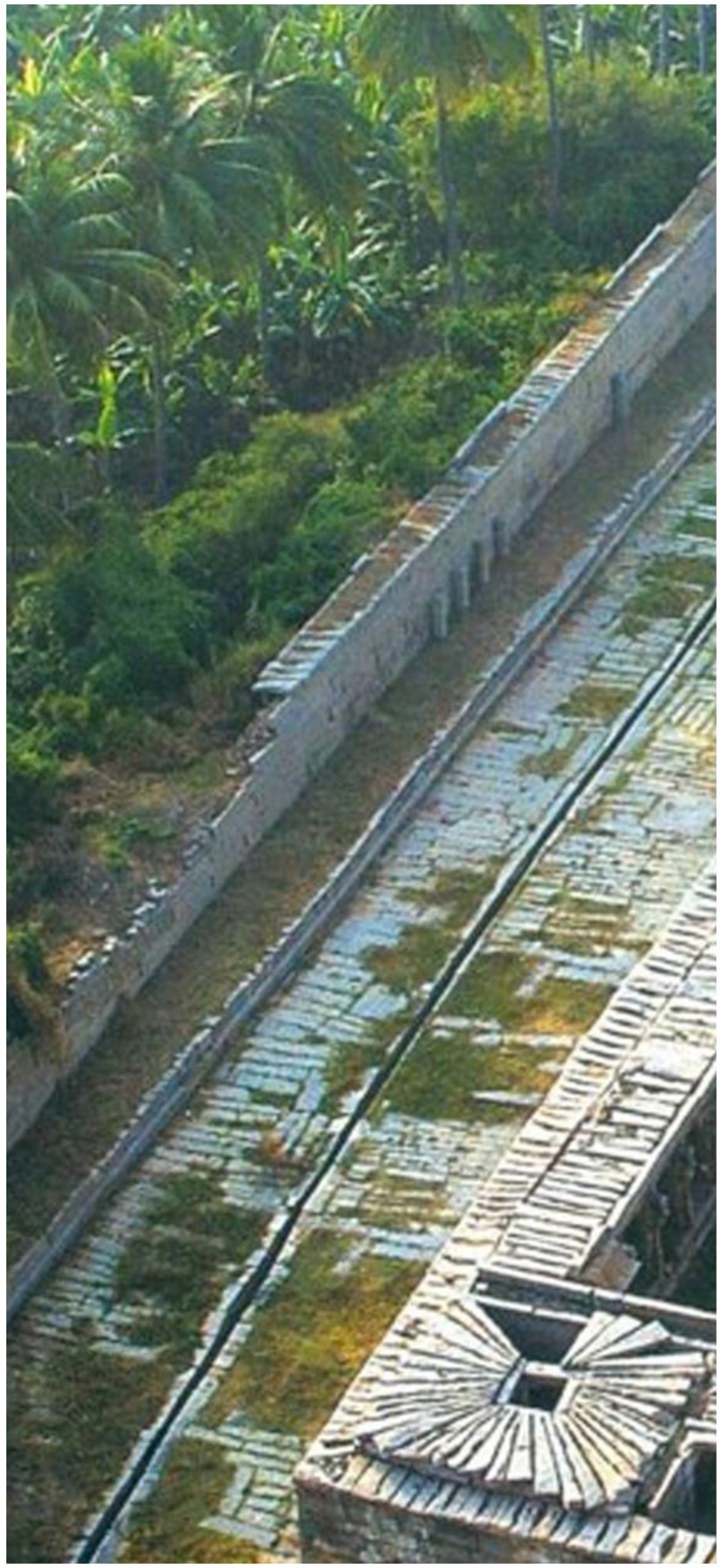
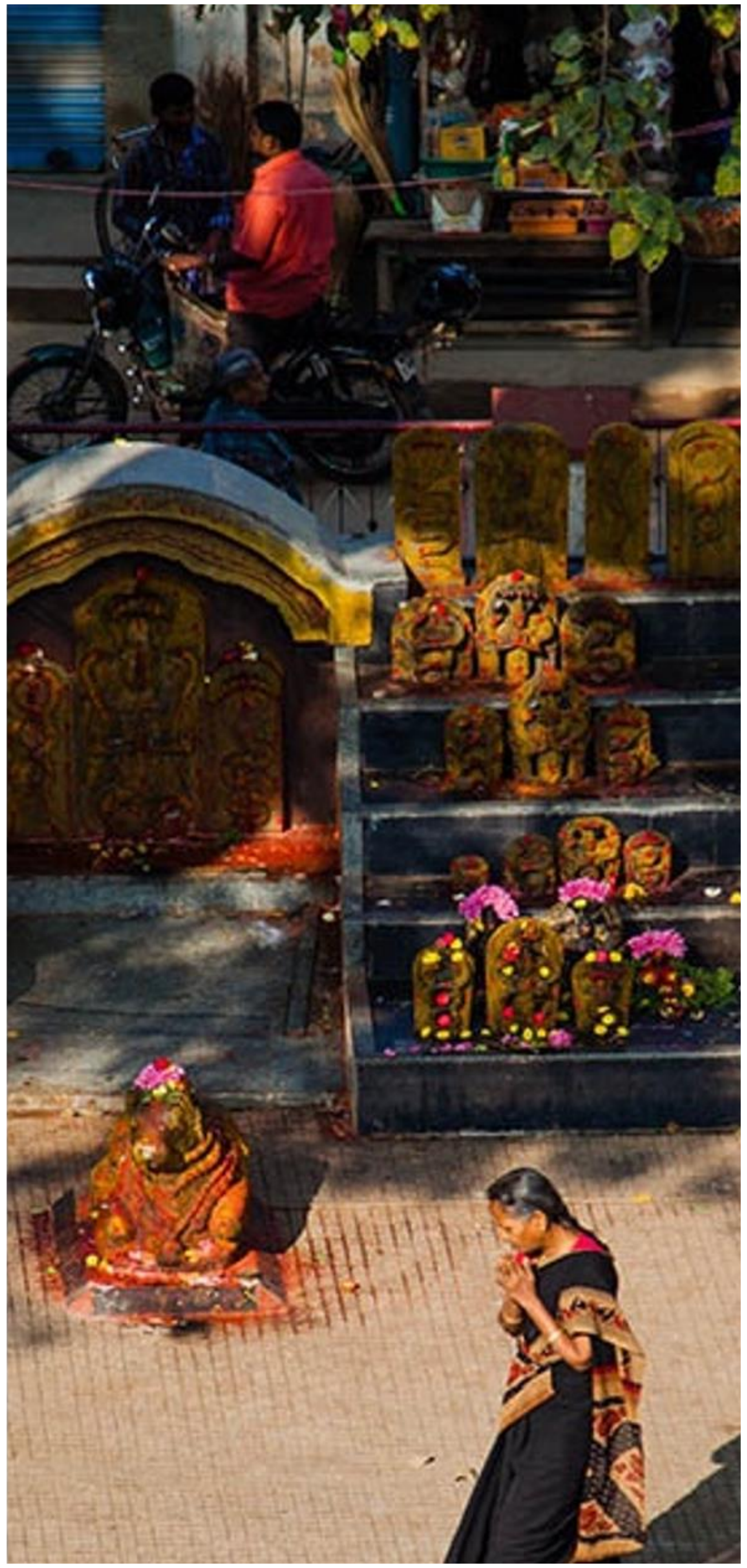


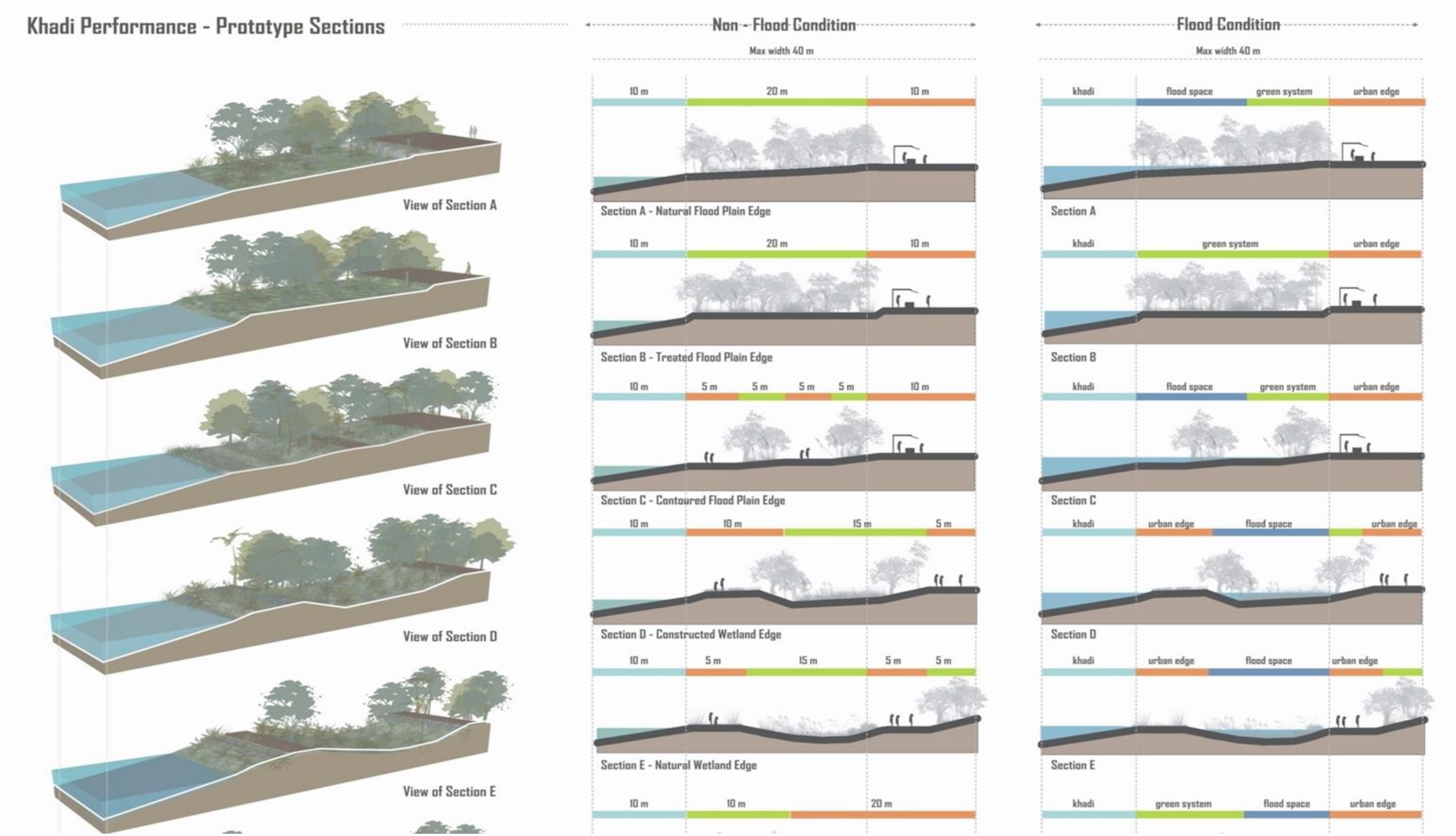
DIGITAL LANDSCAPE ARCHITECTURE CONFERENCE - DLA 2021

Virtual Hybrid, May 26 – 28 in Dessau-Köthen-Bernburg

MOHAN RAO
PARTNER
INDÉ
INTEGRATED DESIGN

International Resilient Landscape Architecture

resilience (n):
The ability of a substance to return to its usual shape after being bent, stretched, or pressed:
The quality of being able to return quickly to a previous good condition after problems:



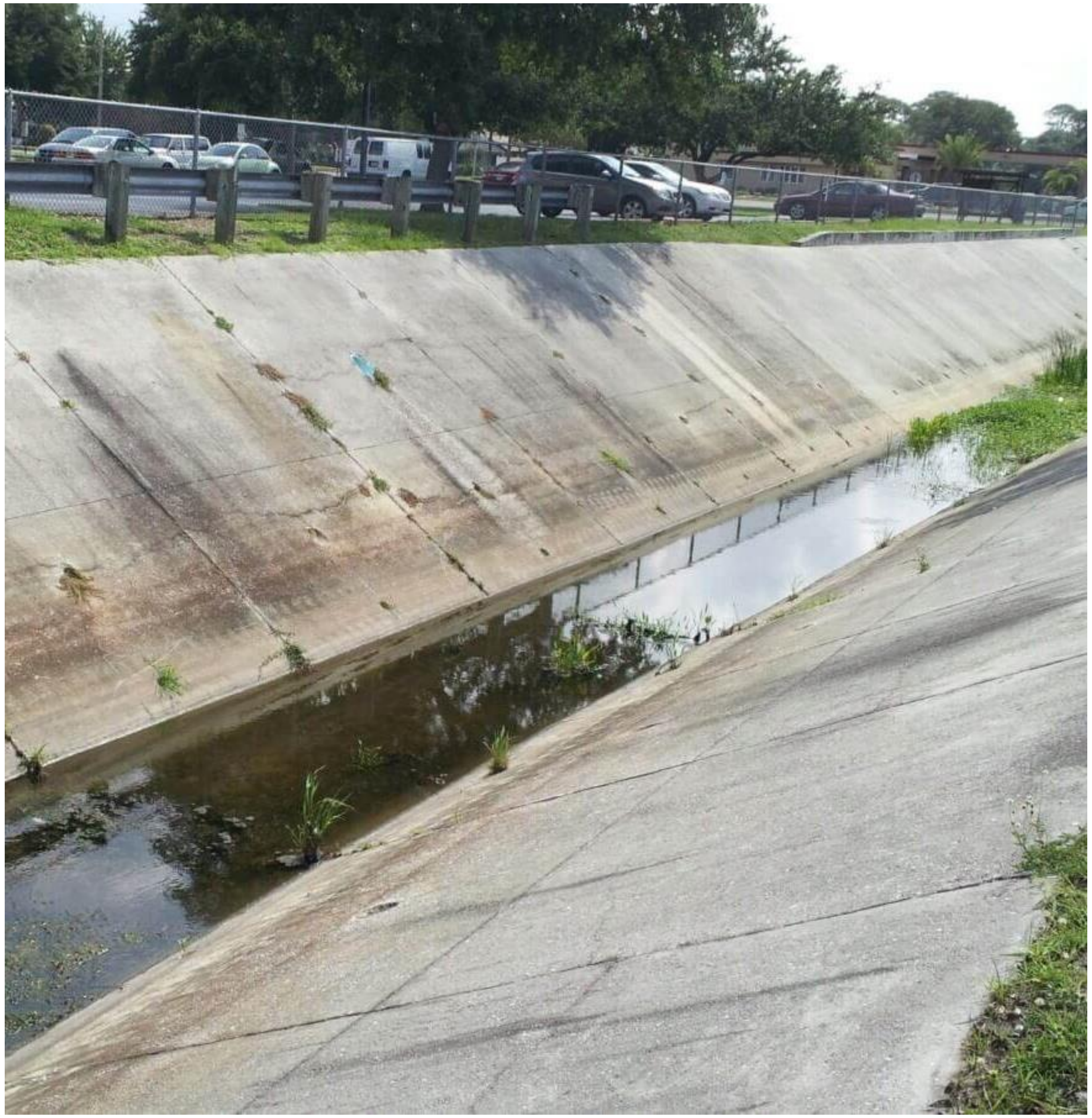
DEFINING RESILIENCE

- inherent strength of a system to neutralize the negative impact of external forces.
- should resilient landscapes encompass not only the natural but cultural landscapes too?
- address communities in specific agro-ecological landscapes?
- not just loss of life or property but of access to livelihoods and disruptions to cultural continuity?

