LANDSCAPES IN-FLUX

Dynamic Landscape | Productive Landscape | Religious Landscape

Journey through the Dynamic Floodplains of holy river Ganga at Prayagraj in India

Mentors

Dr. Ir. G.A. Verschuure-Stuip | Dr. Ir. Marjolein Spaans

Tanvi Gupta [4809394] | MSc Landscape Architecture | TU Delft 2019-2020

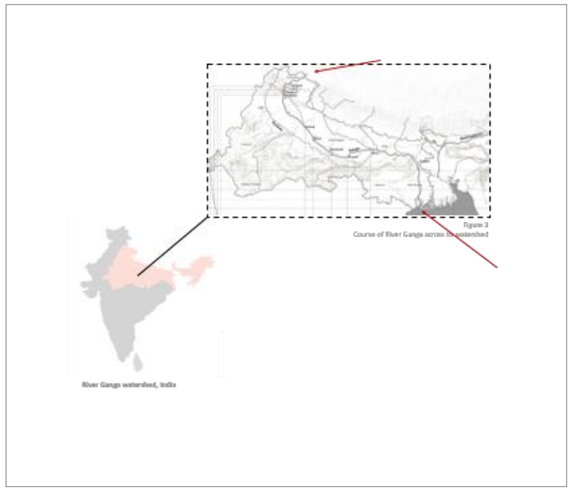
STARTING NOTE…

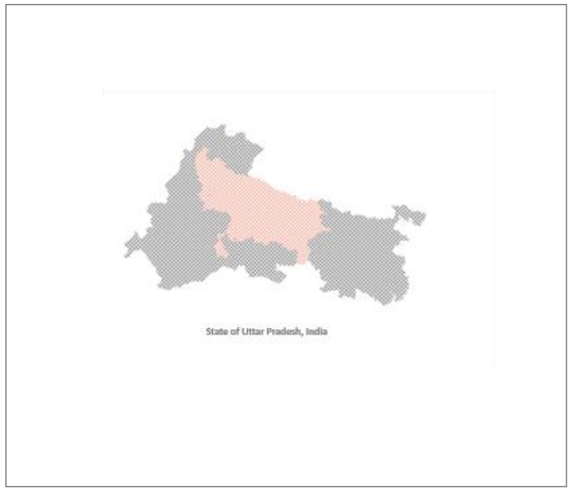
SACRED RIVERS

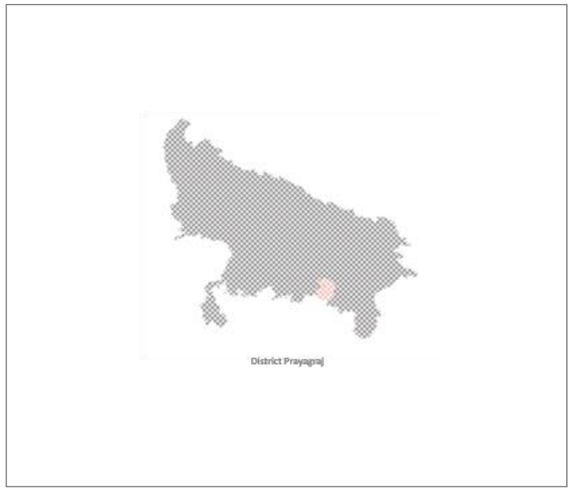
Figure 1
Ganga goddess of purity and personification
Figure source: Wikipedia

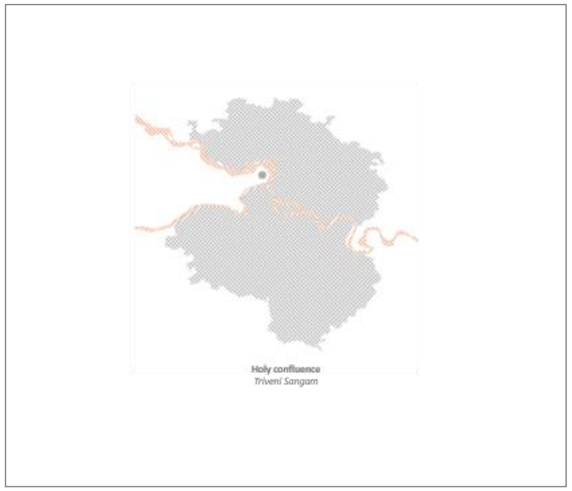
Figure 2
Pilgrim worship of river Ganga
Figure source: EPA/Piyal Adhikary

SITE CONTEXT









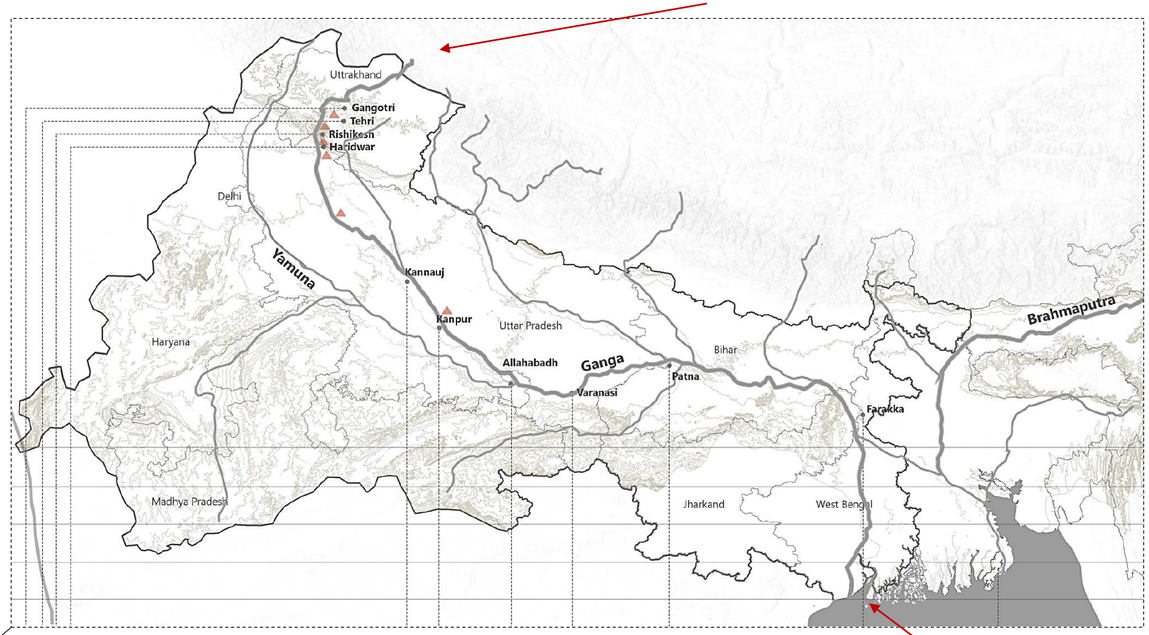
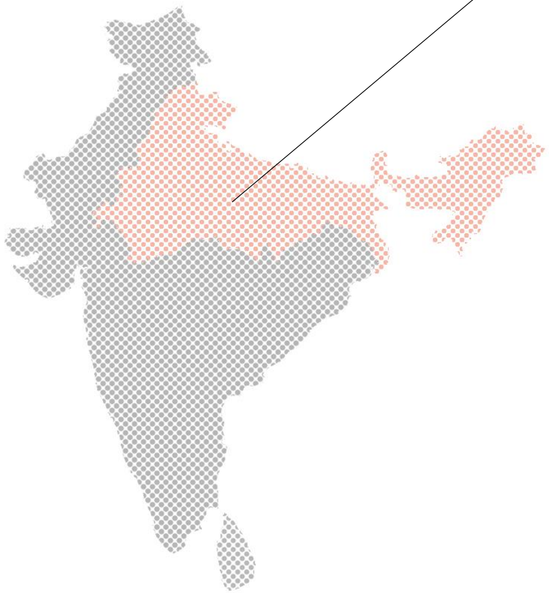
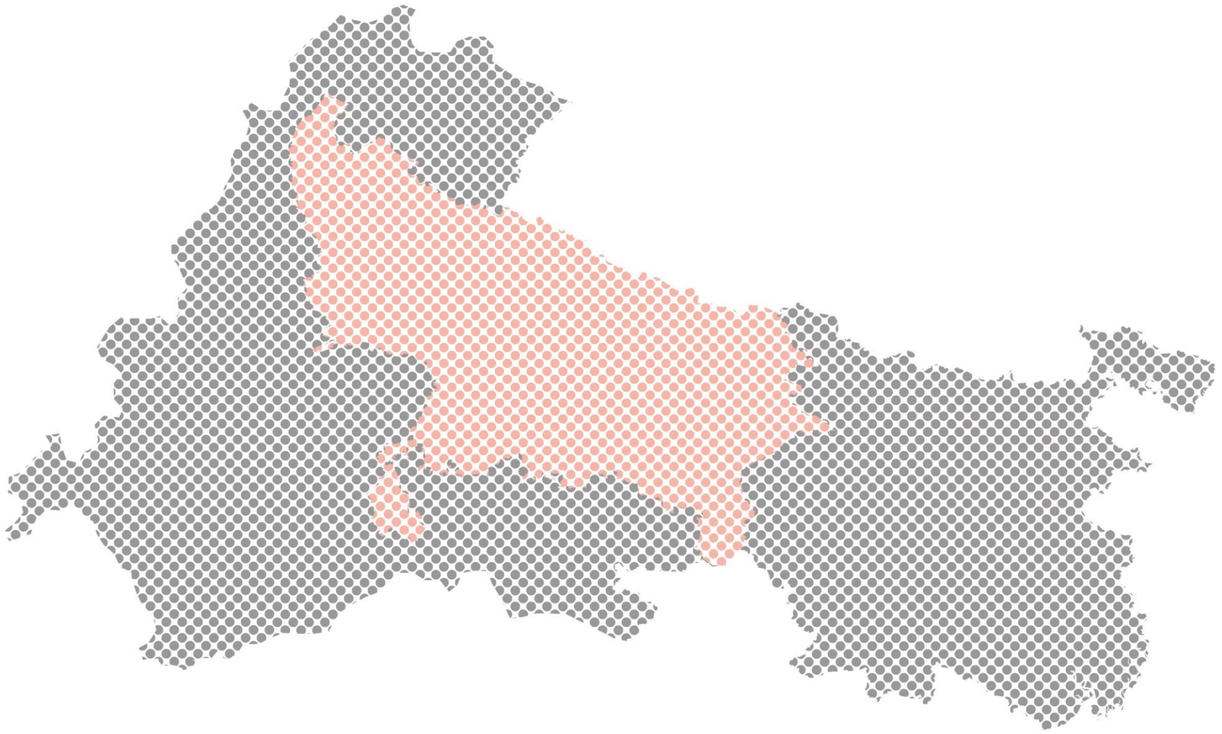


Figure 3
Course of River Ganga across its watershed

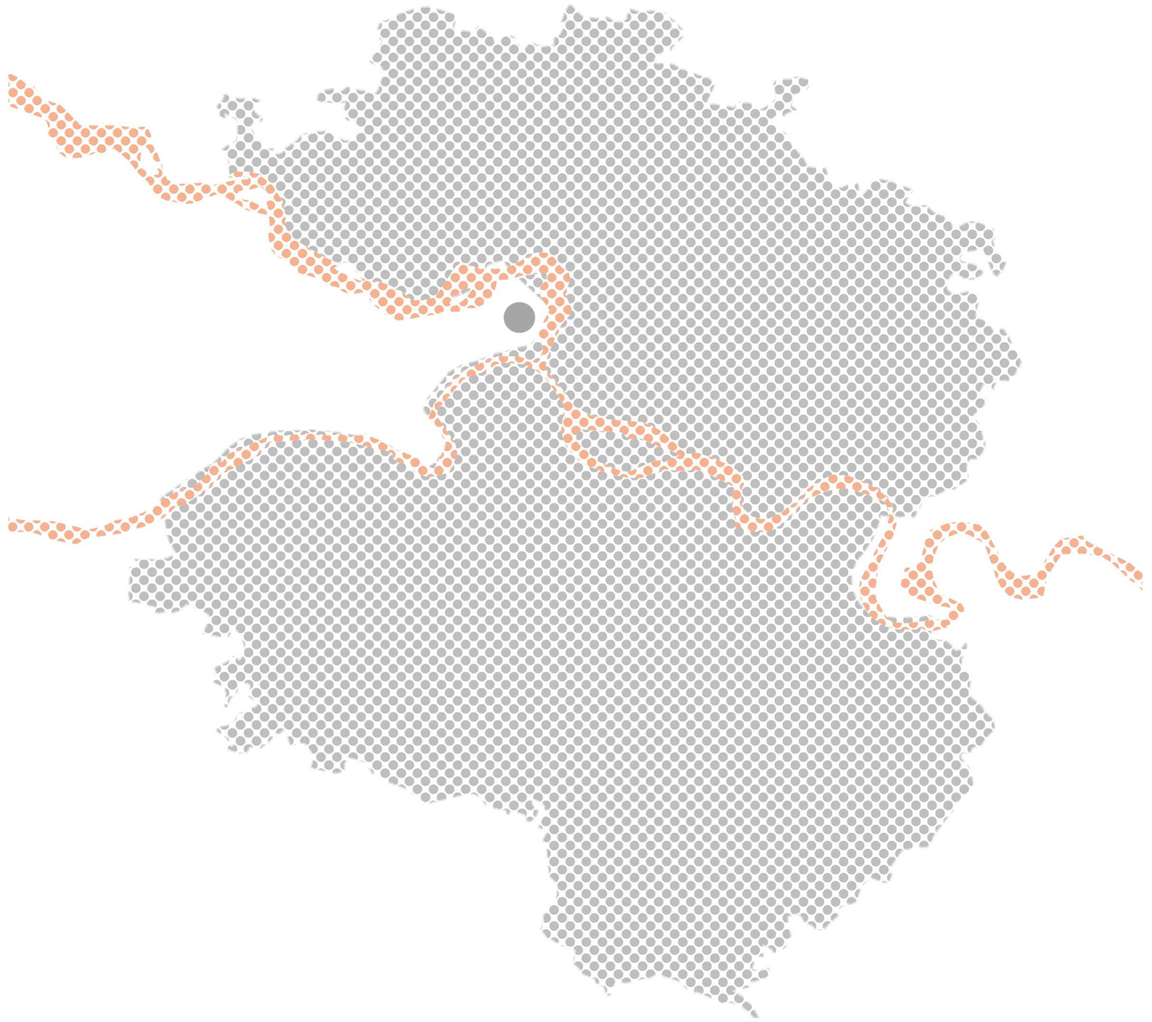


River Ganga watershed, India



State of Uttar Pradesh, India

District Prayagraj



Holy confluence

Triveni Sangam


JANUARY - FEBRUARY

‘GENIUS LOCI’ – DYNAMIC IDENTITY

I

FESTIVAL LANDSCAPE

JANUARY - FEBRUARY

II

AGRICULTURAL LANDSCAPE

FEBRUARY - JULY

III

DELUGED LANDSCAPE

JULY - OCTOBER

IV

PREPARATION LANDSCAPE

OCTOBER - JANUARY

Figure 4
Phases of the dynamic floodplain landscape
Figure source: Author, 2020

FUTURE CHALLENGES

I

CLIMATE CHANGE VULNERABILITY

II

URBAN GROWTH

III

INCREASING PILGRIMAGE

During the 2010 floods **135 villages** faced grim situation. Approximately 7000 people were **displaced** to different relief camps. (C. Richa, M. Shyam, 2015)


INDIAN EXPRESS

Largest combined net sales among all daily newspapers in India

Published from New Delhi, Chandigarh, Bombay, Madras, Madurai, Vijayawada, Hyderabad, Bangalore, Ahmedabad and Cochin

Vol. XLVII No. 258 New Delhi: Friday August 31, 1979 35 p

Services chiefs for major overhaul of rank structure

Current dry spell is longest

RAINFALL JUNE 1 TO AUG. 29 1979

RAINFALL JUNE 1 TO AUG. 30 1978

UP kharif crop destroyed

Problems of married women in IFS, IAS

Janata executive to plan poll strategy

Now famine in Rajasthan

Severe **drought** conditions **decimated crops**, **killed livestock** and left millions without water for their daily needs.

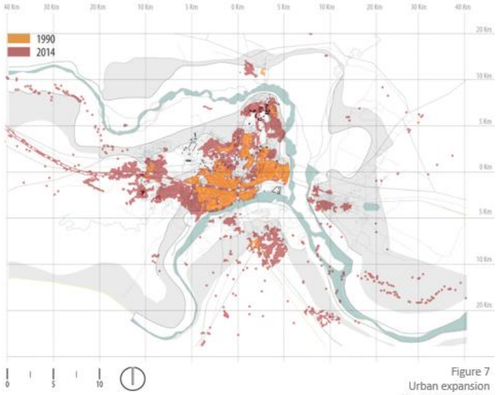


Figure 7
Urban expansion
Figure source: Author

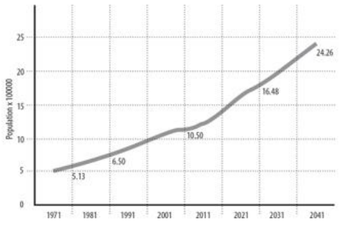


Figure 8
Population trend and projection 1971 to 2041
Figure source: City delevlopment plan for Prayagraj 2041, 2015

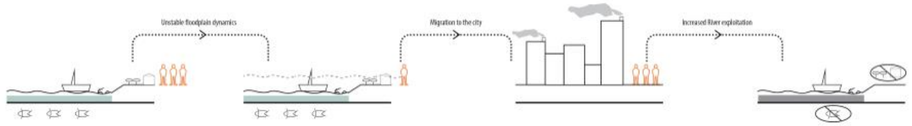
The urban population of Prayagraj is on a constant rise due to livelihood opportunities the city offers. Rural to urban migration has contributed much to the city's growth.

1990 vs 2014 Urban expansion

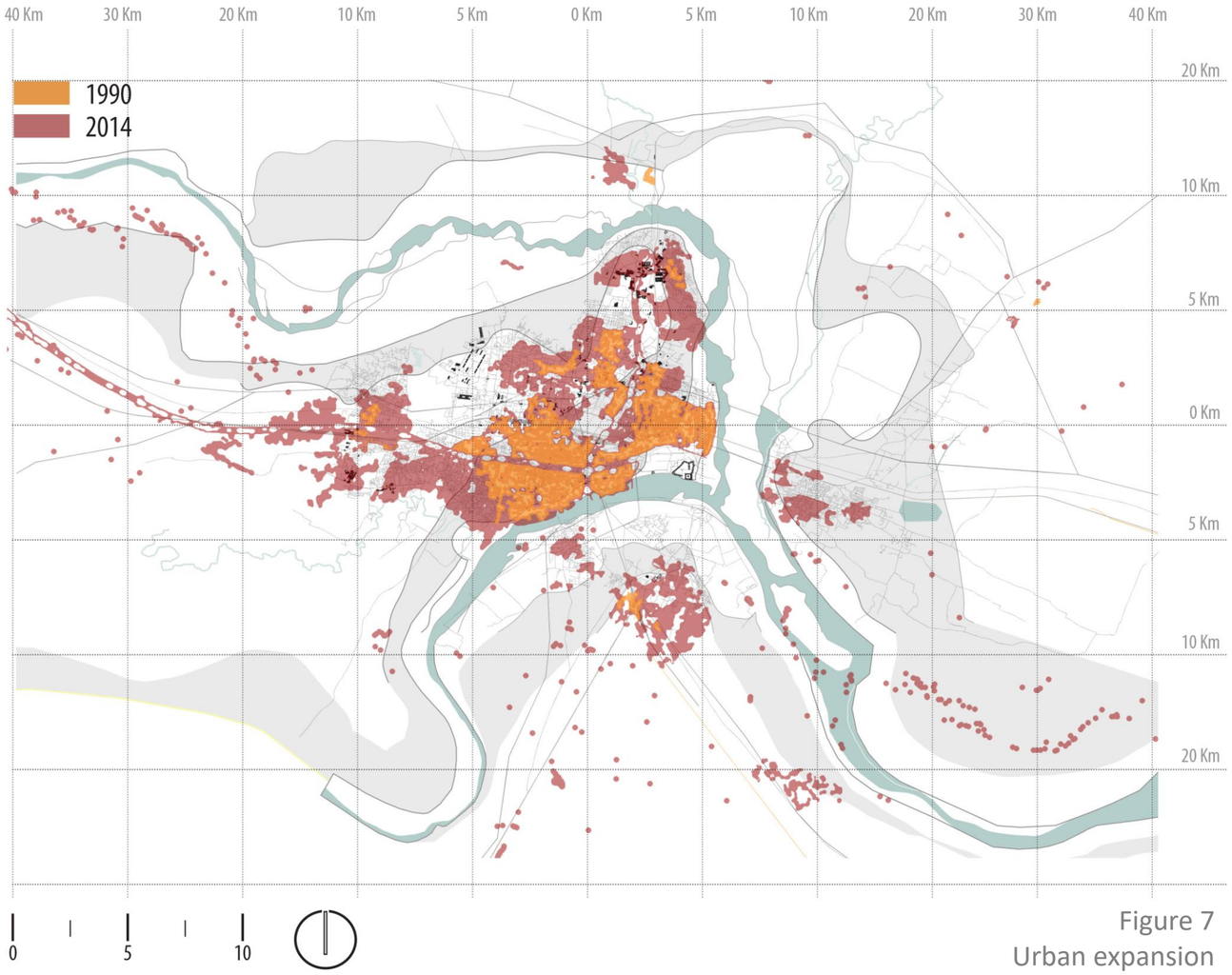
Many of these migrants are male agricultural workers who move to the city in search of permanent job opportunities.

Thus, reducing dependence of local communities of the floodplain landscape leads to its exploitation by urban areas threatening its holiness and dynamic identity.

Figure 9
Rural to urban migration
Figure source: Author



Rural to Urban migration



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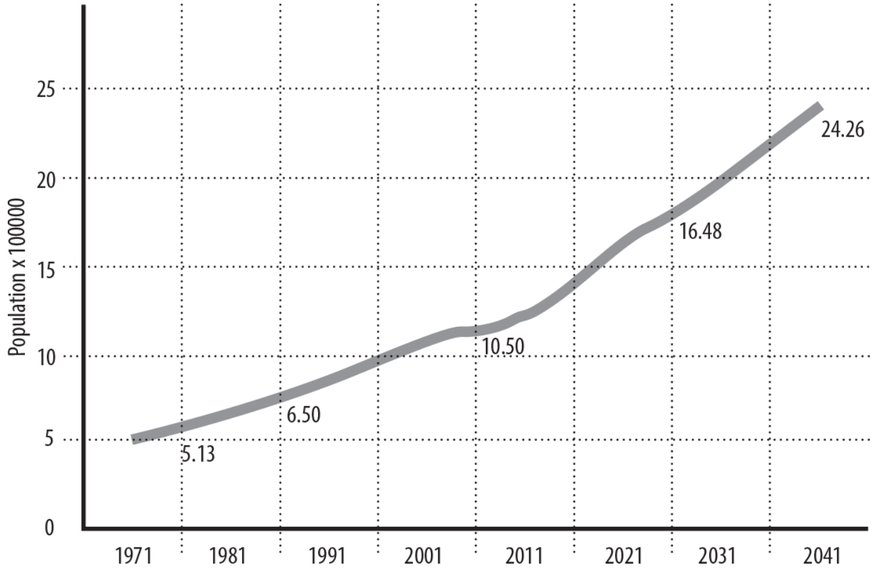

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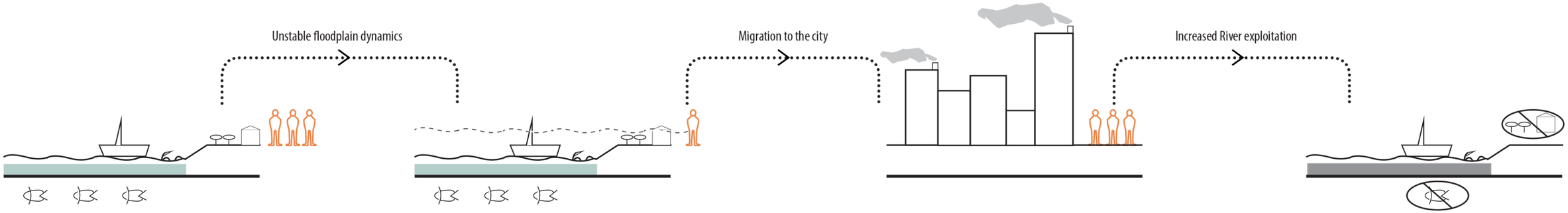
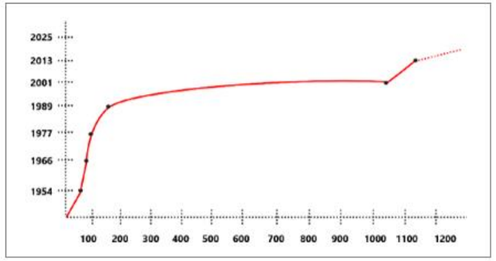


Every year the district of Prayagraj experiences an **increased** number of **pilgrims**. There is an increasing trend in pilgrimage with an in advert rise from year 2000 onwards as shown in the figure below.



Pilgrim Population

Figure 10
Increasing pilgrimage trends
Figure source: Author

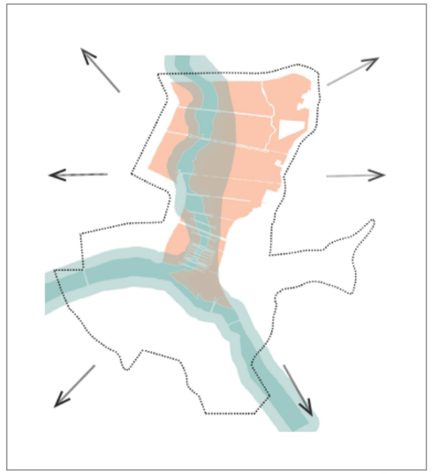


Figure 11
Festival ground expansion
Figure source: Author

2019 KUMBH MELA:

25% Land increased.

Sectors increased from **12 to 14**.

Every year the festival authorities prepare a blue print for the temporary city. There is uncertainty among authorities due to prolonged ground setting time leading to delays in construction and planning problems (Dwivedi S., Cariappa M., 2015).

