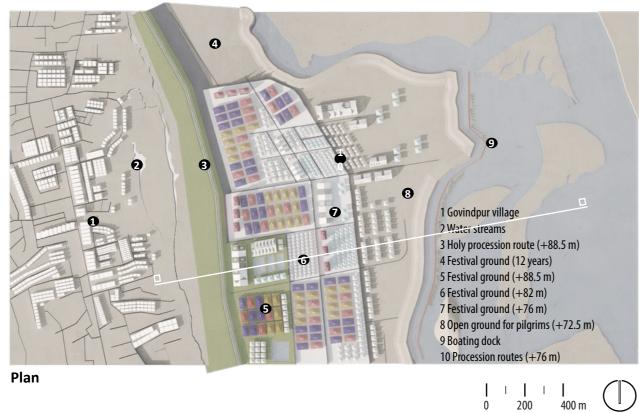
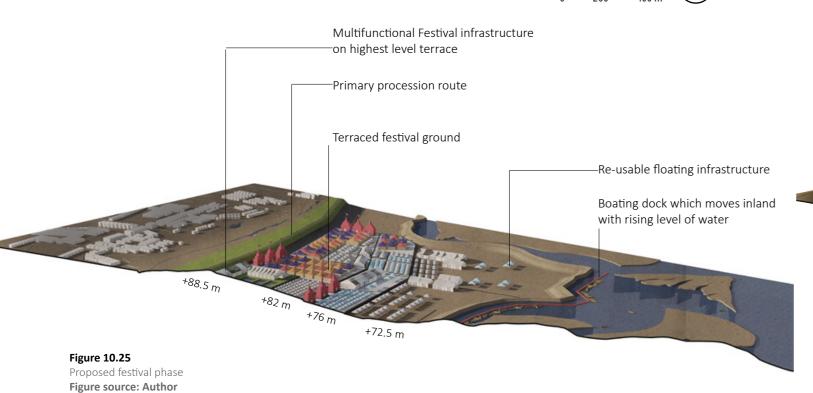


Figure 10.24
Existing vs proposed situation
Figure source: Author

10.3.1 FESTIVAL LANDSCAPE

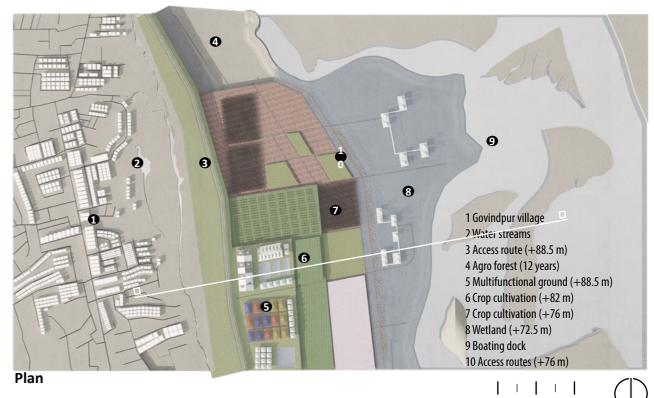


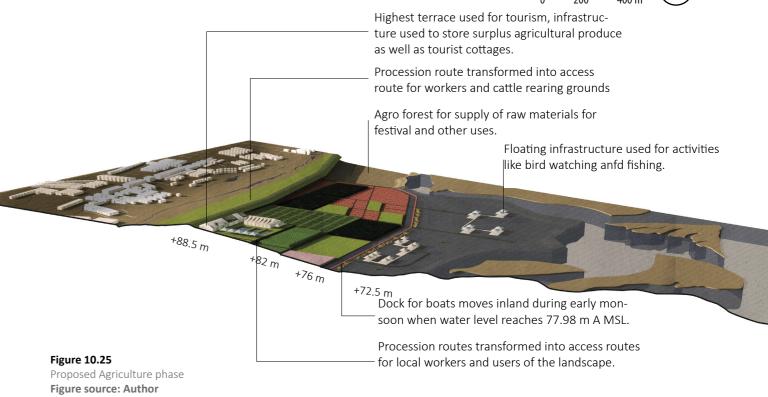




FESTIVAL AGRICULTURE MONSOON PREPARATION MATER RETENTION MAGRO PREP

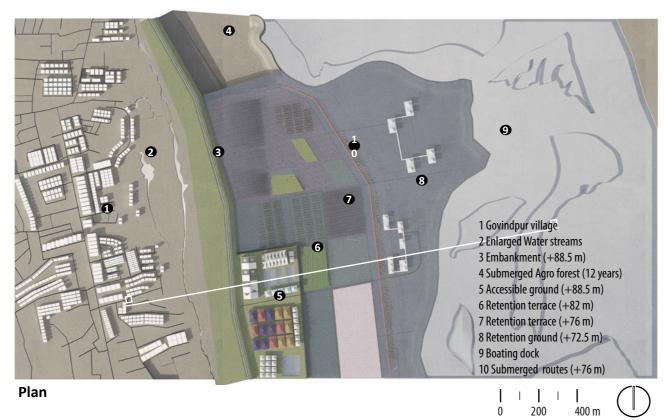
10.3.2 AGRICULTURAL LANDSCAPE

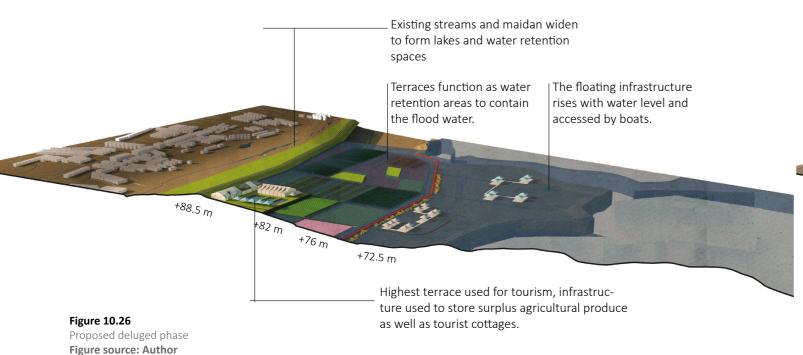




10.3.3 DELUGED LANDSCAPE







6 YEAR CYCLE **10.3.4 PREPARATION LANDSCAPE** 1 Govindpur village 2 Water streams 3 Embankment (+88.5 m) 4 Controlled felling in Agro forest (12 years) 5 Accessible ground (+88.5 m) 6 Terrace in preparation (+82 m) 7 Terrace in preparation (+76 m) 8 Marshland (+72.5 m) 9 Boating dock 10 Access routes (+76 m) Plan 200 The elevated routes are used as grids. Local workers start preparing land for cultivation, the primary route is used to access the marshland for its preparation. Breakwaters slows speed of water infiltration, vegetation cover trapping sediment and fasten process of ground hardening. +82 m +76 m

Floating infrastructure returns to its normal level and is used by the users of this phase of

the landscape.

182

Figure 10.27

Proposed preparation phase

Figure source: Author

10.4 ROUTE TRANSFORMATION

DURING FESTIVAL



KEY PLAN

- Turf grass
- 2 Porous pavers
- 3 Gravel setting bed4 Geotextile filter fabric
- Geotextile filter faUndisturbed soil

The key plan shows the path detail for primary route, which is located at the highest elevation level of +88.5 metre of the floodplains.