AMPHAN CYCLONE, SUNDERBANS

UNDERSTANDING RESILIENCE

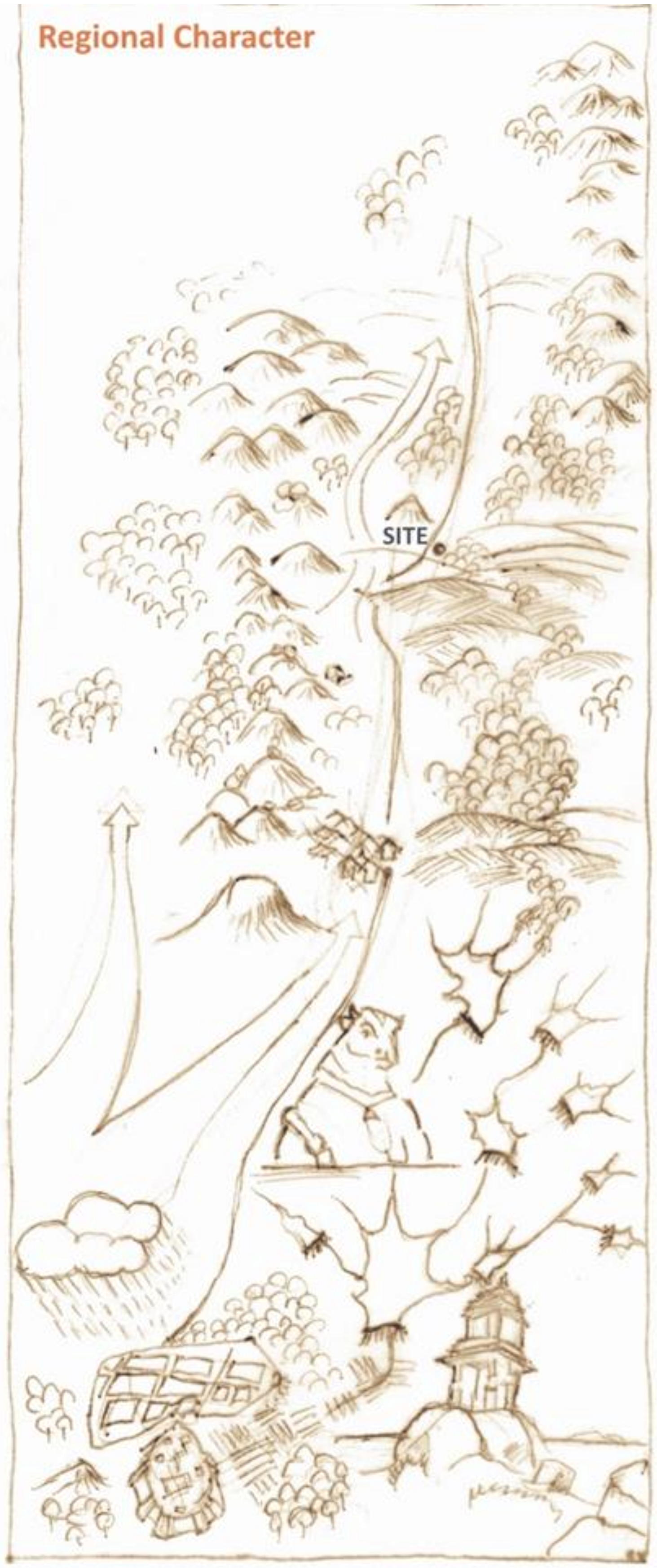
- To be in sync with natural cycles
- Imbibe the idea of temporality
- Engage with a system that is both cyclic and dynamic - an idea missing in the current development discourse
- To erase those lines we have drawn separating water and land, nature and culture.

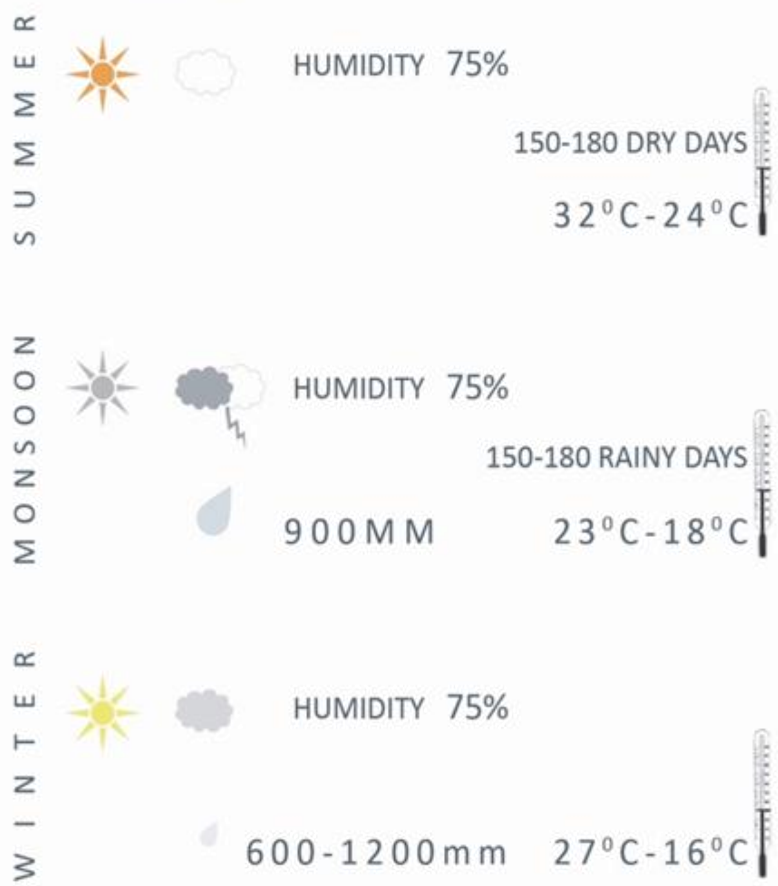


NATURE AND CULTURE BINARIES…

Nature and culture occupy the same space either sequentially, cyclically or even as once. Neither culture need to control nature nor nature to obstruct culture. Not a new paradigm; rather to rediscover the dynamic relationships nurtured between nature and culture in the past.

An energetic tango of sorts with its ebbs and flows of varied tempos, each receiving and responding to the other's needs, thoughts and desires as an incredibly beautiful medley; always in rhythm but forever moving, dancing.





Climate:
The region falls in the Eastern dry agro climatic zone. It experiences semi-arid climate, characterized by typical monsoon tropical weather with hot summers and mild winters. September and October are the wettest months with over 100mm monthly rainfall. **April** is generally the hottest month and **December** is the coolest month of the year. During summer is Max temperature is 32°C & Min temperature is 24°C. In winter, Max temperature is 27°C & Min temperature is 16°C. The average annual rainfall is 773 mm in the region. Annual Rainfall: 650 to 847.3mm

Physiography:
Pediment, valley, laterite mounds, rolling land
Landform: South Deccan plateau
Situated in the Southern Deccan plateau, the topography is a rolling terrain at an elevation 900m above msl, as part of the Pediment of the Nandi hills.

Hydrology:
Surface water: There are no perennial rivers in the region. The region is dotted with several ancient irrigation tanks some of which are in a degraded condition. The drainage pattern is highly dendritic in nature. The region is the basin of river North Pinakani, which originates from Nandi hills.

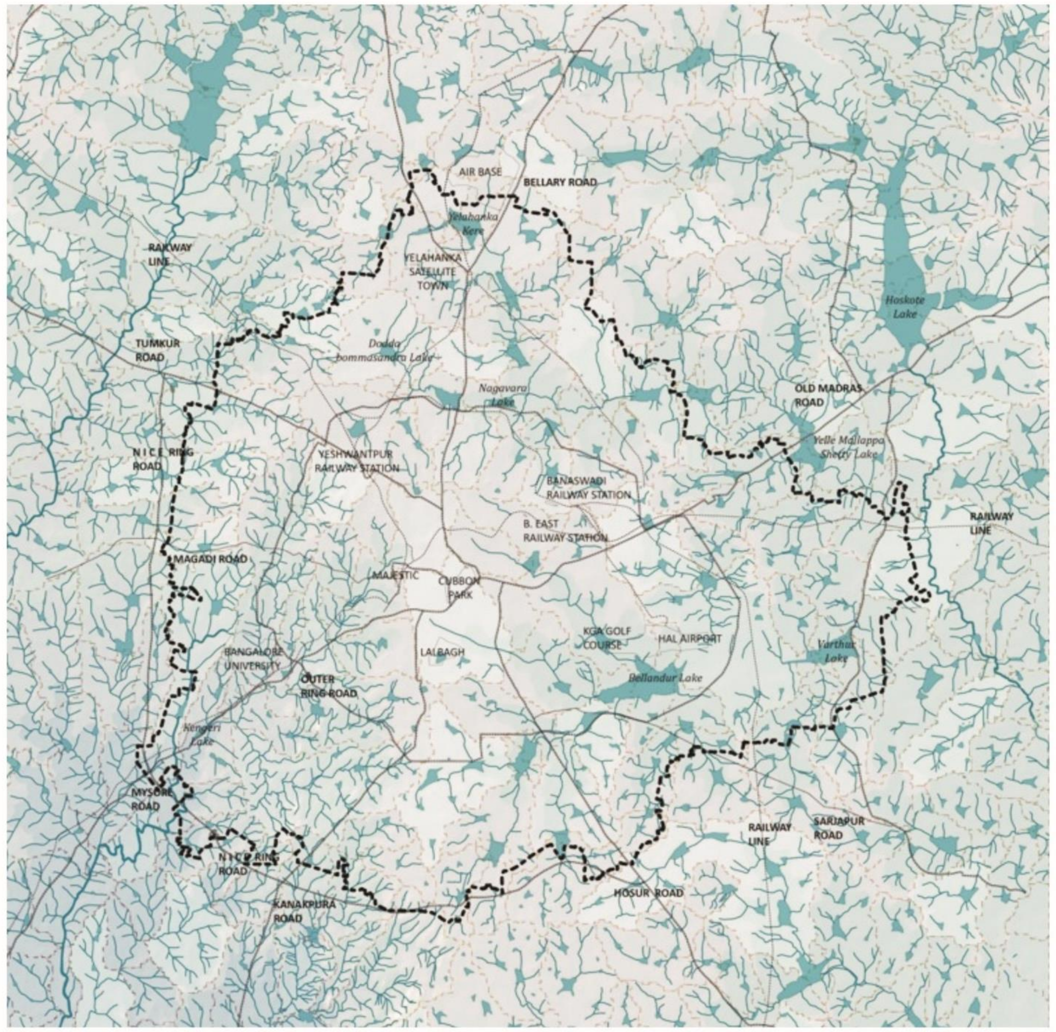
Land use:
Major part of the region is cultivated land, with small size rural settlement dotting the landscape. Only in the hilly terrain there are few patches of forest left.

RESILIENCE AND NATURAL CAPACITY

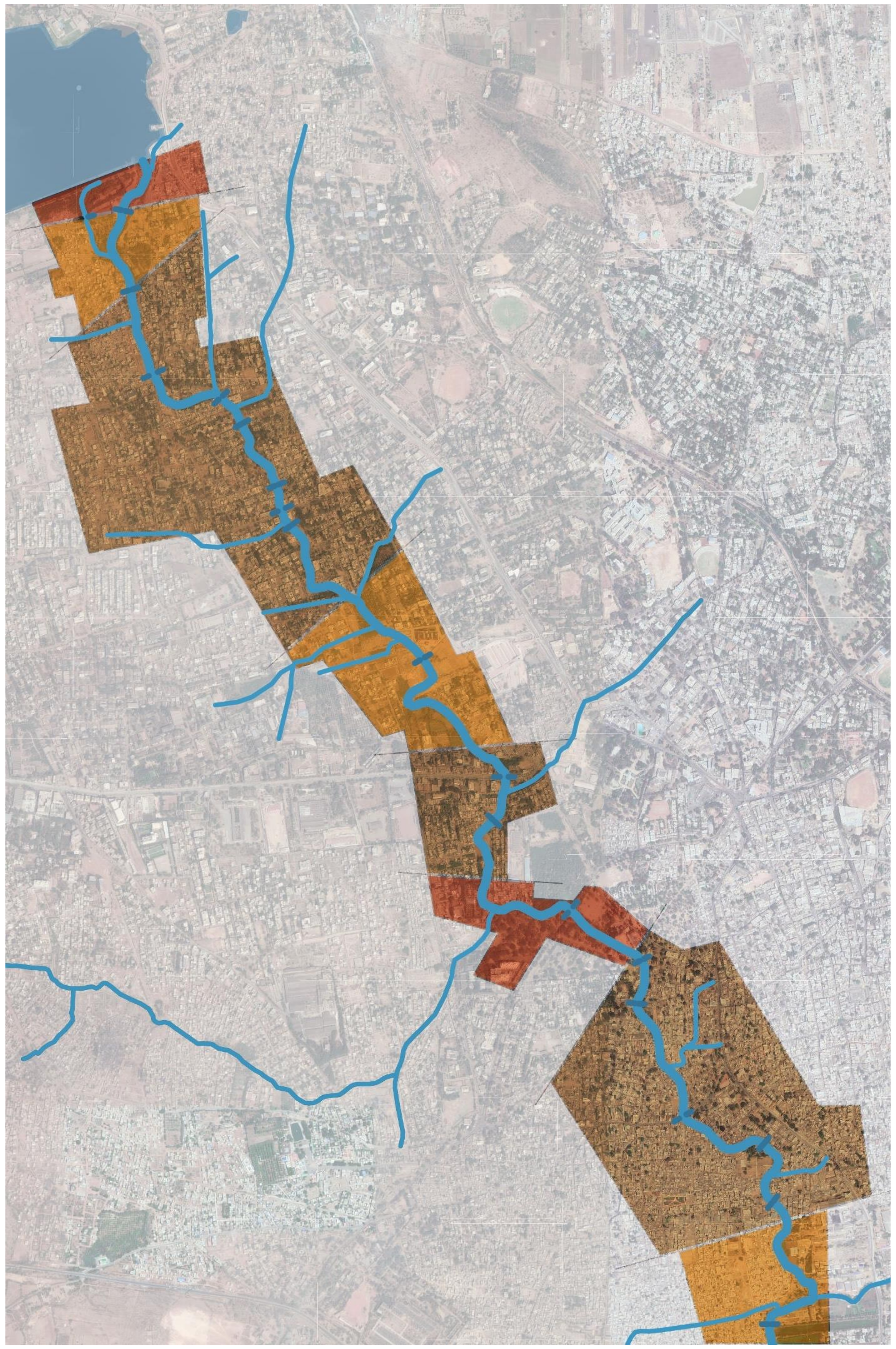
- resilience measured in terms of the performance expected of landscape systems
- an infinite source for provisioning human demands and an endless sink for our waste
- When either needs or demands or both are not met, the community is seen as vulnerable, in need of building resilience.
- To explore the opposite; starting with the natural capacity of landscape systems to potentially provision specific aspects of a community's needs.