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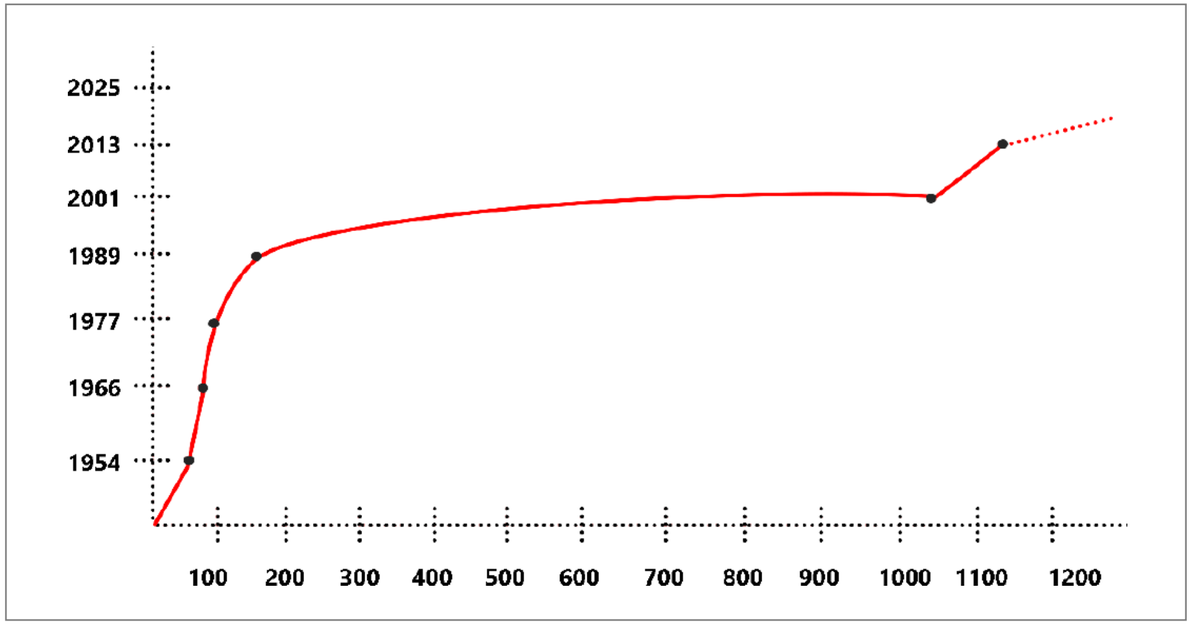

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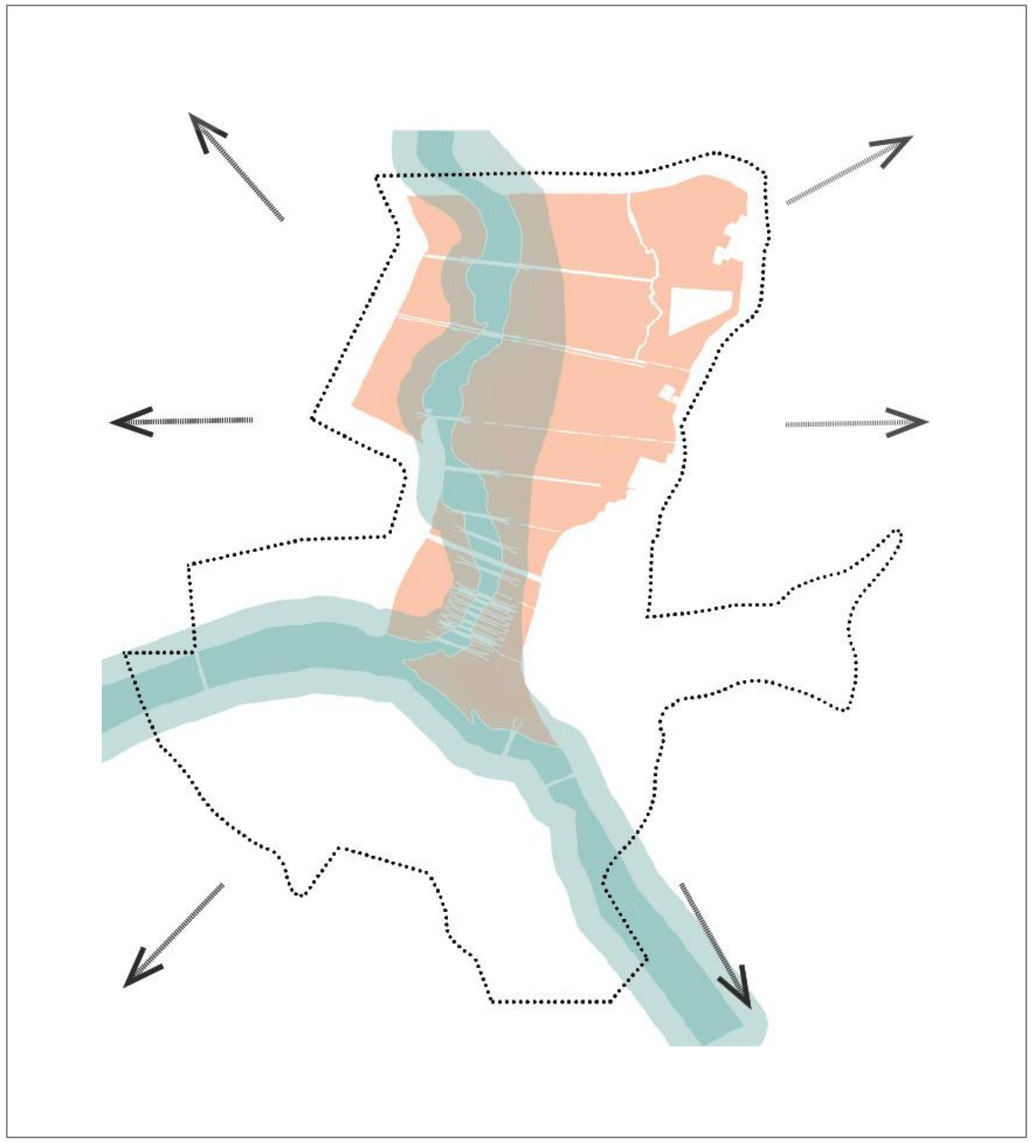

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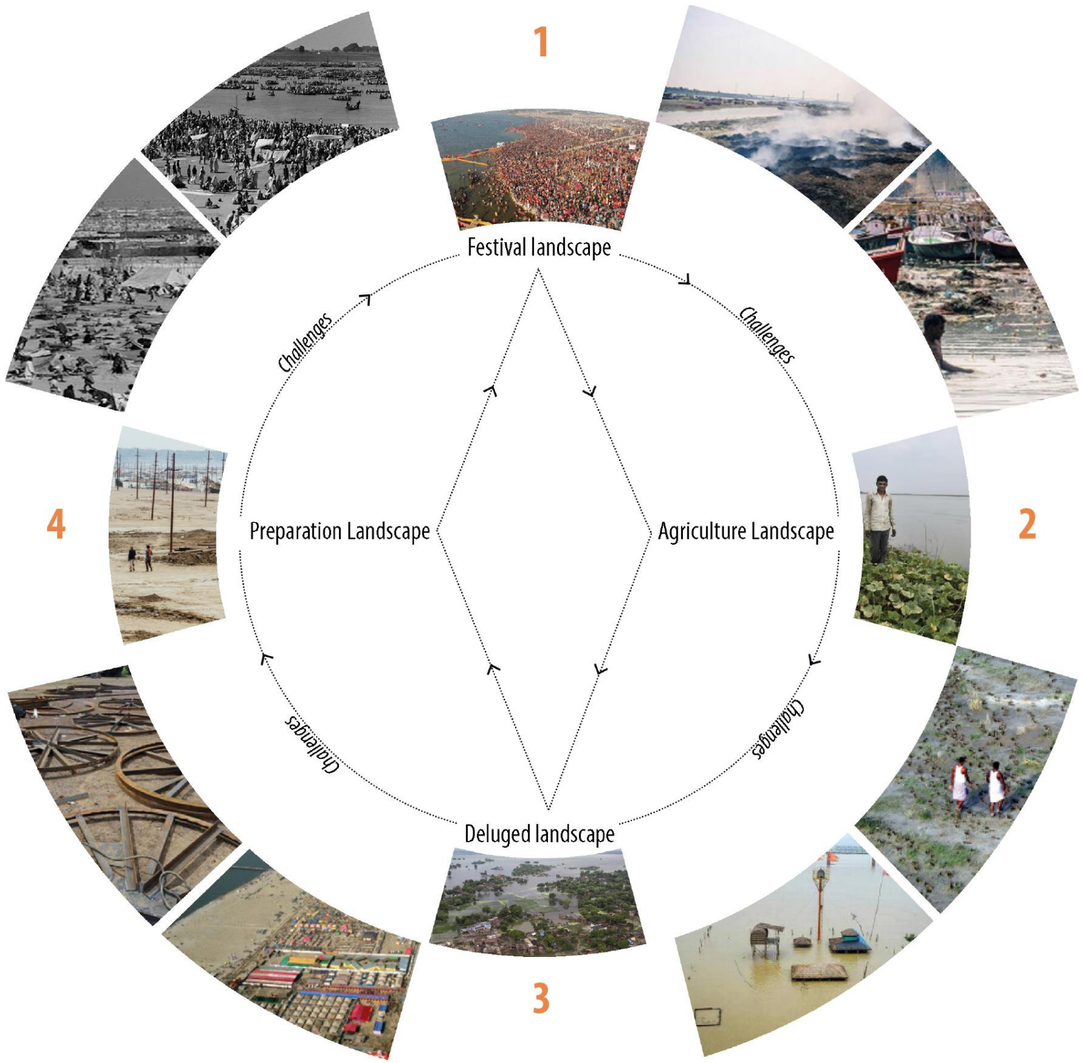


These changing phases form the dynamic identity of the site which are threatened due to the following challenges it faces.

Figure 12
Challenges faced by changing phases of dynamic floodplain of river Ganga
Figure source: Author

FESTIVAL TO AGRICULTURAL LANDSCAPE

Soil nutrient content loss
Land unsuitable for agriculture

Figure 13
Impact of festival on floodplains
Figure source: Down to Earth

AGRICULTURAL TO DELUGED LANDSCAPE

Loss of productive land and produce
Submerged low-lying areas

Figure 14
Impact of monsoon deluge
Figure source: Down to Earth

DELUGED TO PREPARATION LANDSCAPE

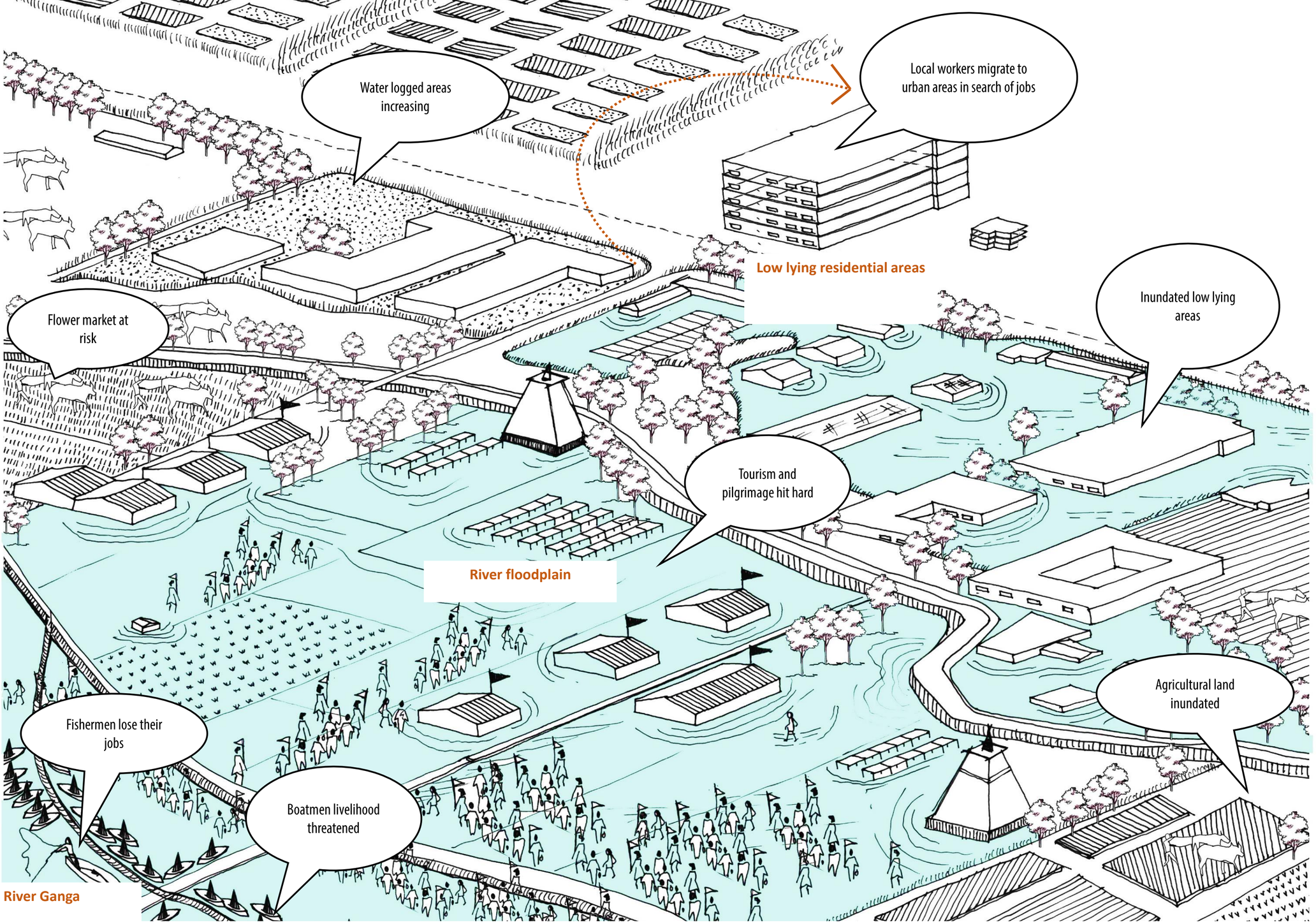
Prolonged ground setting time
In-access post monsoon

Figure 15
Pilgrim try to cross marshland after receding water
Figure source: Sanjay Kanojia

PREPARATION TO FESTIVAL LANDSCAPE

Delayed construction
Management problems

Figure 16
Incomplete festival infrastructure
Figure source: NDTV India


Water logged areas increasing
Local workers migrate to urban areas in search of jobs
Low lying residential areas
Flower market at risk
Inundated low lying areas
Tourism and pilgrimage hit hard
River floodplain
Agricultural land inundated
Fishermen lose their jobs
Boatmen livelihood threatened
River Ganga

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

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**? **phases of floodplain landscape with its users**?

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?**

METHODOLOGY

DYNAMIC PARAMETERS

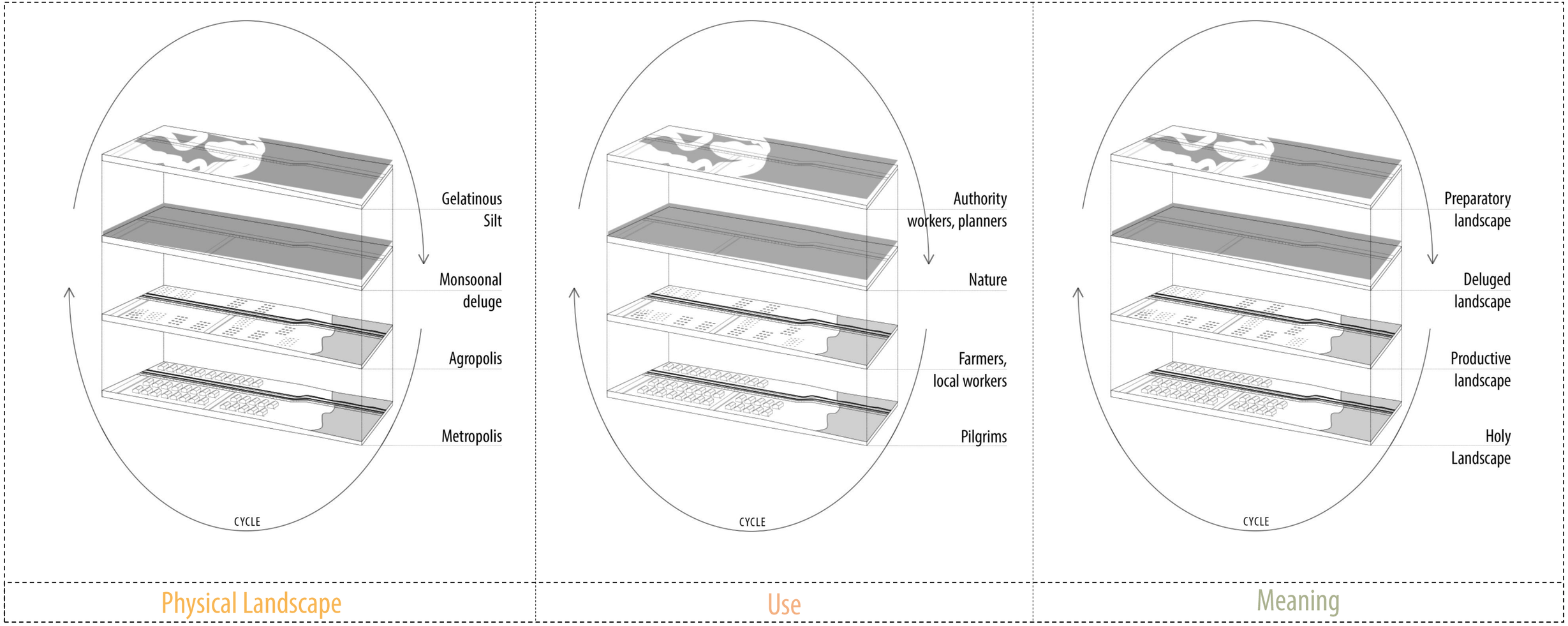


Figure 17
Dynamic Parameters of floodplains of river Ganga
Figure source: Author

THEORETICAL BACKGROUND

DYNAMIC LANDSCAPE THEORY

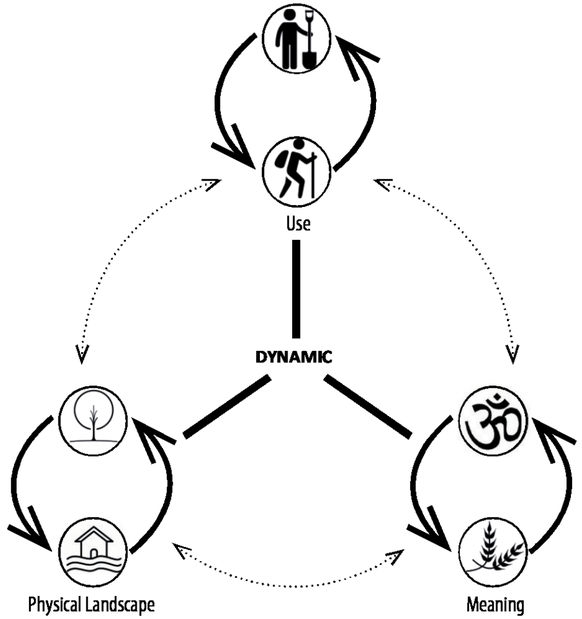


Figure 18
Dynamic Parameters of floodplains of river Ganga
Figure source: Author

External and **internal influences** on a landscape frames conditions for its dynamic nature. Theory supports **sustainable multifunctional landscape** design to maintain critical ecosystem functions along with human influences (Farrell, Anderson, 2010).

LANDSCAPE RESILIENCE

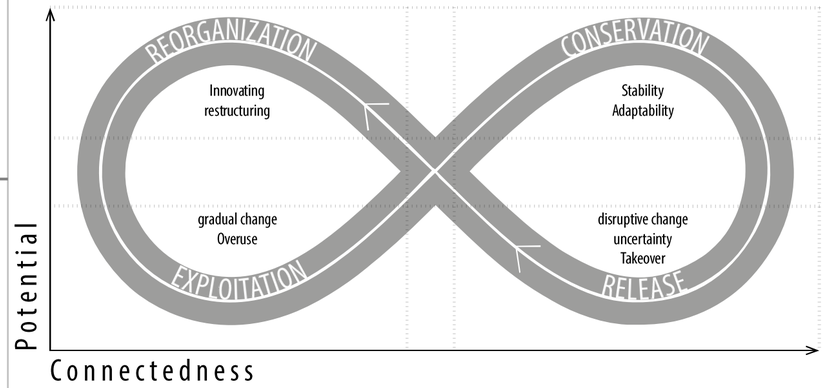


Figure 19
Phases of system renewal for floodplains of river Ganga
Figure source: adapted from Holling and Gunderson 1986

Resilient landscape approach is related to degree of which system is capable of **recovery** and **adaptation**. Theory helps in realising **socio-ecologically** resilient landscapes which can **absorb change** to disturbances by **setting conditions for human interaction with the ecosystem** (Holling, 1986).

DESIGNING WITH NATURE

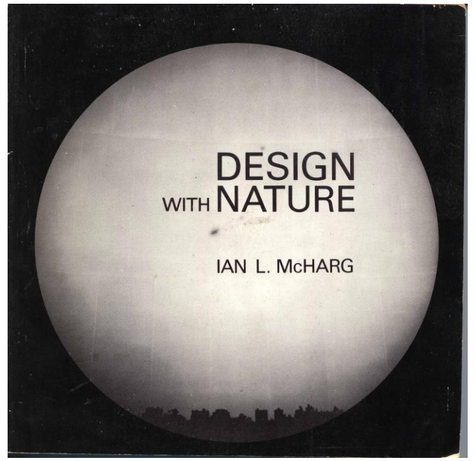
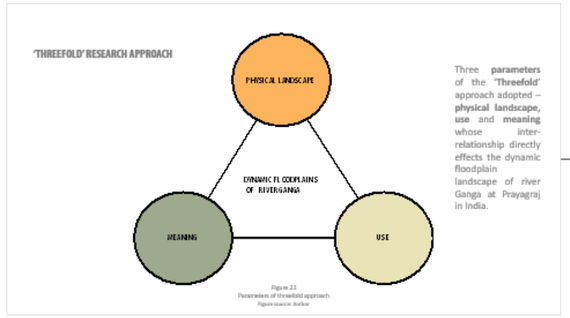


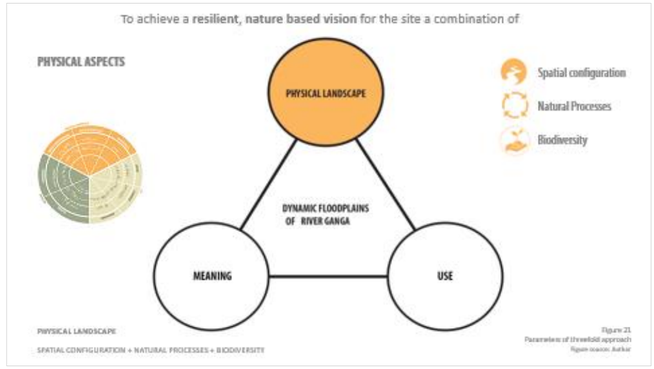
Figure 20
Design with Nature book by Ian Mcharg
Figure source: Open library

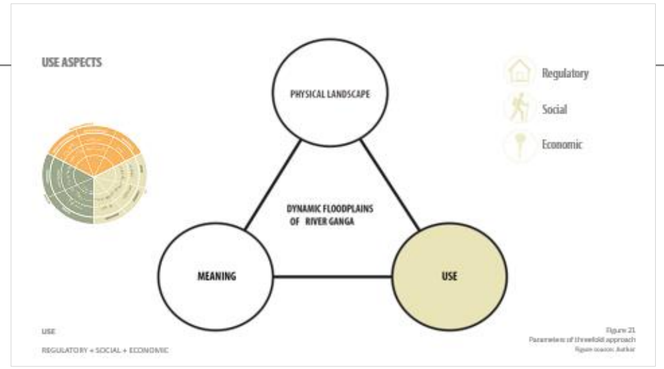
Ecological science and **ecosystem services** as basis for design and decision making (Mcharg, 1969).

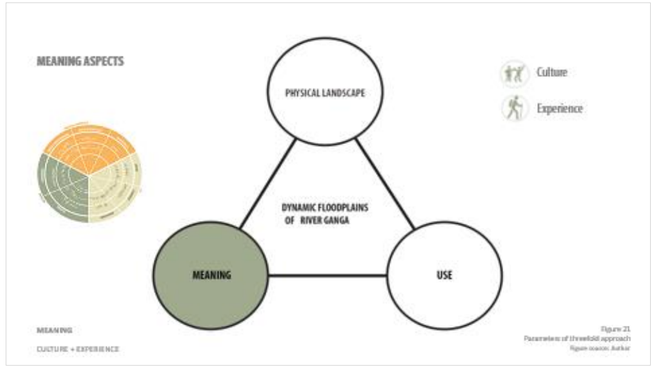
THE APPROACH



Three **parameters** of the **'Threefold'** approach adopted – **physical landscape, use** and **meaning** whose inter-relationship directly effects the dynamic floodplain landscape of river Ganga at Prayagraj in India.







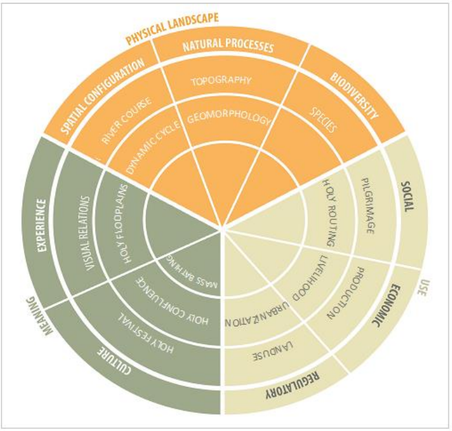


Figure represents a **valuation diagram** on the basis of which the dynamic floodplain landscape is **analysed** and then **envisioned** to attain a **resilient landscape framework** for the site.

Figure 22
Valuation diagram along with data per aspect of parameters
Figure source: Author

‘THREEFOLD’ RESEARCH APPROACH

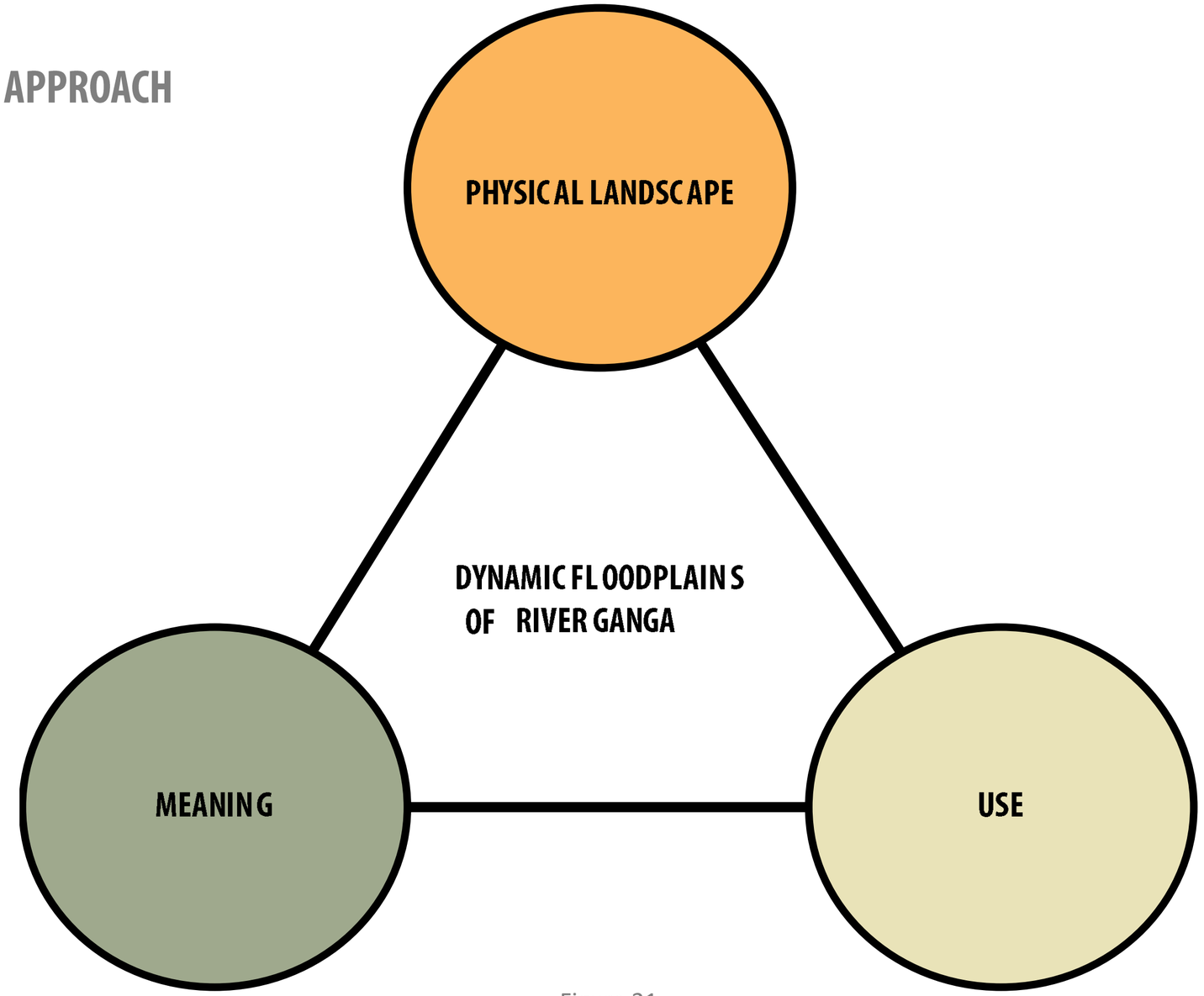
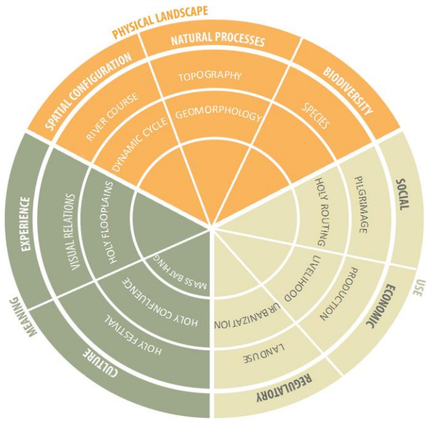


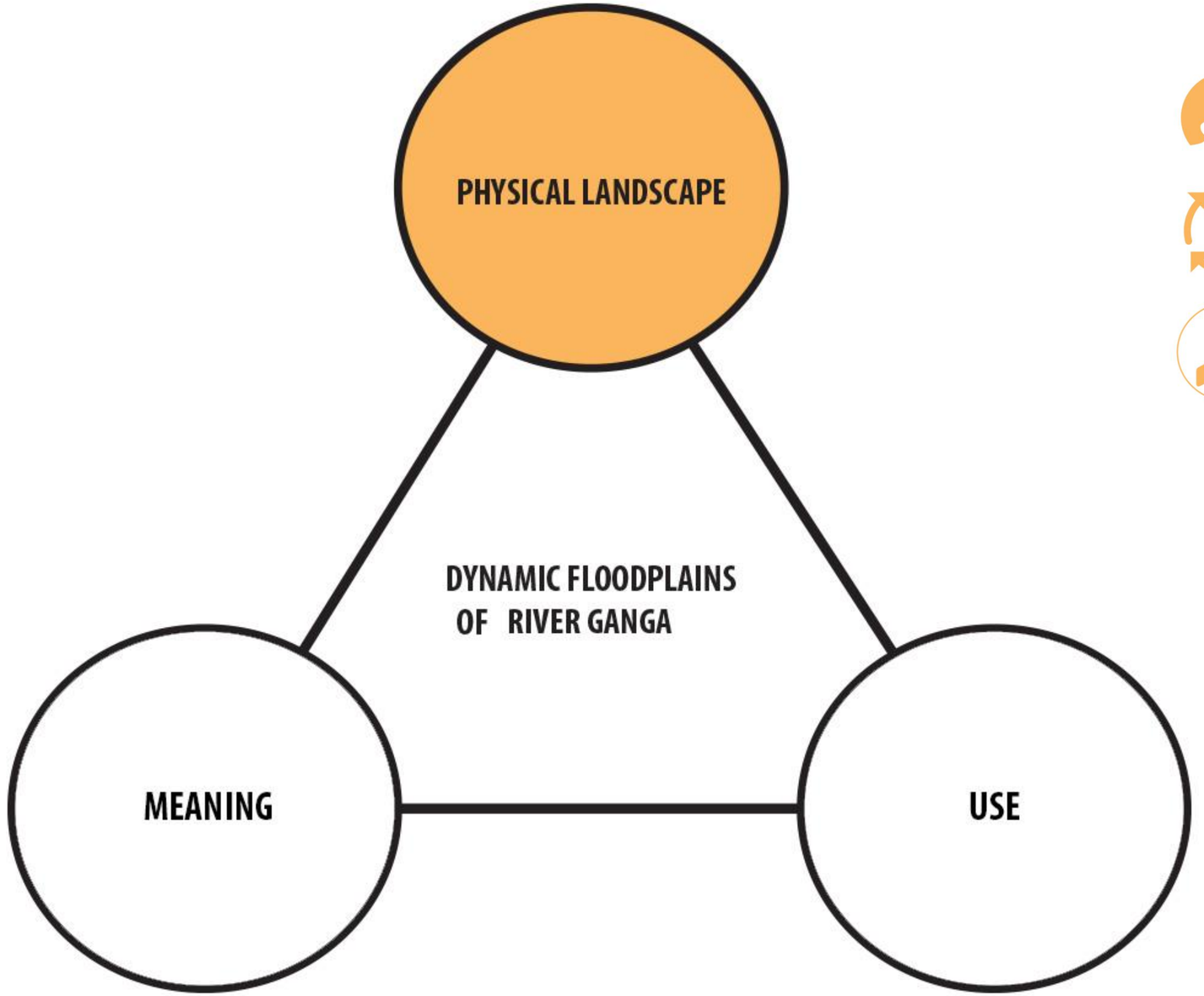
Figure 21
Parameters of threefold approach
Figure source: Author

Three **parameters** of the ‘**Threefold**’ approach adopted – **physical landscape, use** and **meaning** whose inter-relationship directly effects the dynamic floodplain landscape of river Ganga at Prayagraj in India.