Figure 10.30 Route transformation during festival

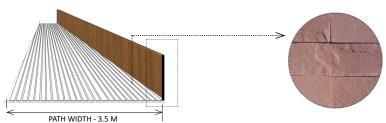
Figure source: Author

Figure 10.30 depicts the transformation of the proposed route into a holy procession route during the festival of 'Kumbh mela'.

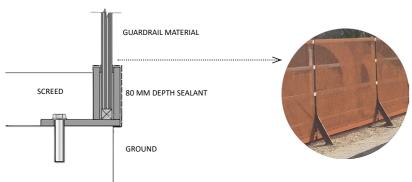
The routing is used by the pilgrims and religious travelers as a procession route which they use to access the holy floodplains and holy water of river Ganga. Along the route as we see temporary shrines are constructed where the pilgrims take shelter during the day or take part in religious rituals and processions. The procession route shown in the figure is a dynamic route which is used for other functions and uses of the floodplains as per its constantly changing phases.

The materials used for the construction of this route are traditional locally available materials shown in figure 10.28 and 10.29. Sandstone is used as a permeable paver due to its properties of water absorption and weathering steel is used for the pedestrian parapet due to its property of withstanding extreme weather conditions. Both the construction materials are chosen keeping in mind their ease of availability and local production.

MATERIAL - PATHWAY



MATERIAL - RAILING



PERMEABLE PAVERS - SANDSTONE

Sandstone is a locally available material in the region. It is known for its properties of being a porous stone which can store large amounts of water. It can withstand time and wet weather.

Figure 10.28

Pathway detail Figure source: Author

GUARD RAIL - WEATHERING STEEL

Weathering steel is used as a material for the guard rail due to its properties of withstanding extreme weather conditions and durability. It is an easily available material in the city of Prayagraj.

Figure 10.29

Railing detail Figure source: Author

POST FESTIVAL - AGRICULTURAL LANDSCAPE



PERMEABLE PAVING - DETAIL A

Permeable pavers (sandstone)

Bedding layer (30 mm)

Non woven geotextile filter fabric

Base course (gravel)

Subgrade soil

Figure 10.31
Permeable Paver detail
Figure source: Author

Figure 10.32 Route transformation during post festival Figure source: Author

Figure 10.32 depicts the transformation of the primary route, elevated at +88.5 m after the 'Kumbh mela' festival is over and the landscape changes into an agricultural landscape. The route changes from functioning as a procession route to being used as a nature trail and access route by the users of this phase of the dynamic floodplain landscape of river Ganga at Prayagraj in India. Next to this nature trail we see the transformation of the festival ground into an agricultural field for crop cultivation.

The ability of the route to transform itself from procession route into a nature trail creates awareness among its users about the dynamic nature of this routing and its ability to adapt as per changing phases of the landscape. Porous sandstone pavers are provided as a paving material as they are highly resistant to wear and tear and their porous nature makes it easy for water to percolate.

DELUGED LANDSCAPE



Figure 10.34 Route transformation during monsoon Figure source: Author

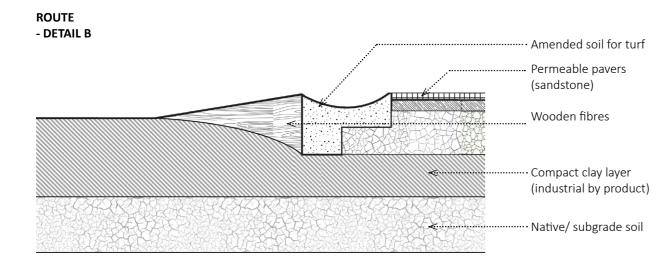


Figure 10.33 Route detail Figure source: Author Figure 10.34 shows the transformation of the primary path (+88.5m) during the monsoon season. In the proposed situation the route primarily functions as an embankment along with being used as a recreational route or nature trail for the users of the dynamic floodplain landscape. Agricultural workers, boatmen, fishermen continue to sustain their livelihood activities during this period as the elevated route aids them in accessing the floodplain landscape, river Ganga and part of the grounds for their daily needs.

The route also makes the people and users of the landscape aware about the dynamic nature of river Ganga by manifesting a relationship between the people and the changing levels of river water.

SUBMERGED SPECIES







Aponogeton natans Potamogeton Nodosus Sagittaria guayanensis

EMERGENT SPECIES







Acorus calamus

Hydrocera triflora

Monochoria vaginalis

AMPHIBIOUS SPECIES







Trichophyllus

Persicaria amphibia

Acanthus montanus

TERRESTRIAL SPECIES







Dalbergia sissoo

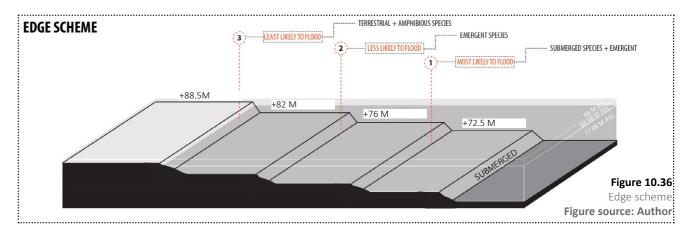
Shorea robusta

Eucalyptus platypus

Figure 10.35 Proposed vegetation Figure source: Author

10.5 TERRACE EDGE TREATMENT

The formation of terraces having different elevations is depicted in figure 10.36 and 10.37. These terraces are introduced to generate a multi-functional landscape framework which helps in making the floodplains adaptive to its constantly changing nature as per changing phases of the dynamic floodplain landscape of river Ganga at Prayagraj in India. However, these terraces are equally vulnerable to this dynamic nature as they are constantly subjected to natural forces of sedimentation and erosion due to the changing water levels as per the varying levels of monsoon rain. Hence, it is essential to protect and prevent them from degradation. It is important to ensure proper edge treatment for these terraces to minimize the rate of erosion during the period when water of river Ganga recedes post the monsoon season. This is achieved by treating the edges with erosion control species or cover crops depicted in figure 10.35. This local flora is also used as indicators for a restored ecosystem. The planting is derived from local ecology indigenous to the region which help in erosion control by sending out nets of roots to bind the topsoil in place while also reducing weed infiltration into the system. Moreover, composting of these species over time leads to increase in nutrient content of the soil.



SCHEME CONTEXT

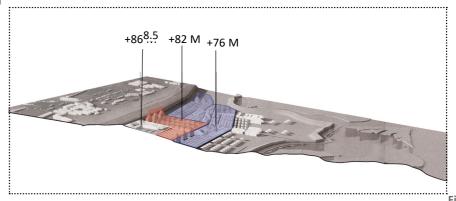


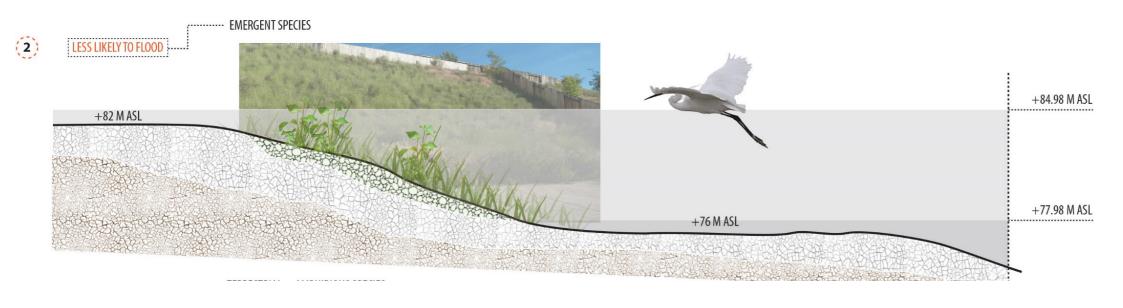
Figure 10.37 Levels context Figure source: Author

191



This edge is most prone to flooding and floods every year during the monsoon season as the water of Ganga swells. The edge is planted with submerged species which can survive frequent inundation or survive in high levels of water. A few of these species include - Aponogeton natans, potamogeton nogosus, Sagittaria guayanesis etc.