NATURAL CAPACITY AND E.S.S

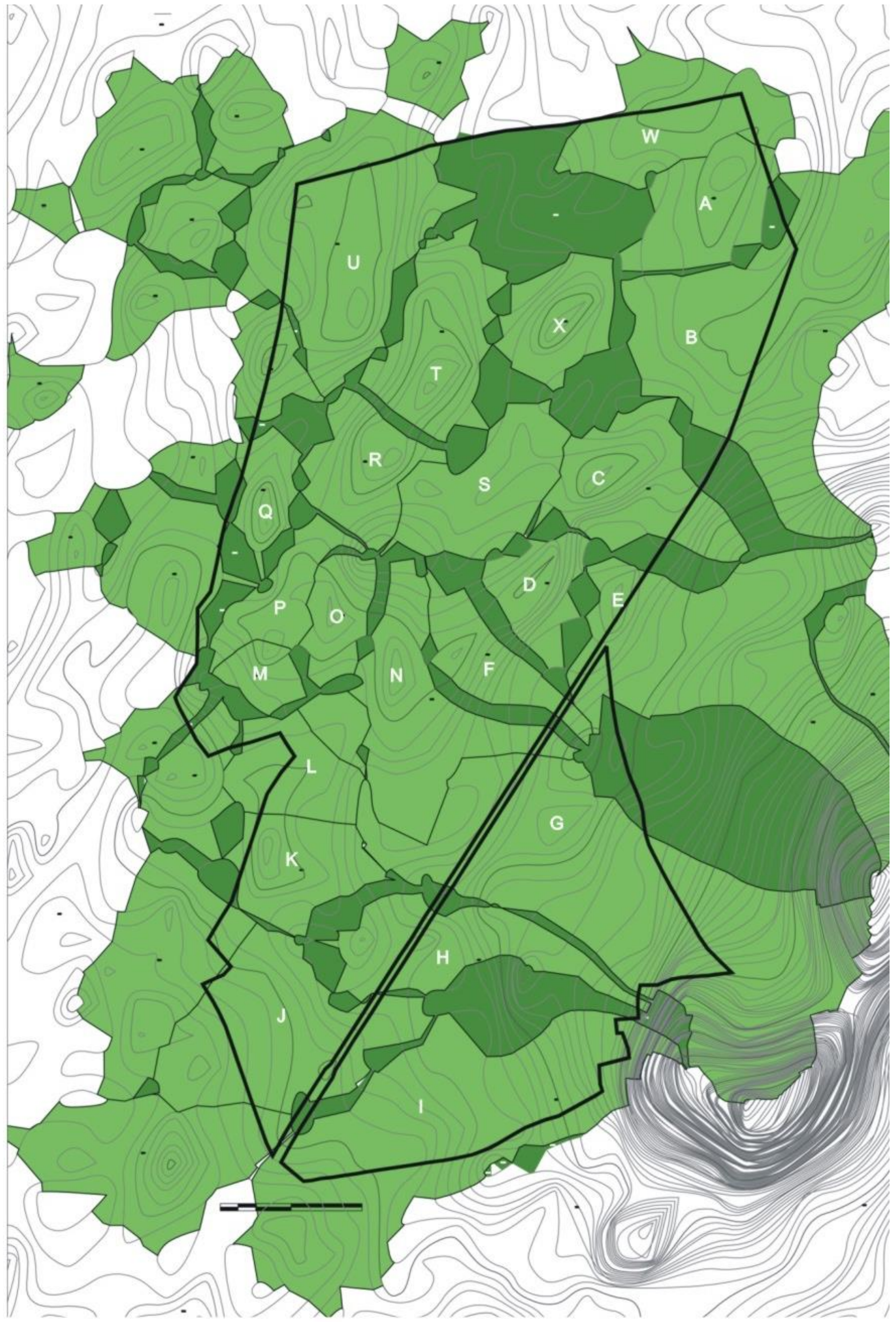
- The question of Need and demand; human needs and expectations derived from a deep understanding of what the landscape has to offer – termed Ecosystem Services – rather than demand what is beyond the natural capacity of the landscape system.
- While the rootedness of traditional societies in the natural landscape seems quite obvious, current post-industrial-modernist thinking has consistently failed to recognize this crucial aspect of context and sustainability.



REGIONAL



CITY



Watershed grading as per depression and flat areas

Figure 1

Watershed depression areas
Watershed flat areas

Natural storm water flow direction is from watershed flat areas to watershed depression areas

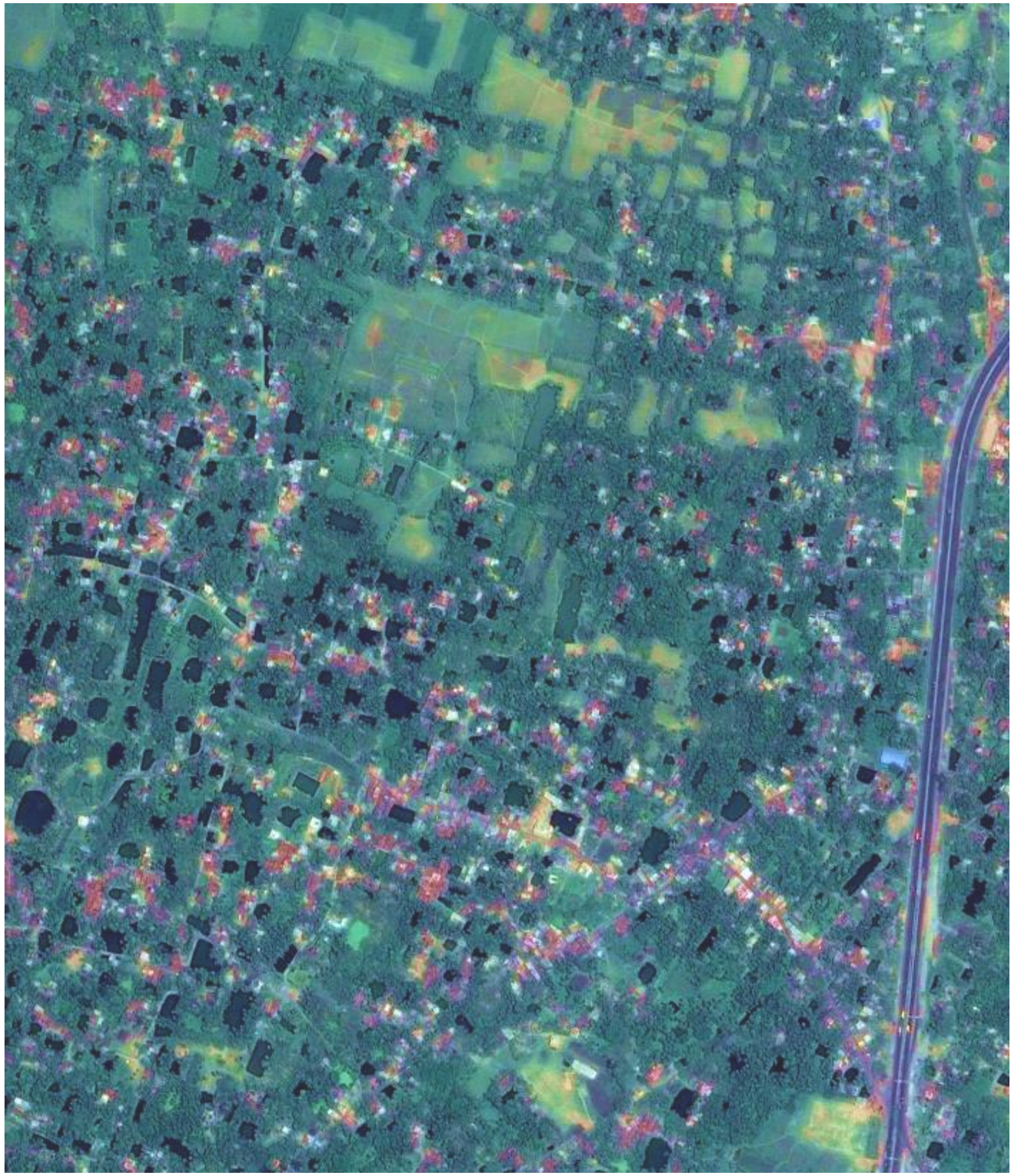
Figure 2

Watershed depression areas
Watershed flat areas
Drainage/ slope direction:
I) within site
II) outside site / adjacent watershed
III) within site bringing effluents from outside

SITE

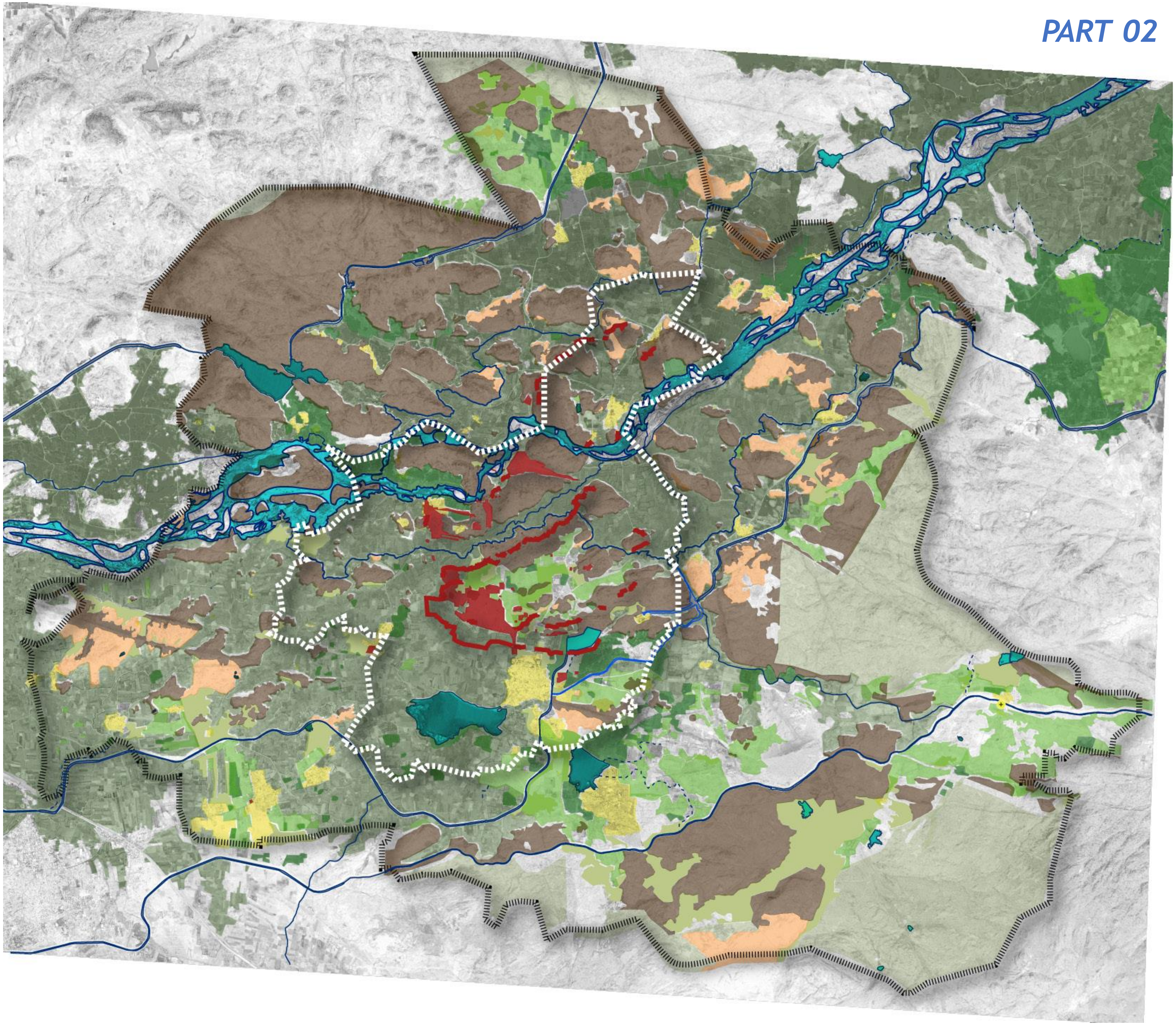
RESILIENCE AND TRADITIONAL KNOWLEDGE SYSTEMS

- Immense efforts made to develop 'international' standards that guide every aspect of the built environment
- Sad and quite needless homogenization of societies and landscapes
- Leads to two very critical and mutually reinforcing outcomes; sets unrealistic expectations for human habitats while destroying traditional knowledge systems rooted in particular landscapes.
- Frameworks of traditional practices to contest current trends in standardization in both problem definition as well as in exploring solutions.



WHY TRADITIONAL KNOWLEDGE SYSTEMS…?

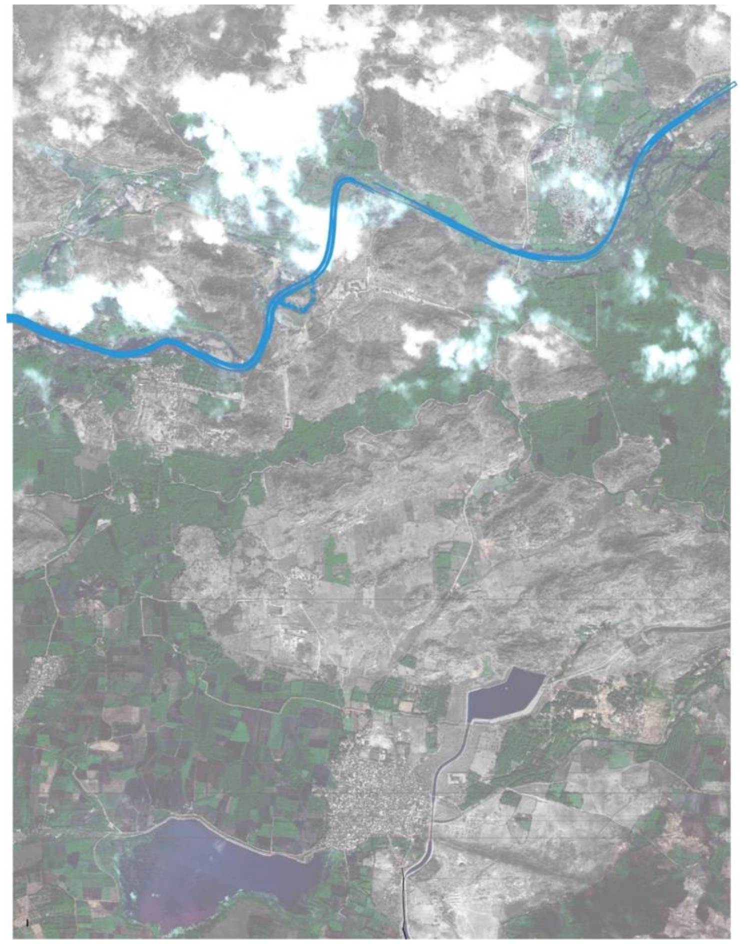
- Processes evolved over centuries / millennia
- Scales of intervention and technologies deployed ensured solutions were incremental and self-correcting
- Rather than standard, ‘universal’ solutions, every challenge / issue prompted responses rooted in specific socio-agro-ecological landscapes.
- With rare exceptions, they satisfy most sustainable, low-carbon development frameworks.
- A large array of examples across geographies are an invaluable repository of knowledge



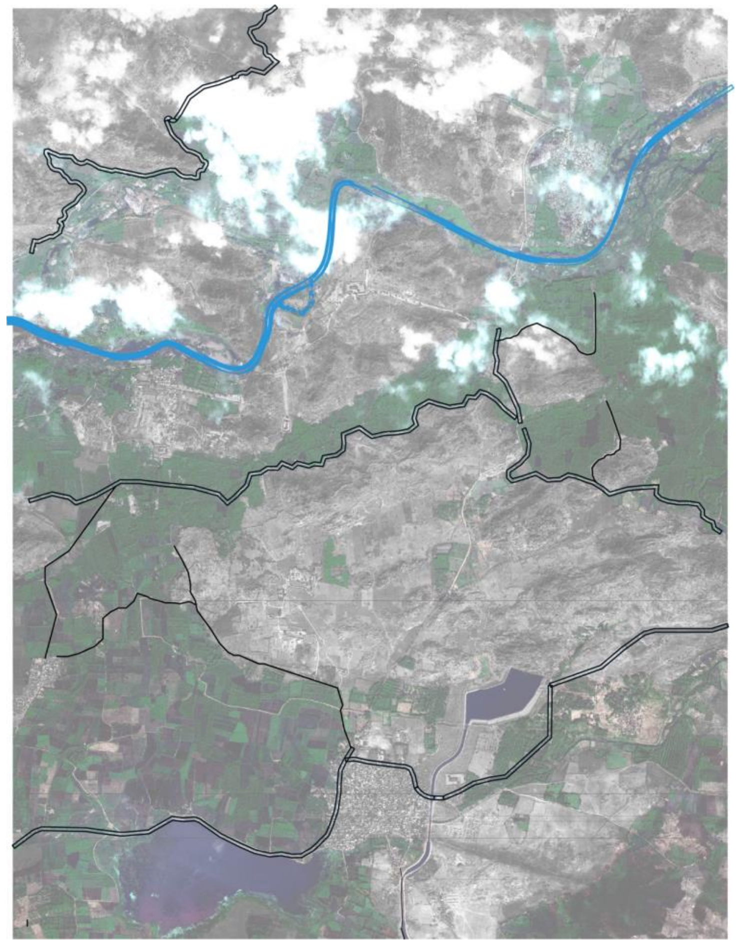
Known as the **capital of the Vijayanagara Empire between the 14th and 16th century**, the group of 56 monuments in Hampi was nominated as a World Heritage Site (WHS) in 1986. **The protected area of 236 sq.km. covers not only the ruins of the city Vijayanagara but also spectacular natural features and 29 settlements with over 600,000 inhabitants.**

Interconnected natural and physical components, including hydrology, geology, topography, vegetation, hills and boulders areas, river and other water features, views and vistas, etc form an integral part of the scenery which has influenced the historical development of the site.