To achieve a **resilient, nature based vision** for the site a combination of

PHYSICAL ASPECTS





Spatial configuration

Natural Processes

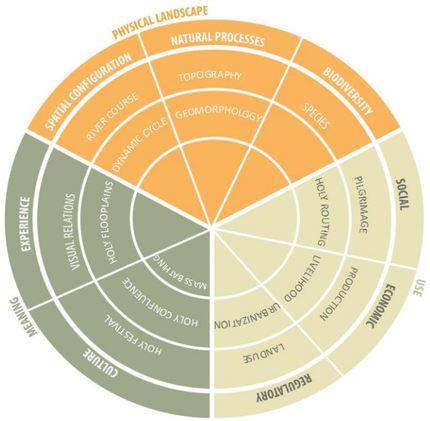
Biodiversity

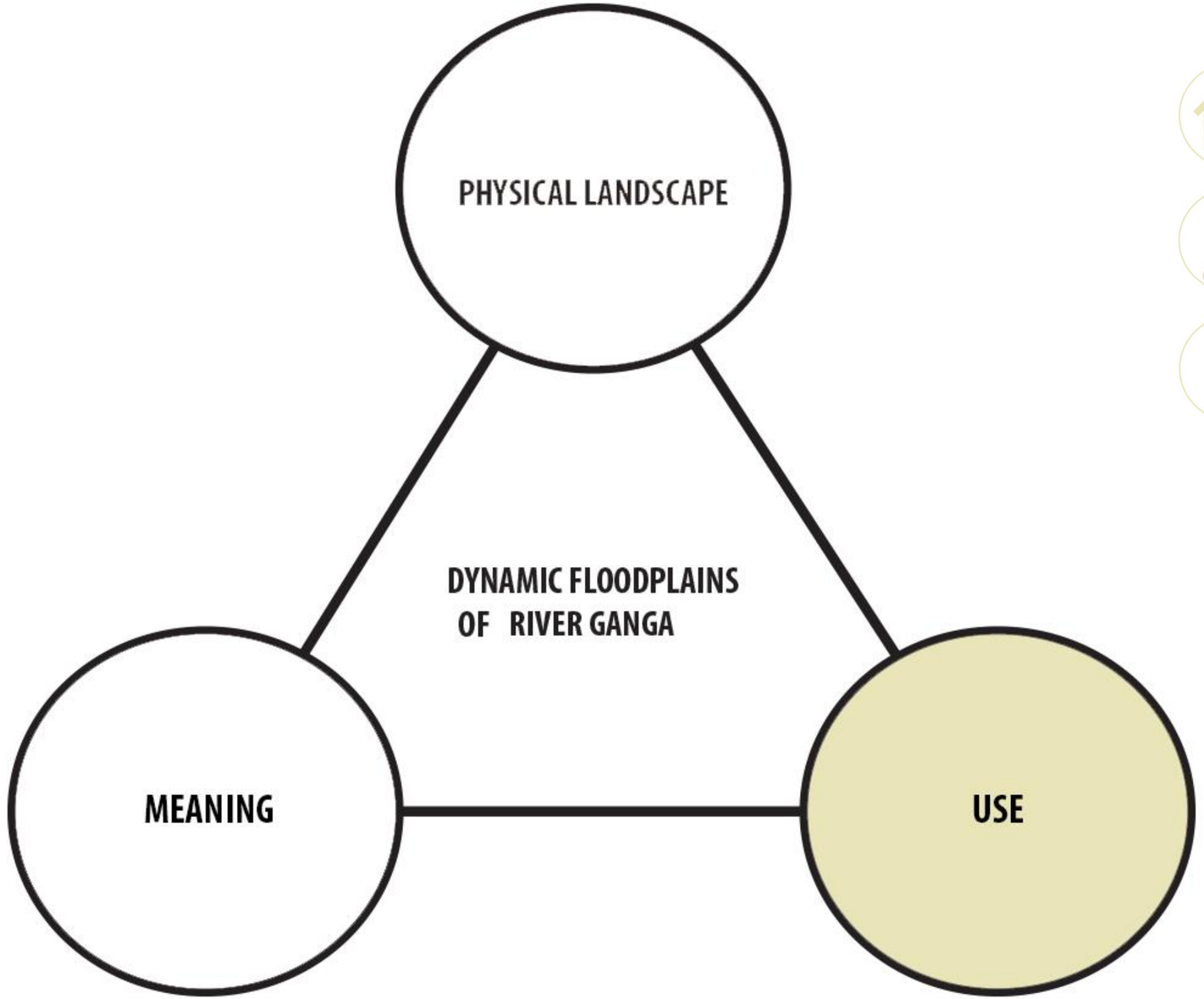
PHYSICAL LANDSCAPE

SPATIAL CONFIGURATION + NATURAL PROCESSES + BIODIVERSITY

Figure 21
Parameters of threefold approach
Figure source: Author

USE ASPECTS





Regulatory

Social

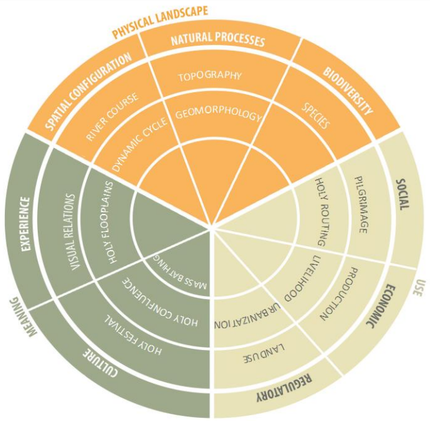
Economic

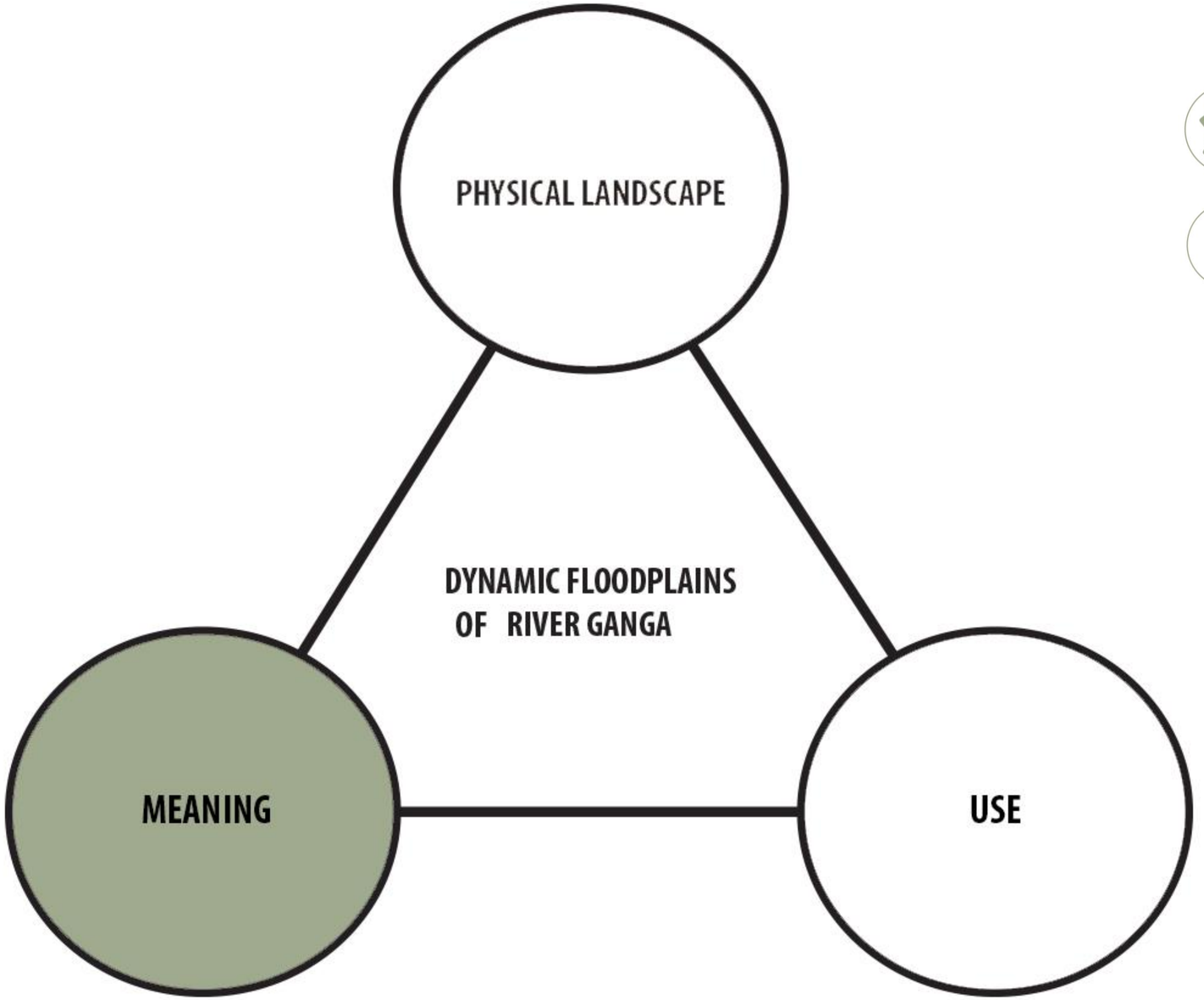
USE

REGULATORY + SOCIAL + ECONOMIC

Figure 21
Parameters of threefold approach
Figure source: Author

MEANING ASPECTS





Culture

Experience

MEANING

CULTURE + EXPERIENCE

Figure 21
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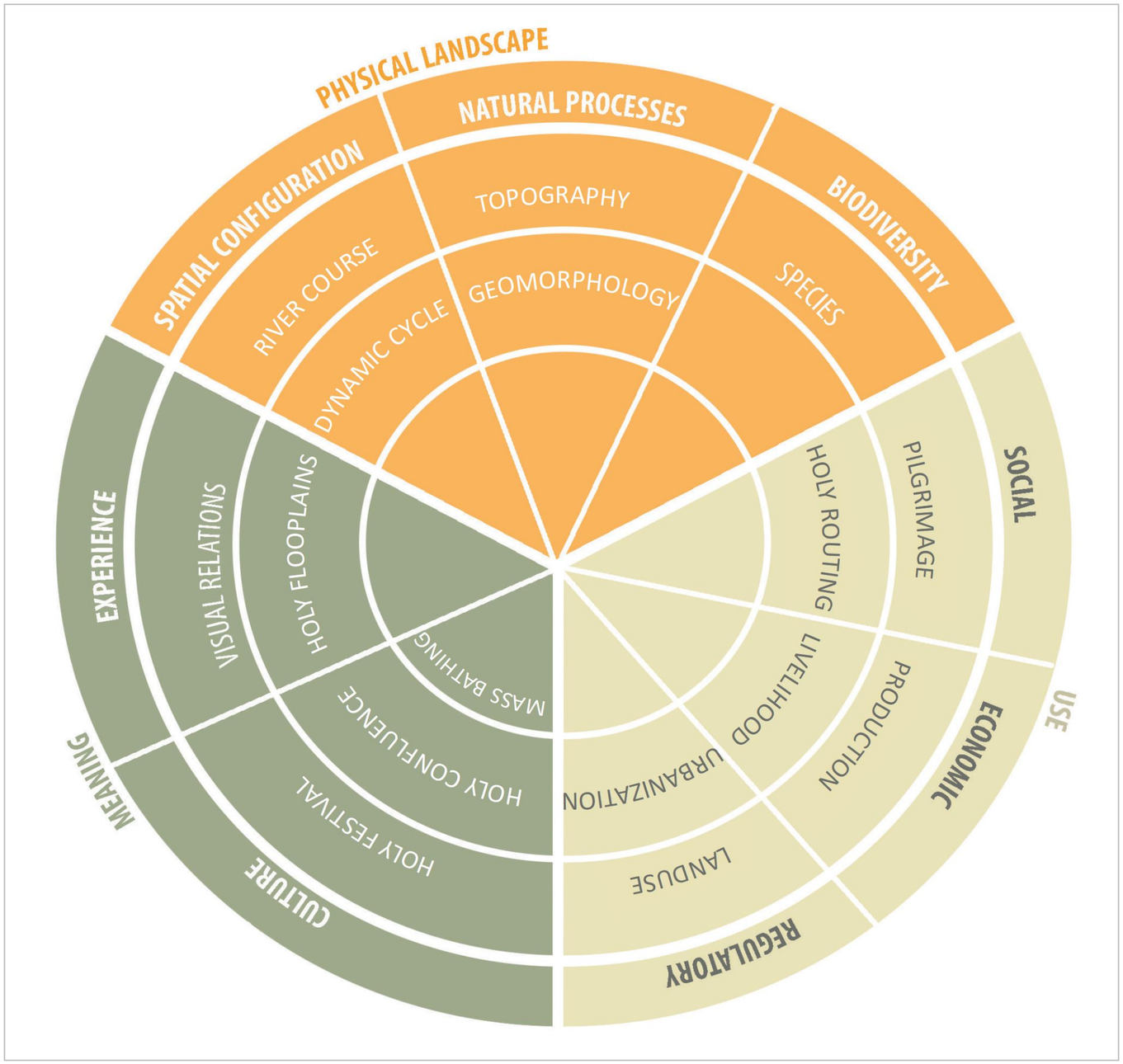

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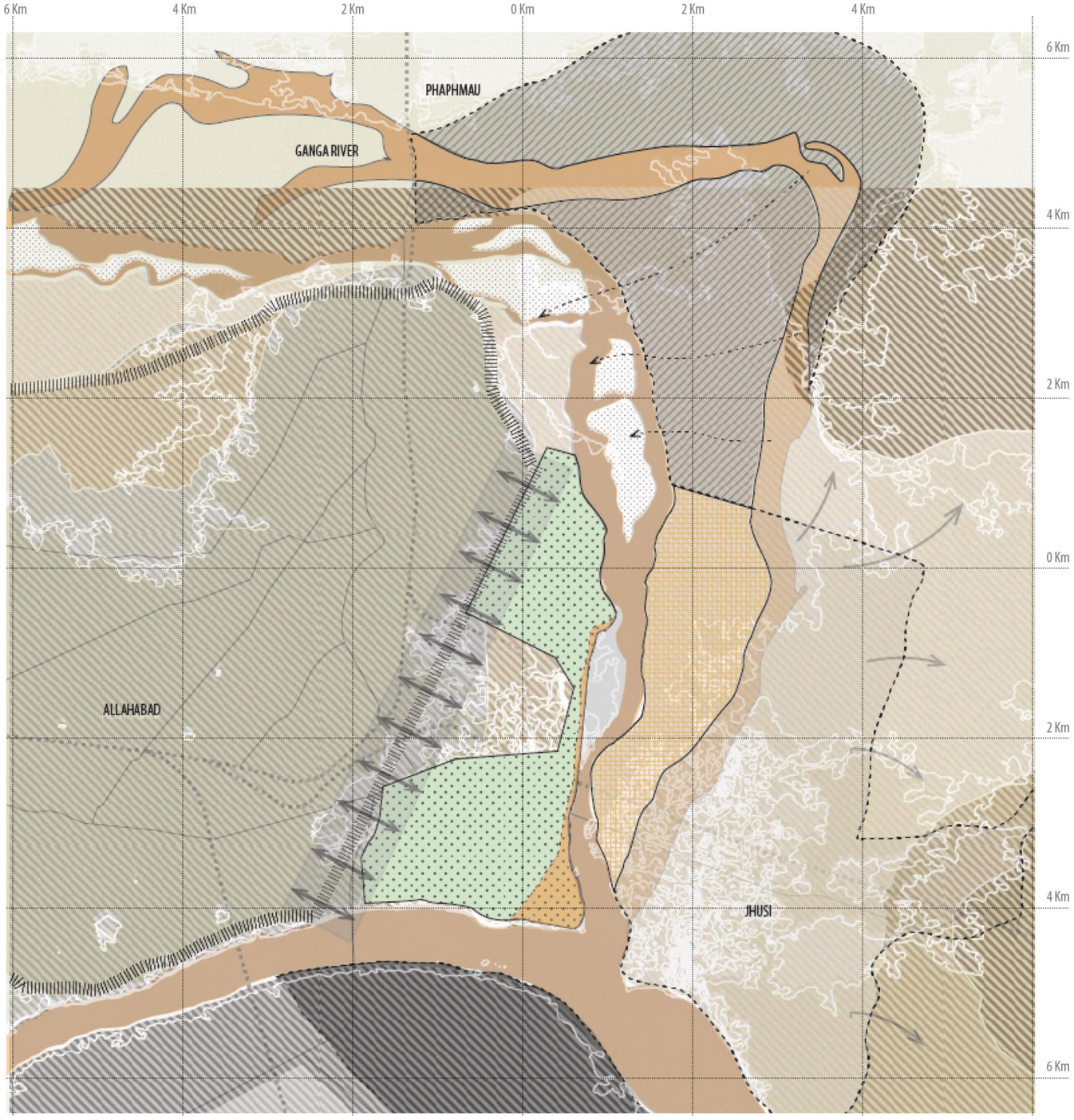
Valuation diagram along with data per aspect of parameters
Figure source: Author

INTERSCALE APPROACH

Figure 23
Inter-scale analysis approach
Figure source: Author

ANALYSIS



PHYSICAL LANDSCAPE

There are major impacts with respect to physical landscape of the site:

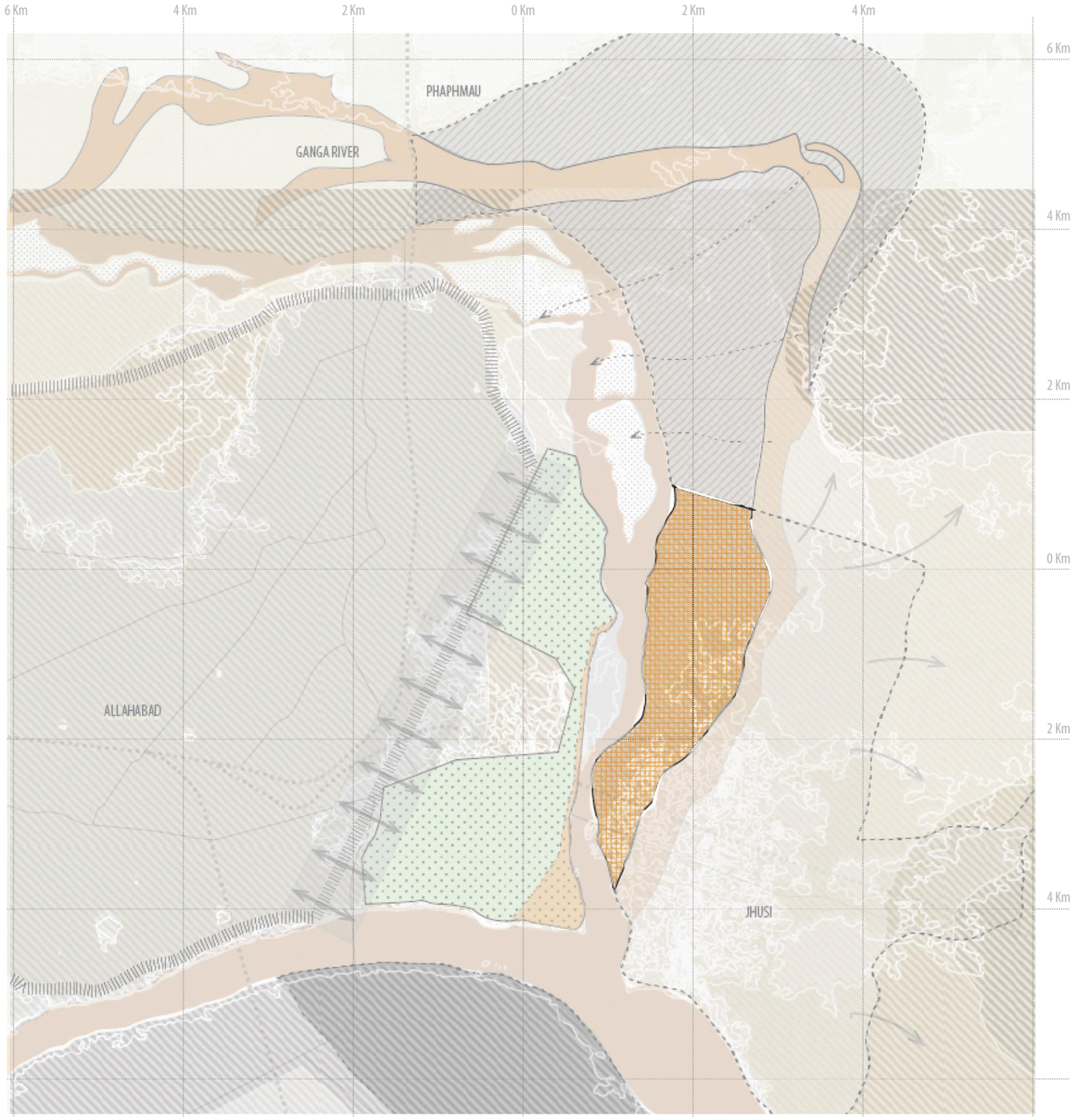
Floodplain land lying westwards of river has reduced due to **westward river migration**. The west side of the floodplains are more **vulnerable to river swelling.**

Western floodplain vulnerable to river flooding due to **proximity to low-lying settlements** and **pilgrimage pressure**.

Old course of river which forms active floodplain, has potential for **water retention and storage**.

Vulnerable edge to **urban expansion** and **river swelling** during the monsoons season.

Figure 24
Conclusion map
Figure source: Author



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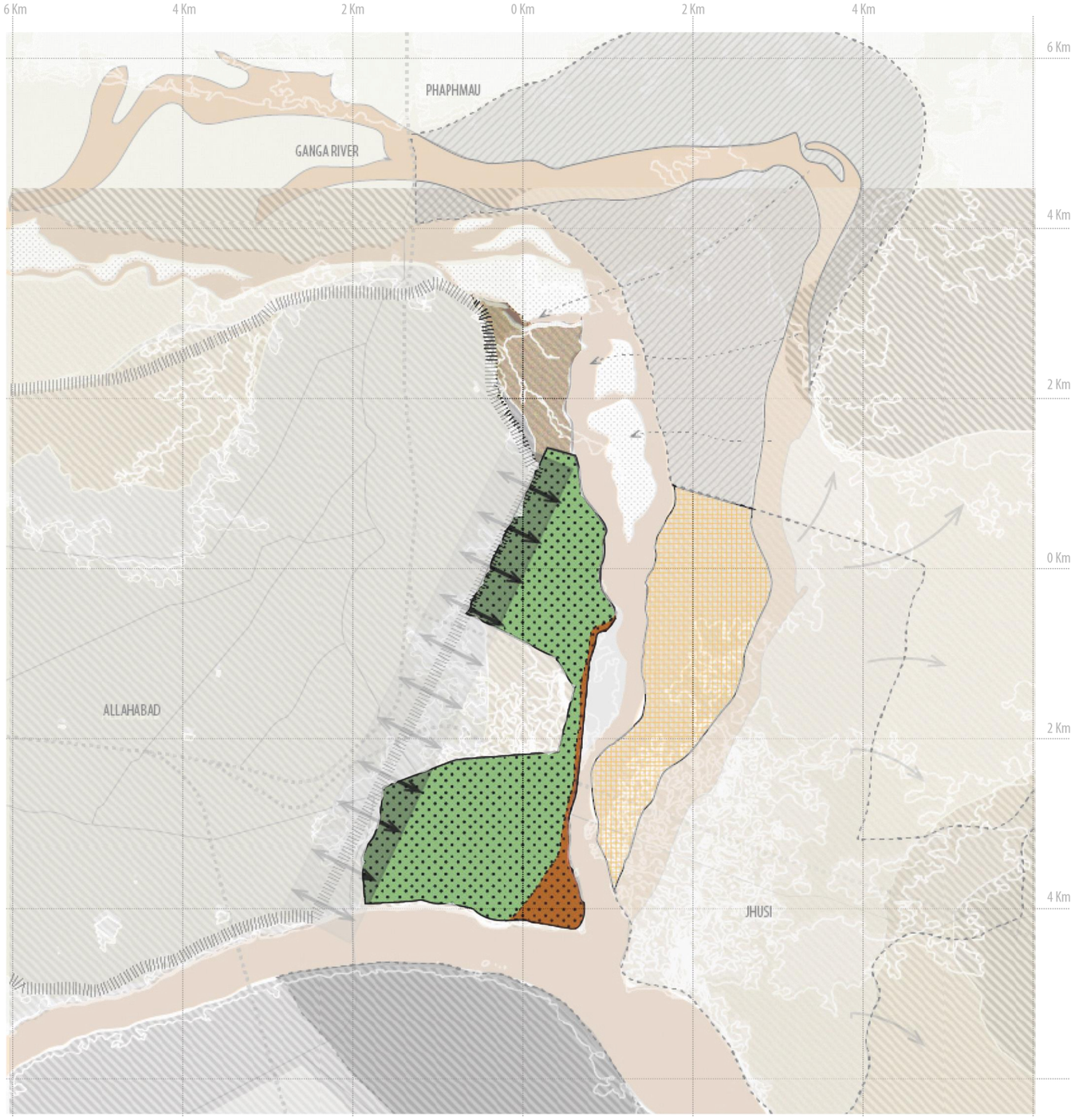

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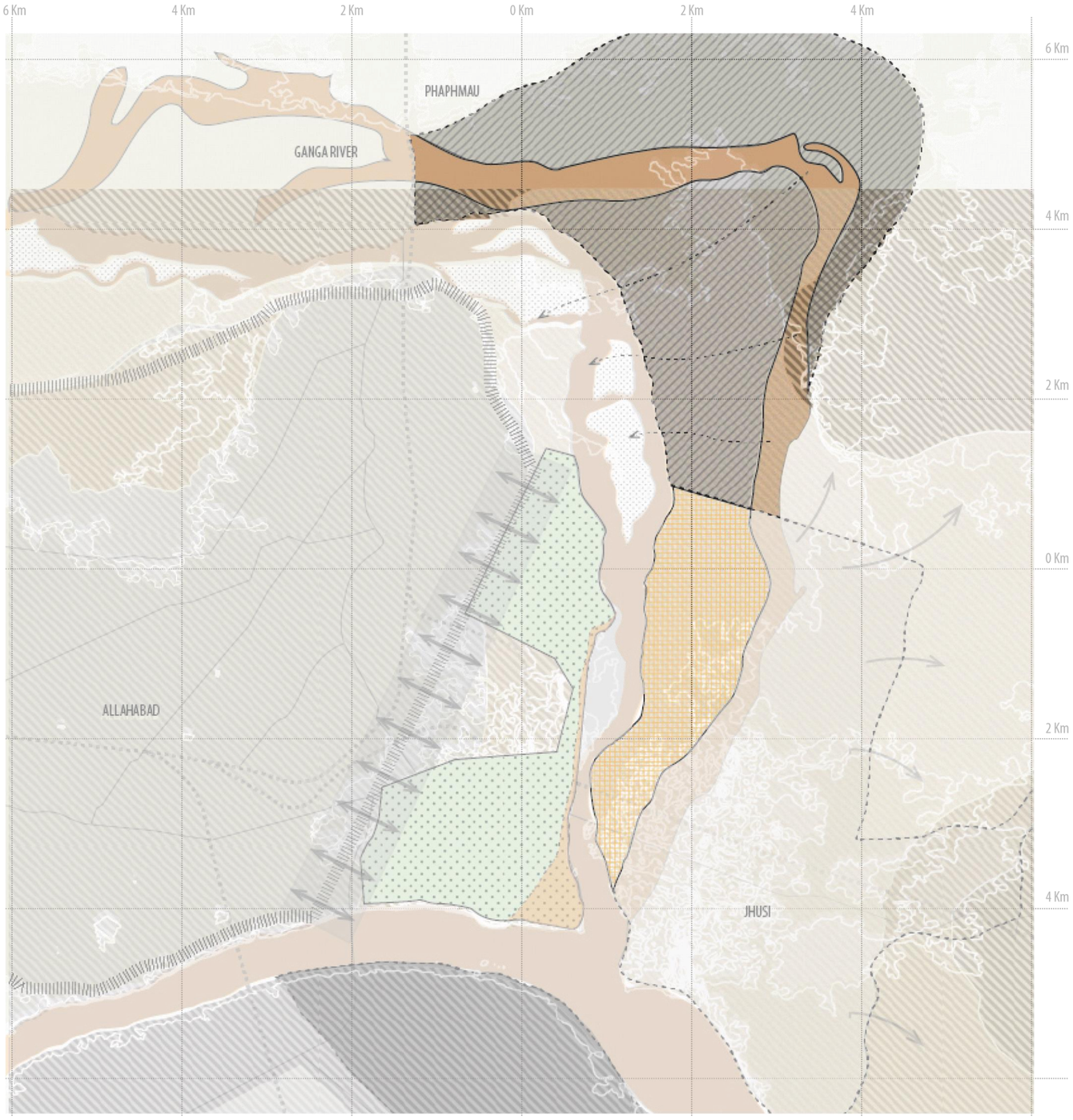