The edge condition is like that of a marsh which provides habitat for various species of flora and fauna which adapt to living in flood conditions.



The edge is less likely to flood, it is partly inundated annually and experiences full inundation between a period of 5 to 10 years. Thus, the edge is planted with the typology of emergent plant species which are rooted with stiff stems and stand above the water surface. In some cases these species can be found submerged such as during a high water event.

A few of these species include - Acorus calamus, Hydrocera triflora etc. which are native to the region.

This edge is least likely to flood and undergoes complete submergence once in 10 to 15 years. It is planted with amphibious and terrestrial plant species. Amphibious species survive in fluctuating water levels and terrestrial plants include agrichturual plants, trees etc.

A few of these species include - *Dalbergia sissoo*, *Shorea robusta, Eucalyptus platypus* ec.



Figure 10.38
Edge sections
Figure source: Author

10.6 MULTIFUNCTIONAL INFRASTRUCTURE

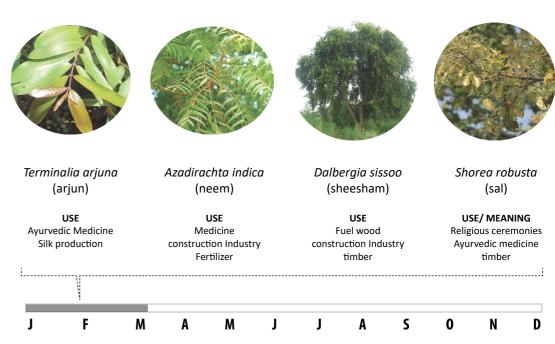
DURING FESTIVAL



Figure 10.39 depicts the view towards highest terrace level which is occupied by re-usable, multi-functional infrastructure on the floodplains of river Ganga at Prayagraj in India. The view depicts transformation during the festival when area is occupied by pilgrims. The infrastructure is primaruly used by the pilgrims for the purpose of religious recreation during festival phase of the dynamic floodplain landscape.

Species of trees are planted in the landscape which helps in providing shade to the pilgrims as well as contribute to the livelihood of the locals living in the region. The tree species include of - *Terminalia arjuna, Azadirachta indica, Dalbergia sissoo, Shorea robusta* etc. which are native to the region shown in figure 10.40. A few uses of these species include the production of wood for construction industry and ayurvedic medicine.

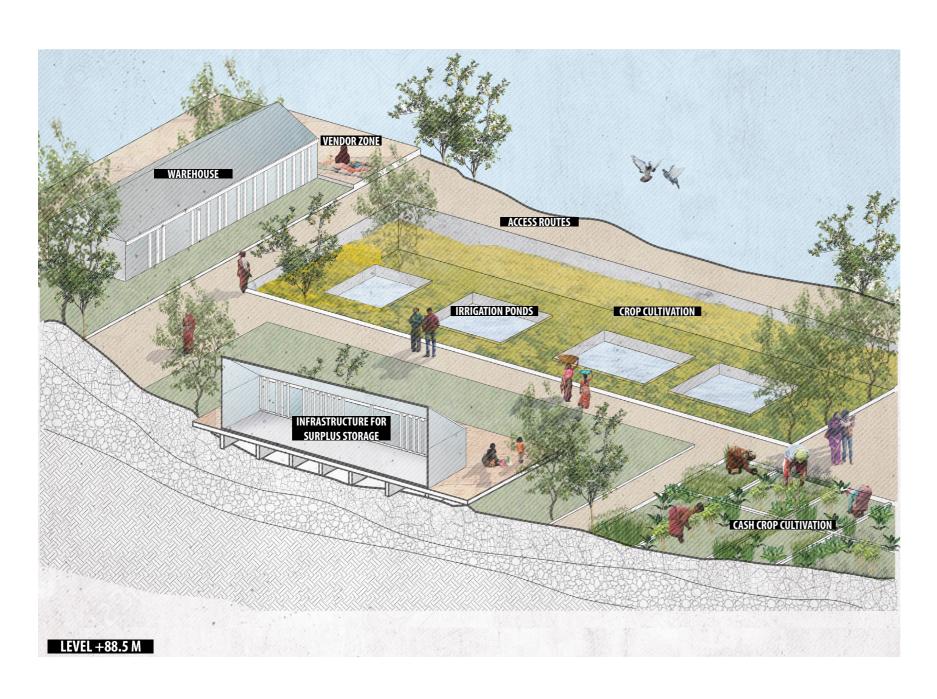
Flora



Adaptive infrastructure during festival Figure source: Author

Figure 10.40
Proposed vegetation
Figure source: Author

AGRICULTURAL LANDSCAPE



tourists, locals and agricultural workers to store the surplus agricultural produce. The fields which were previously used to set up tents for pilgrims are now converted into agricultural fields where farmers cultivate crops as shown in figure 10.42.

Figure 10.41 depicts how the site transforms post festival into an agricultural landscape. The infrastructure which was previously used for the festival is now used by

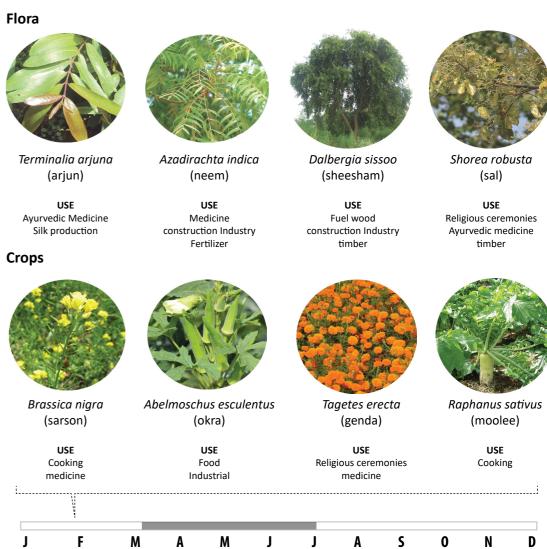


Figure 10.41Adaptive infrastructure post festival **Figure source: Author**

Figure 10.42
Proposed vegetation
Figure source: Author

197

DELUGED LANDSCAPE



Figure 10.43 depicts how the dynamic floodplain landscape transforms during the monsoon season. The highest terrace is still accessible and fully functional during the monsoon season. Few agricultural fields surrounded by ponds are transformed into water retention areas to store excessive monsoon water. The water can be used for irrigation purposes post the monsoon season. It can also be used by the locals and villagers nearby for their daily activities.