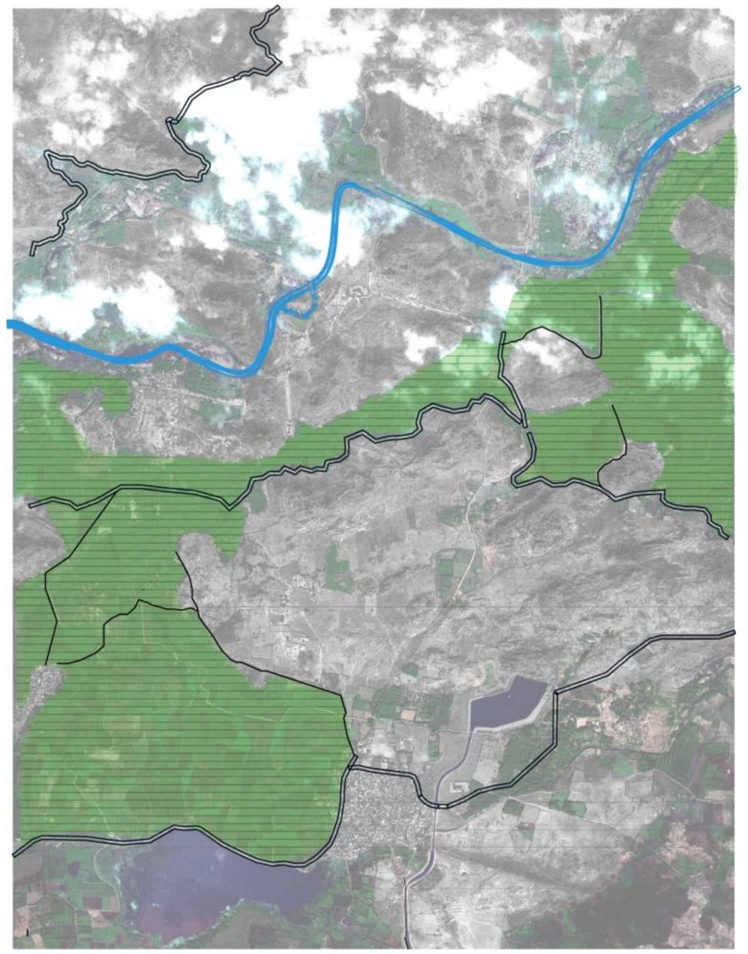
The significance of the site presents a complex interface between natural environment and man-made vocabulary which are expressed in both tangible and intangible forms, structures and practices.