PHYSICAL LANDSCAPE

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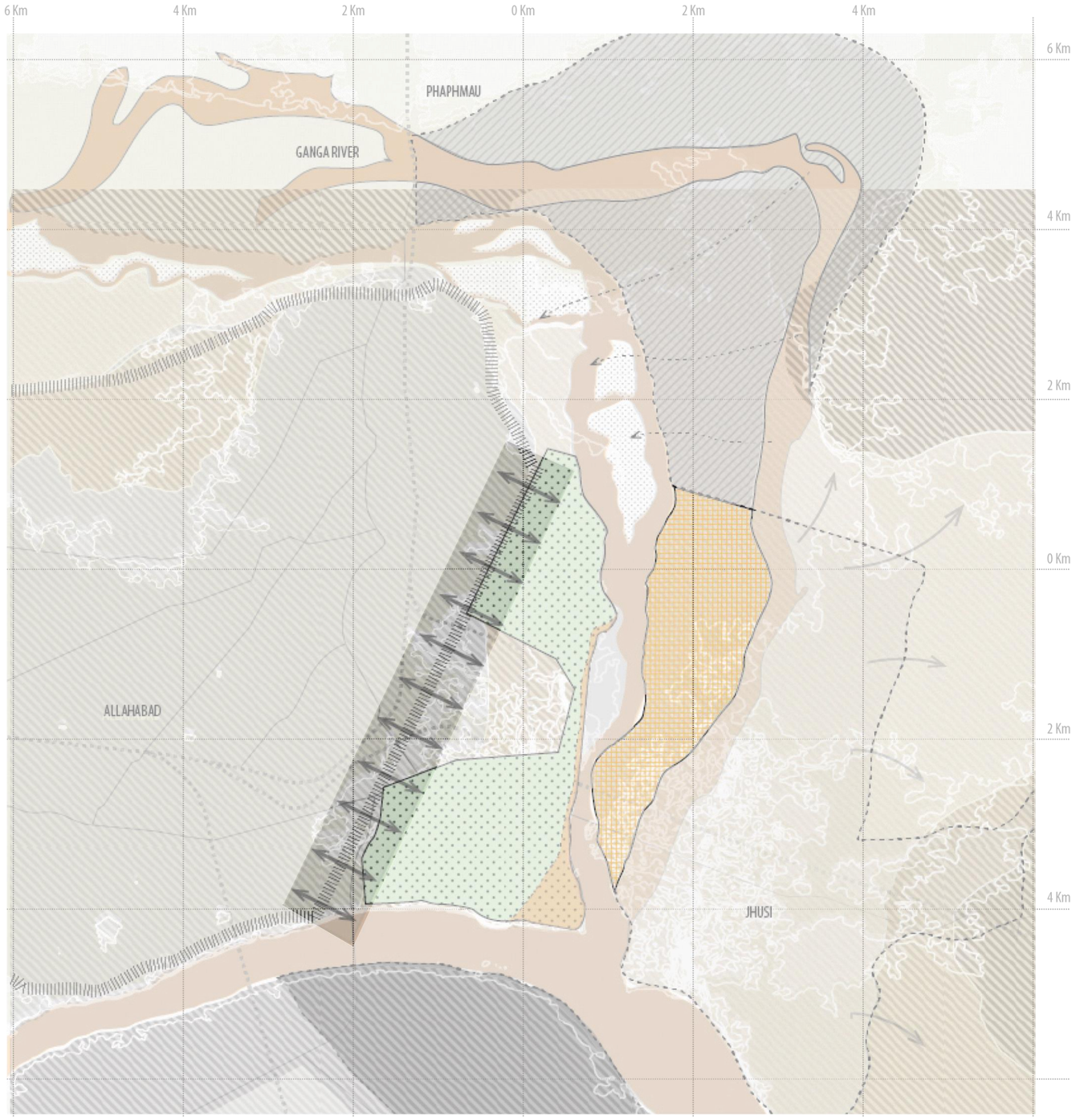
Floodplain land lying westwards of river has reduced due to **westward river migration**. The west side of the floodplains are more **vulnerable to river swelling.**

Western floodplain vulnerable to river flooding due to **proximity to low-lying settlements** and **pilgrimage pressure**.

Old course of river which forms active floodplain, has potential for **water retention and storage**.

0 1 2 km



PHYSICAL LANDSCAPE

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Western floodplain vulnerable to river flooding due to **proximity to low-lying settlements** and **pilgrimage pressure**.

Old course of river which forms active floodplain, has potential for **water retention and storage**.

Vulnerable edge to **urban expansion** and **river swelling** during the monsoons season.

0 1 2 km

USE

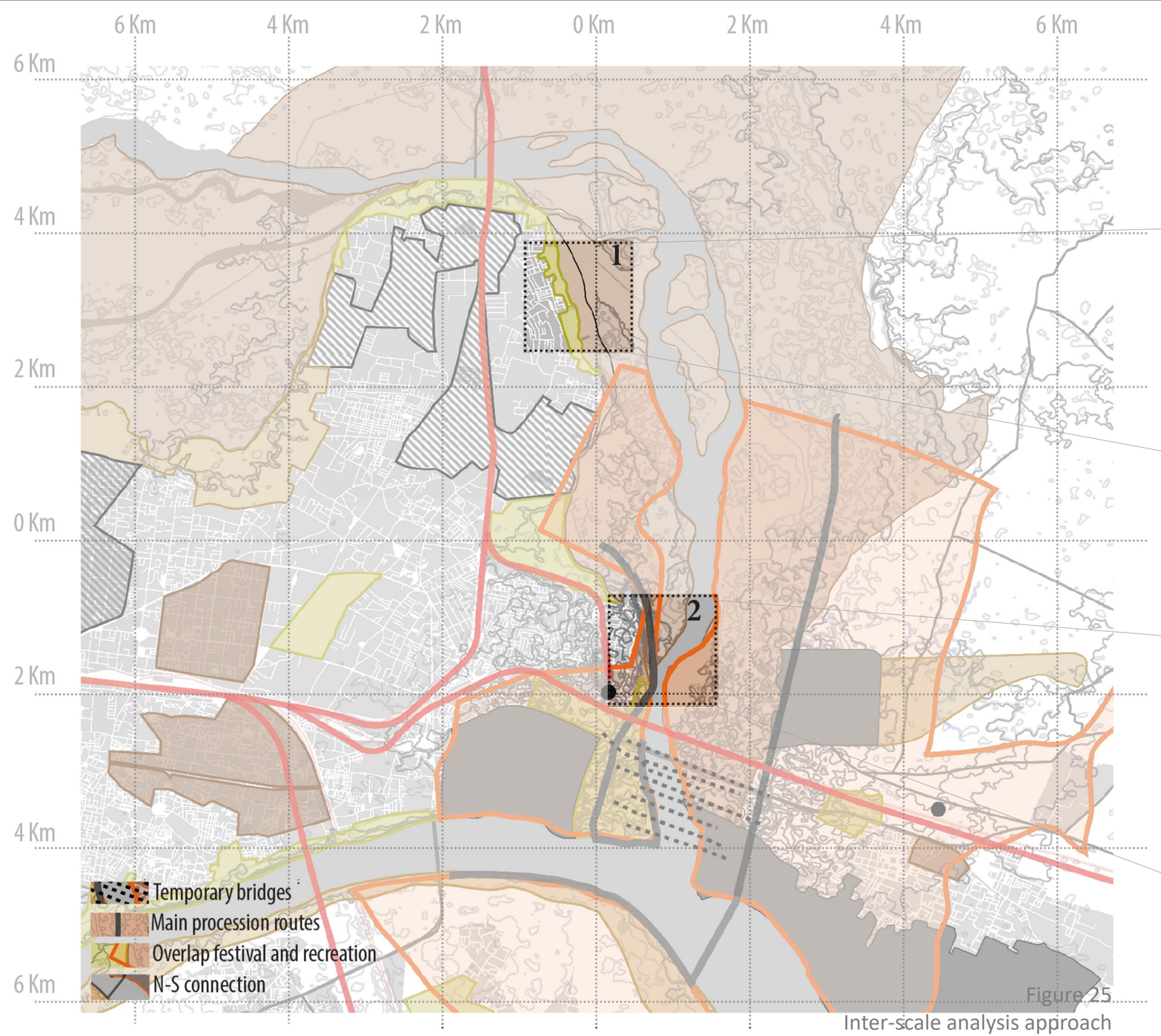


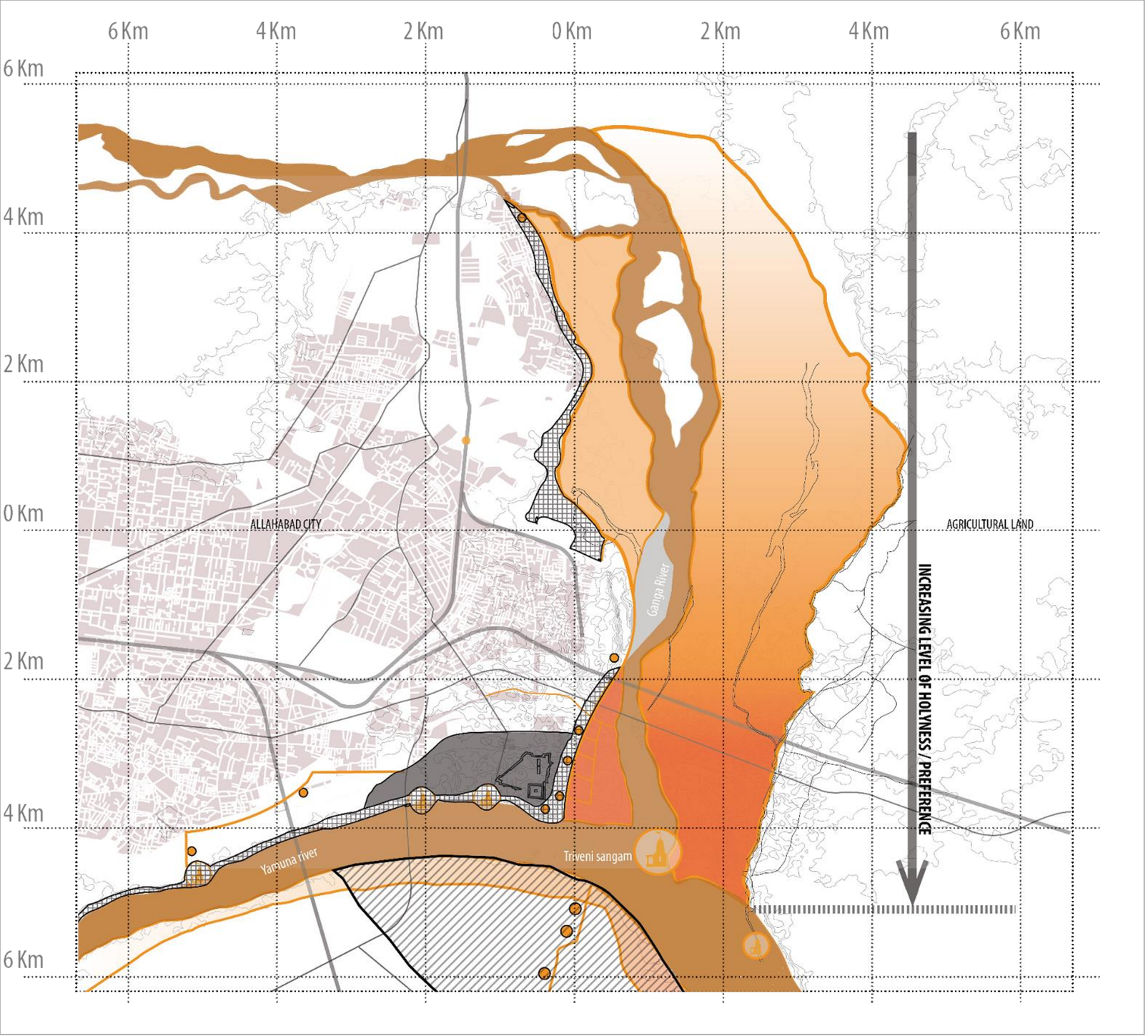
Figure 25
Inter-scale analysis approach
Figure source: Author

1 GOVINDPUR VILLAGE

Inhabitants practice crop cultivation, cattle rearing and fishing. **Livelihood threatened** during monsoon.

2 BUXI BUND EMBANKMENT

Buxi bund embankment **unable to protect** Daraganj village during monsoon season.



MEANING

Most pilgrimage spots located along **edge of floodplains.**

As distance from **confluence increases**, the **holy character of floodplains decreases**. They are more susceptible to functions of crop cultivation, animal husbandry, fishing etc.

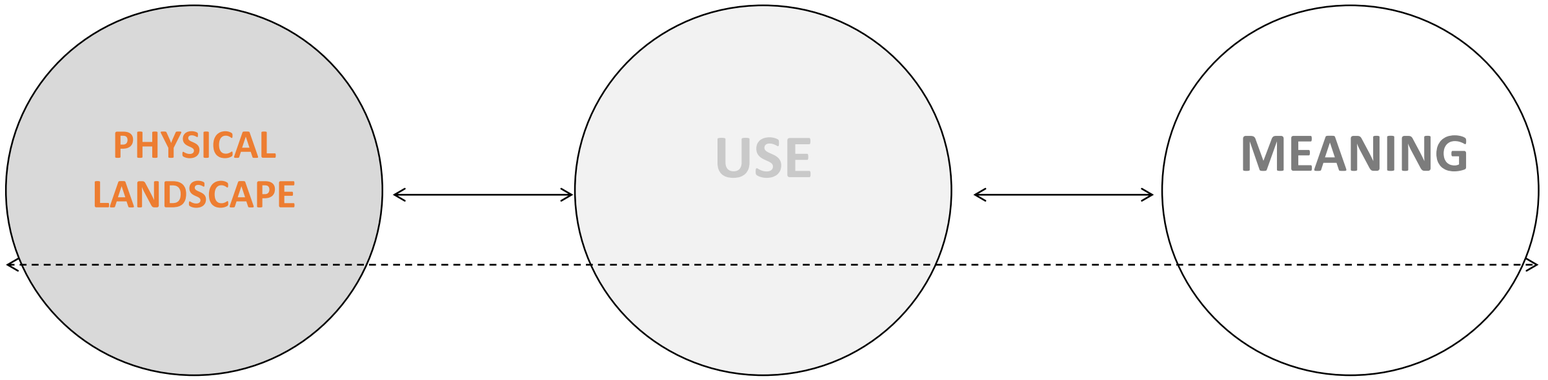
The **confluence of Ganga with Yamuna** and mythological river Saraswati is the **holiest locations along its entire course**.

Confluence or *Sangam* is the holiest location which **guides holy character of entire floodplains which host temporary city for 'Kumbh mela'.**

Figure 26
Conclusion map
Figure source: Author

CONCLUDING

DYNAMIC



FLOWS

RIVER
WATER RETENTION

SEDIMENTATION
EROSION

RESILIENCE

MULTIFUNCTIONAL SPACES

ADAPTIVE REUSE

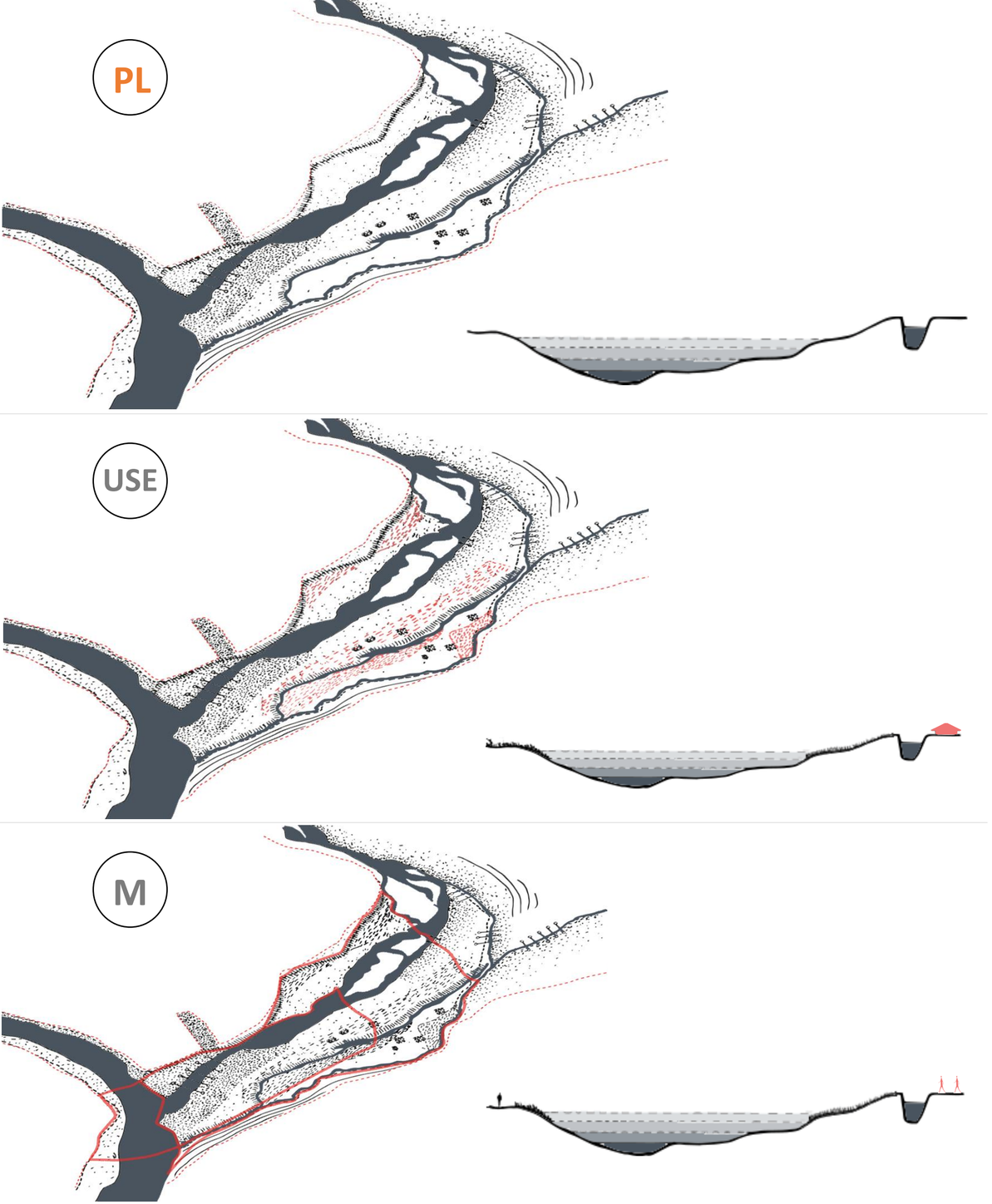
ADAPTIVE
AGRICULTURE

SPATIAL DESIGN

PILGRIMAGE
EXPERIENCE

CONNECTIVITY - HOLY
ROUTES

VISION



The idea is to **breed a permanent connection** among parameters of physical landscape, use and meaning to make dynamic floodplains **resilient** to disturbances and **adaptive to its changing phases**.

Figure 27
Vision scheme as per threefold parameters
Figure source: Author

SPATIAL STRATEGIES

I

PHYSICAL LANDSCAPE

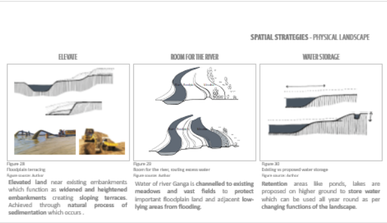


Figure 28
Floodplain terracing
Figure source: Author

Elevated land near existing embankments which function as **widened and heightened embankments** creating **sloping terraces**. Achieved through **natural process** of **sedimentation** which occurs .

Figure 29
Room for the river, routing excess water
Figure source: Author

Water of river Ganga is **channelled to existing meadows and vast fields** to **protect** important floodplain land and adjacent **low-lying areas from flooding.**

Figure 30
Existing vs proposed water storage
Figure source: Author

Retention areas like ponds, lakes are proposed on higher ground to **store water** which can be used all year round as per **changing functions of the landscape.**

II

USE

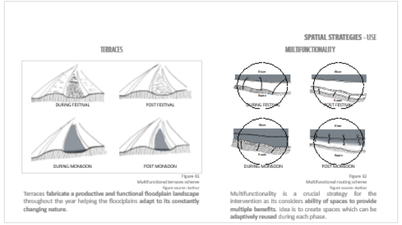


Figure 31
Multifunctional terraces scheme
Figure source: Author

Terraces **fabricate a productive and functional floodplain landscape** throughout the year helping the floodplains **adapt to its constantly changing nature.**

Figure 32
Multifunctional reading scheme
Figure source: Author

Multifunctionality is a crucial strategy for the intervention as its considers **ability of spaces to provide multiple benefits.** Idea is to create spaces which can be **adaptively reused** during each phase.

III

MEANING

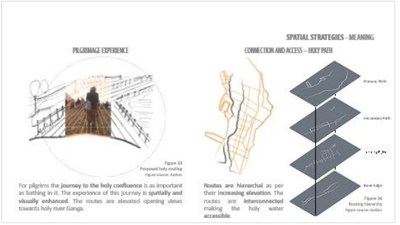


Figure 33
Proposed holy reading
Figure source: Author

for pilgrims the **journey to the holy confluence** is as important as bathing in it. The experience of this journey is **spatially and visually enhanced.** The routes are elevated opening views towards holy river Ganga.

Figure 34
Routing hierarchy
Figure source: Author

Routes are hierarchal as per their **increasing elevation.** The routes are **interconnected** making the holy water **accessible.**

DYNAMIC LANDSCAPES

LANDSCAPE RESILIENCE

DESIGN WITH NATURE

SPATIAL STRATEGIES - PHYSICAL LANDSCAPE

ELEVATE

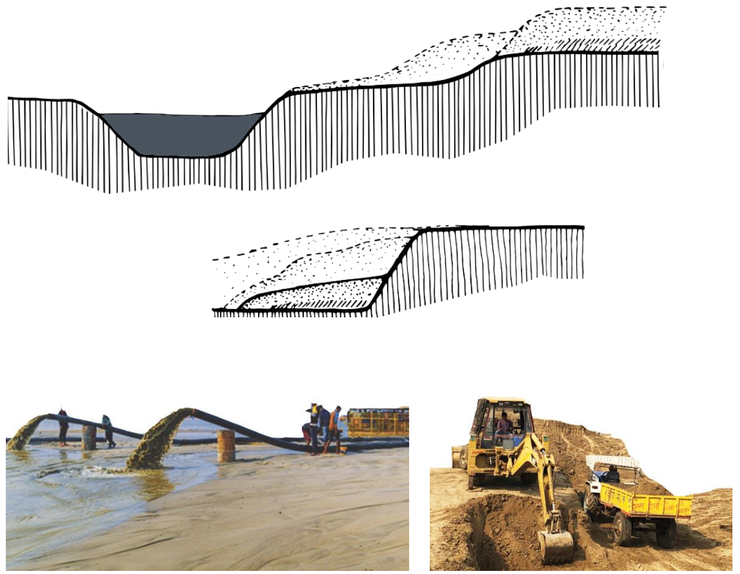


Figure 28
Floodplain terracing
Figure source: Author

Elevated land near existing embankments which function as **widened and heightened embankments** creating **sloping terraces**. Achieved through **natural process of sedimentation** which occurs .

ROOM FOR THE RIVER

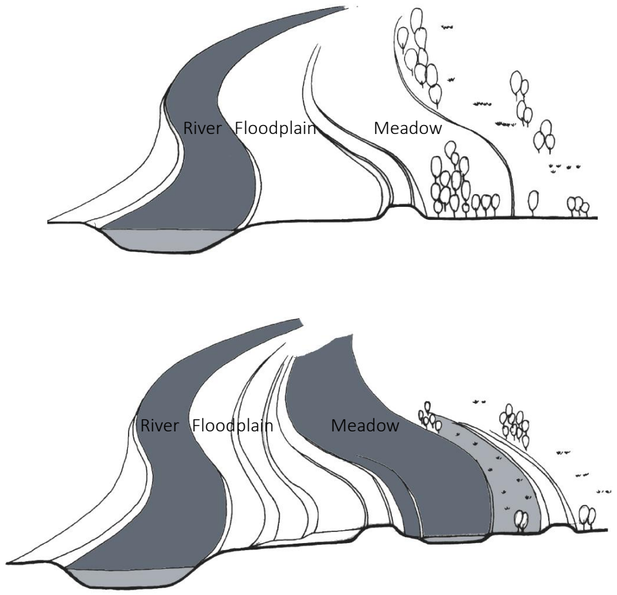


Figure 29
Room for the river, routing excess water
Figure source: Author

Water of river Ganga is **channelled to existing meadows and vast fields** to **protect** important floodplain land and adjacent **low-lying areas from flooding**.

WATER STORAGE

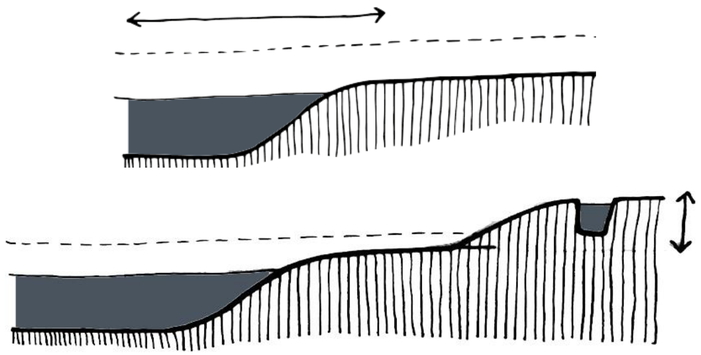


Figure 30
Existing vs proposed water storage
Figure source: Author

Retention areas like ponds, lakes are proposed on higher ground to **store water** which can be used all year round as per **changing functions of the landscape**.

TERRACES

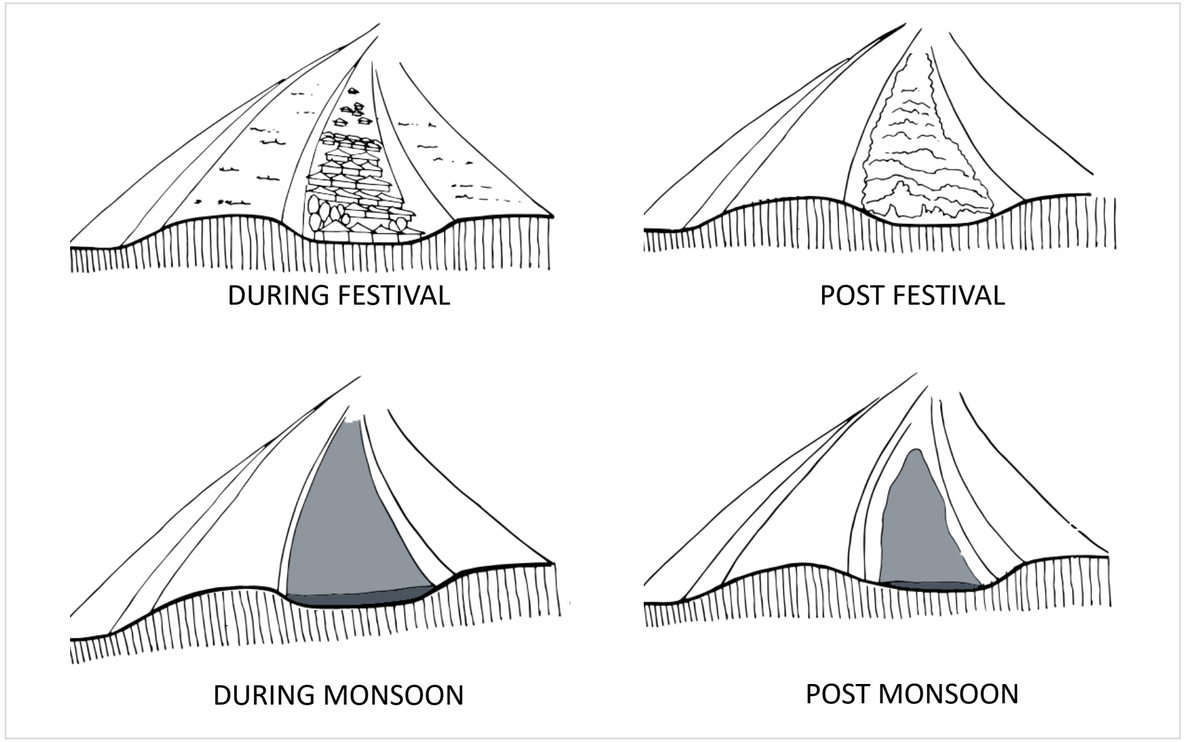


Figure 31
Multifunctional terraces scheme
Figure source: Author

Terraces **fabricate a productive and functional floodplain landscape** throughout the year helping the floodplains **adapt to its constantly changing nature**.