Farmers can now grow crops like *Oryza sativa* which can survive wet conditions as shown in figure 10.44.

Crops

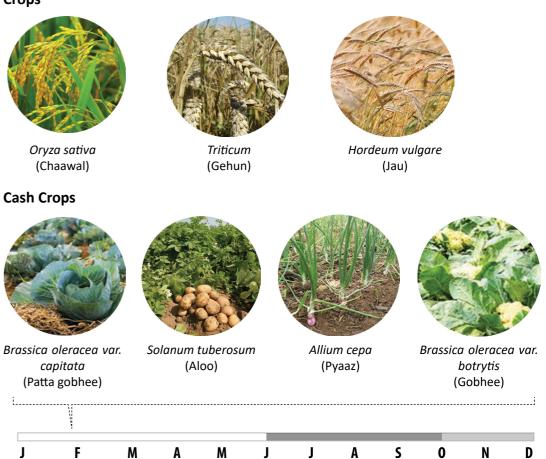


Figure 10.43
Adaptive infrastructure during monsoon
Figure source: Author

Figure 10.44
Proposed vegetation
Figure source: Author

The proposed floating infrastructure on the dynamic floodplain landscape can adapt to the changing phases of festival, agriculture, monsoon and preparation. Figure 10.45 shows how different user groups can use this infrastructure as per their requirements.

FESTIVAL LANDSCAPE

+77.98 M

+72 M

During this phase the floating platforms lie on the floodplain ground as foundations for tents of the temporary city which are constructed on them depicted in figure 10.45(a). They are used for construction of structures which host religious rituals and processions indoors.

AGRICULTURE LANDSCAPE

Post the festival of 'Kumbh mela' these platforms are used to grow agricultural crops by the farmers in a similar manner as they practice cultivation on the floodplain ground 10.45(b).

DELUGED LANDSCAPE

During monsoon season when the water of river Ganga rises deluging the land these platforms which are fixed via subsurface elastic anchoring cables rise with the rising water levels 10.45(c). They are connected to the floodplain via elevated routes which can be used by fishermen and tourists to access the water of river Ganga.

PREPARATION LANDSCAPE

Festival authorities can use these platforms and start constructing and preparing for the festival of 'Kumbh mela' even before the water of river Ganga has completely receded to its normal level as shown in figure 10.45(d).

(b) Agriculture Landscape

+84.98 M

PREPARATION PLATFORM

+77.98 M

+72 M

CROP CULTIVATION

ANCHORING CABLE

PLATFORM

ANCHORING CABLE

FLOODPLAIN

FLOODPLAIN

(c) Deluged Landscape

ANCHORING CABLE

(a) Festival Landscape

(d) Preparatory Landscape

Figure 10.45
Floating infrastructure through phases
Figure source: Author

10.8 USER EXPERIENCE AND AWARENESS

10.8.1 EXPERIENCE OF A PILGRIM



Figure 10.46 depicts the existing pilgrim experience along a procession route during the holy festival of 'Kumbh mela'. The procession route is flanked by the tents and temporary shrines on either side. The view towards holy river Ganga is obstructed and there is no visual connection and in-access to procession areas and temporary shrines which are situated along this route. The route is constructed with temporary sheets which cause compaction of the floodplains reducing its water absorption capacity.



Figure 10.47 depicts proposed pilgrimage experience along the procession route of the dynamic floodplain landscape of river Ganga at Prayagraj in India. The route is elevated opening up views towards holy river Ganga. Species of plants are proposed on either side of the elevated route to prevent the elevated land from erosion during the monsoon season. The route is flanked by temporary shrines easily accessed by the pilgrims during processions when pilgrims participate in religious rituals and ceremonies. The route is constructed using permeable sandstone as a traditional locally available material which helps in absorption of water during the monsoon.

Figure 10.47
Proposed situation
Figure source: Author

203

10.8.2 EXPERIENCE OF LOCAL WORKERS



Figure 10.48 shows existing condition of the floodplains of river Ganga at Prayagraj in India post the festival of 'Kumbh mela'. The dynamic floodplain land is now used for agricultural production. However, the recreational function of the land is lost owing to lack of access, connectivity and dilapidated state of the floodplain land post the festival. Furthermore, this land is deluged during the monsoon season destroying crops and causing land loss for the agricultural workers who depend on it for their livelihood and income support.



Figure 10.49 shows the transformation of the floodplains during the agricultural phase. The proposed terraces acts as areas for production as well as protecting the valuable land from deluging during monsoon season. The holy paths proposed during the festival phase are retained and used by the local workers and users of the floodplain landscape during its agricultural phase.

As depicted in figure 10.46 the users of the dynamic floodplain landscape experience its changing nature and transformation from a festival into an agricultural landscape.

Figure 10.49
Proposed situation
Figure source: Author

10.8.3 EXPERIENCE OF LOCALS DURING MONSOONS



In figure 10.50, the submerged condition of the dynamic floodplains is observed. Land is inaccessible and submerged in rising water of river Ganga making it hard for its users to experience and access it. The productive function of the floodplain landscape has come to a stand still during this phase which risks the livelihood and daily income of local communities of the region who wait for the river water to subside to resume their daily activities.



The proposed situation in figure 10.51 shows the elevated pathway which now acts as an embankment protecting adjacent low-lying areas from flooding as the water of river Ganga rises during the monsoon season .

The local communities can continue to experience the dynamic floodplain landscape during this phase. This gives them a chance to experience the changing levels of water of river Ganga creating awareness among them about the dynamic nature of their surrounding environment.

Figure 10.50
Existing situation
Figure source: Author, 2020

Figure 10.51
Proposed situation
Figure source: Author

10.8.4 EXPERIENCE POST MONSOON

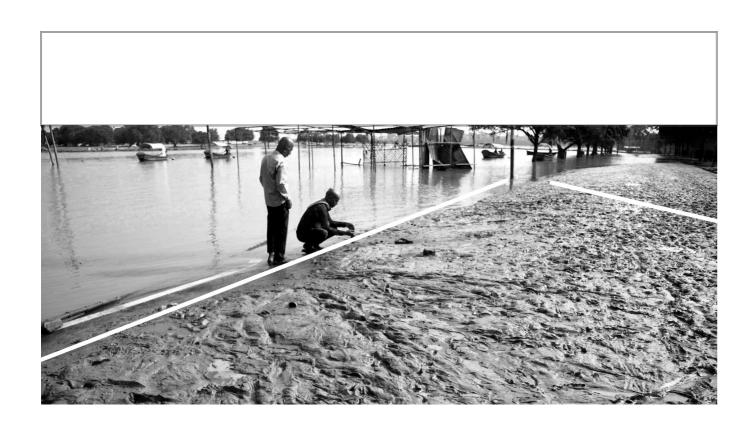


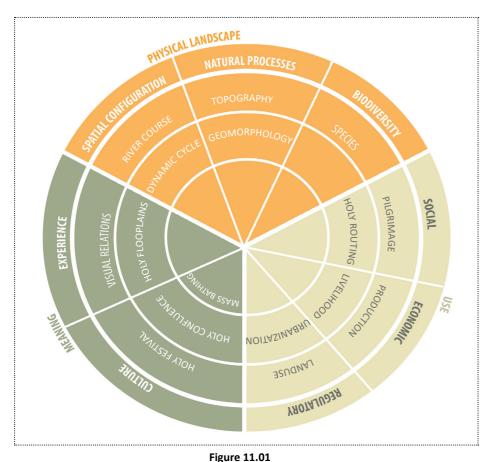
Figure 10.52 shows the existing situation of the dynamic floodplain landscape of river Ganga at Prayagraj in India post the monsoon season when the water starts receeding and the authorities wish to start preparing the floodplain land for the festival of 'Kumbh mela'. The floodplain ground has marshland like conditions making it impossible for festival authorities to access the floodplain land to start preparing for the annual festival of 'Kumbh mela'.