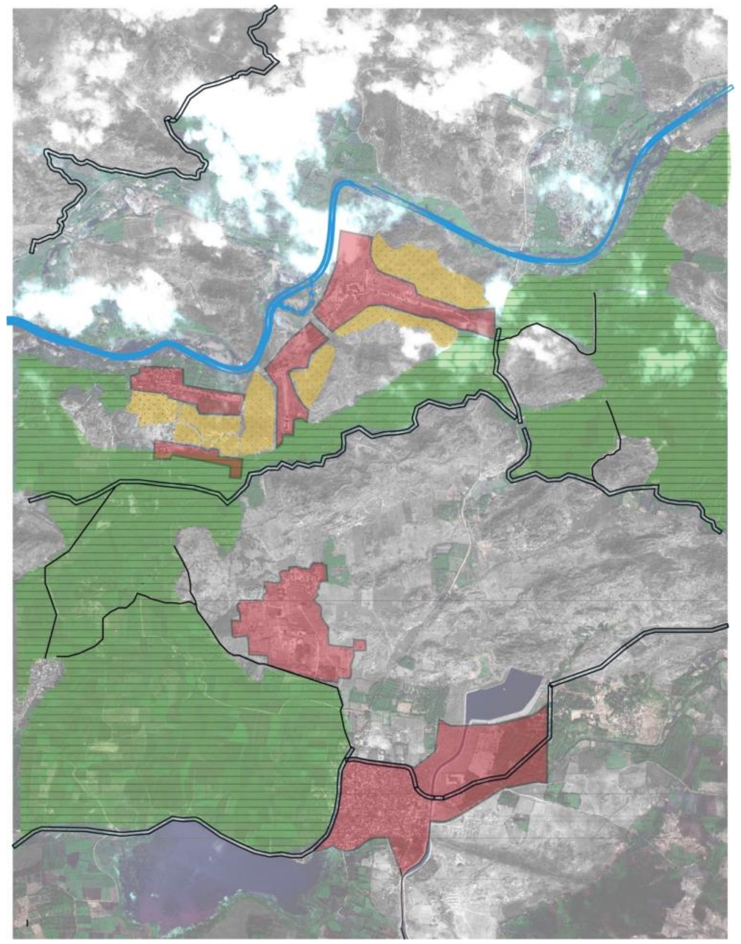
TUNGABHADRA RIVER



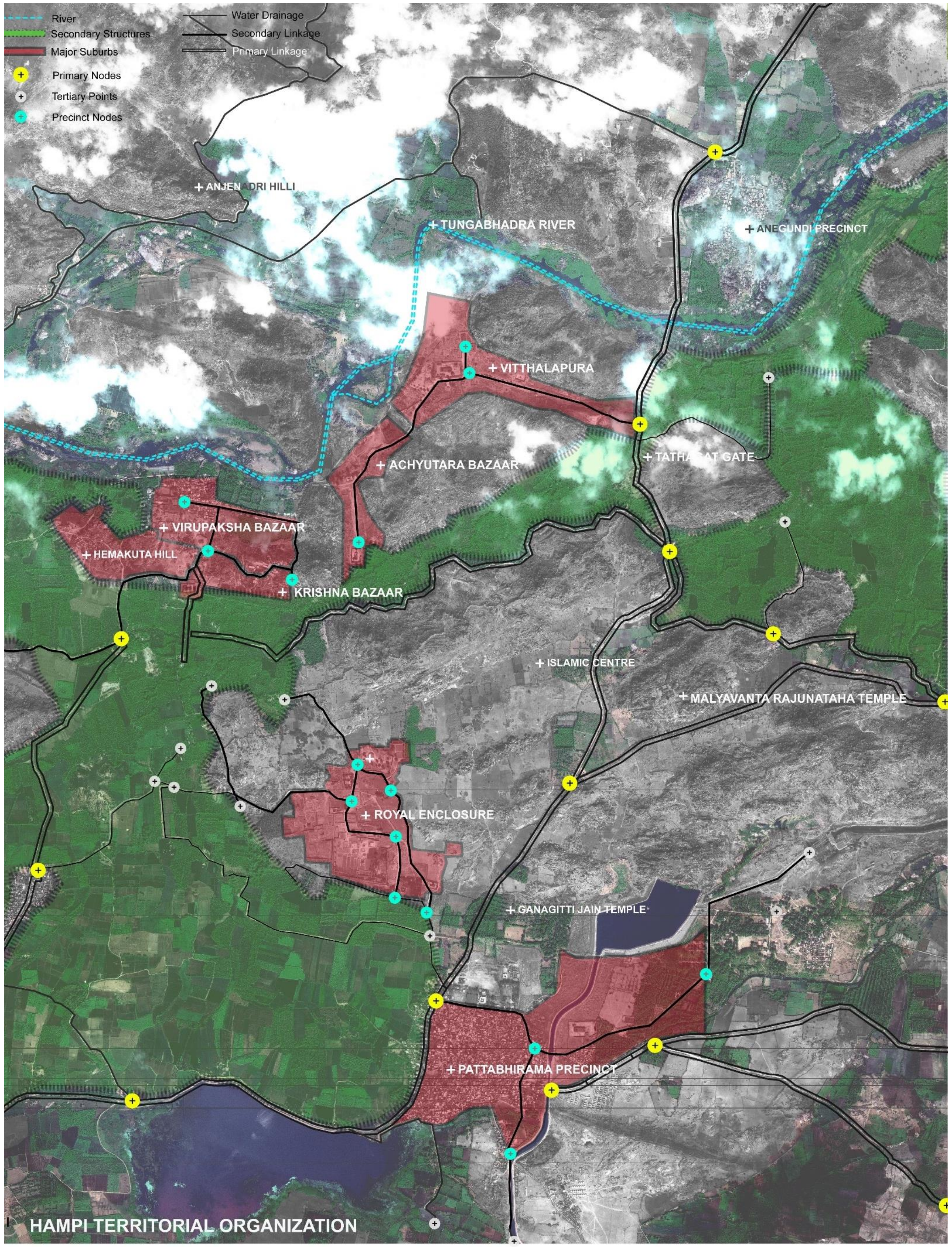
ANCIENT IRRIGATION CANALS



PRODUCTIVE LANDSCAPES

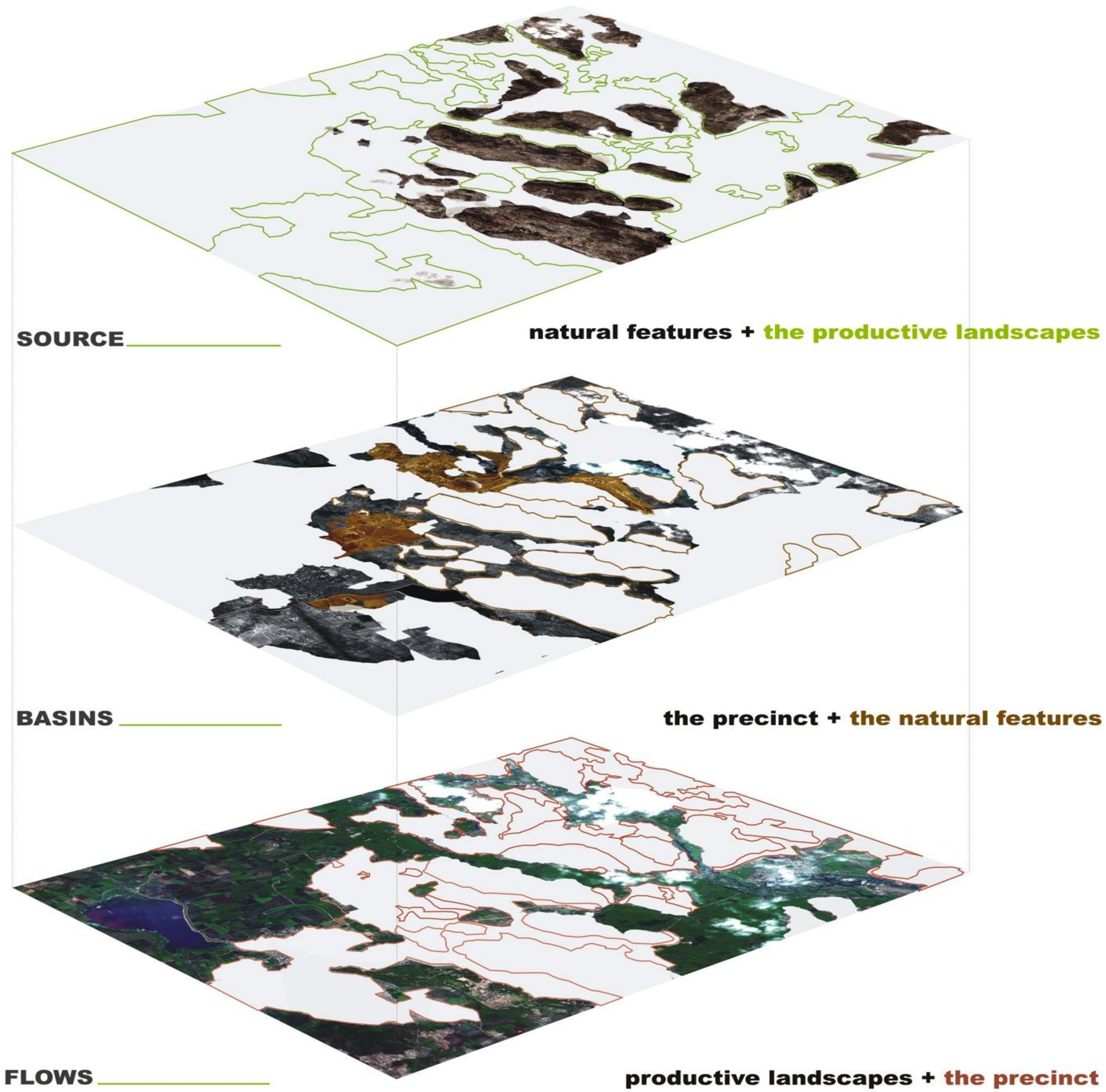


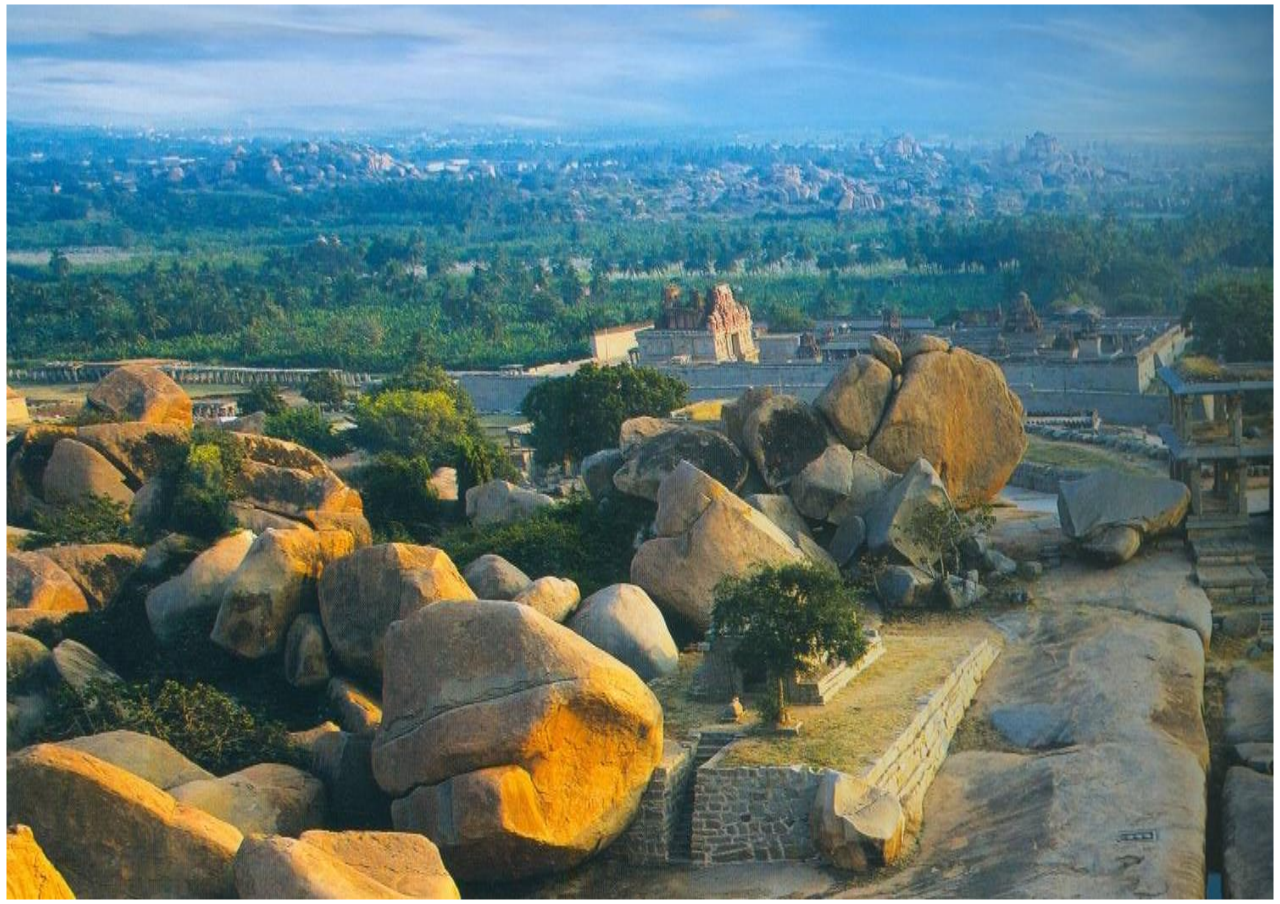
THE 'PURA' - SETTLEMENT



UNRAVELLING LAYERS OF A HISTORIC LANDSCAPE

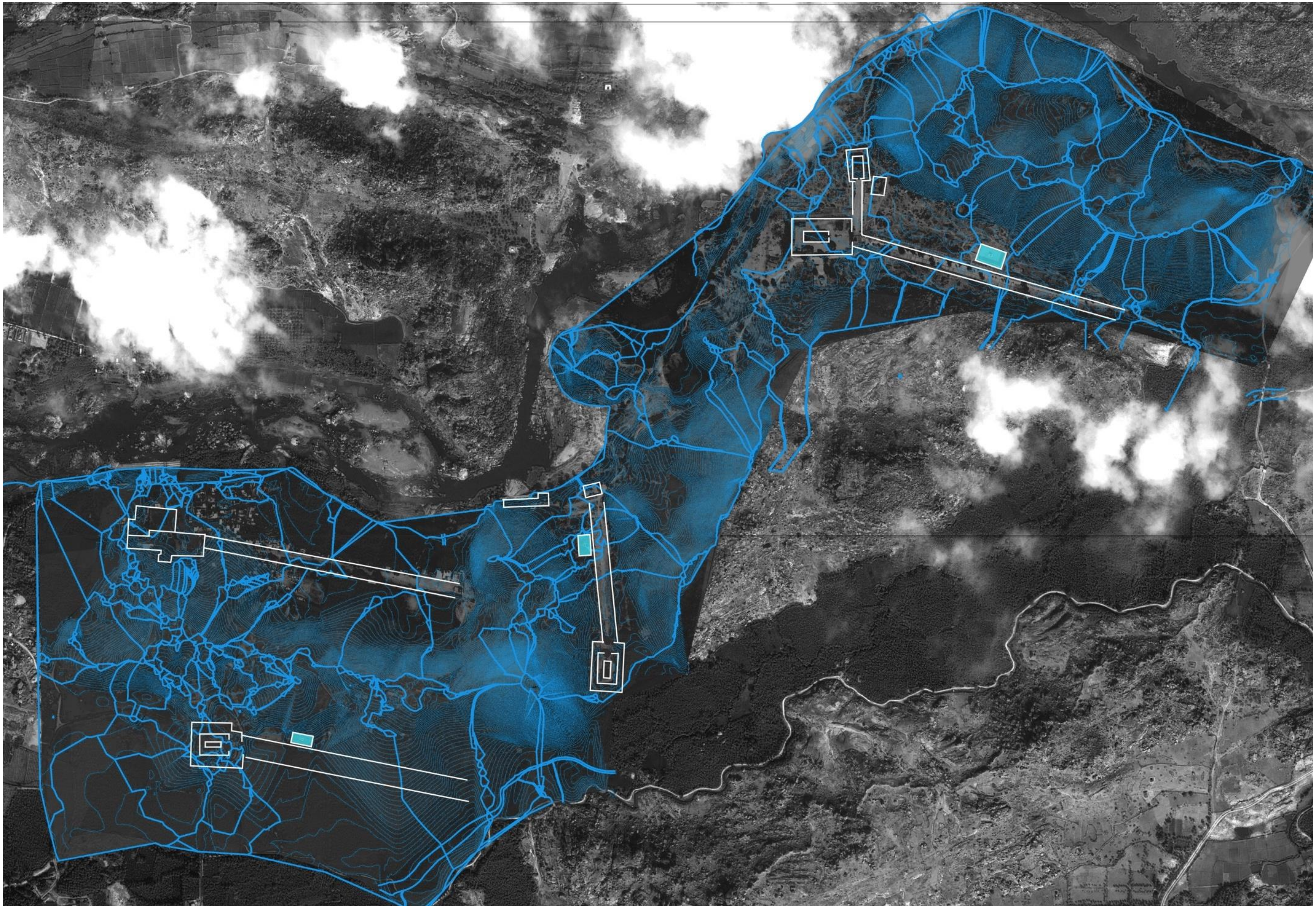
Traditional wisdom offers valuable lessons in how best to 'extract' ecosystem services of a landscape in the most sustainable manner; one that nurtures both natural and cultural landscapes – with minimal disruption to the natural and maximum impact on the cultural.



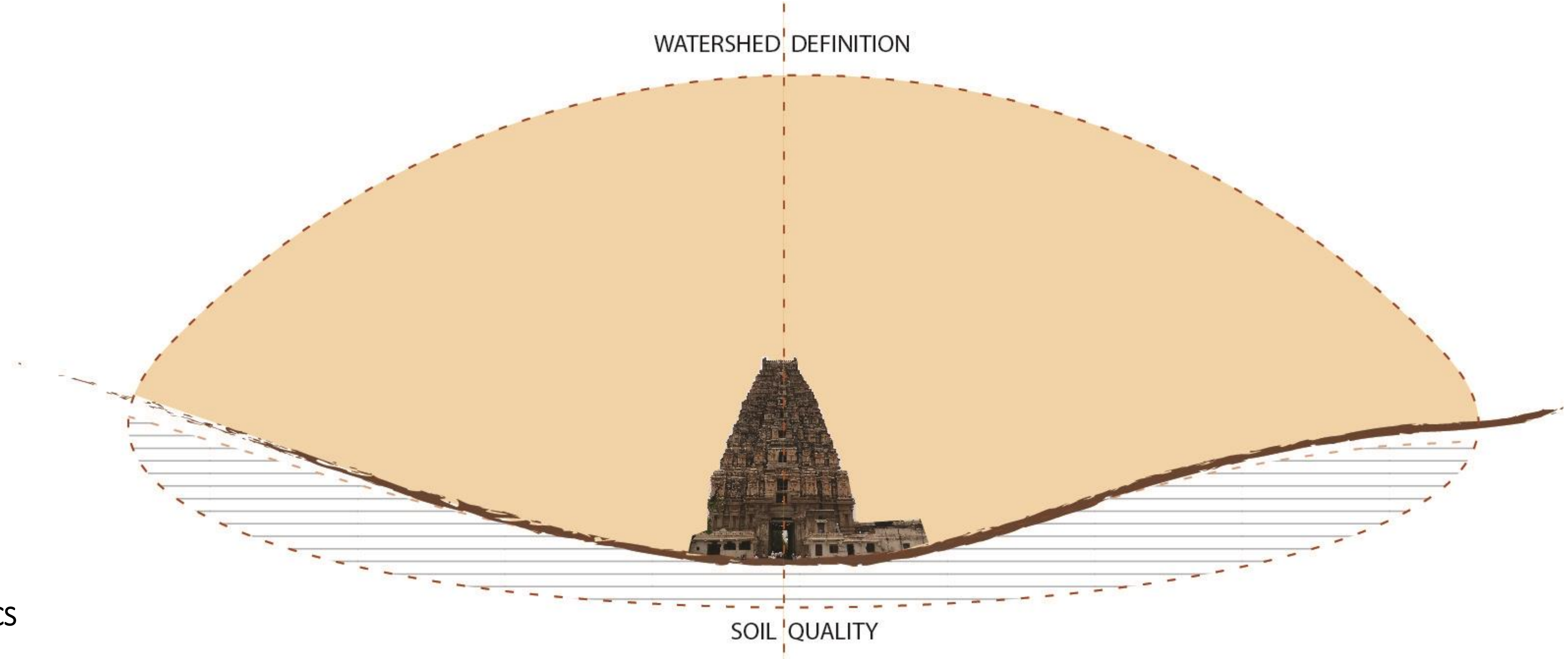


DIGITAL MODELS AND LAYERING

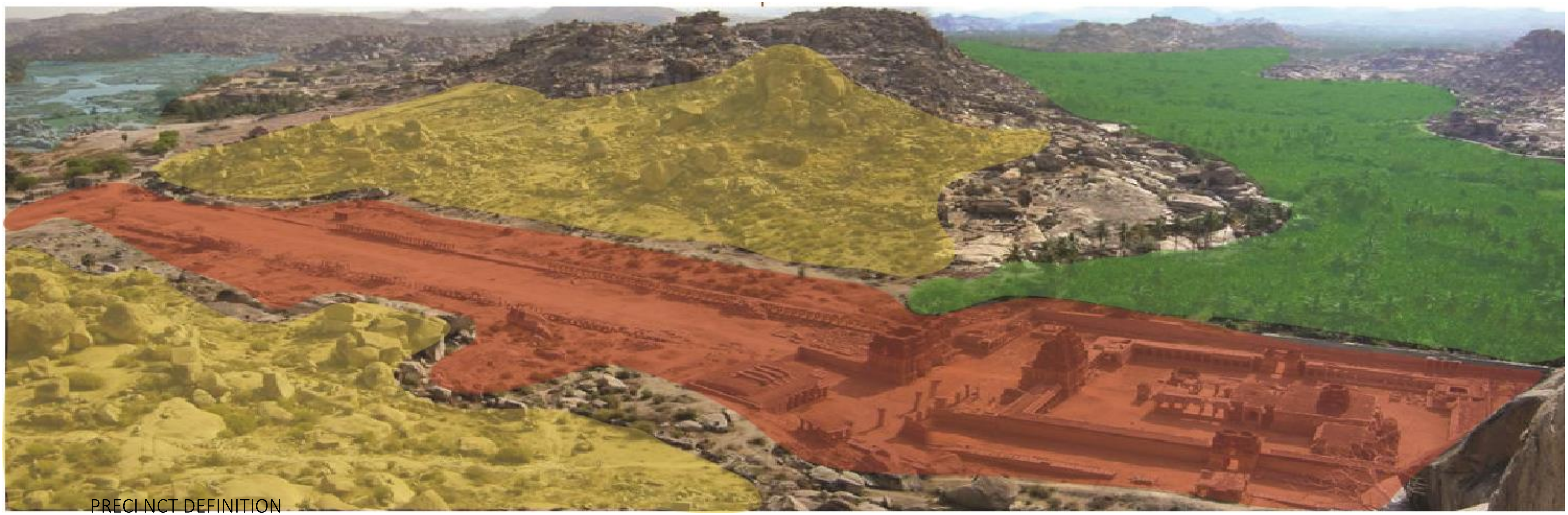
Varied aspects of landscape systems captured and layered on digital platforms… hydrogeology, productivity, built and unbuilt.. Tangible and intangible..
On-ground investigations combined with digital interpretations reveal complex relationships between the natural and cultural landscapes.

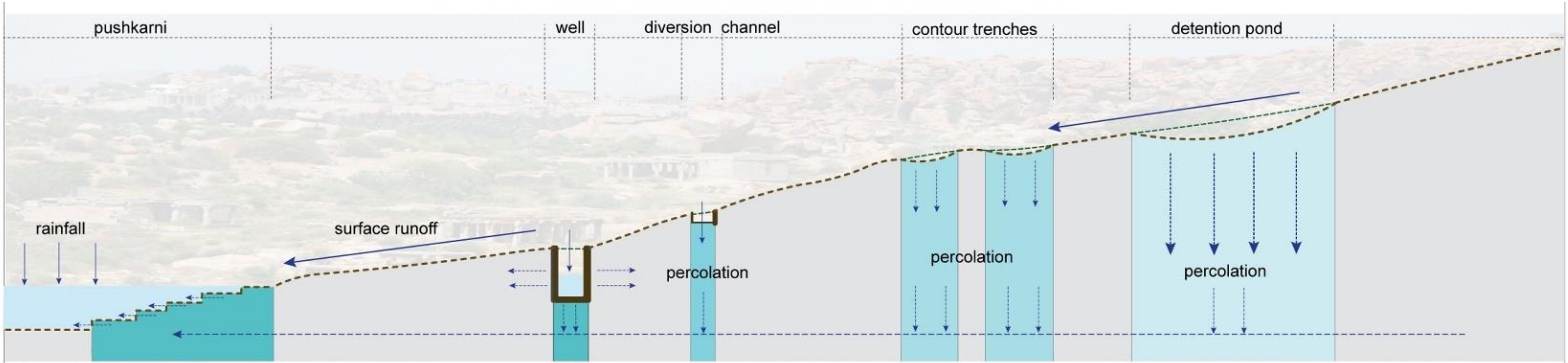


THE DECENTRALIZED PLANNING ORDER



LAND CHARACTERISTICS





water performance A


pushkarni


well


diversion channel

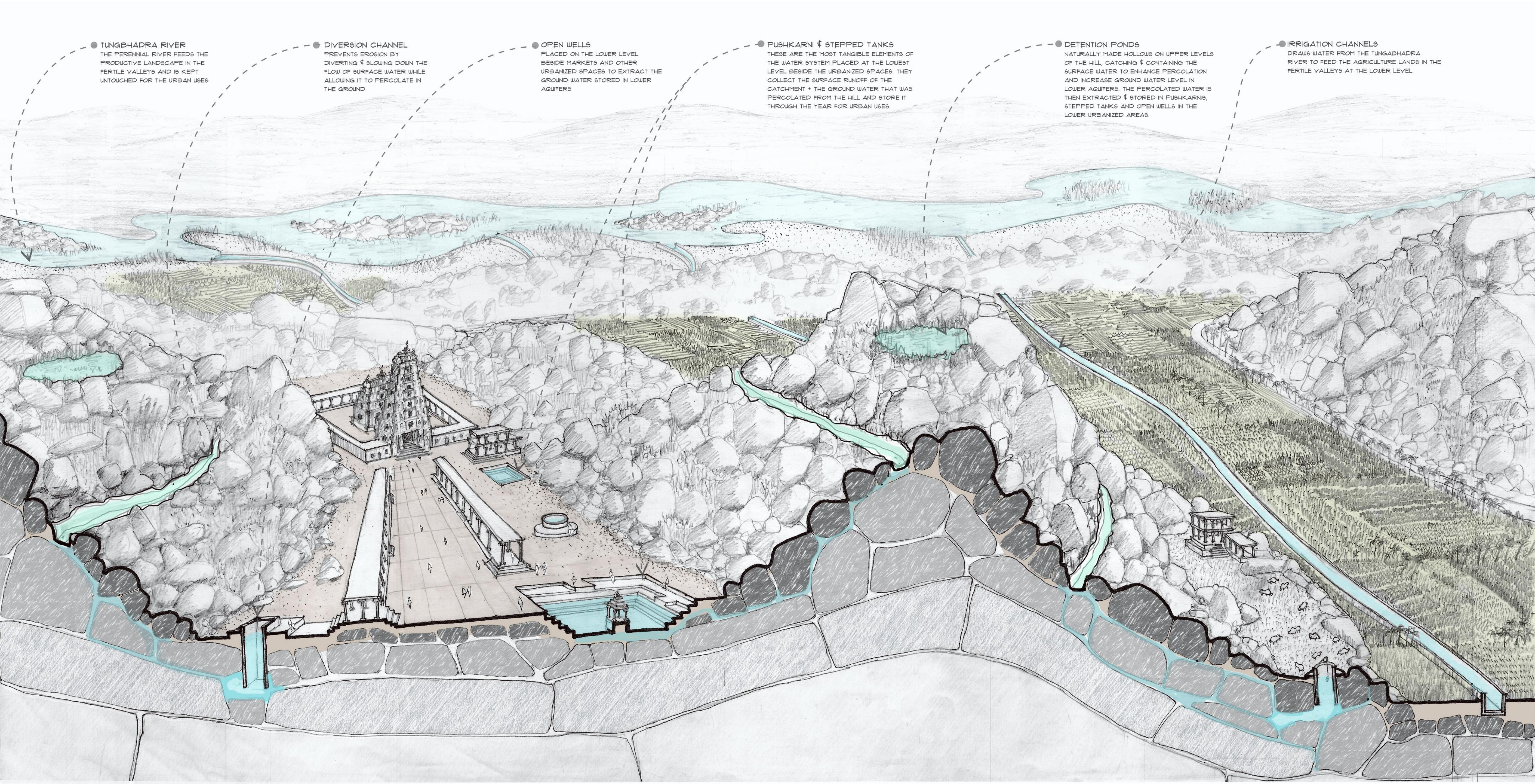

contour trenches


detention pond seen atop the hills

FEB 2004

READING NATURAL AND CULTURAL LANDSCAPES

Mapping the varied narratives – digital, historical, cultural – reveals a dynamic and resilient fabric sustained over centuries.