MULTIFUNCTIONALITY

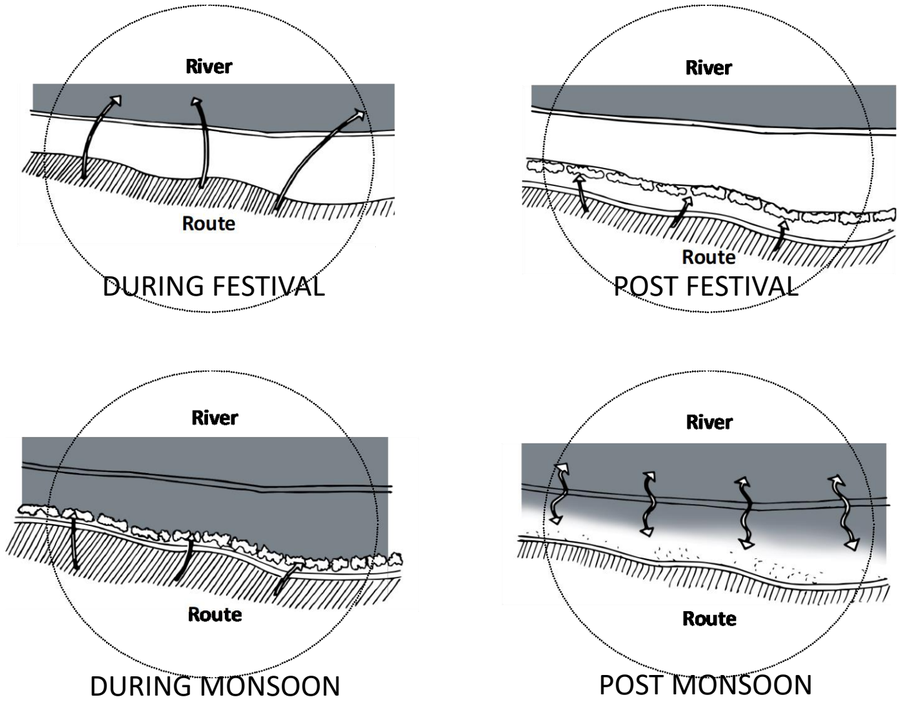
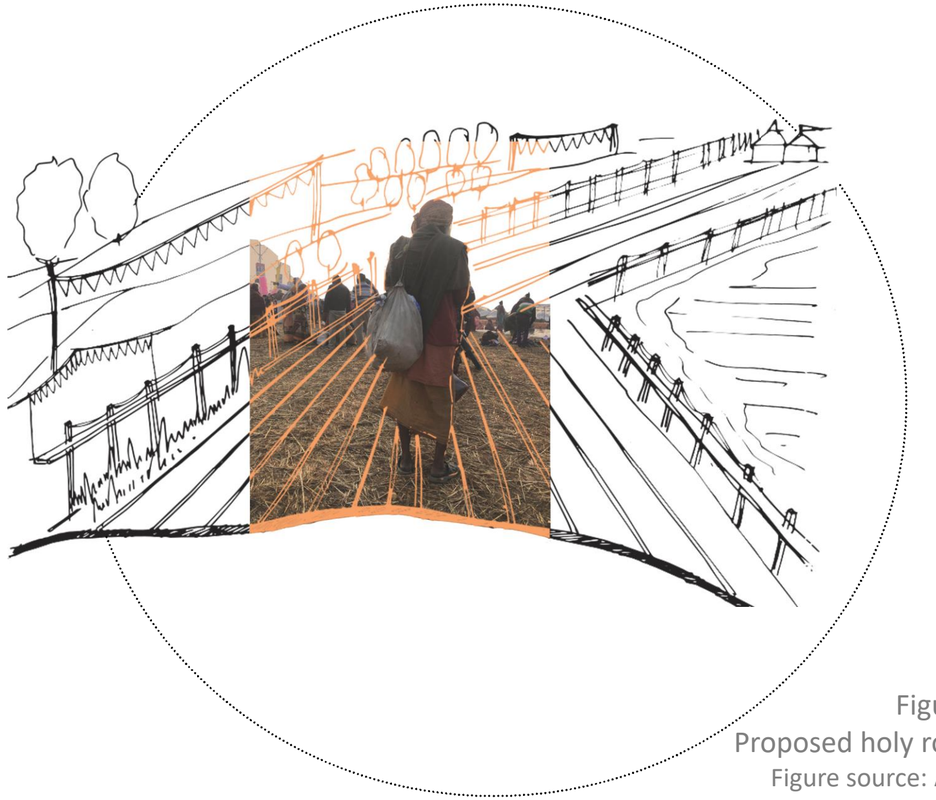


Figure 32
Multifunctional routing scheme
Figure source: Author

Multifunctionality is a crucial strategy for the intervention as its considers **ability of spaces to provide multiple benefits**. Idea is to create spaces which can be **adaptively reused** during each phase.

SPATIAL STRATEGIES - MEANING

PILGRIMAGE EXPERIENCE



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Proposed holy routing
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For pilgrims the **journey to the holy confluence** is as important as bathing in it. The experience of this journey is **spatially and visually enhanced**. The routes are elevated opening views towards holy river Ganga.

CONNECTION AND ACCESS – HOLY PATH

Routes are hierarchal as per their **increasing elevation**. The routes are **interconnected** making the holy water **accessible**.

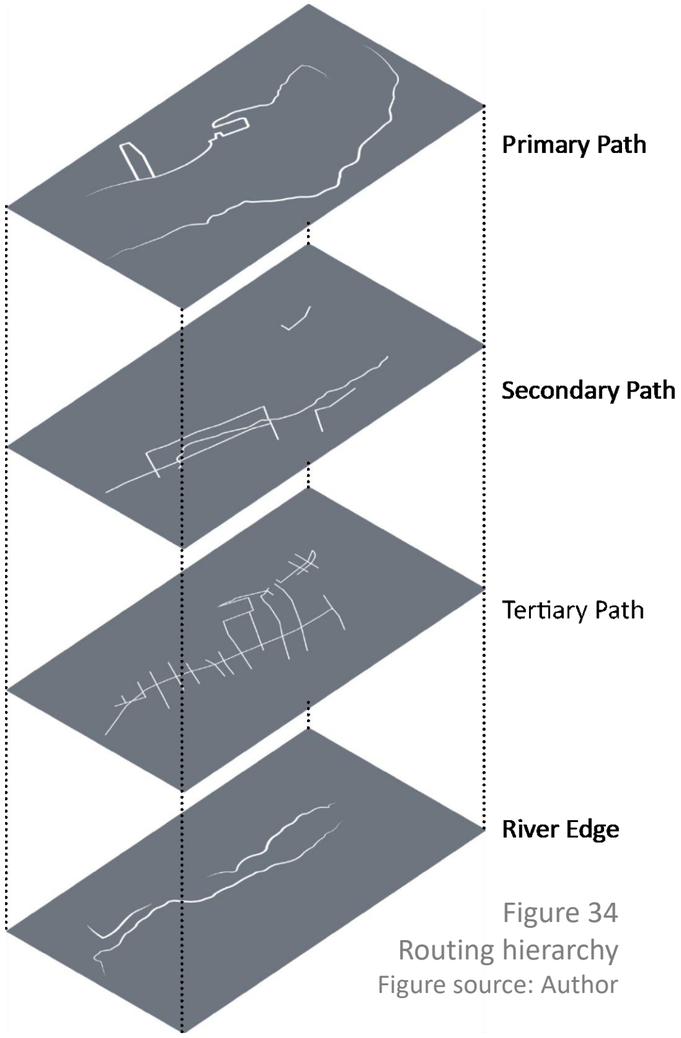


Figure 34
Routing hierarchy
Figure source: Author

DESIGNING WITH NATURAL PROCESSES

HOW IS PROCESS OF SEDIMENTATION USED OVER TIME TO CREATE TERRACES ?

DESIGNING WITH NATURAL PROCESSES

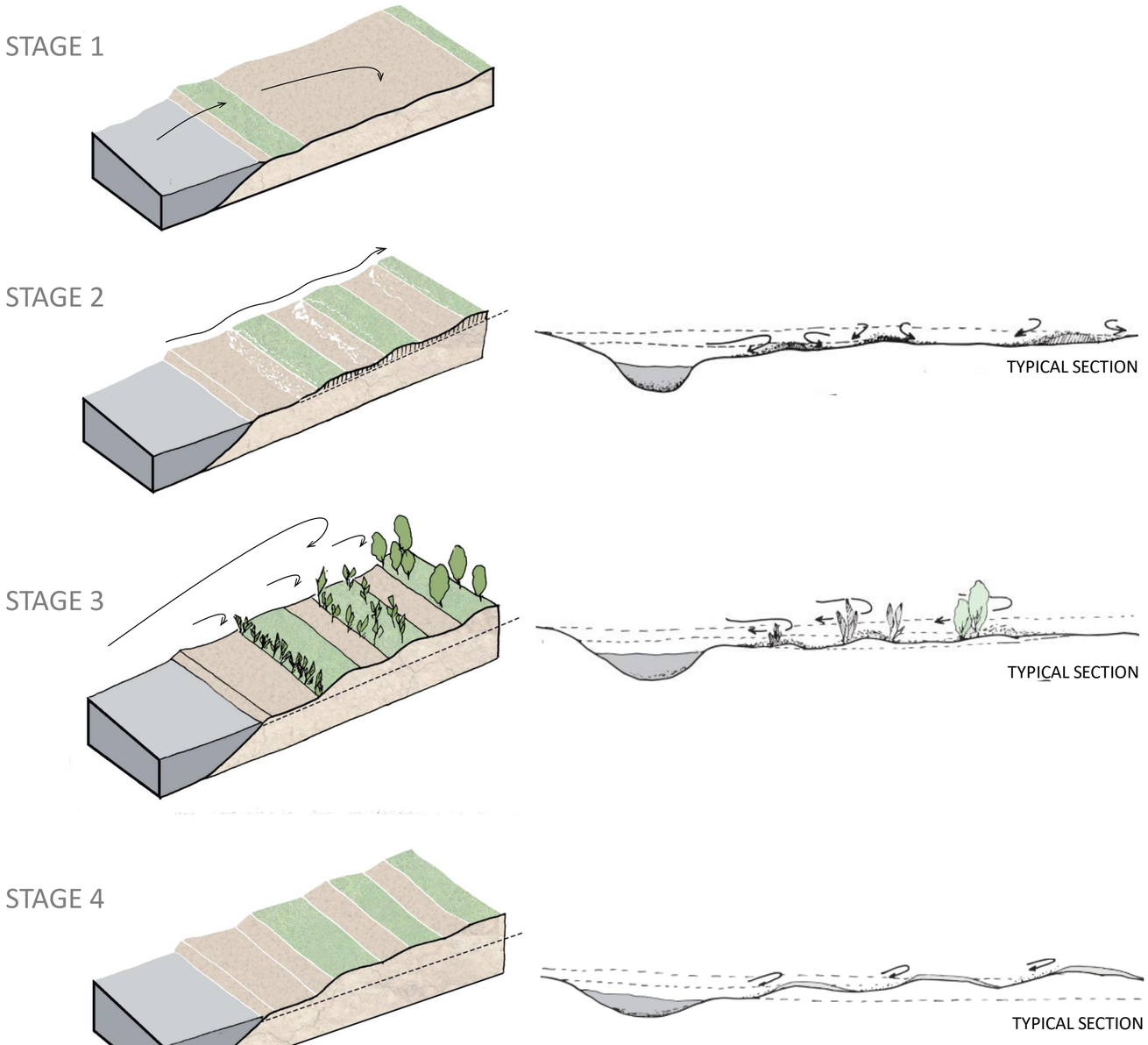
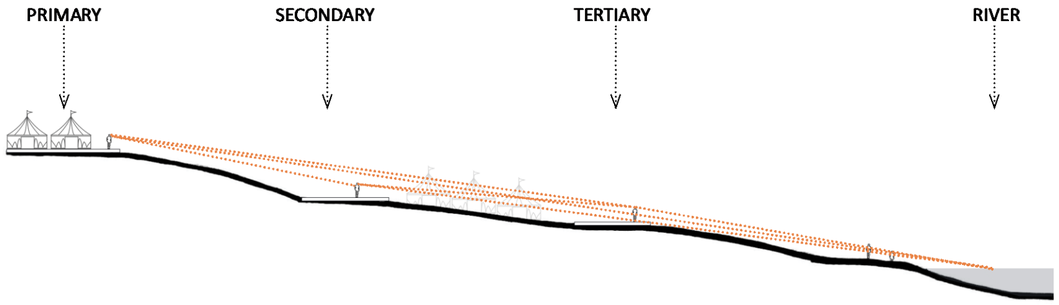


Figure 35
Stages of terrace formation
Figure source: Author



The **alluvium deposits** after monsoon season which are excavated by ground levelling workers are used in the **formation of the terraces**.

This **natural process of sediment accumulation** is used to **elevate land gradually** in the dynamic floodplain landscape of river Ganga.

Principal objective of this terracing is to **reduce surface runoff, loss of soil and increase soil moisture content**.

PHASING OF INTERVENTIONS

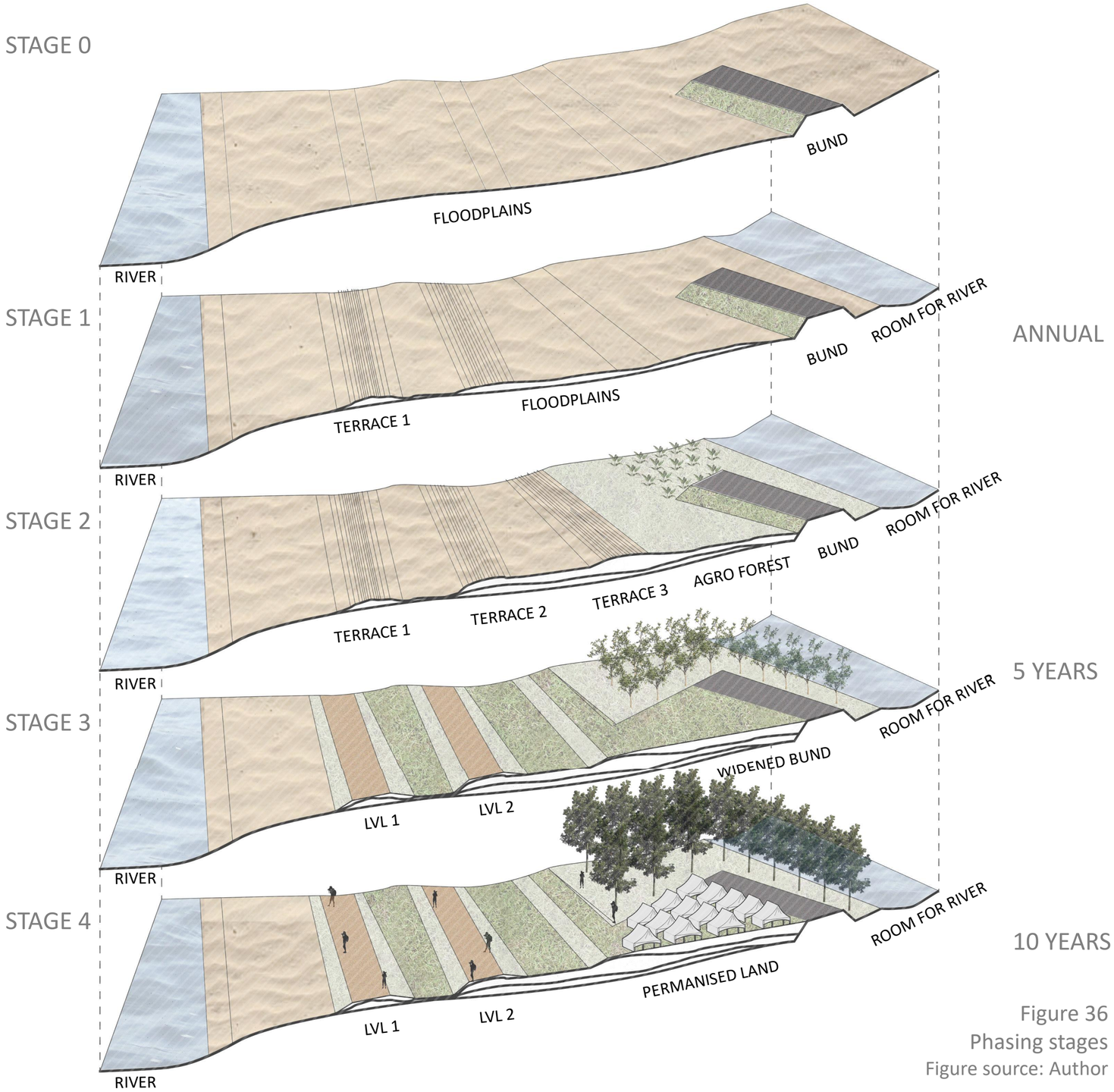
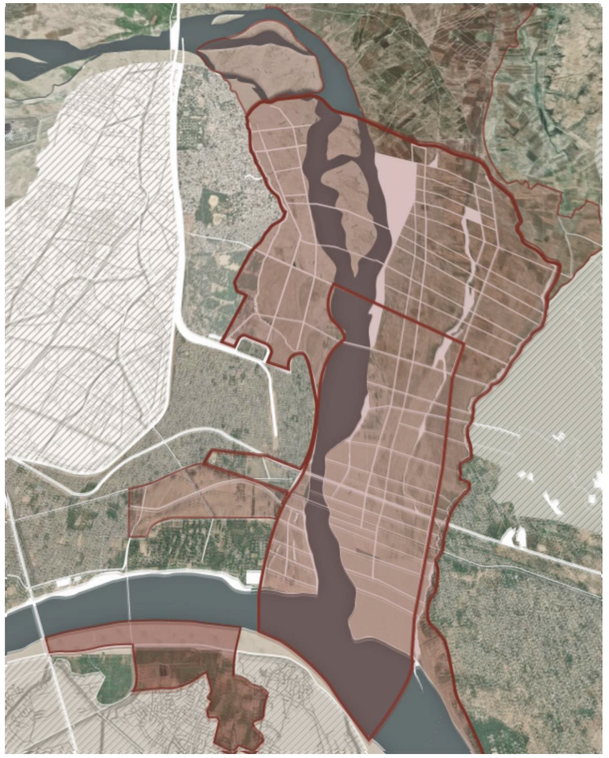
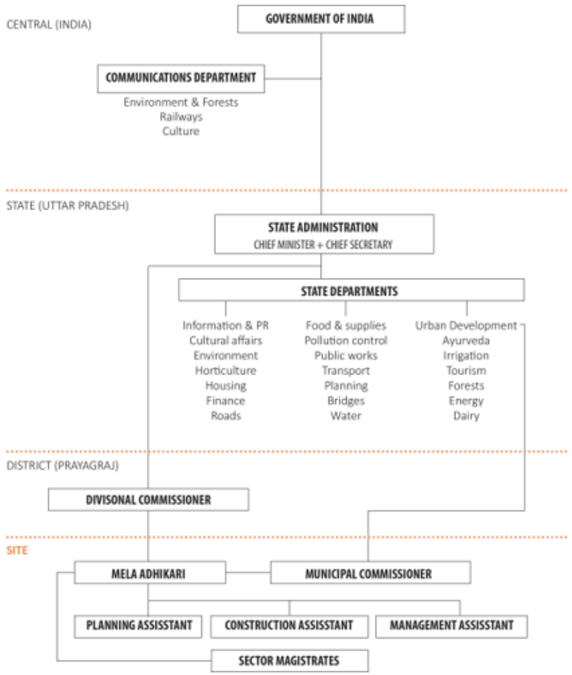