Figure 10.53 shows the proposed situation of the dynamic floodplain landscape post the festival. The highest elevated routes are used by the authorities to access the floodplain land and start preparing for the festival in advance. The proposed vegetation traps sediment reducing time taken for the ground to set enabling construction for the festival. The lower terraces are still left for the water to recede and the ground to set while construction starts on the upper terraces.

Figure source: Author

| CONCLUSION |



Valuation diagram along with data per aspect of the parameters

Figure source: Adapted from De groot, Hein, 2007

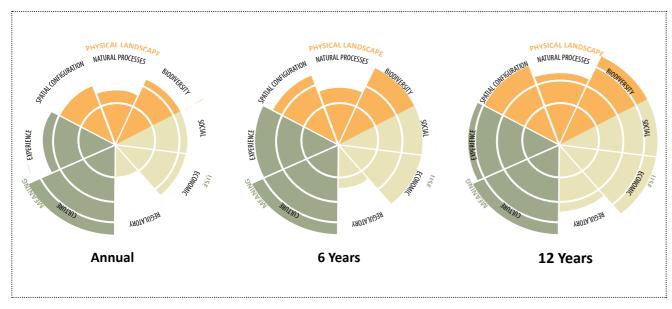


Figure 11.02

Value assessment of the design parameters of threefold approach

Figure source: Adapted from De groot, Hein, 2007

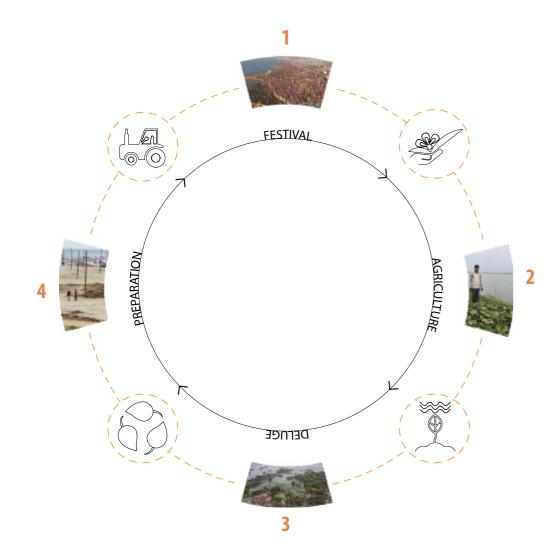
11.1 CONCLUSION

'Kumbh mela' is an ancient religious Hindu festival which takes place on floodplains of river Ganga at Prayagraj in India. The festival is the largest mass gathering where millions of devotees come together to celebrate the water of holy river Ganga by bathing in it. The festival is an external force of human influence on this ecologically sensitive floodplain landscape which facilitates its dynamic nature. The floodplain landscape endures changing phases of festival, agriculture, deluge and preparation landscapes all within the span of a year. Another dynamic process which the landscape experiences is due to different cycles of festival which happens at intervals of time — annual, every six years and every twelve years at increasing scales respectively. Hence, the festival as an external force triggers this constant change in the floodplain landscape making it dynamic in nature.

The research summarizes various challenges faced by the dynamic floodplains as they transition from one phase into another. The festival of 'Kumbh mela' causes degraded land conditions for agricultural use of the floodplains due to nutrient content loss of the soil, early onset of monsoon causes crop loss and land loss causing flooding of low lying areas disrupting livelihood of local communities, post monsoon the essential problem faced is inaccess to floodplains due to marsh land conditions delaying festival planning which leads to insufficient festival infrastructure. Along with the future challenges of climate change, urban expansion and increasing pilgrimage trends, these issues threaten the dynamic identity of this holy landscape making it vulnerable to the constant change it experiences. Thus, the floodplain landscape is incapable of adapting to its diverse functions of pilgrimage, agriculture, fishery and river swelling. The users of the floodplain landscape are deprived a sustainable relationship with their surrounding environment due to the constantly changing nature of the dynamic floodplains of river Ganga at Prayagraj.

The thesis devises a mulit-functional landscape framework through a resilient, nature-based approach to help the floodplains respond suitably to its constantly changing nature thereby adapting to its diverse functions. The framework is used to assist activities like crop cultivation, animal husbandry, fishery and tourism to co-exist with pilgrimage. For instance, significant areas have been assigned multiple functions. Hence, the proposed interventions change function as per the changing phases of the landscape helping it adapt to its dynamic nature thereby developing a floodplain landscape which is resilient to existing as well as future challenges.

The adopted methodology which includes theory back up of 'Dynamic landscapes', 'Landscape resilience' and 'Design with Nature' along with the threefold approach parameters of physical landscape, use and meaning help in exploring design solutions and conceptualizing a strategic plan for the dynamic floodplains of river Ganga at Prayagraj. The threefold approach also acts as an analytical tool which helped in unravelling the dynamic nature of the site with respect to its parameters of physical landscape, use and meaning.





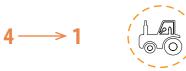
Value the floodplain land by **enhancing vegetation** and biodiversity to preserve nutrient content of the soil.



Establish a **resilient multifunctional landscape framework** by introducing terraces in the floodplain landscape which prevents loss of essential land.



Utilizing **natural processes facilitating land formation** thereby reducing ground setting time.



Increased access and connectivity via terracing benefits the festival authorities and construction for festival.

Figure 11.03

Addressed challenges faced by dynamic floodplains of river Ganga at Prayagraj

Figure source: Author, 2020

These parameters of the 'threefold' approach were then used to formulate a valuation diagram as depicted in figure 11.01 to assess these values. The assessment of these values as per changing cycles and scale of festival land is shown in figure 11.02 where parameters are valued as per expanding festival land which hosts the festival of Kumbh mela every year, every six years and every twelve years. Figure 11.03 depicts how the challenges faced by the changing phases of the dynamic floodplains are dealt with and overcome to achieve a dynamic floodplain landscape adaptive to its changing nature.

Furthermore, tapping into the varying cycles of the festival, floodplain land used annually, every six years and every twelve years, the cycle is used in the land phasing of the proposed interventions to develop the dynamic floodplain landscape over time. This changing cycle of the festival is utilized to increase landscape resilience making the dynamic floodplains self-sustainable. For instance, extent of floodplain land used as per festival cycle has been ascribed primary functions to equip the floodplains to adapt to its changing phases and shaping conditions for a self-sustainable landscape. Using this festival cycle to impart primary functions to parts of the festival land helped in manifesting a sustainable relationship between the dynamic floodplain landscape with its constantly changing nature increasing the self-sustenance value of the floodplains of river Ganga at Prayagraj in India.