BOULDER TOPOGRAPHY

THE HILL WORKS AS A SPONGE, COLLECTING AND HOLDING THE SURFACE WATER TO PREVENT EROSION, AND INCREASE PERCOLATION

FLAT + UNFERTILE

URBANIZED WITH TEMPLE PRECINCTS AND MARKETS + WATER EXTRACTING & STORING ELEMENTS SUCH AS PUSHKARNI, STEPPED WELLS, ETC.

BOULDER TOPOGRAPHY

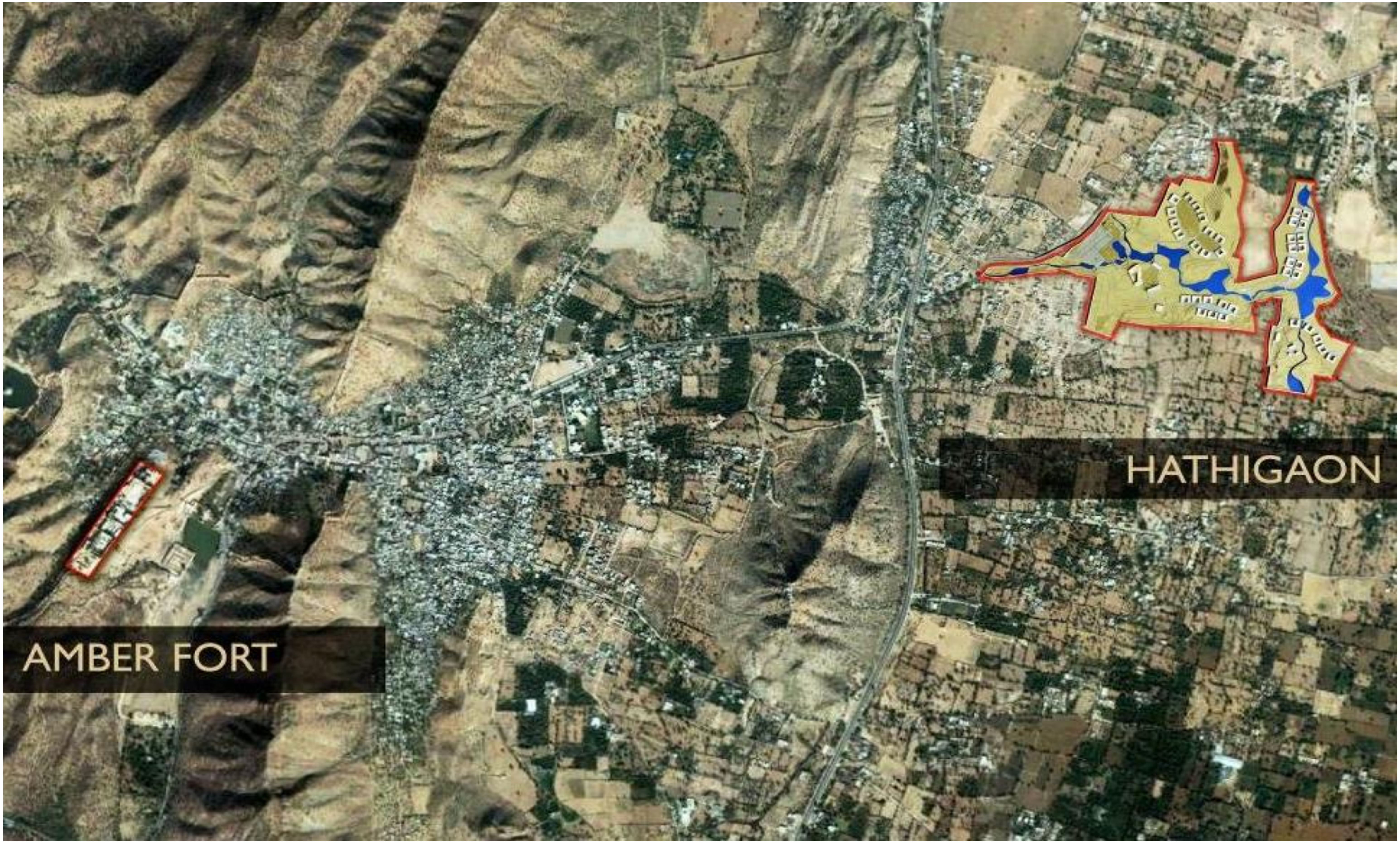
WATER ABSORBING ELEMENTS SUCH AS DETENTION PONDS, DIVERSION CHANNELS ETC, TO HOLD AND PERCOLATE THE SURFACE RUNOFF AND ENHANCE THE GROUND WATER LEVEL IN LOWER AQUIFERS. + CATTLE GRAZING IN THE FOOTHILLS + WATCH TOWER AND SHRINES TO KEEP THE SACRED LANDSCAPE INTACT

FLAT + FERTILE

AGRICULTURE IN THE FERTILE VALLEYS FED WITH WATER FROM THE TUNGABHADRA RIVER THROUGH IRRIGATION CHANNELS

LEARNINGS FROM HAMPI

- Response to specific context
- Decentralization – spaces, functions, systems and services
- Minimal disruption to the natural landscape
- Maximise leveraging of natural capacity – production of food, water and space
- Natural capacity reflected in settlement patterns and functions


HATHIGAON
AMBER FORT

CONTEXT


Image 1


Image 2


Image 3


Image 4


Image 5

The planning of the campus had to address diverse but overlapping issues that emerged due to the unusual project setting. The first and foremost was the creation of a sustainable habitat for a group of elephants that did not belong to the particular region. The idea of relocation was not considered due to livelihood of human dependents; also the nearest region for the elephant habitat was more than 1000kms away from the site. The second consideration was to address the arid landscape and regenerate it into a sustainable territory by appropriate vegetation, water management and soil conditioning. Third was the inclusion of tourists within the site, which would act as a major revenue for the maintenance of the site and the animals. This meant a careful segregation yet inclusive site arrangement between the elephant habitat space and tourist/public interface.

Nature as a Museum | Incorporating Existing Ecology | Recreation | Merging of Traditions

Zoning for Separation and Interaction | Educational Experience for Tourist | Clean Water

Sensitive to Elephants and humans | Create a sustainable habitat for elephants and mahouts

DIGITAL MODELLING AND FORECASTING

Understanding the Elephant Community

Roof Plan

First Floor Plan

Ground Floor Plan

Colour	Range Start	Range End	Percent	Area (in mm)
	89000	92000	24.5	127804900114.33
	92000	95000	30.7	160047842735.81
	95000	98000	37.9	197786852510.11
	98000	101000	4.3	22373005446.74
	101000	105000	1.4	7295859815.01
	105000	108000	0.7	3461636693.92
	108000	116000	0.5	2643504882.44

DIGITAL MODELLING AND FORECASTING

COMPUTATION OF ANNUAL WATER REQUIREMENT (IN LITRES)

A. Water requirement for elephants can be capped at 250 litre (drinking) + 300 litre (Miscellaneous):

550 l./day/elephant. Hence, 550x365 days x 100 nos.: **2,00,75,000 litres/ year.**

B. Domestic water requirement for Mahout settlements:

100 elephants x 2 dependants x 100 lpcd x 365 days: **73,00,000 litres/year**

C. Annual requirement for staff (30 nos.) at 60 l./day and visitors (500nos./day) at 50 l./day:

(60x365x30) + (50x365x500): 91,25,000 + 6,57,000: **97,82,000 litres/year**

D. Annual water requirement for Irrigation:

Site area x 1mm/sq.m. x (365-30 rainy days) x 1000: **11,76,68,750 litres/year**

Hence, Water Closure needs to be achieved for (A + B + C + D): **15,48,25,750 litres/year.** This requirement can be derived from water retained on site and from external water sources/ agencies.

ESTIMATED WATER RECHARGE AND RETENTION AT SITE

Site Area: **3,51,250 sqm.**
Annual Rainfall : **600 mm./ year.**
Recharge possible after deduction of losses to evapo-transpiration and percolation: **100-70: 0.3**

Therefore, recharge within site is [(Site Area + Area of higher elevation around site) x Annual rainfall x Recharge percentage]

(3,51,250 + 91,450) x 0.6 x 0.3: 79,686 cu.m. : **7,96,86,000 litres/year.**

But only **25%** will be perennially retained: 0.4 x 7,96,86,000: **3,18,74,400 litres/year**

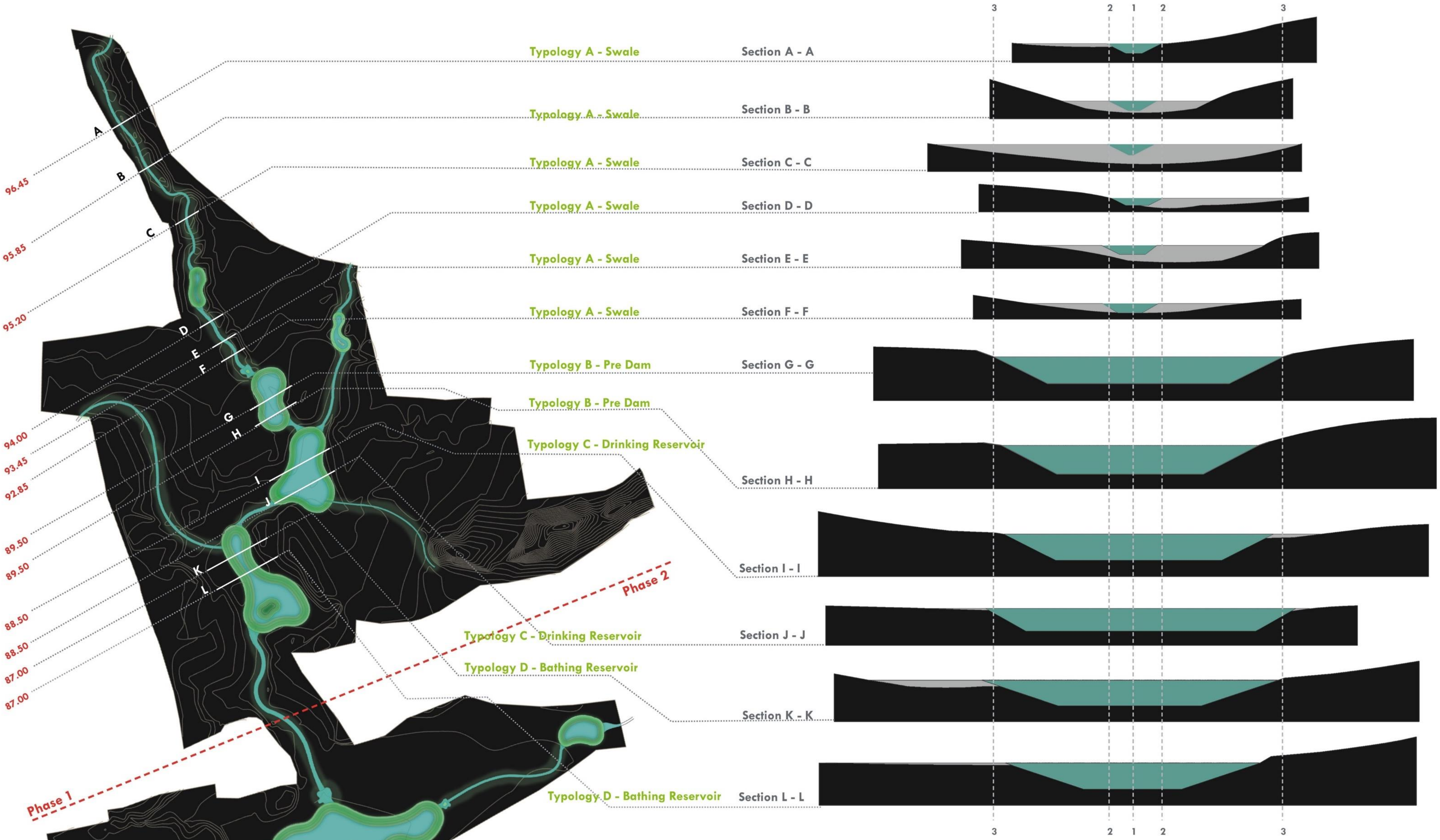
Water that can be sourced from across the site (through a sluice network):
Annual rainfall x Area of site x Recharge percentage x Retention percentage:

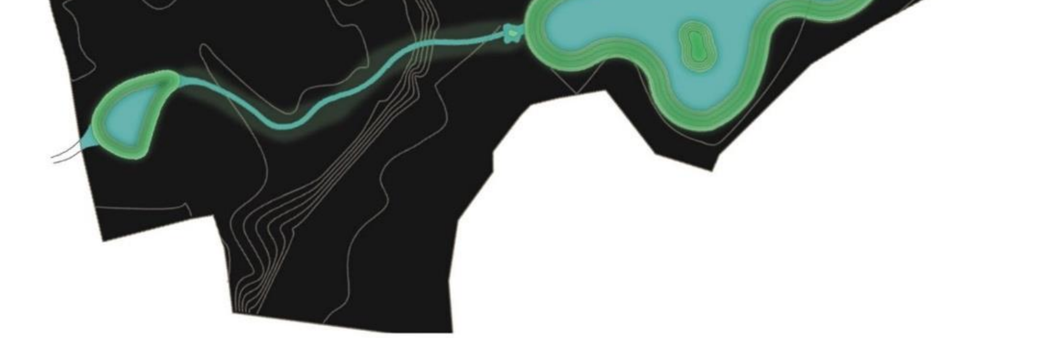
0.6 m./year x 33,800 sq.m. x 0.1 x 0.4 x 1000 : **8,11,200 litres/year.**

Total sum of water available: 3,18,74,400+8,11,200: **3,36,85,600 litres/year.**

Therefore, the deficit is: 15,48,25,750-3,26,85,600: **12,21,40,150 litres/year.**

Note:
Recharge percentage will see a rise in its figure every consecutive monsoon,





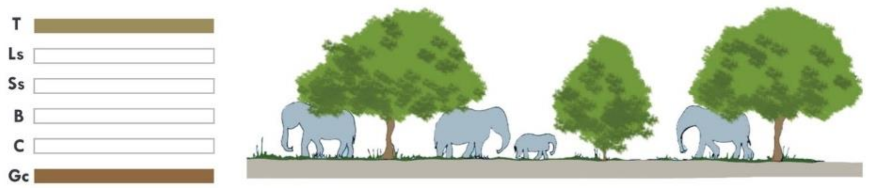
The water harnessed in the site is treated through a series of reservoirs of varying intensities and an integrated swale system. The system of reservoirs in the site vary not only in their physical form but also in their relation to topography as they incorporate the existing slopes of the terrain with minimum modulation. The system of reservoirs thus developed bear a strong hierarchical relationship that is based on two conditions - the principles of water management and on the relationship between elephants and water. The first components are the pre dams that hold water before the overflow reaches them to the reservoirs that also act as communal spaces for the elephants' mud bath. The second are the drinking water reservoirs with steeper sections, limiting direct access to water. The third are the bathing reservoirs integrated with ramps to allow access into the water for the mahouts to bathe the elephants. Thus the reservoirs become not only a system integral to the sustainable design initiative but also one that shapes the social interactions of the inhabitants of the site