Figure 36
Phasing stages
Figure source: Author

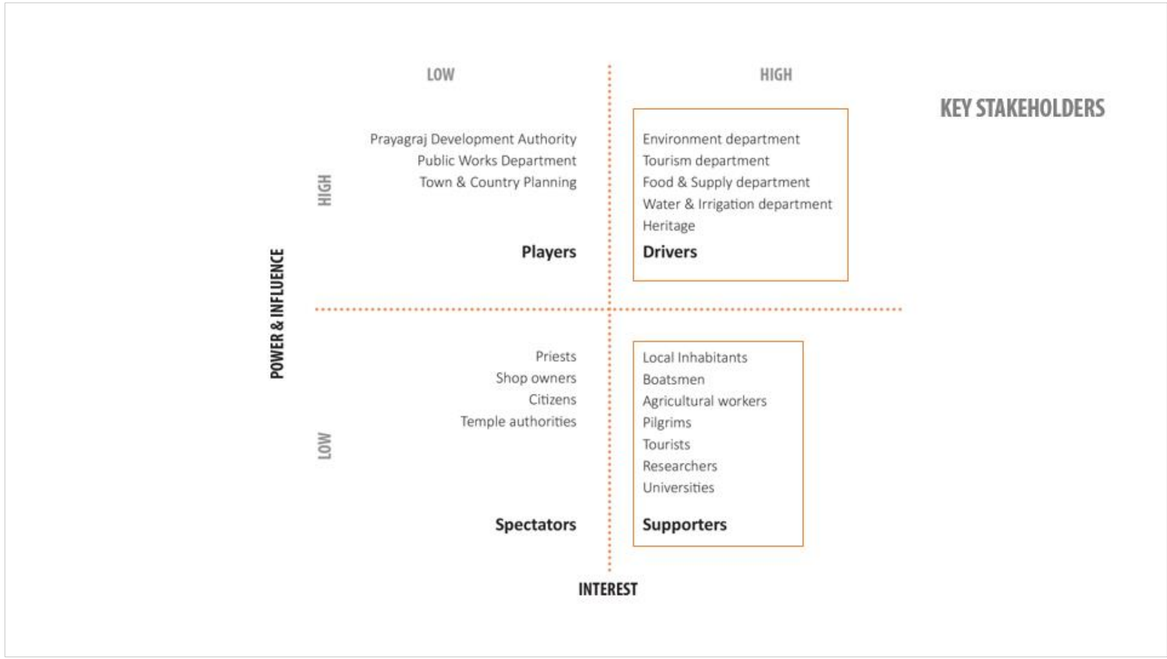


12 YEAR FESTIVAL LAND

STAKEHOLDERS MANAGEMENT



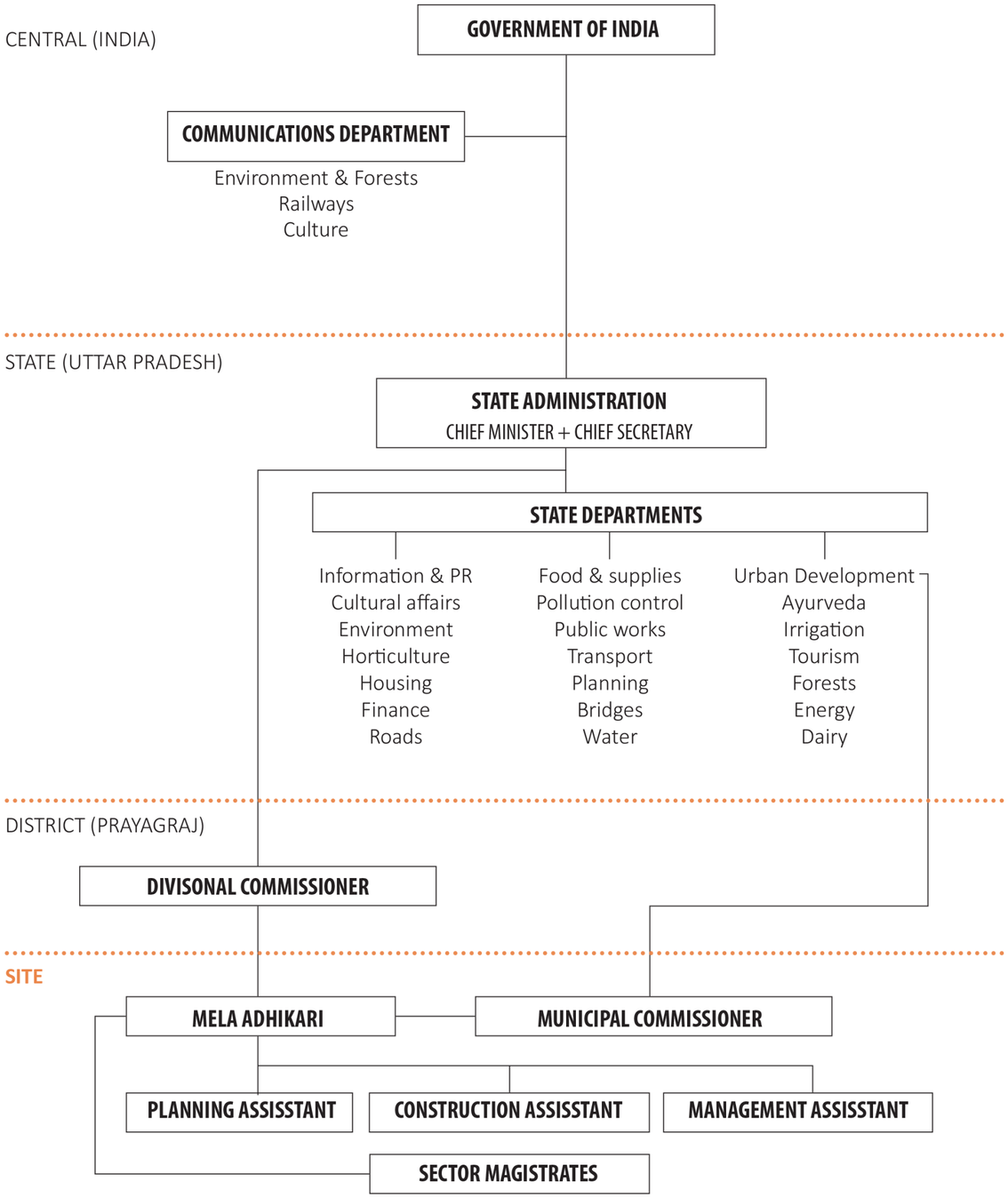
ADMINISTRATIVE STRUCTURE



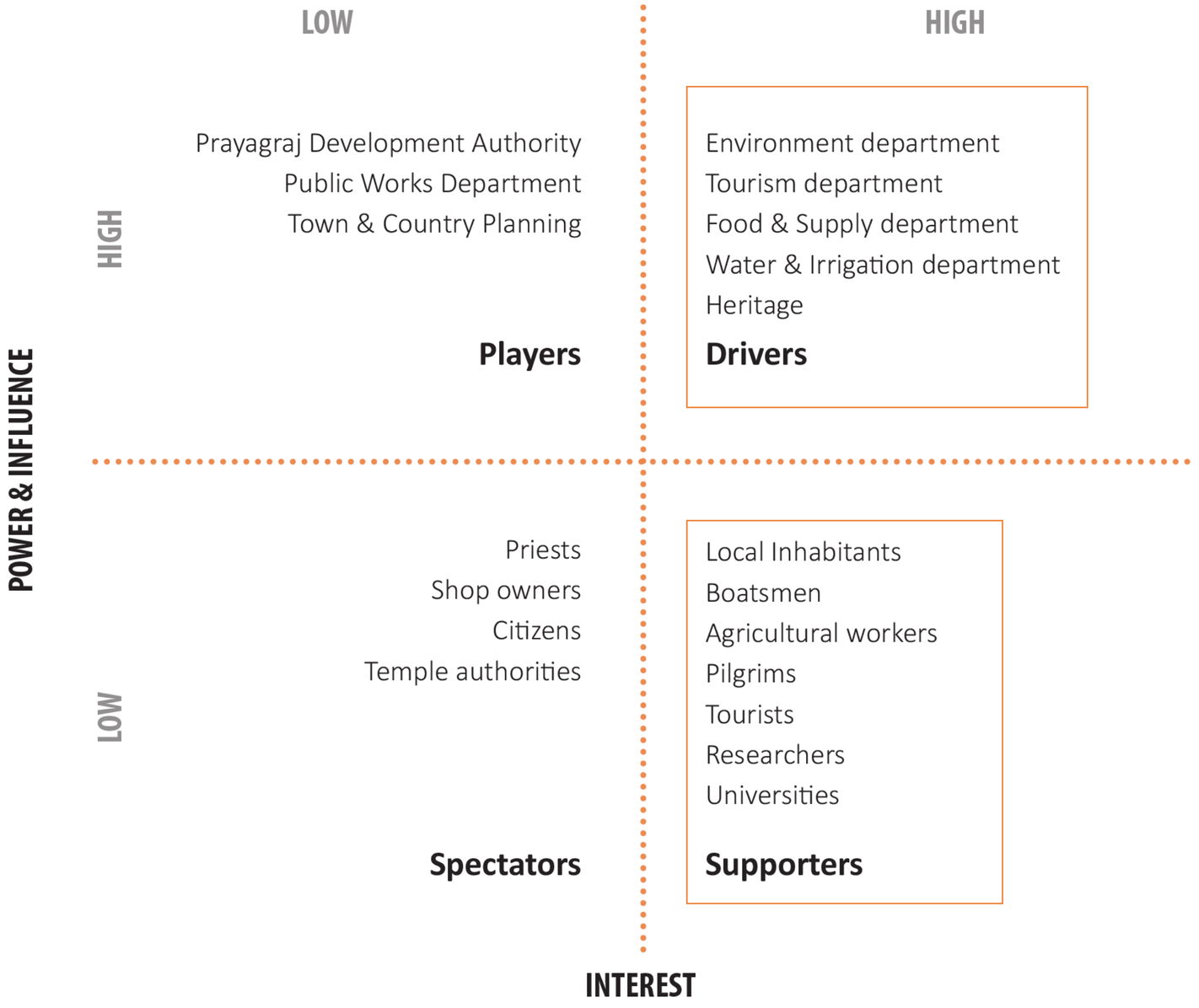
ADMINISTRATIVE STRUCTURE

STAKEHOLDER ANALYSIS

ADMINISTRATIVE STRUCTURE

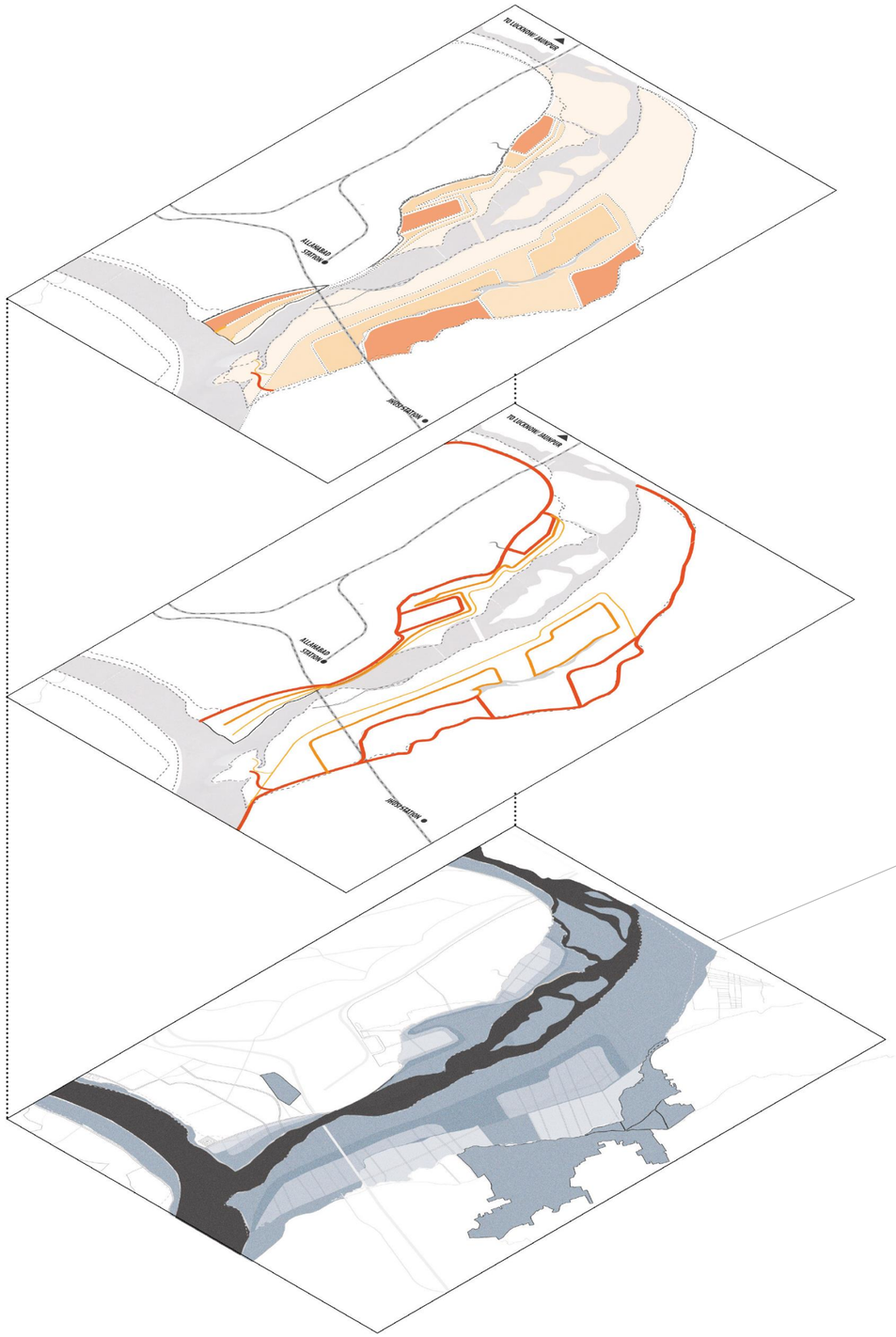


KEY STAKEHOLDERS



DESIGN

MACRO SCALE | MESO SCALE | MICRO SCALE



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

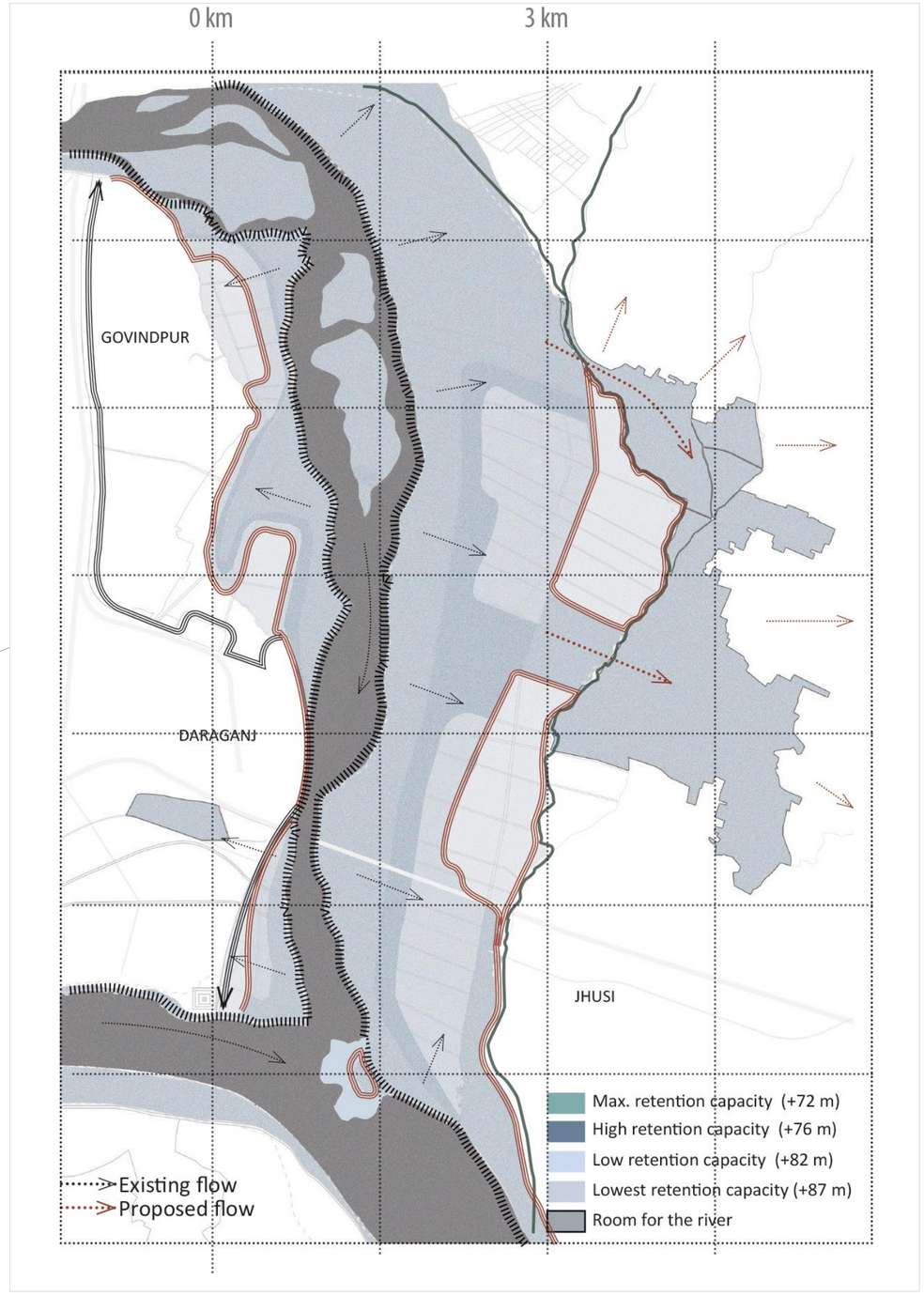


Figure 37
Main interventions
Figure source: Author

SECTIONS

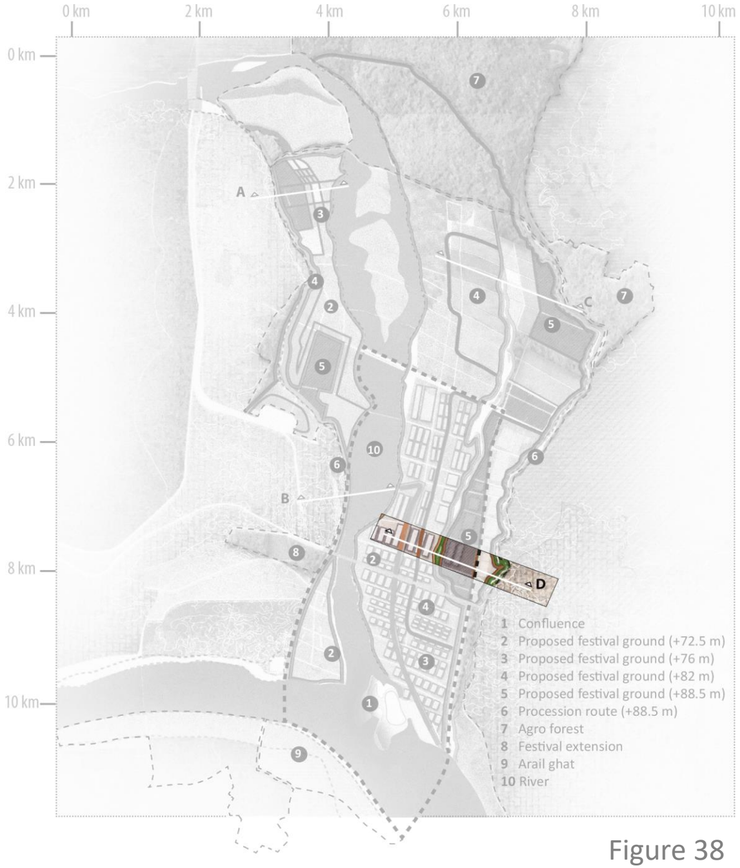
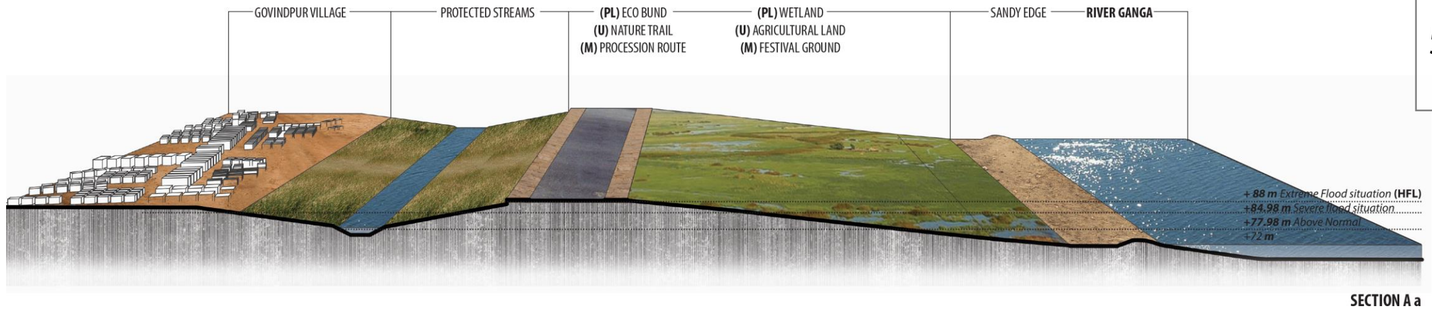
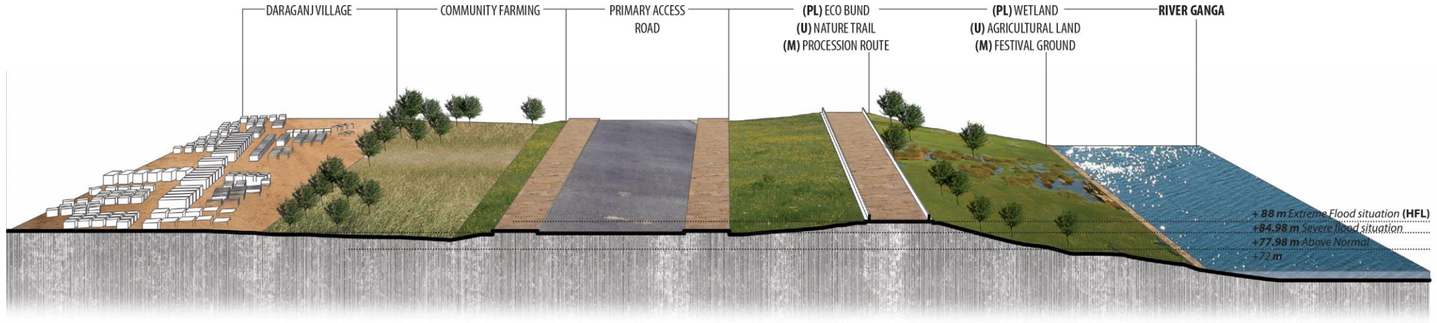


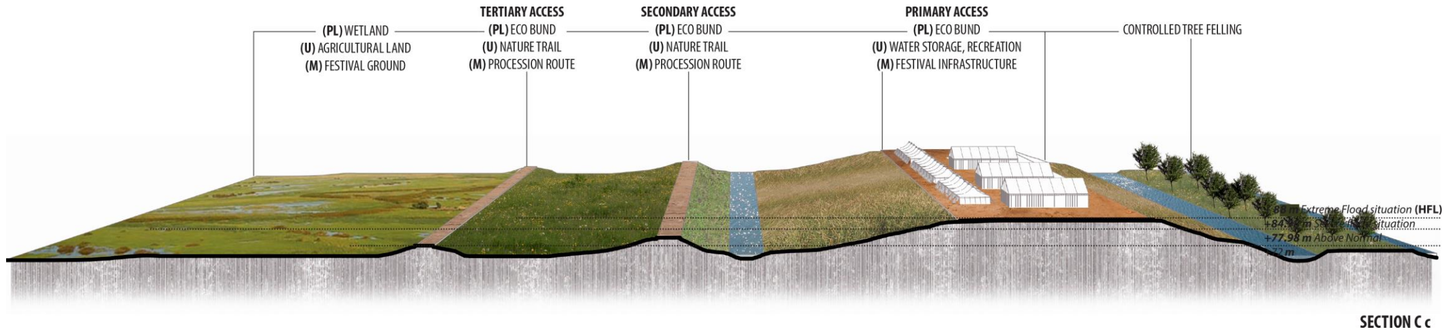
Figure 38
Key plan
Figure source: Author



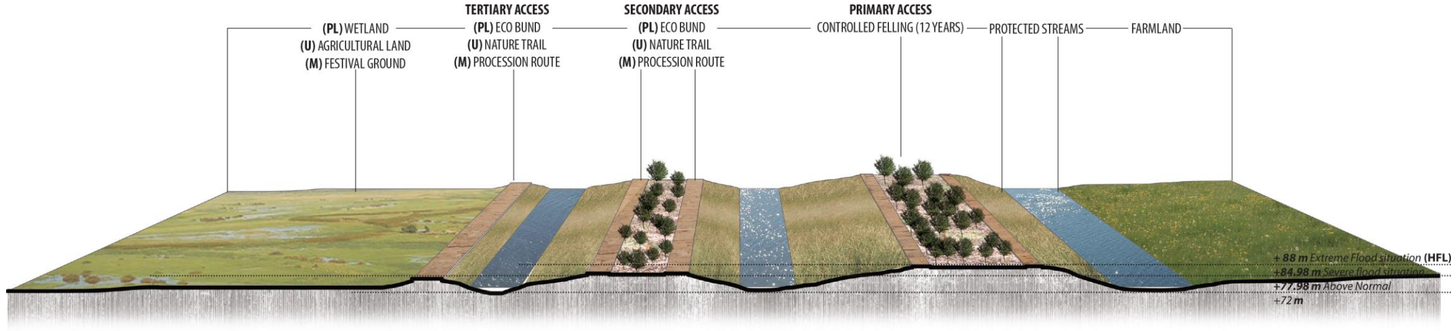
SECTION A a



SECTION B b



SECTION C c



SECTION D d

DESIGN

MACRO SCALE | **MESO SCALE** | MICRO SCALE

HOLY CONFLUENCE

CONTEXT

Figure 38
EXISTING LOCATION CONTEXT
Figure source: Adapted from Google Earth

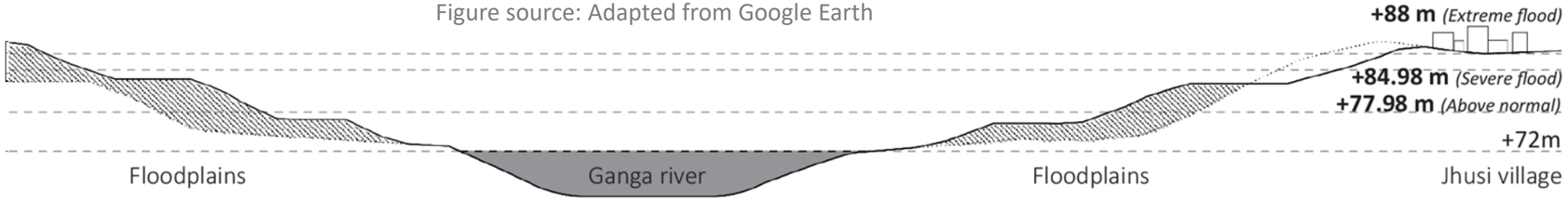


Figure 39
EXISTING VS PROPOSED SITUATION
Figure source: Author

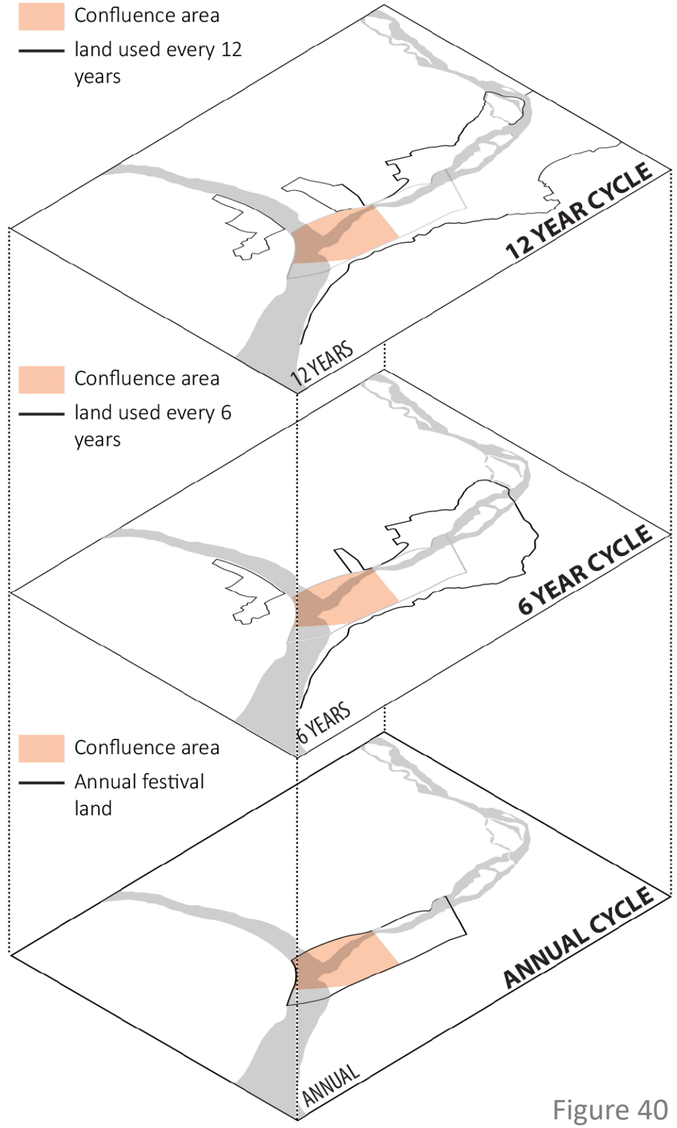
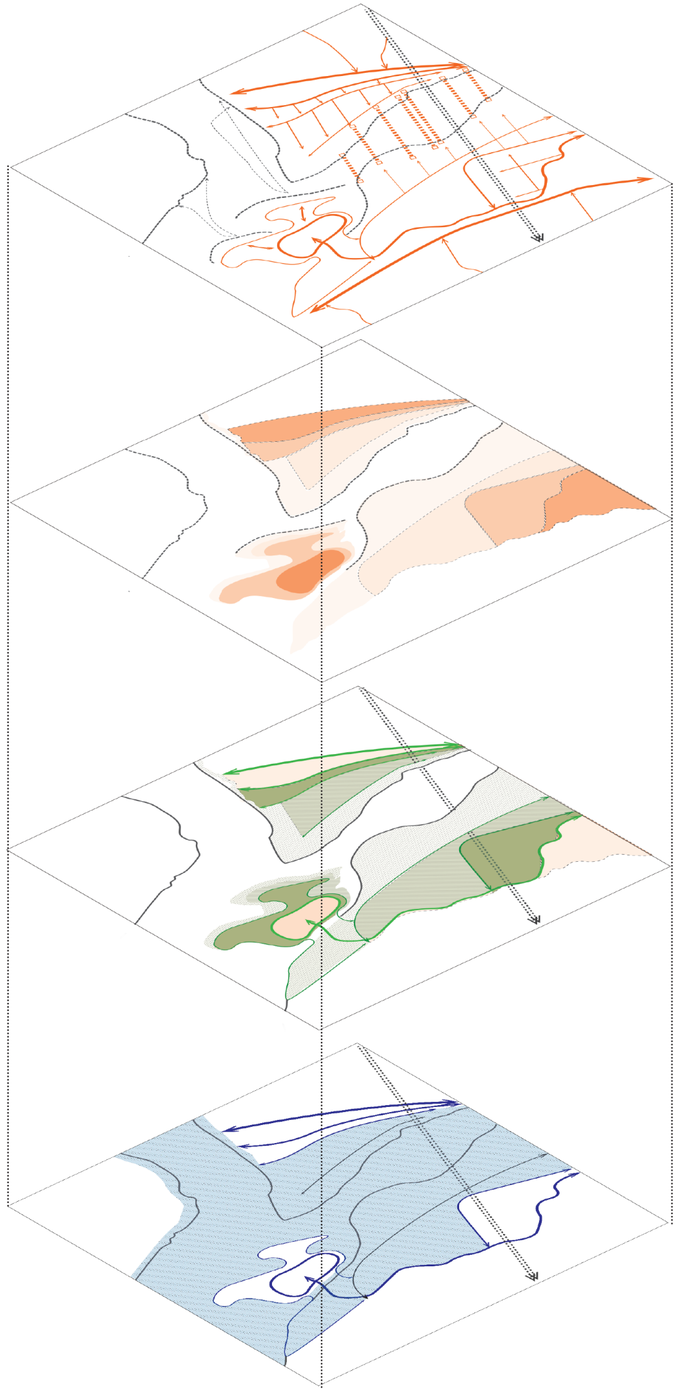


Figure 40
LOCATION THROUGH PHASES
Figure source: Author



FESTIVAL LANDSCAPE

Primary access
Secondary access
Tertiary access

Terrace level +88.5 m
Terrace level +82 m
Terrace level +76 m
Terrace level +72.5 m

AGRICULTURE LANDSCAPE

High ground (+88.5 m)
Agriculture (+82 m)
Adaptive cultivation (+82 m)
Grassland (+72.5 m)
Routing

DELUGED LANDSCAPE

water retention
Primary access/ embankments

Figure 41
MAIN INTERVENTIONS
Figure source: Author

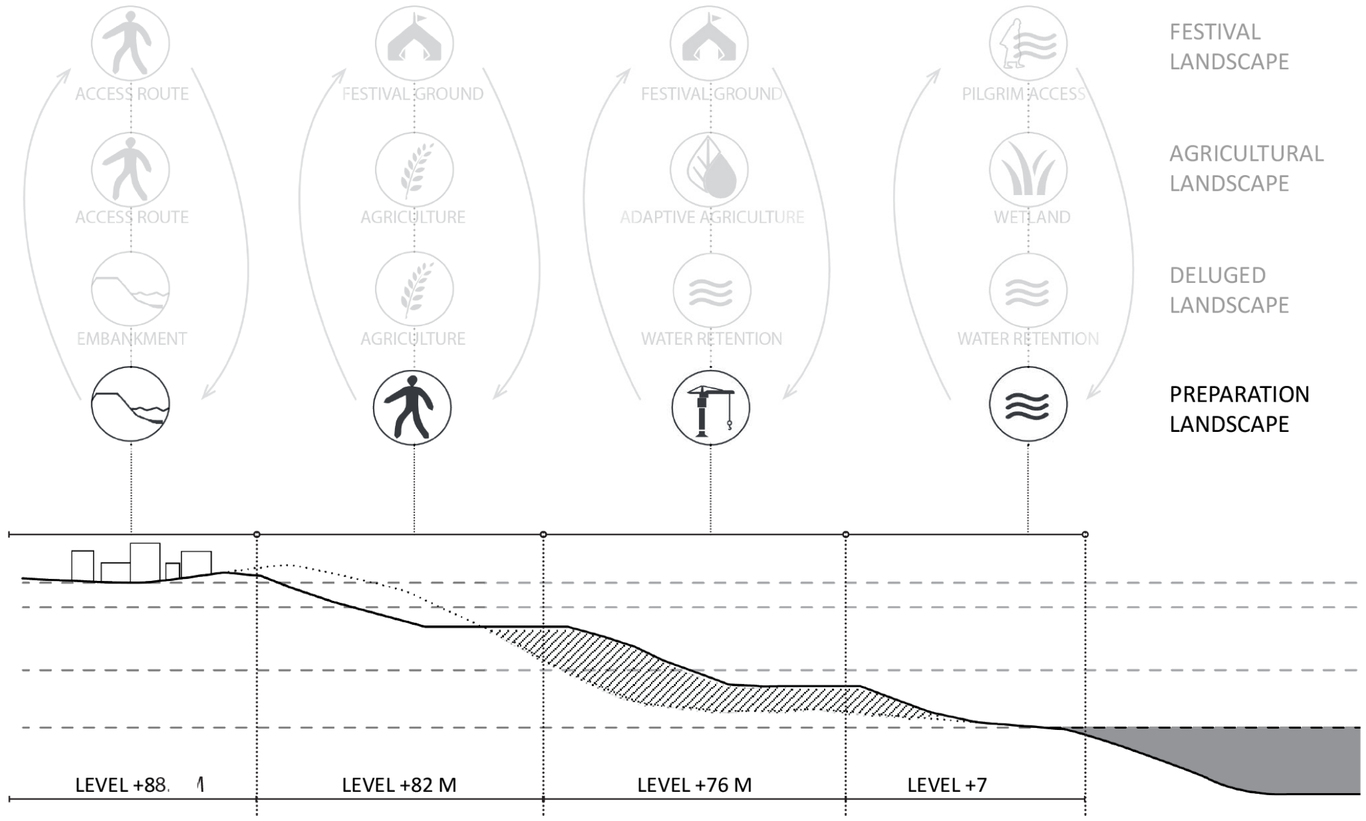
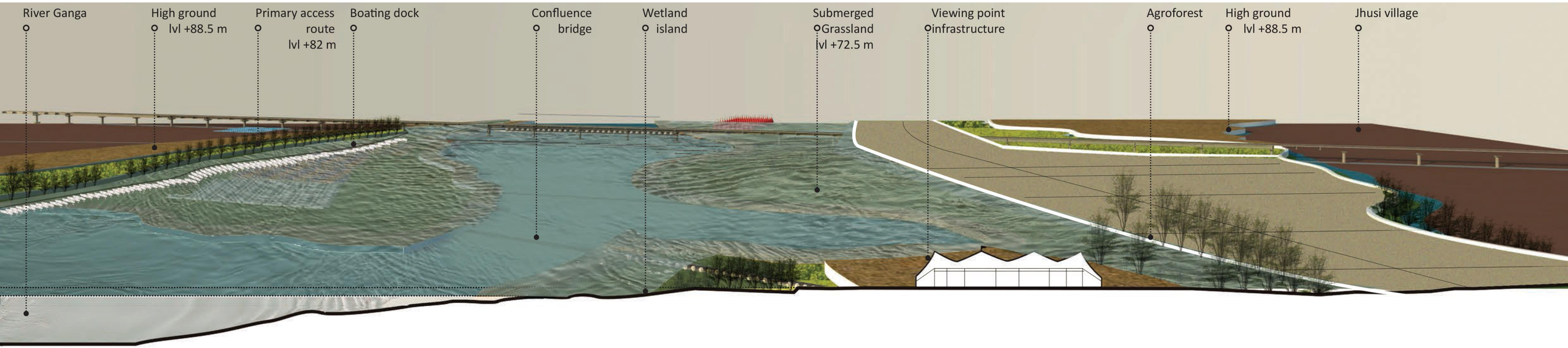