'Designing with Nature' by using natural processes of sedimentation and erosion was an important part of the designing process. The process of sedimentation over time is used to enhance the existing floodplain topography of fluvial terraces by elevating ground, thereby creating conditions for the development of terraces in the floodplain landscape. These terraces are envisioned to adapt to the changing functions of the floodplains by engaging users with its constantly changing nature. Also, working with this fluvial terrace topography contradicts the essential function of the floodplains which is to receive discharge from the river during monsoon season. To overcome this problem 'Room for the river' approach has been applied where areas on this floodplain landscape have been assigned to store excessive water during the monsoon season to prevent important areas from impact of the deluge. Therefore, landscape and ecology has played a crucial role in improving the relationship between this dynamic, constantly changing landscape with its user groups.

Educating and bringing awareness among people as well as users of the landscape was also an important part of the design. It is vital for people to know the dynamic nature of the environment they are living in as well as the consequences of their influences on it. Through the medium of this thesis, a sense of responsibility towards their surroundings is spread as the different user groups form a relationship with each phase of the landscape. The proposition enagages users with the dynamic floodplains manifesting a relationship between them and its constantly changing nature.

Hence, the project seeks to achieve a balance between dynamic floodplains of holy river Ganga at Prayagraj in India and the existing as well as future challenges this landscape endures with respect to climate change, urban growth and increasing pilgrimage. This is executed by establishing a resilient multi-functional landscape framework integrating scales of macro, meso and micro to preserve the sanctity, identity of the constantly changing floodplains. With this framework the dynamic floodplains are made to adapt to its changing nature and diverse phases of festival, agriculture, monsoon and preparation landscapes.



11.2 FUTURE RECOMMENDATIONS

Along with the district of Prayagraj, festival of 'Kumbh mela' is hosted by three other riverbank pilgrimage sites in Haridwar, Ujjain and Nashik in India. A recommendation for the three sites could be to use the similar methodology, adopting analytical tools of the threefold approach parameters of physical landscape, use and meaning to critically look at the landscape and establishing a framework plan for it. These parameters help in understandig the multiple dynamic processes the site incurs over a period as per its physical setting, use and meaning. The idea to empower the landscape to adapt to human influences supporting livelihood functions along with its cultural values of pilgrimage can be applied on these locations.

In the case of a holy site like floodplains of river Ganga at Prayagraj in India – the religious experience of the pilgrims pertaining to the meaning parameter of the threefold approach was kept in mind while re-envisioning the dynamic floodplains. Thus, the thesis could act as a module of how heritage and culturally significant sites all over the world can be spatially enhanced as per external human influences on them to make them resilient to external forces and adaptive to change.

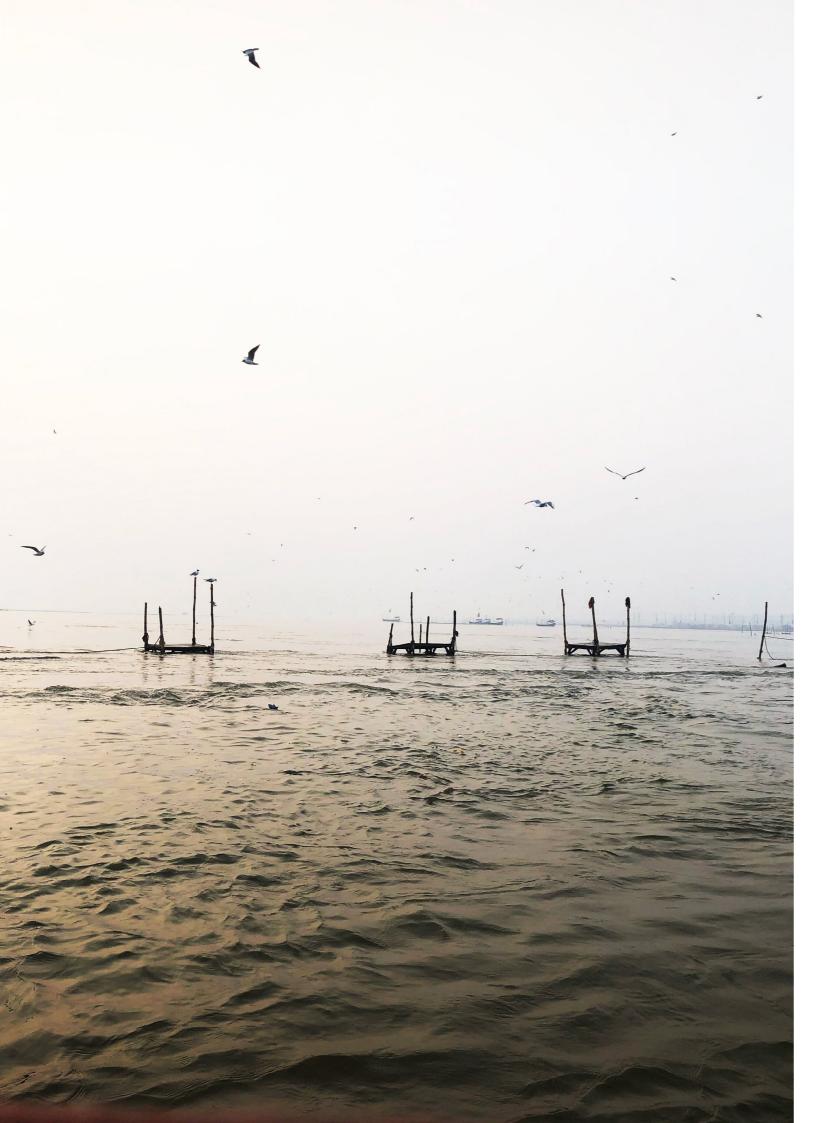
Another recommendation for further growth and advancement for the site would be to initiate community involvement with a participatory approach. Incorporating direct opinions of people of the land-scape would enable better acceptance from its inhabitants. This will make them more aware of their surroundings along with a greater knowledge of the site, hence, helping them engage with the dynamic floodplain landscape and increasing their adaptability to its changing phases.

Figure 11.04

Future vulnerable population of the dynamic floodplain landscape

Figure source: Author

| REFLECTION |



12. REFLECTION

PRELIMINARY RESULTS (PRODUCT, PROCESS AND PLANNING)

The project revolves around the floodplains of river Ganga at Prayagraj in India which hosts the largest mass gathering, festival of 'Kumbh mela' on its floodplains. This generates conditions for constantly changing phases of festival, agriculture, deluge and preparation which make the floodplains dynamic. This frames 'Genius Loci' of the landscape which is continuously threatened by future and current challenges making floodplains in-adaptive to functions of pilgrimage, agriculture, river swelling etc. depriving local communities' sustainable relationship with their surroundings.

The research aims at reading landscape as more than just a physical landscape but a landscape with use and meaning. Understanding human influences on the festival landscape which makes it dynamic was an important part of the process. Landscape resilience and designing with nature were essential theories to study as it helped to address the capacity of local ecosystems to adapt to human influences important for local livelihoods but also for the landscape's cultural values like pilgrimage and festival.

Adaptive, flexible and resilient landscapes are important features for a constantly changing landscape. In that way, the vision of this project is to create a landscape framework as a basis for development and growth of the floodplains and generating awareness that landscapes have the ability to respond to changing conditions.