BIODIVERSITY MANAGEMENT

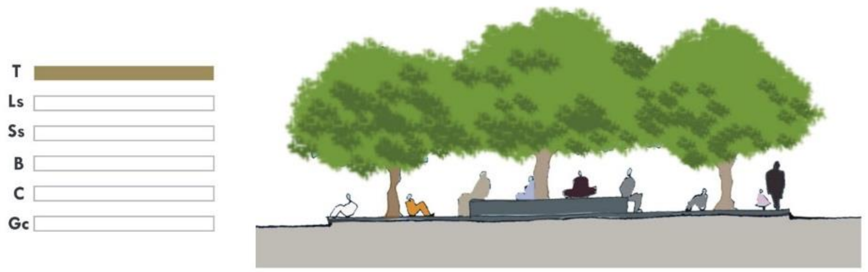
Planting around the Perimeter

Kitchen garden patches for the mahouts

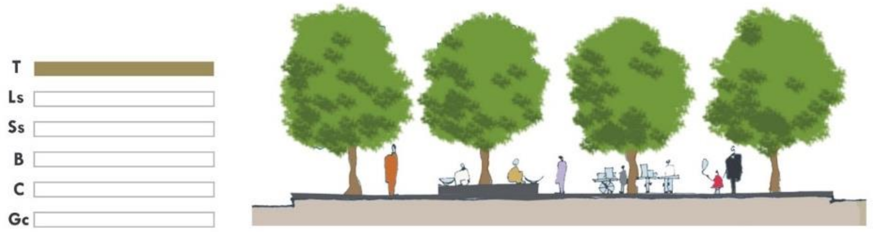
Levels of vegetation near elephants habitat



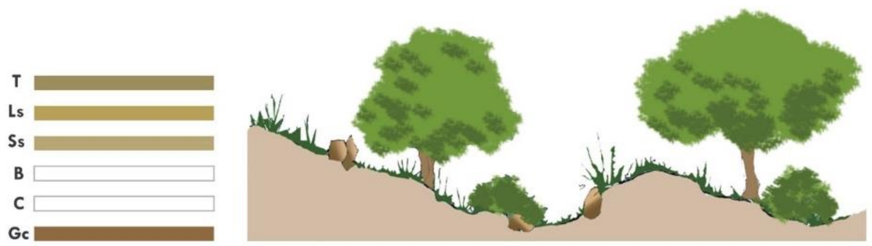
Space between visitor and elephant interaction



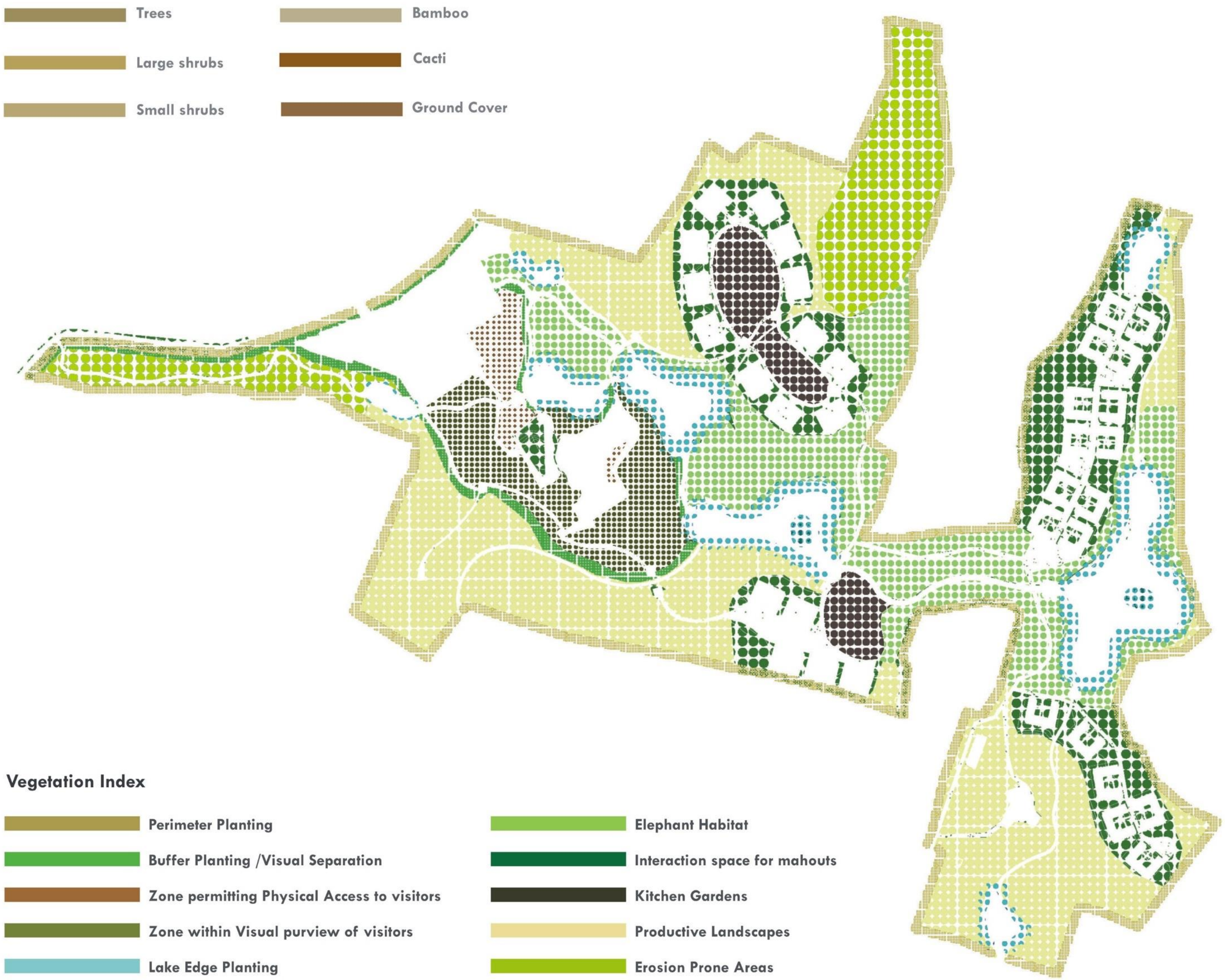
Spaces for the Mahout Community



Visitors Zone



Erosion Control Mechanism



Planting Strategy

Establishment of a balanced ecosystem in this degraded site formed the crux of the design policy, an approximation of the natural habitat of the elephants. The selection of species for multi-storied vegetation is derived from the larger region, more specifically based on the ecosystem of the Aravali ranges. Zone-wise interpretation of the vegetation, such as the definition of the perimeter and microcosms of grasslands and wetlands, are characteristics that modulate visual access to the elephant habitat. The root system of the indigenous plant palette stabilizes the topsoil layer in this erosion-prone site in conjunction with other soil conservation measures.

Strategic Master Plan
Mahout units treated with central large court to integrated services and act as a community space
Entrance plaza treated with dense planation as an interface to the habitat
Parking plaza for visitors treated with permeable surfaces
Pre dam created to control water flow
Series pf pathways catering to both elephants and visitors
Public space including visitors museum and viewing gallery
Pre Dam treatment
Drinking Reservoir for elephants
Bathing Reservoir for elephants
Mahout units treated with internal hardcourts
Pre dam created to control water flow
Mahout units treated with internal hardcourts
Bathing Reservoir for elephants treated with ramp access
Mahout units treated with internal hardcourts connected through a spine
Hospital and other services
Pre dam created to control water flow tapped from external sources
To Amber fort
Public Zone
Elephant Habitat
Phase 2
Phase 1

BEFORE INTERVENTION – CIRCA 2004

EXTENDED SITE ENGAGEMENT

Continuous engagement over 15 years.. Integrating soil, water and biodiversity management using traditional technologies


Site Image 2009


Site Image 2010


Site Image 2009


Site Image 2009

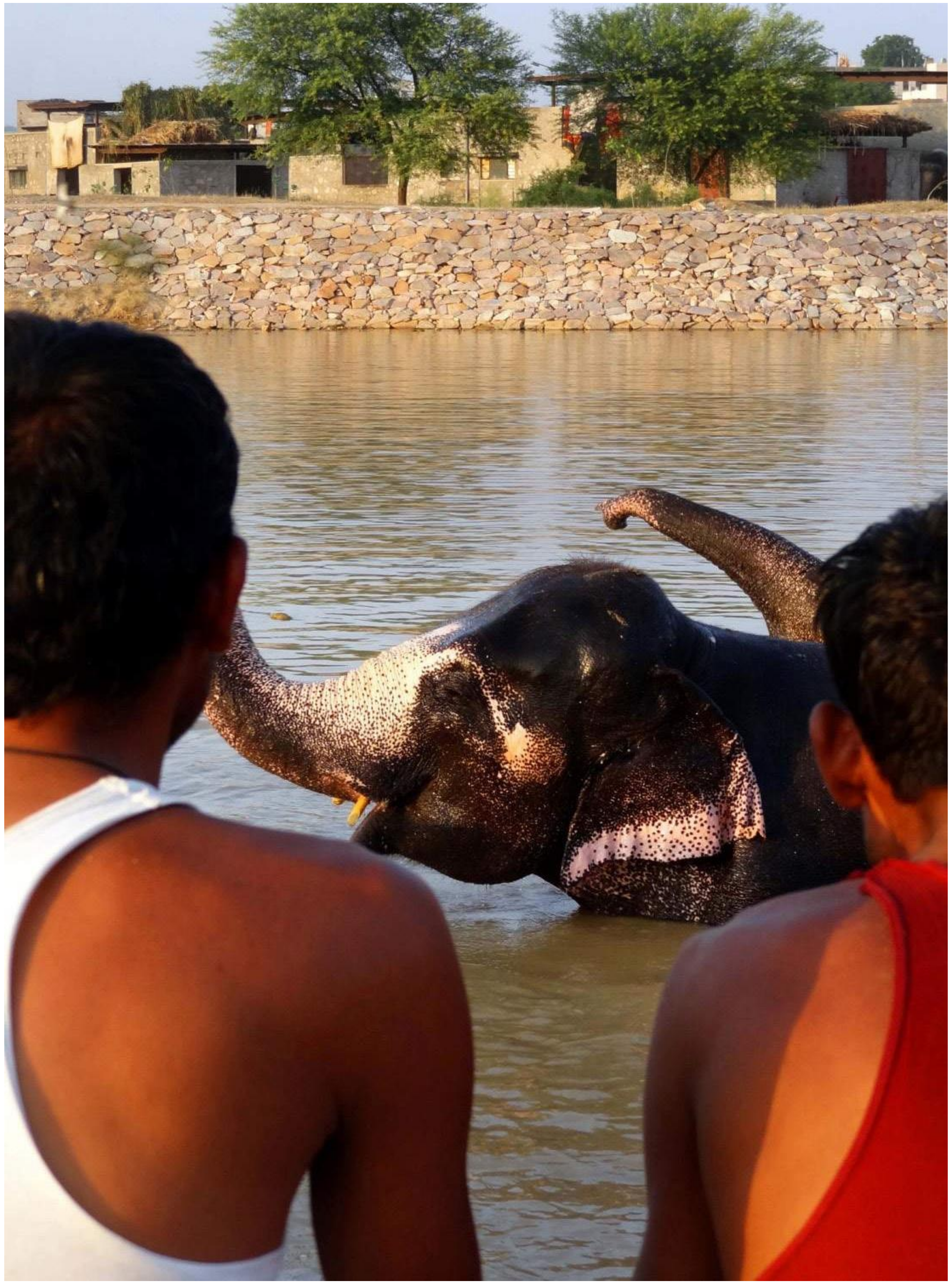

Site Image 2010

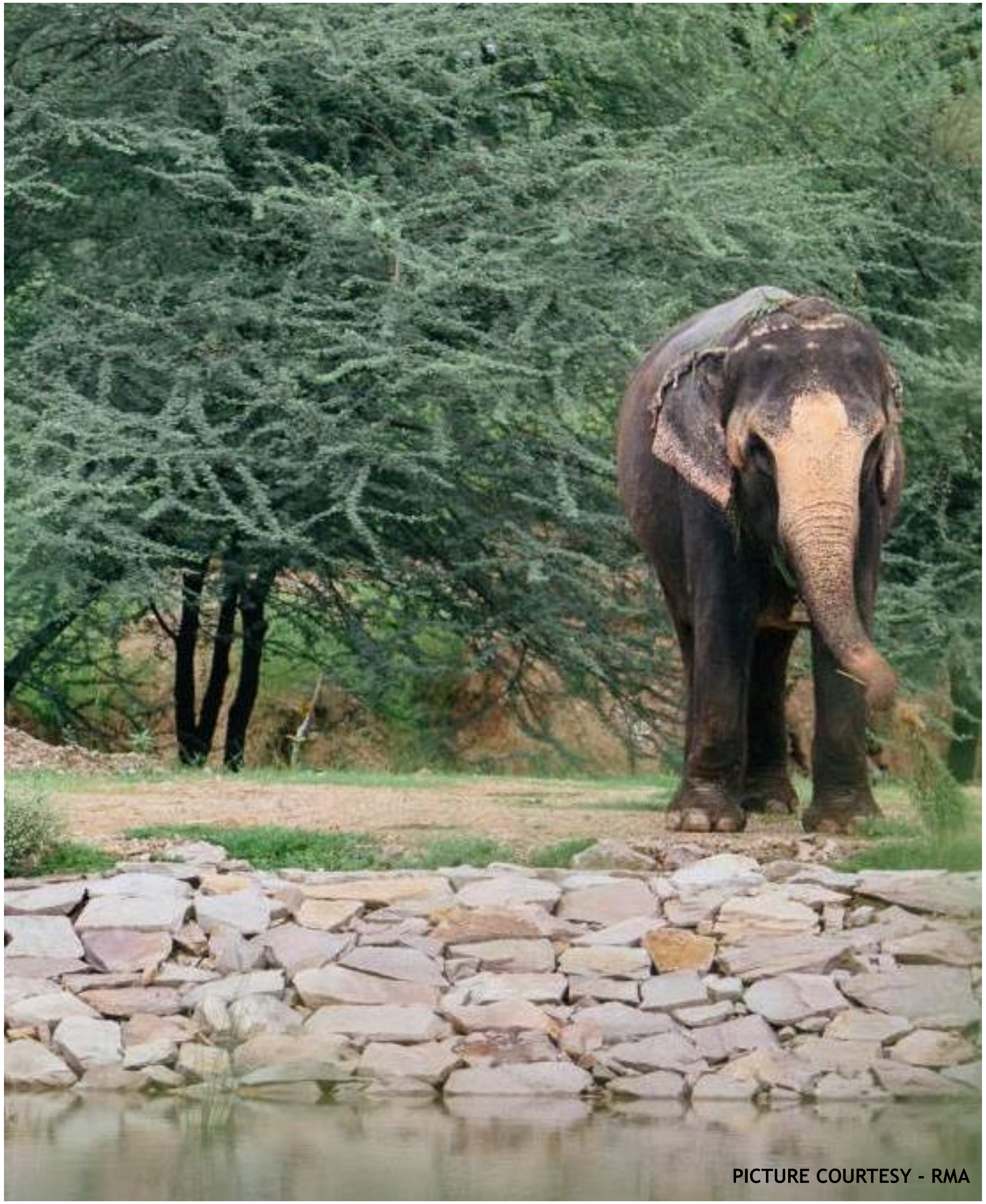
TRADITIONAL STRATEGIES ADAPTED TO MEET CONTEMPORARY NEEDS

Learning from desert communities – from water management to construction techniques.