Figure 42
CHANGING TERRACE FUNCTIONS AS PER EACH PHASE
Figure source: Author

PLANNING


1 Embankment (+88.5 m)
2 Agriculture ground (+82 m)
3 Selective Agriculture ground (+76 m)
4 Sand flats (Marshland) (+72.5 m)
5 Access route (+82m)
6 Marshland (+76m)
7 Marshland (+72.5m)
8 Dismantled Pontoon bridge location
9 Boating dock
10 Marsh island (confluence)
11 Multifunctional ground

SECTIONAL VIEWS TOWARDS CONFLUENCE

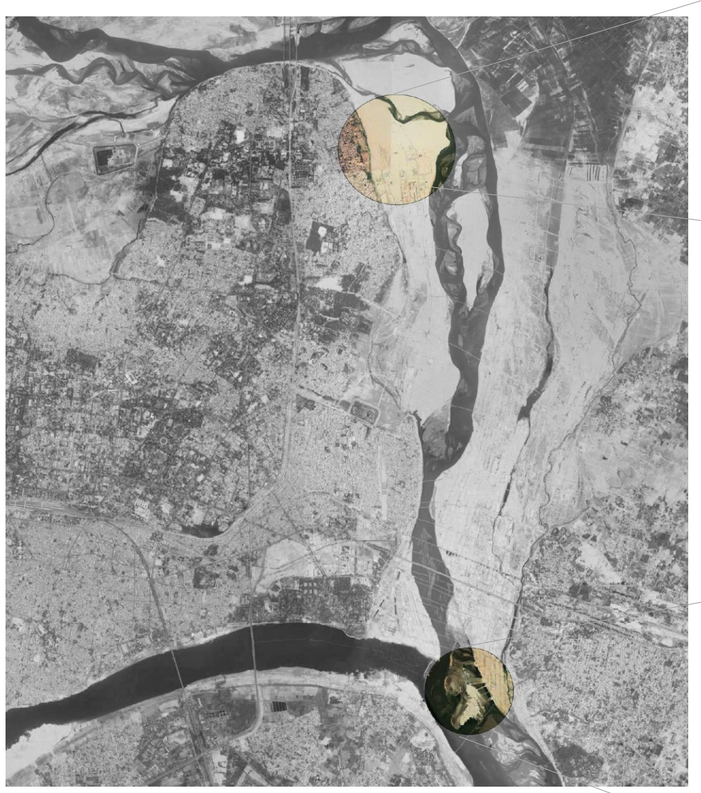


DESIGN - MICRO SCALE

I II

CONFLUENCE ISLAND | NORTH FRINGE

LOCATION CONTEXT



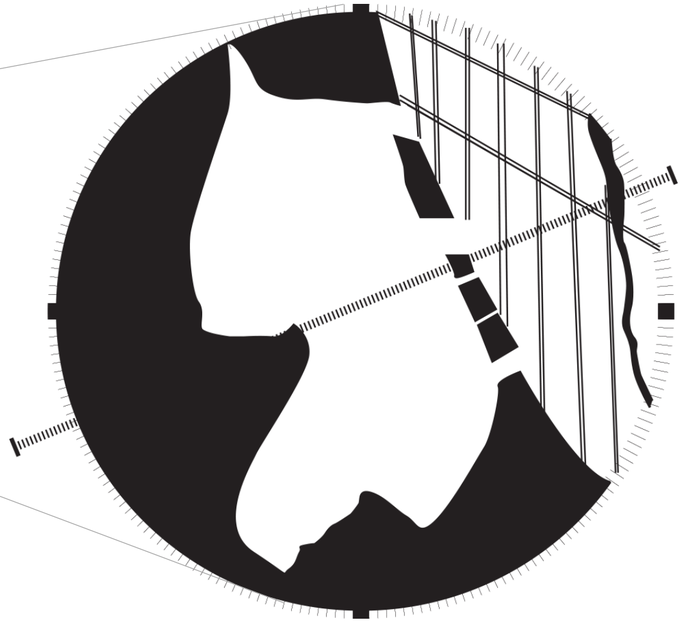


Figure 43
Location context
Figure source: Author

MARSH ISLAND

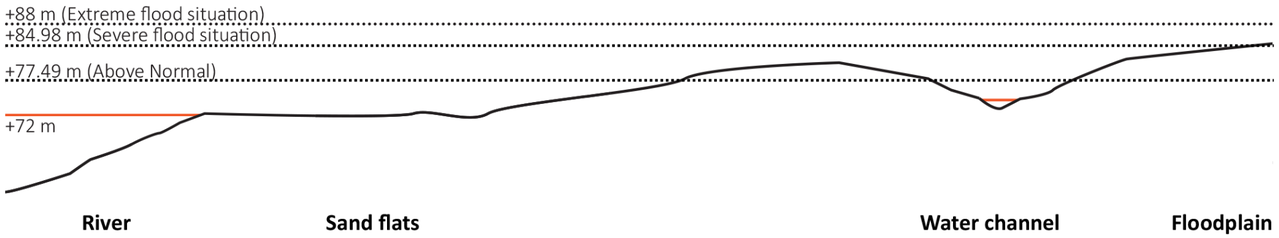
MOTIVATION

Essential for **pilgrimage meeting point of rivers Ganga and Yamuna**.

Most dynamic part of confluence pertaining to maximum **influence of river flows**.

MARSH ISLAND AT HOLY CONFLUENCE

Past situation



Existing situation

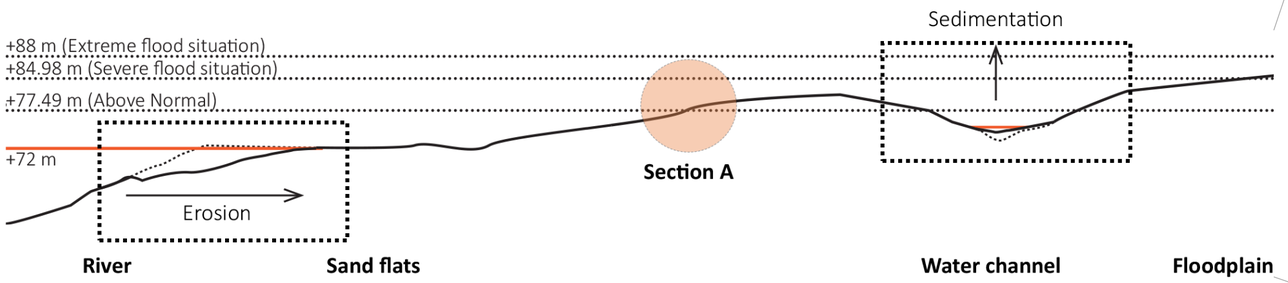


Figure 44
Past vs present situation
Figure source: Author

Impact of these processes over time

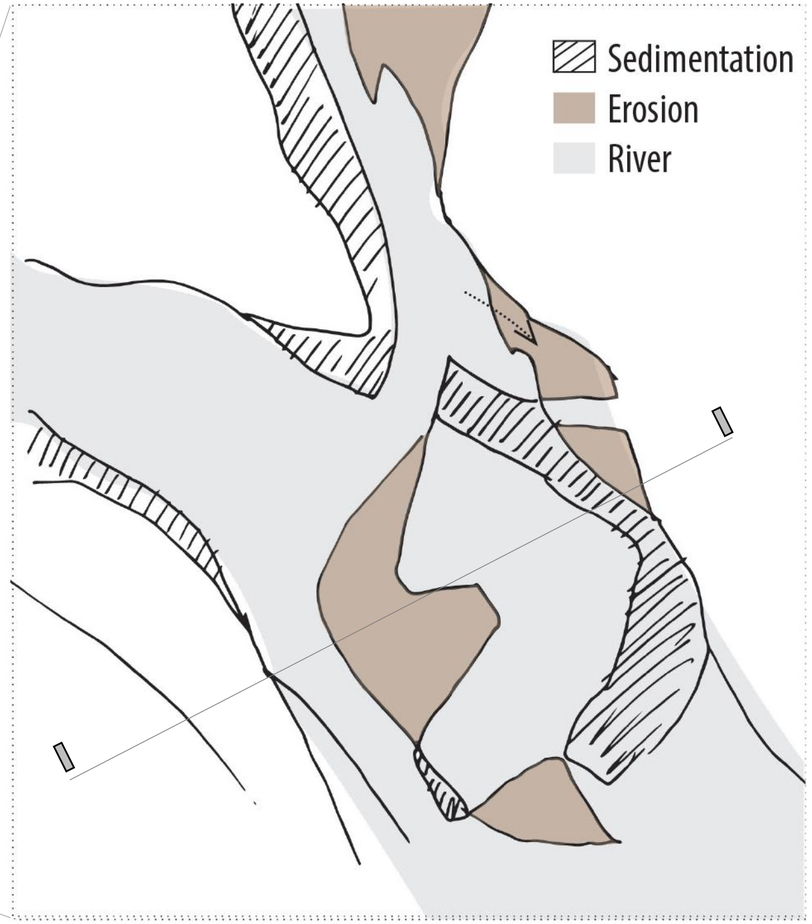
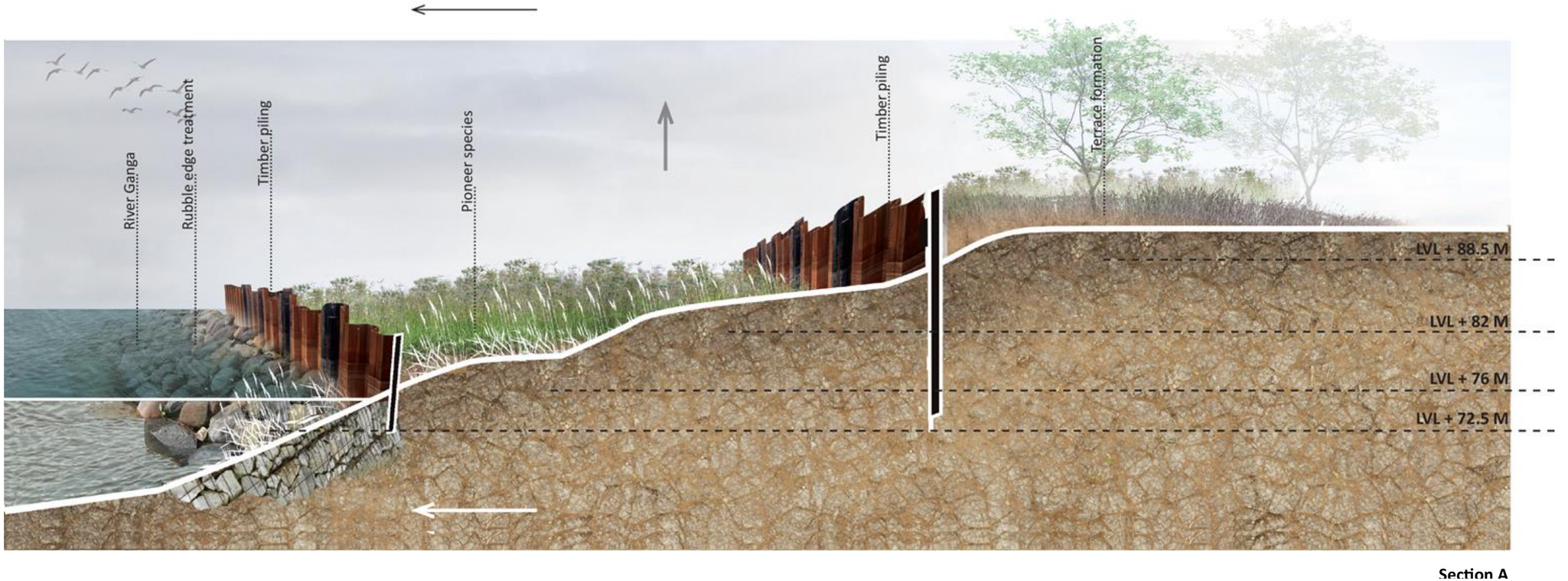


Figure 45
Natural processes
Figure source: Author

DEVELOPMENT OVER TIME



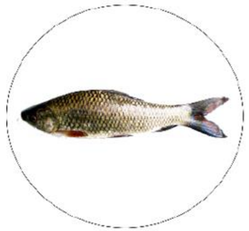
Section A

Over time **pioneer species form a dense cover** stabilizing the trapped sediment. The new layers of **trapped sediment act as barriers protecting elevated land** from deluging river flows during the monsoon season.

PLANS PER PHASING

PREPARATION LANDSCAPE

SECTIONS

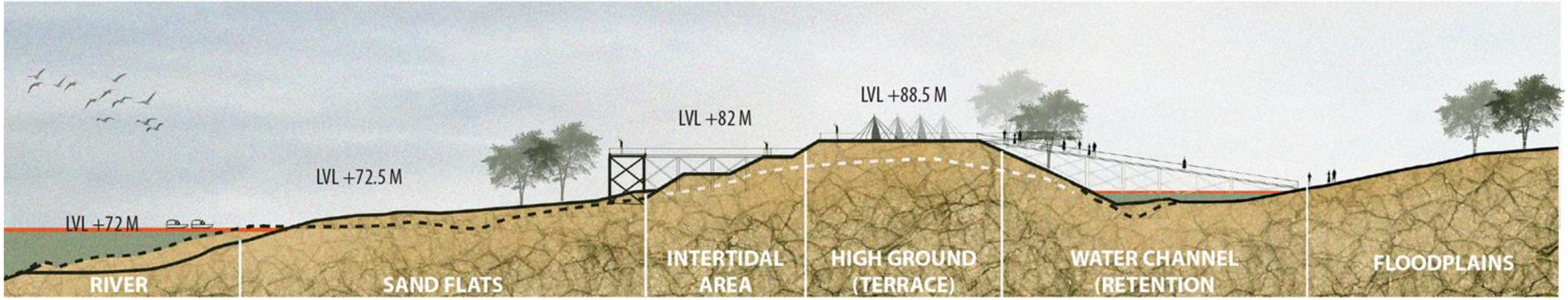


labeo rohita

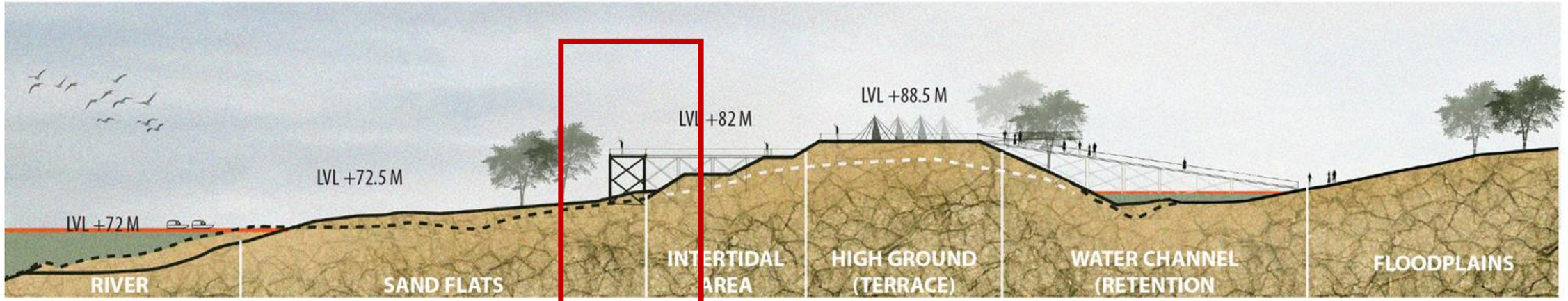
cyperus iria

Coturnix ypsilophora

Pavo cristatus



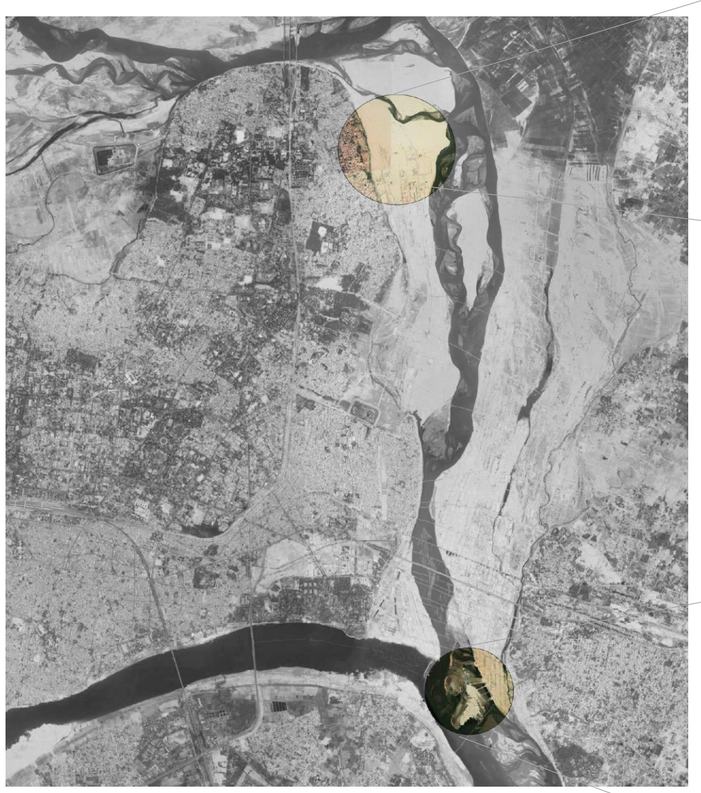
SECTION 1- PREPARATION LANDSCAPE

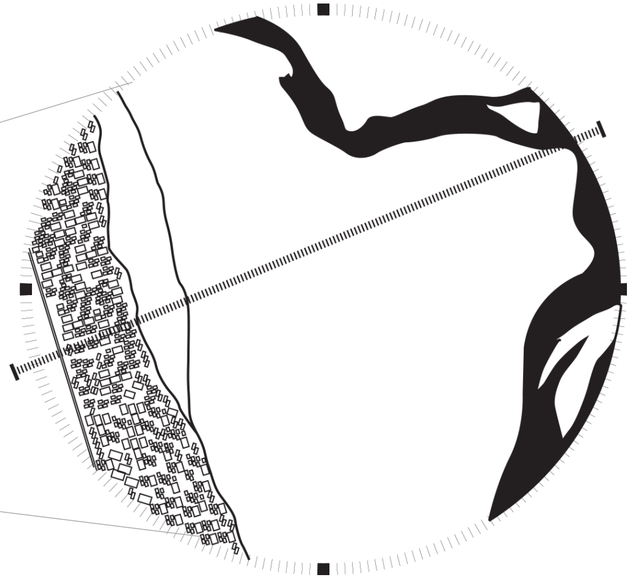


SECTION 1- PREPARATION LANDSCAPE


SUBMERGED SAND FLATS
RIVER GANGA
VIEWING PPOINT
HIGHER TERRACE GROUND
INTER-TIDAL AREA
PREPARATION GROUND
ELEVATED BRIDGE
ACCESS ROUTE

LOCATION 2





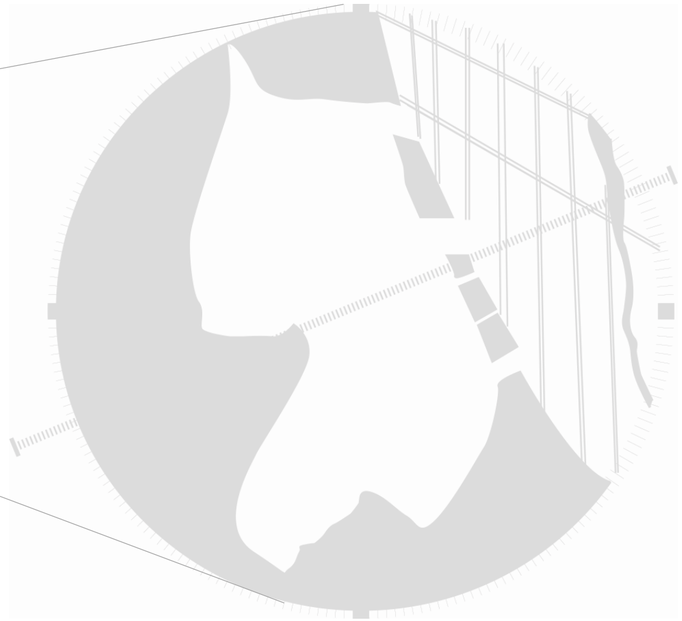


Figure 47
Location context
Figure source: Adapted from Google Earth

NORTH FRINGE

MOTIVATION

Proximity to **low-lying village** of Govindpur. Inhabitants depend on floodplains for their **livelihood**.

Onsite interviews conducted.

CONTEXT

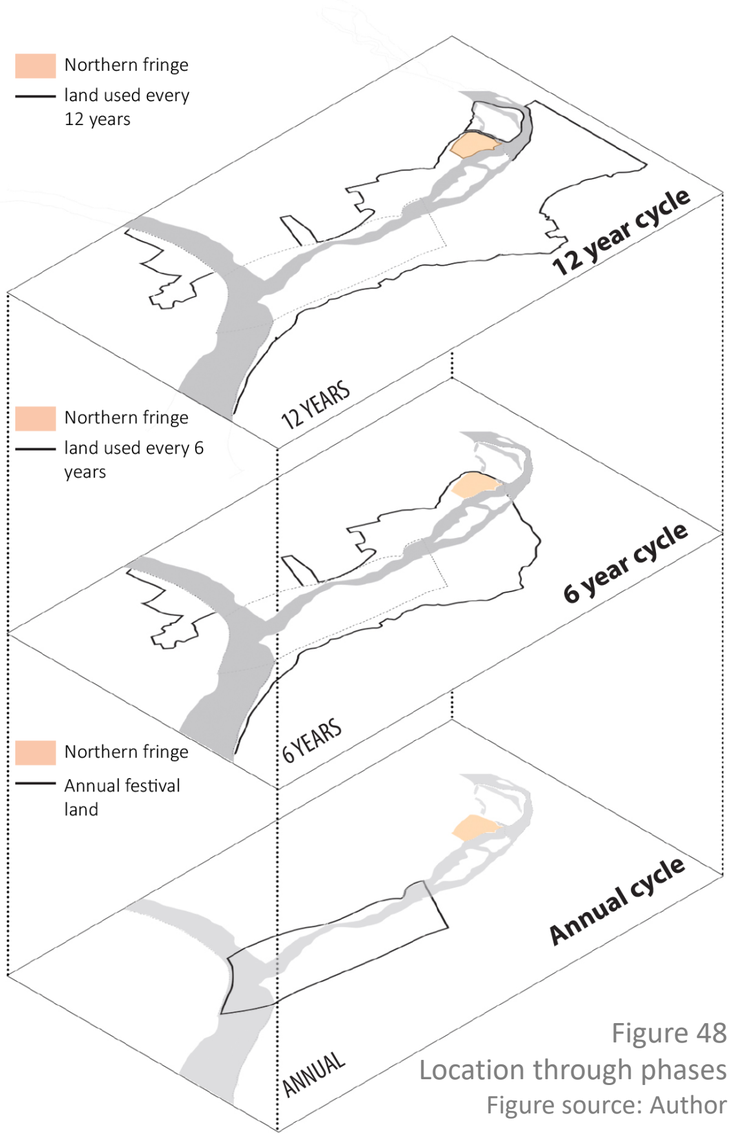
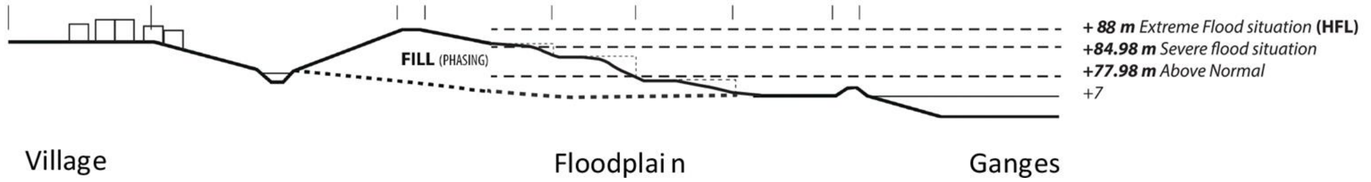


Figure 48
Location through phases
Figure source: Author

Proposed situation



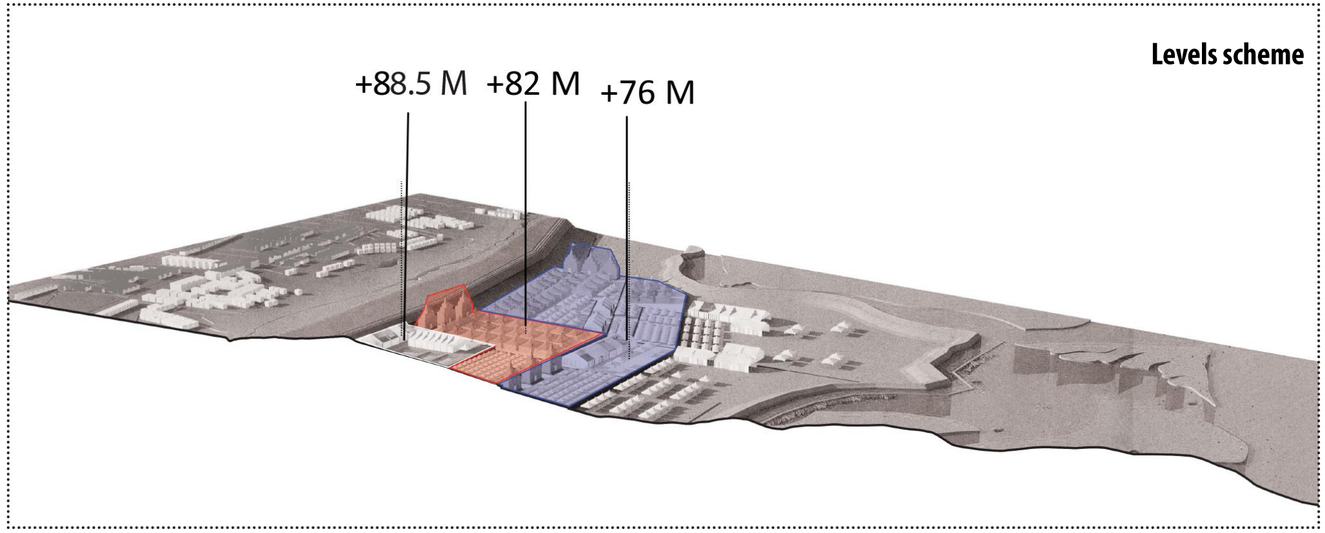
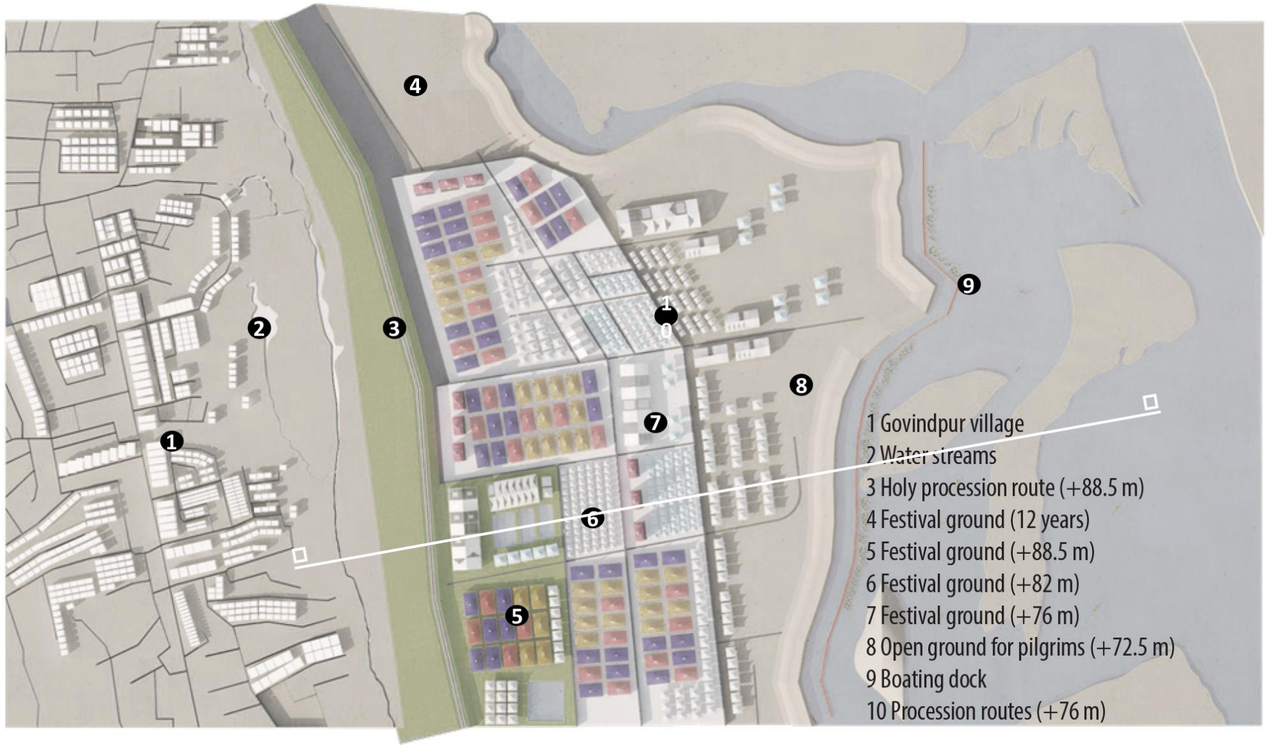
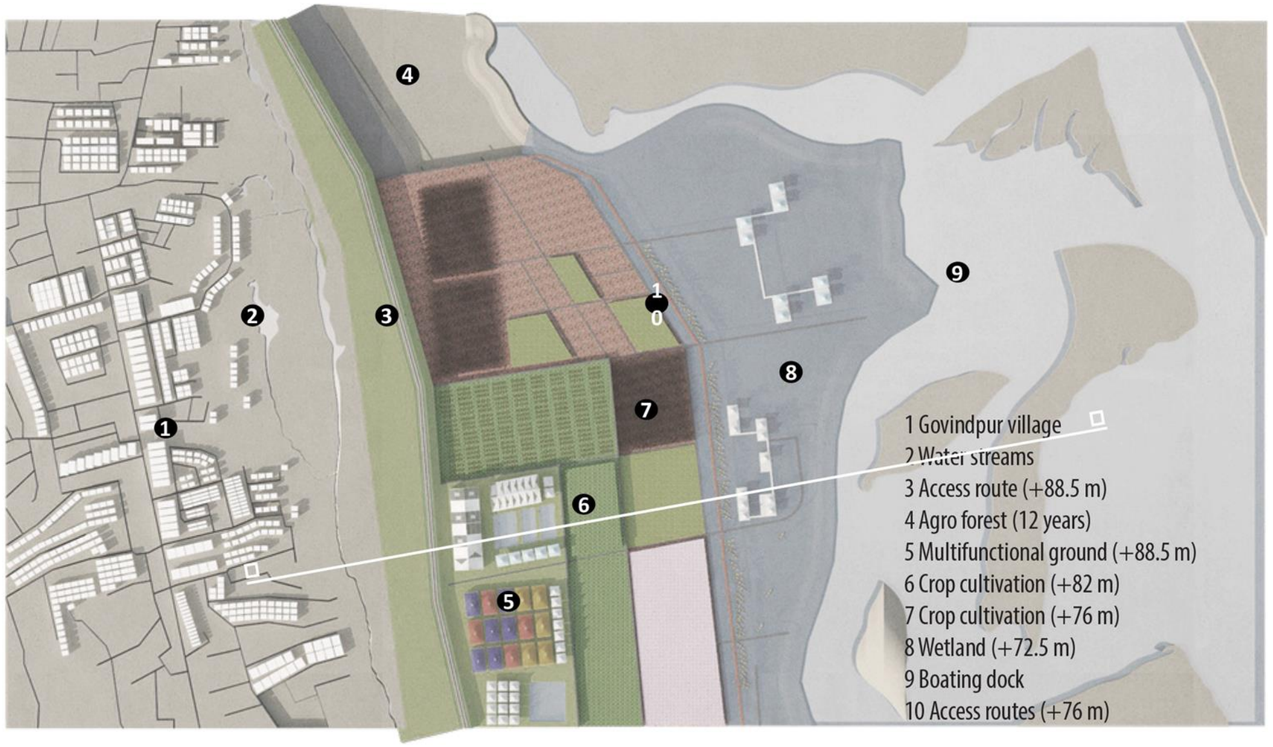