RELATION BETWEEN RESEARCH AND DESIGN

The research begins with fascination which starts from the constantly changing nature of the flood-plains of river Ganga at Prayagraj, India and the festival of 'Kumbh mela'.

Through literature research and upon visiting the site during annual festival of 'Kumbh mela' an indepth understanding of the consequences of this change on the floodplain landscape was attained, making me comprehend the different phases within the landscape.

But how can we deal with this constant change as a landscape designer and empower the floodplain landscape to respond to it? From this, an exploration of different theories started towards understanding how 'Genius loci' — dynamic nature of the floodplains can be protected. Therefore, concepts like 'Dynamic landscape theory', 'Landscape resilience' and 'Design with nature' were studied to base the vision for design.

I started with the need to devise a landscape framework plan for the dynamic floodplain landscape with an adaptive, resilient and nature-based approach to enable different functions of floodplains to co-exist and respond to different phases of the dynamic floodplains. This helped in generating a dialogue between research outline, genius loci of site and design process. Therefore, the vision and design were directly influenced by the research.



RELATION BETWEEN GRADUATION TOPIC, STUDIO TOPIC AND MASTER TRACK

The presented project is part of the 'Flowscapes' graduation studio and the 'Circular Water stories' lab. It explores the spatial, societal and environmental issues of the dynamic floodplains of river Ganga at Prayagraj in India. By doing this the project aims at understanding the dynamic between landscape processes and its morphological aspects as per interpretation of the 'Flowscapes studio'. The research uses a multi-layered understanding pertaining to the 'threefold' approach where spatial structures, ecological processes relates to physical landscape, history context relates to meaning and economic, social processes to use of the dynamic floodplain landscape.

In relation, the project works with dynamics and constant change of the landscape which are central to the flow of river Ganga. The relationship between people and holy river Ganga was analyzed to understand the holy nature of the floodplains which helped in devising strategies for the dynamic floodplain landscape of river Ganga at Prayagraj.

RESEARCH METHOD AND APPROACH CHOSEN (SCIENTIFIC RELEVANCE)

The research method chosen is based on the 'Threefold' approach parameters of physical landscape, use and meaning where tangible aspects compares to physical landscape, functional utility compares to use, and user experience and affiliation compares to meaning. This helps in analyzing the various dynamic aspects of the floodplains not just with respect to its physical setting but also its use and meaning.

The aspects relevant to these parameters are integral to the theoretical background and vice versa as they offer solutions in generating resilience within a landscape thereby allowing it to adapt to its changing nature.

Thus, the relevance, of this methodology lies in understanding the dynamic nature of the floodplain landscape with respect to its physical setting, use and meaning across shifting scales of macro, meso and micro. This helps in giving a new perspective towards the floodplain landscape which guides design values conscious to various dynamic processes it experiences across scales.

As scientific relevance, floodplains are viewed as an ecologically sensitive and one of the most endangered ecosystems worldwide (Olson, Dinerstein, 1998). Therefore, it is essential to devise strategies and create a landscape framework for these susceptible regions to make them self-sustaining thereby protecting their inherent identity.

SOCIAL AND ENVIRONMENTAL RELEVANCE

The project tends to explore the social dynamic along the floodplains of river Ganga at Prayagraj in India. The most important aspect being that of the ancient age-old tradition of pilgrimage which is affiliated with this holy floodplain landscape. The thesis provides spatial strategies or solutions which help in the co-existence of pilgrimage along with other functions the landscape supports, thereby, initiating a sustainable relationship between different user groups with the floodplain landscape.

In relation to the environment, the proposed intervention in the floodplain landscape is done keeping in mind the future challenges with respect to climate change vulnerability of the landscape and enhancing biodiversity of the landscape by creating conditions for biodiversity (wetlands, marshlands, grasslands, woodlands etc.).

ETHICAL ISSUES AND DILEMMAS

The main ethical dilemma of a proposal which is aiming at intervening with this dynamic floodplain landscape of river Ganga at Prayagraj is the conflict in intervening with natural function of dynamic floodplain ecosystem.

On one hand the floodplains are responsible to support fundamental ecosystem functions and support livelihood of local communities. On the other hand, the floodplains of river Ganga at Prayagraj are obligated to host the festival of 'Kumbh mela' which has religious affiliation with the people of India. This influence activates the dynamic nature of the floodplain landscape, which is a hinderance to its primary ecosystem functions, threatening its identity.

Pilgrimage as a primary phase creates reluctance among people in understanding the landscape as an entity which could adapt to its constantly changing nature thereby supporting other functions. Therefore, it was essential to keep the local communities and their livelihood functions at the forefront along with pilgrimage by involving them with the changing phases of the landscape to help the dynamic flood-plains respond to its functions other than pilgrimage.

Furthermore, the association of festival as a primary phase of this landscape benefits the religious activists, entrepreneurs and various political parties in India by using this dynamic floodplain landscape for their own advantages benefitting from this vulnerable land and its local communities.

Hence, the project seeks to devise strategies for a landscape framework where livelihood activities of local communities along with natural functions of the dynamic floodplain landscape of river Ganga at Prayagraj can integrate with pilgrimage.

LIMITATIONS

Although the development process for this project was flexible, this project was bound to have certain constraints and limitations. To conduct an informative research the project was discussed with people having religious affluence with river Ganga, local residents of the district of Prayagraj, Prayagraj festival authority, Irrigation department and students of urbanism and landscape architecture. The expertise from these interdisciplinaries have been kept in mind during this graduation project. However, there still maybe certain drawbacks with respect to minor details.

Another limitation was based on the struggle to find reliable data during data collection and field work. This is due to the lack of data transparency in a developing country like India where administration is hesitant in sharing data outside of their authority. Thus, most of the research is based on data collection from online portals, journals, papers, books, documentaries, news articles and observations made during the site visit.

ISSUES RELATED TO THE CORONA-CRISIS

Leading through while adapting to the recently hit corona-crisis was crucial and a critical stage in the development of this graduation thesis. Fortunately, the site visit proceeded as scheduled before the crisis gripped the world and air travel was ground to a halt.

One shortcoming which I faced during latter phase of this project was the inability to experiment with study models due to lack of resources and in access to the modelling hall.

REFERENCES

Abudayyeh R., 2019 'Dynamic Landscapes, Emerging Territories DOI: 10.14324/111.444.amps.2019v15i4.001

Acciavatti A., 2015 Ganges Water Machine: Designing New India's Ancient River Aleksandr Bierig, editor

Beller E.E., 2018 Building Ecological Resilience in Highly Modified Landscapes, *BIOSCIENCE*, *Volume* 69, *Issue* 1, Pages 80–92. https://doi.org/10.1093/biosci/biy117

Bhushan S., 2015 TFP Growth of Wheat and Paddy in Post-Green Revolution Era in India: Parametric and Non-Parametric Analysis. *Agricultural Economics Research Review, 29, 27-40*. DOI:10.5958/0974-0279.2016.00016.1

Chaturvedi R., Mishra S., 2015 Geomorphic features and Flood susceptibility zones: A study for Prayagraj district, Uttar Pradesh, India, Using remote sensing and GIS technique. Retrieved from https://www.researchgate.net/publication/292160640_Geomorphic_features_and_flood_susceptibility_zones_A_study_for_Allahabad_district_Uttar_Pradesh_India_using_remote_sensing_and_GIS_technique

Daily GC., Alexander S., Ehrlich PR., Goulder L., Lubchenco J., Matson P.A., Mooney HA., Postel S., Schneider S.H., Tilman D. and Woodwell G.D., 1997 Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems: Issues in Ecology [Issues Ecol.]. *Vol. 1, no. 2,* pp. 1-18.

Dhar S., Mazumdar A., 2009 Impact of Climate Change under the Threat of Global Warming for an Agricultural Watershed of the Kangsabati river, *JOURNAL OF HYDROLOGY: REGIONAL STUDIES, Volume 13*, Pages 189-207. https://doi.org/10.1016/j.ejrh.2017.07.008

Dorren L., Rey F., 2004, A review of the effect of terracing on erosion. Retrieved from https://www.researchgate.net/publication/228581261 A review of the effect of terracing on erosion

Dwivedi S., Cariappa M., 2015 Mass gathering events: The Public health challenge of the Kumbh Mela 2013. DOI: 10.1017/S1049023X15005245

Fairclough G., 2006 A New Landscape for Cultural Heritage Management: Characterization as Management Tool, *LANDSCAPES UNDER PRESSURE*, pp 55-74. DOI: 10.1007/0-387-28461-3_4

Farina A., 2017 Landscape Dynamics. DOI: 10.1093/OBO/9780199830060-0182

Farrell P., Anderson P., 2010 Sustainable Multi-functional Landscapes: A Review to implementation, *CUR-RENT OPINION IN ENVIRONMENTAL SUSTAINABILITY, Volume 2, Issues 1–2,* Pages 59-65. https://doi.org/10.1016/j.cosust.2010.02.005

Folke C., 2002 Building and Sustainable Development: Building Adaptive Capacity in a World of Transformations, *AMBIO A JOURNAL OF THE HUMAN ENVIRONMENT* 31(5):437-40. DOI: 10.1579/0044-7447-31.5.437

Groot R., Hein L, 2007 Concept and valuation of landscape functions at different scales, *MULTIFUNC-TIONAL LAND USE*, *Page 15-36*. DOI: 10.1007/978-3-540-36763-5_2

Hijioka Y., 2014 Climate Change 2014 Impacts, Adaptation and Vulnerability, Publisher: Cambridge University Press, Cambridge, United Kingdom and New York, NY, USAEditors: Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White. Retrieved from https://www.researchgate.net/publication/272150376_Climate_change_2014_impacts_adaptation_and_vulnerability - IPCC WGII AR5 summary for policymakers/citations

Holling C.S., 1986 Understanding the Complexity of Economic, Ecological And social systems, *ECOSYS-TEMS* volume 4, pages 390–405. DOI: 10.1007/s10021-001-0101-5

Levin S., 1999 *Journal of Ecology, Volume88, Issue 1,* Pages 181-181. DOI: https://doi.org/10.1046/j.1365-2745.2000.00425-5.x

Lily K., 1990 Mapping the Sacred: Religion, Geography and Post-colonial Literatures, *THE PRO-FESSIONAL GEOGRAPHER*, 55(4), P. 541. Retrieved from https://www.tandfonline.com/doi/abs/10.1111/0033-0124.550401010

McGrath B., 2013 Resilience in Ecology and Urban Design: Linking Theory and Practice for Sustain able Cities, Editors: Pickett, Steward, Cadenasso, M.L., McGrath, Brian (Eds.) Retrieved from https://www.academia.edu/3630308/Resilience_in_Ecology_and_Urban_Design

McHarg, I. L., & American Museum of Natural History 1969 *Design with nature*. Garden City, N.Y: Published for the American Museum of Natural History [by] the Natural History Press.

Mehrotra R., Vera F., 2015 'Kumbh mela': Mapping the Ephemeral Megacity, Ostfildern: Hatje Cantz; [Cambridge]: Harvard University, South Asia Institute, Publisher

Ministry of Urban Development, 2015, City Development Plan for Prayagraj, 2041. Retrieved from http://allahabadmc.gov.in/documentslist/City Development Plan Allahabad-2041.pdf

Misra H., 1988 Popular settlements in the city of Prayagraj: Findings from three case studies, CITIES, Volume 5, Issue 2, Pages 163-183. https://doi.org/10.1016/0264-2751(88)90005-4

Monnet J., 2011, The symbolism of place: A geography of relationships between space, power and identity. DOI: 10.4000/cybergeo.24747

Murphy M. D., 2016 Landscape architecture theory: An ecological approach.

Narayanan V., 2001 Water, Wood and Wisdom: Ecological Perspectives from the Hindu Traditions. Retrieved from https://www.researchgate.net/publication/291249533_Water_Wood_and_Wisdom_Ecological_Perspectives_from_the_Hindu_Traditions/citations

Olson D., Dinerstein E., 1998, Terrestrial Ecoregions of the World: A New Map of Life on Earth, *BIOSCI-ENCE, Volume 51*, *Issue 11*, Pages 933–938. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOT-WA]2.0.CO;2

Scholz M., 2016 Wetlands for Water Pollution Control, Amsterdam, Elsevier

Singh R., 1994 Water Symbolism and Sacred Landscape in Hinduism: A Study of Benares (Varanasi)

Senge P. M., Sterman J.D., 1990, Systems thinking and organizational learning: Acting locally and thinking globally in the organization of the future, *EUROPEAN JOURNAL OF OPERATIONAL RESEARCH*, *Volume 59, Issue 1*, Pages 137-150. https://doi.org/10.1016/0377-2217(92)90011-W

Taverne, E., Dembski, S., Klerk de, L., & Ramakers, B., 2012 Greep op de stad. Nieuwe wendingen in het stadsonderzoek. In E. Taverne, L. Klerk de, B. Ramakers, & S. Dembski (Eds.), Nederland stedenland. Continuïteit en vernieuwing (pp. 9- 20). Rotterdam: nai010 uitgevers.

Taylor K., 2012 Sacred Places and Sacred landscapes, *Oxford Handbook of Mesoamerican Archaeology,* Oxford University Press, Deborah L. Nichols, Christopher A. Pool

Tilley C., 2017, An Anthropology of Landscape, UCL Press. Retrieved from https://discovery.ucl.ac.uk/id/eprint/1537609/1/An-Anthropology-of-Landscape.pdf

Turner M.G., 2010 Disturbance and landscape dynamics in a changing world, *ECOLOGY, Volume 91, Issue 10,* Pages 2833-2849. https://doi.org/10.1890/10-0097.1

Uniyal A., Shah P., Rao S., 2018 Sectoral Migration of Ganga river and its Impact on the Stability of Phaphmau Bridge near Prayagraj, U.P., India, *Journal of the Indian Society of Remote Sensing 46(8)*. DOI: 10.1007/s12524-018-0775-1

Verschuure G.A., 2019 Welgelegen Analyse van de Hollandse buitenplaatsen in hun landschappen (1630-1730). Retrieved from https://books.bk.tudelft.nl/index.php/press/catalog/book/699

Warner J., Buuren V.A., 2011, Implementing Room for the River: Narratives of success and failure in Kampen, the Netherlands, *International Review of Administrative Sciences 77(4):779-801*. DOI: 10.1177/0020852311419387

TANVI GUPTA
[4809394] | MSc Landscape Architecture | 2018-20
© Delft University of Technology