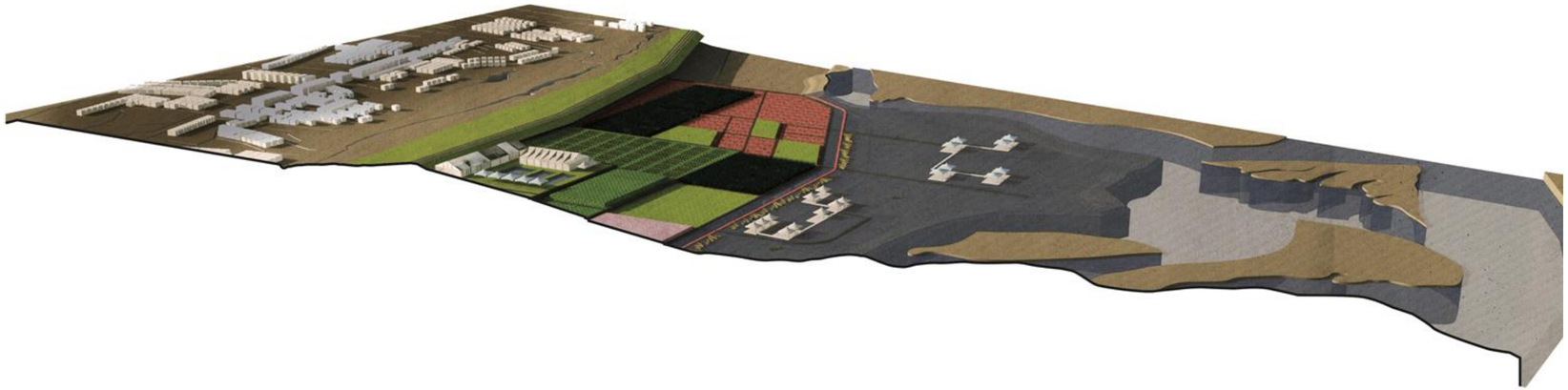
Figure 49
Levels scheme
Figure source: Author

FESTIVAL LANDSCAPE

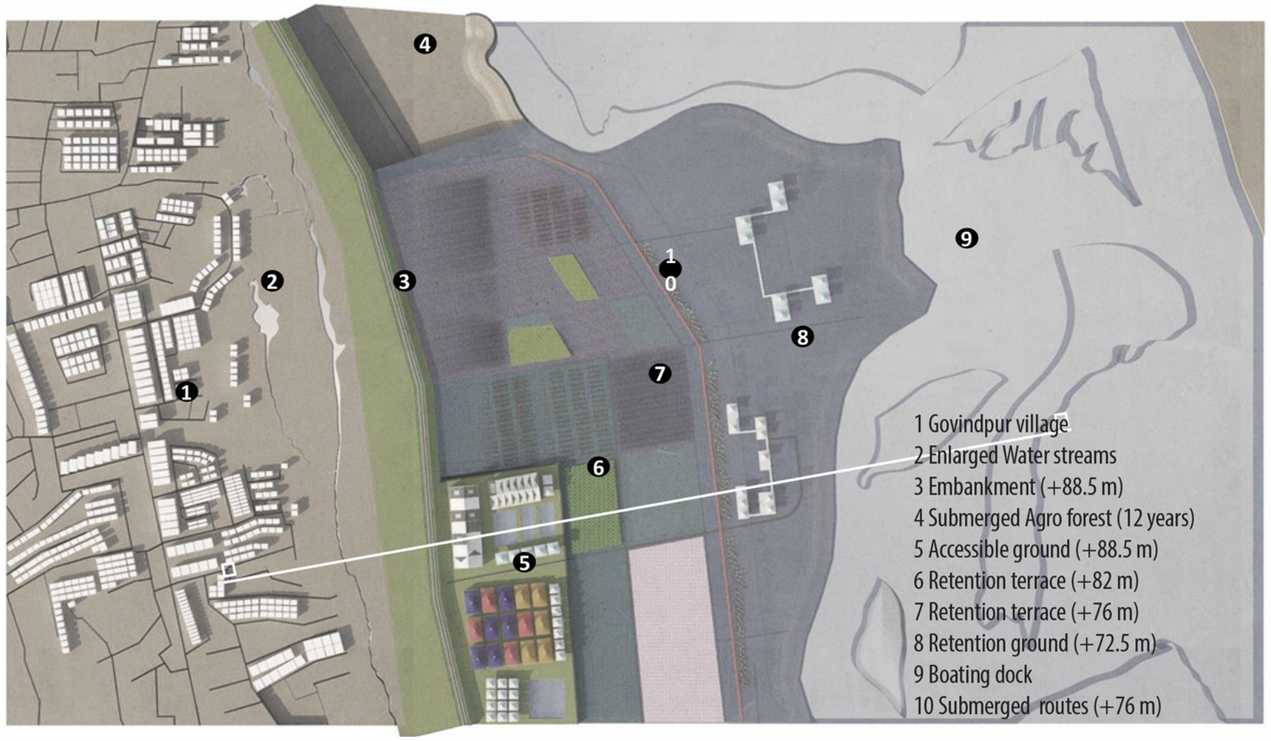


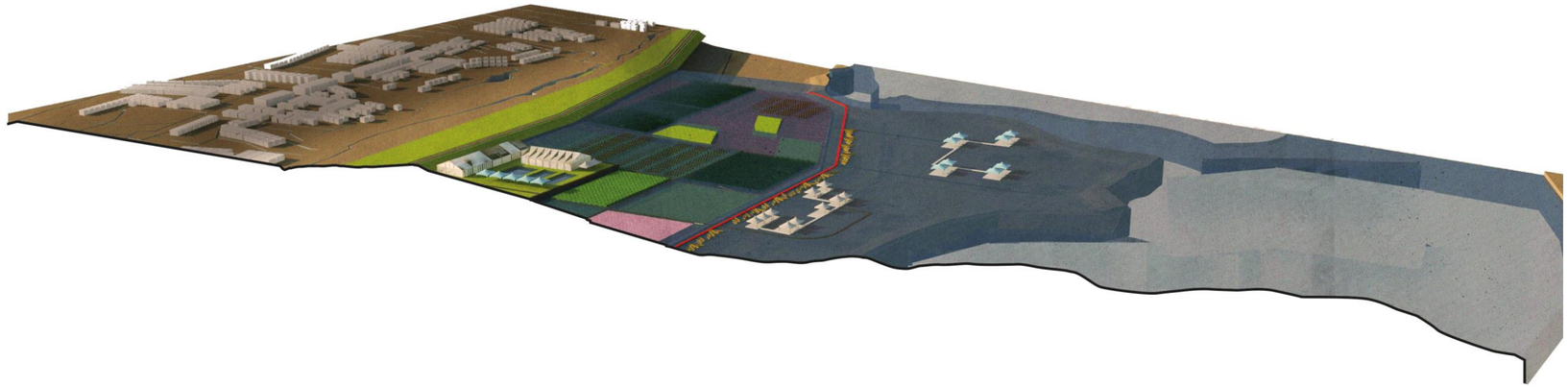
AGRICULTURAL LANDSCAPE



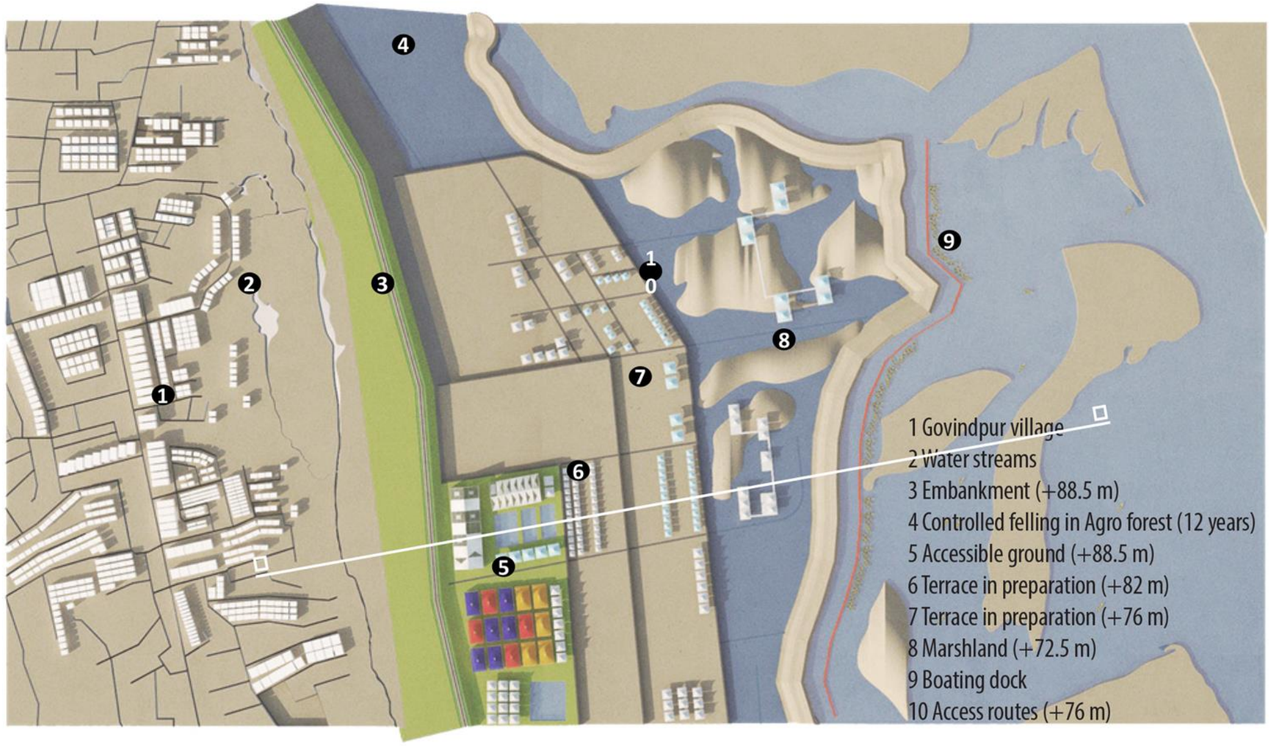


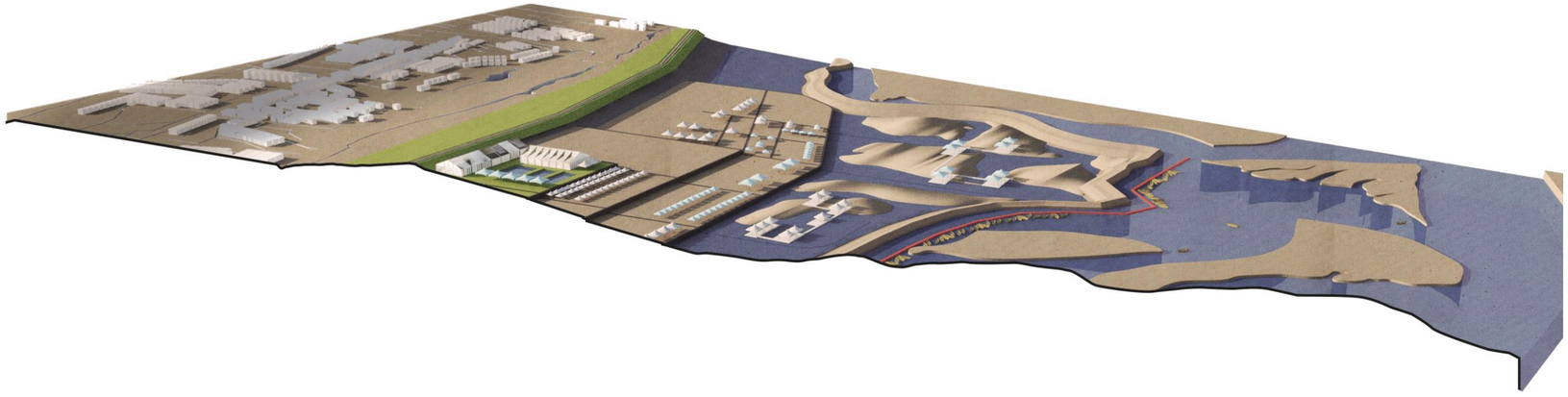
DELUGED LANDSCAPE





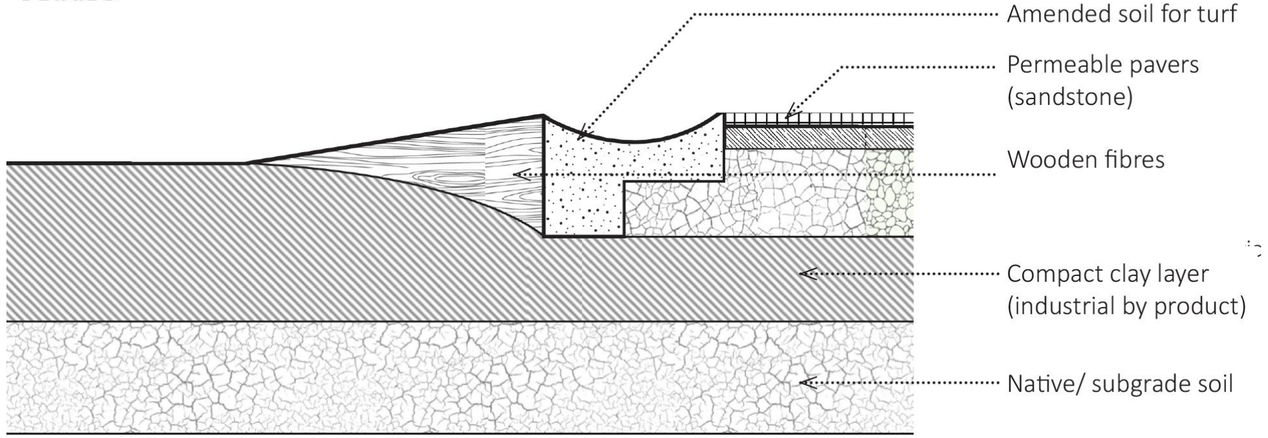
PREPARATION
LANDSCAPE

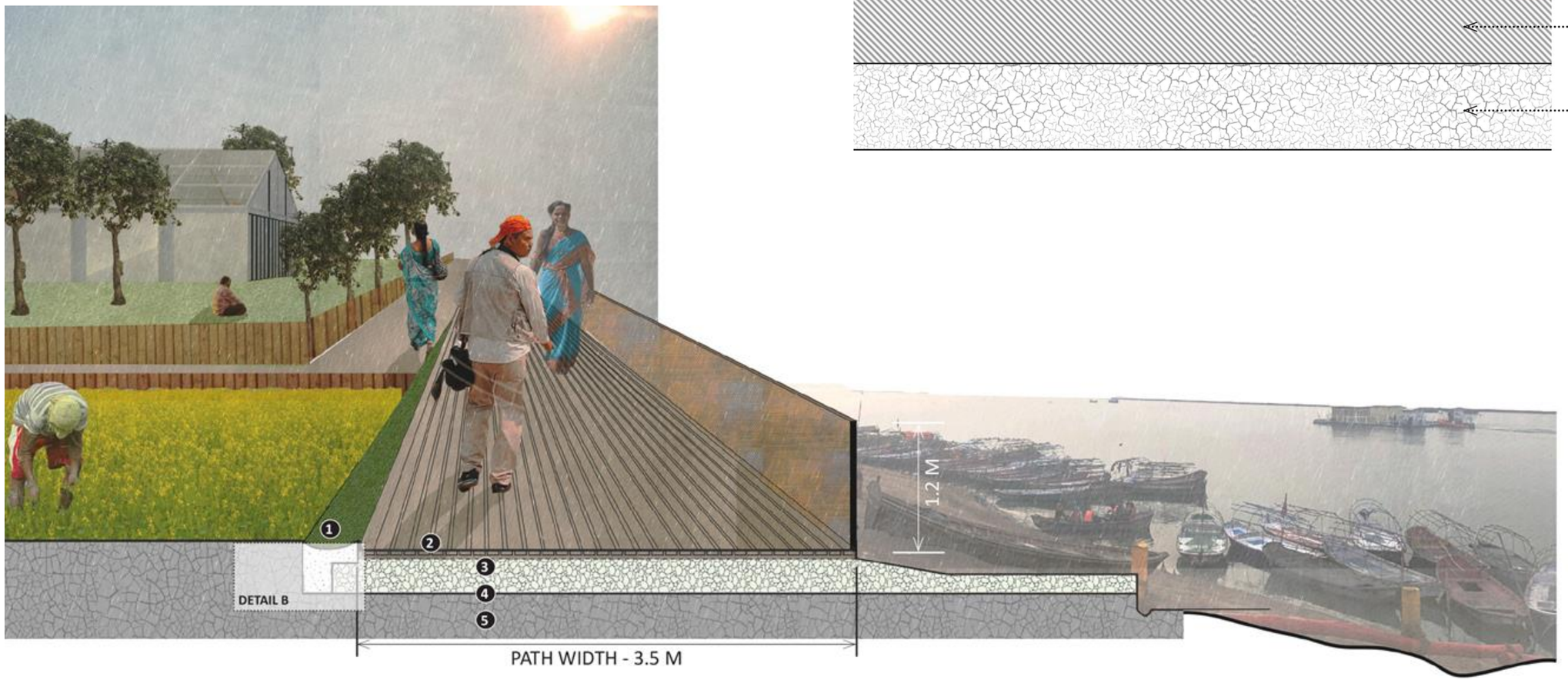




ROUTE TRANSFORMATION

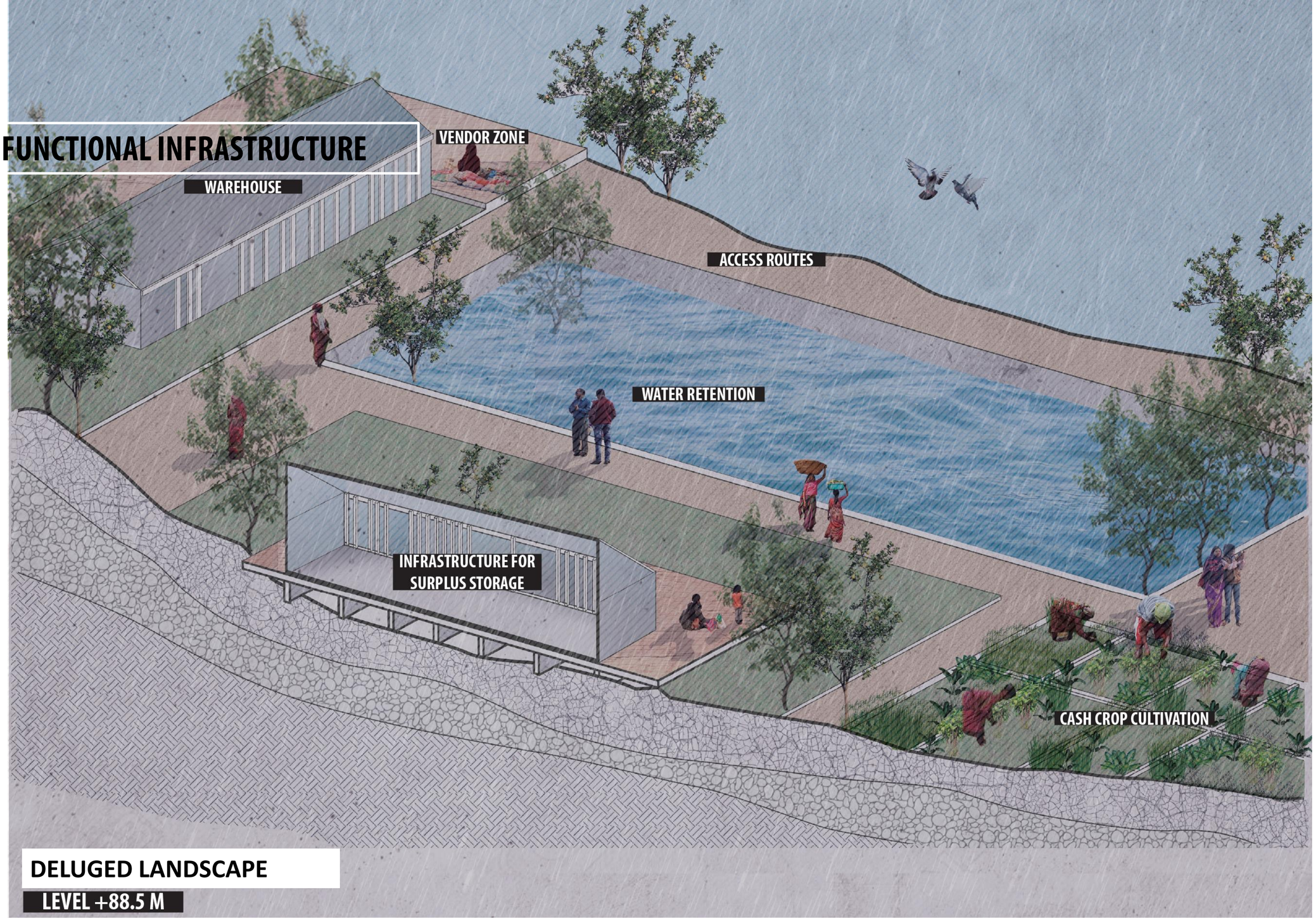
ROUTE
- DETAIL B





DELUGED LANDSCAPE

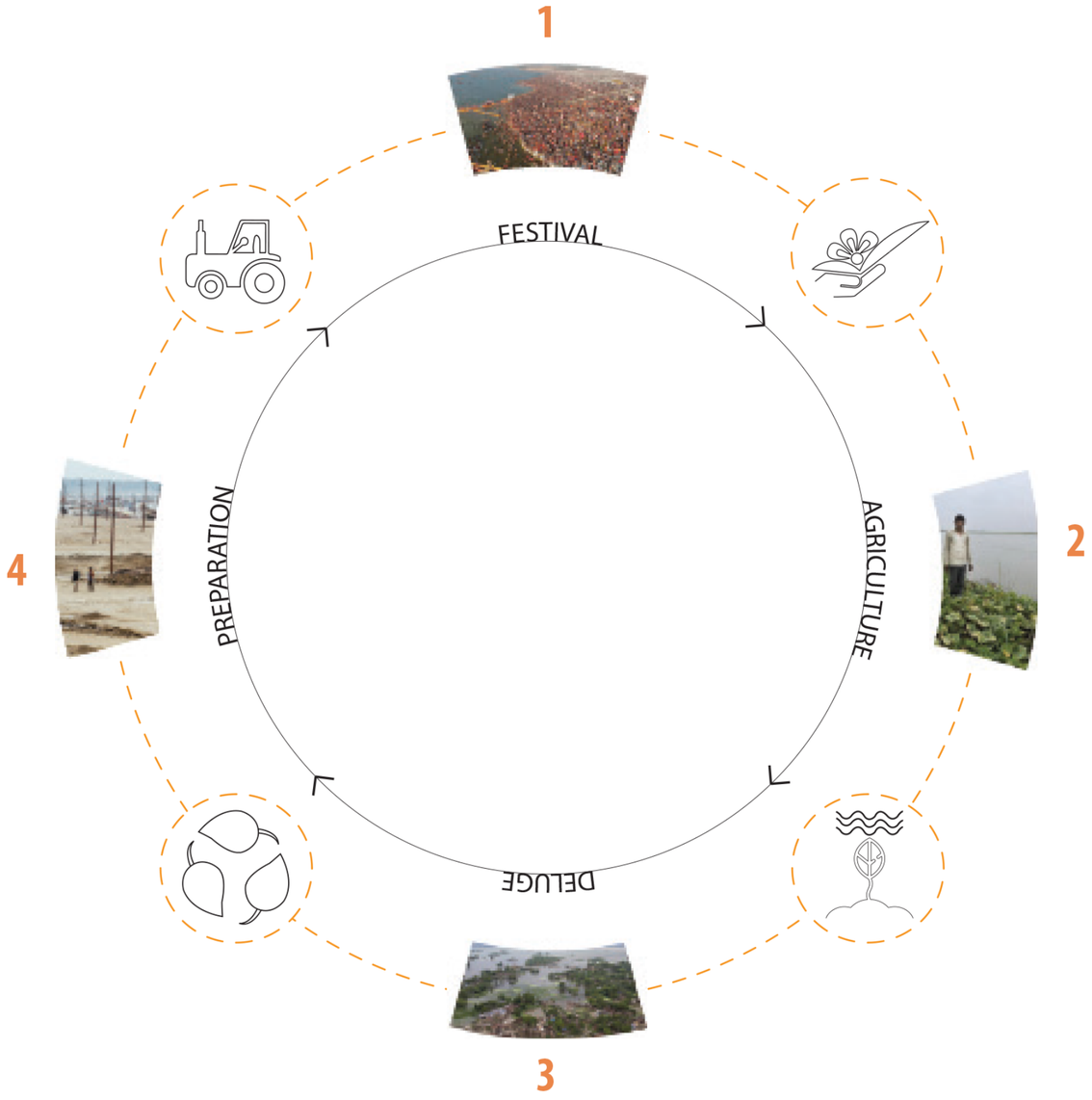
MULTIFUNCTIONAL INFRASTRUCTURE



DELUGED LANDSCAPE

LEVEL +88.5 M

CONCLUSION



CHALLENGES ADDRESSED

1 → 2

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

2 → 3

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

3 → 4

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

4 → 1

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

EXISTING VS PROPOSED
SPATIAL EXPERINCE

Hence,

The resilient landscape framework helps to preserve the sanctity, identity of the constantly changing floodplains of river Ganga at Prayagraj in India.

Thereby,

Allowing the dynamic floodplain landscape to adapt to its changing nature and diverse phases of Festival, Agriculture, Deluge and Preparation Landscapes.

The approach can help to **empower heritage and culturally significant landscapes** all over the world to **adapt to human influences** on them by making them **resilient to disturbances** and accustomed to **constant change they experience**!

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Thank you!

Mentors

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Dr. Ir. Marjolein Spaans

TU Delft