PICTURE COURTESY - RMA

INTEGRATION OF HUMAN – ANIMAL LIVING ENVIRONMENTS



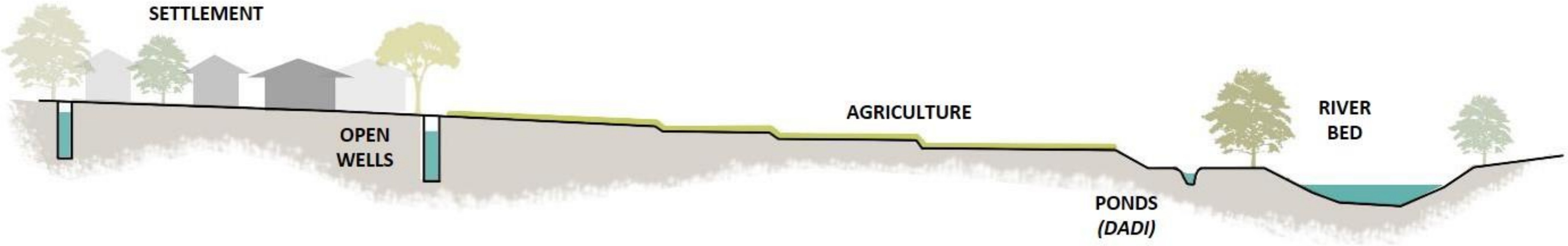


PICTURE COURTESY - RMA

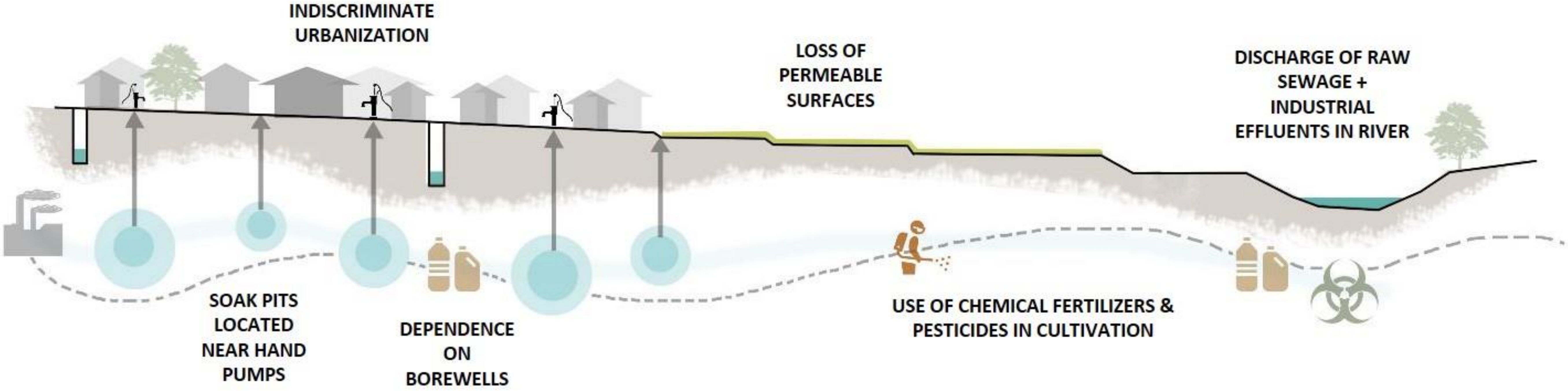
URBAN POOR SETTLEMENTS - RANCHI

ADDRESS LIVELIHOOD DISRUPTION LINKED WITH CLIMATE CHANGE

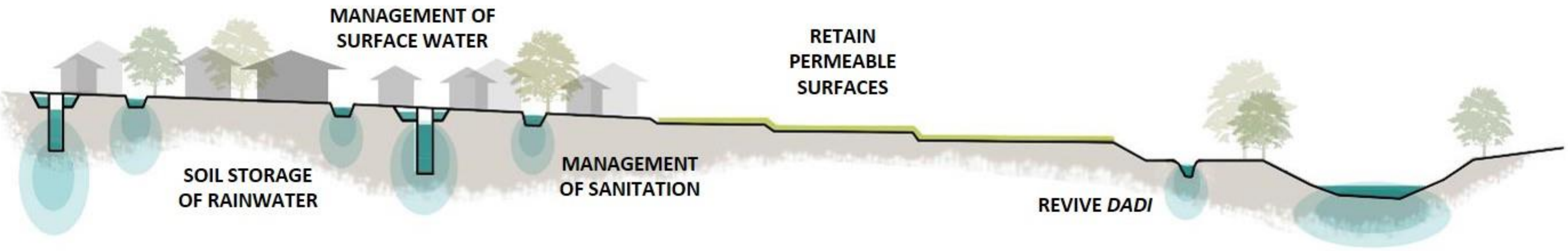
PAST – Traditional relationships with water systems in village



PRESENT – Village subsumed by urban growth



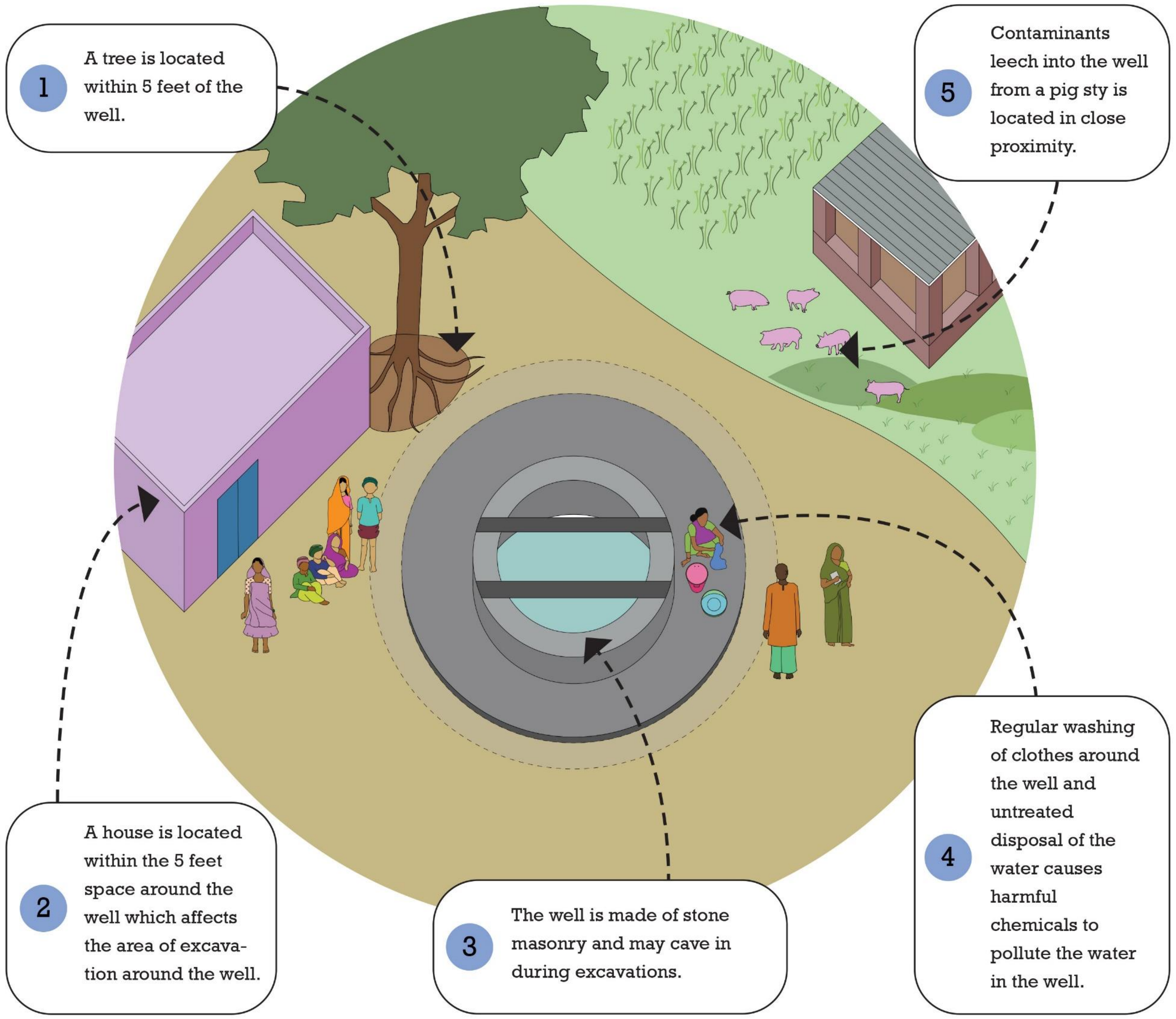
RECOMMENDED INTERVENTIONS



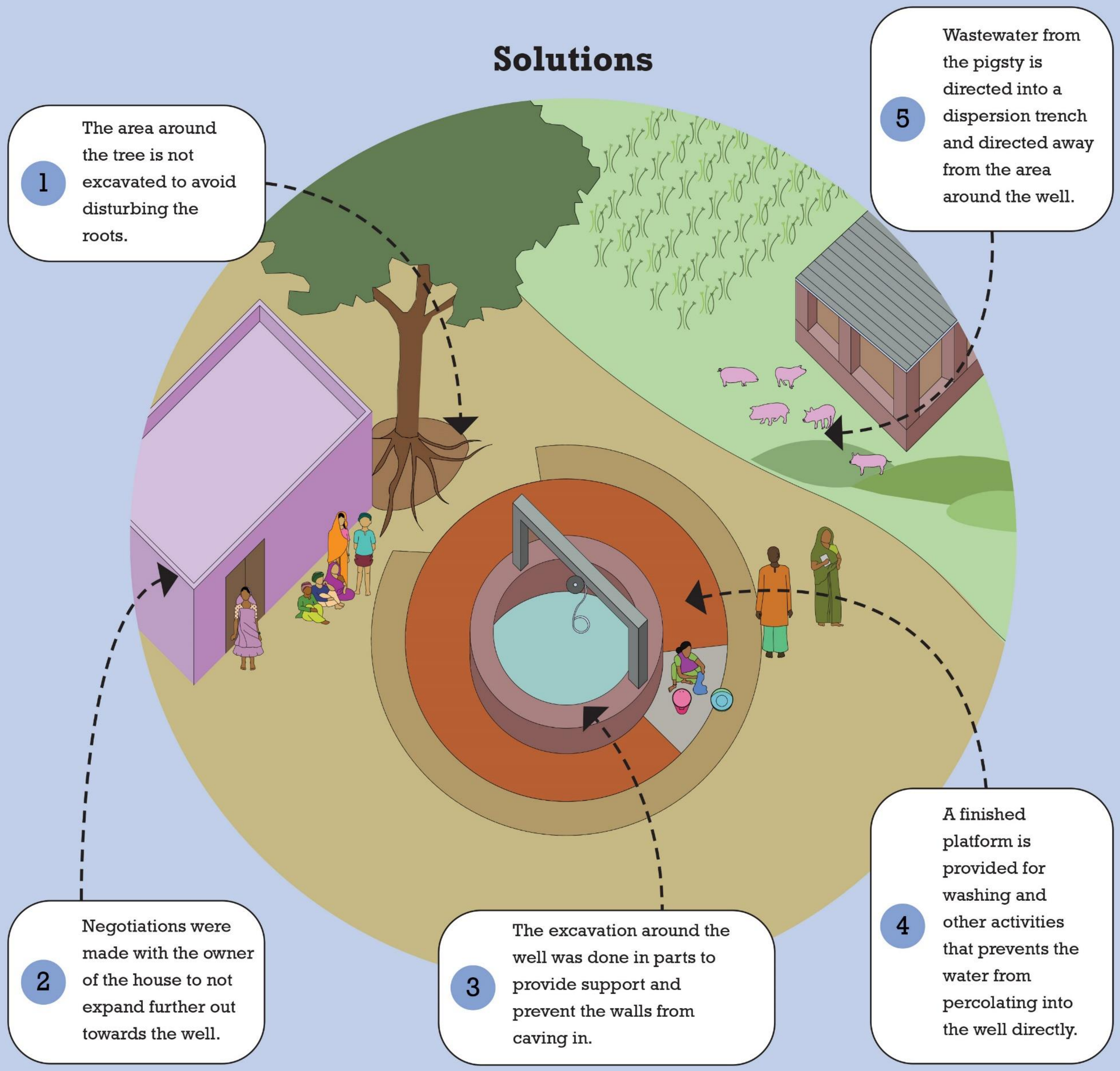

Sirom Toli Wells 1, 2 & 3
Gopal Well
Mahto Well
Sarna Toli Well
Dangdang Well
Sarna Toli Well
Government Well
Jagran Toli Well

5 D. Gopal Well

Concerns

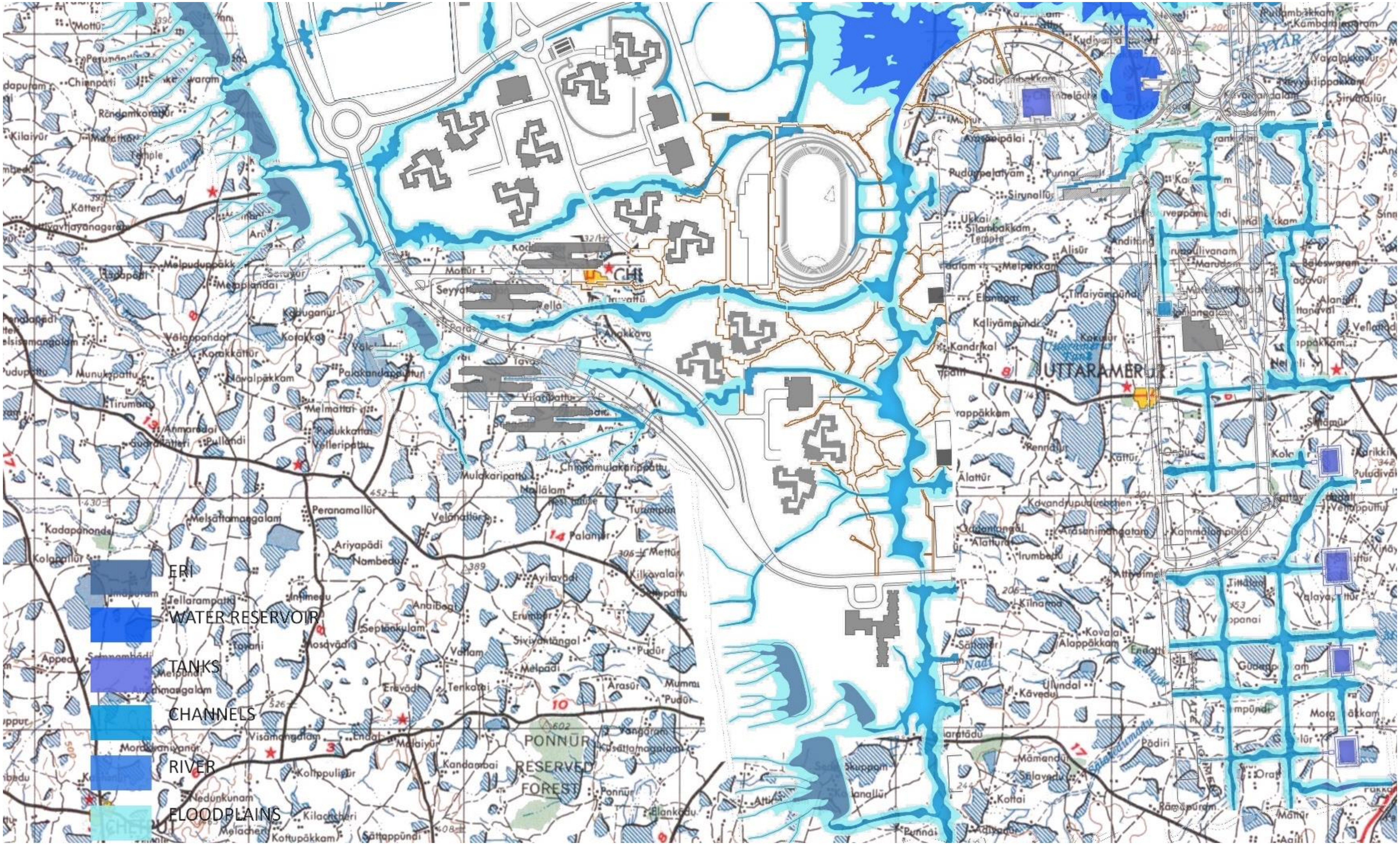


Solutions



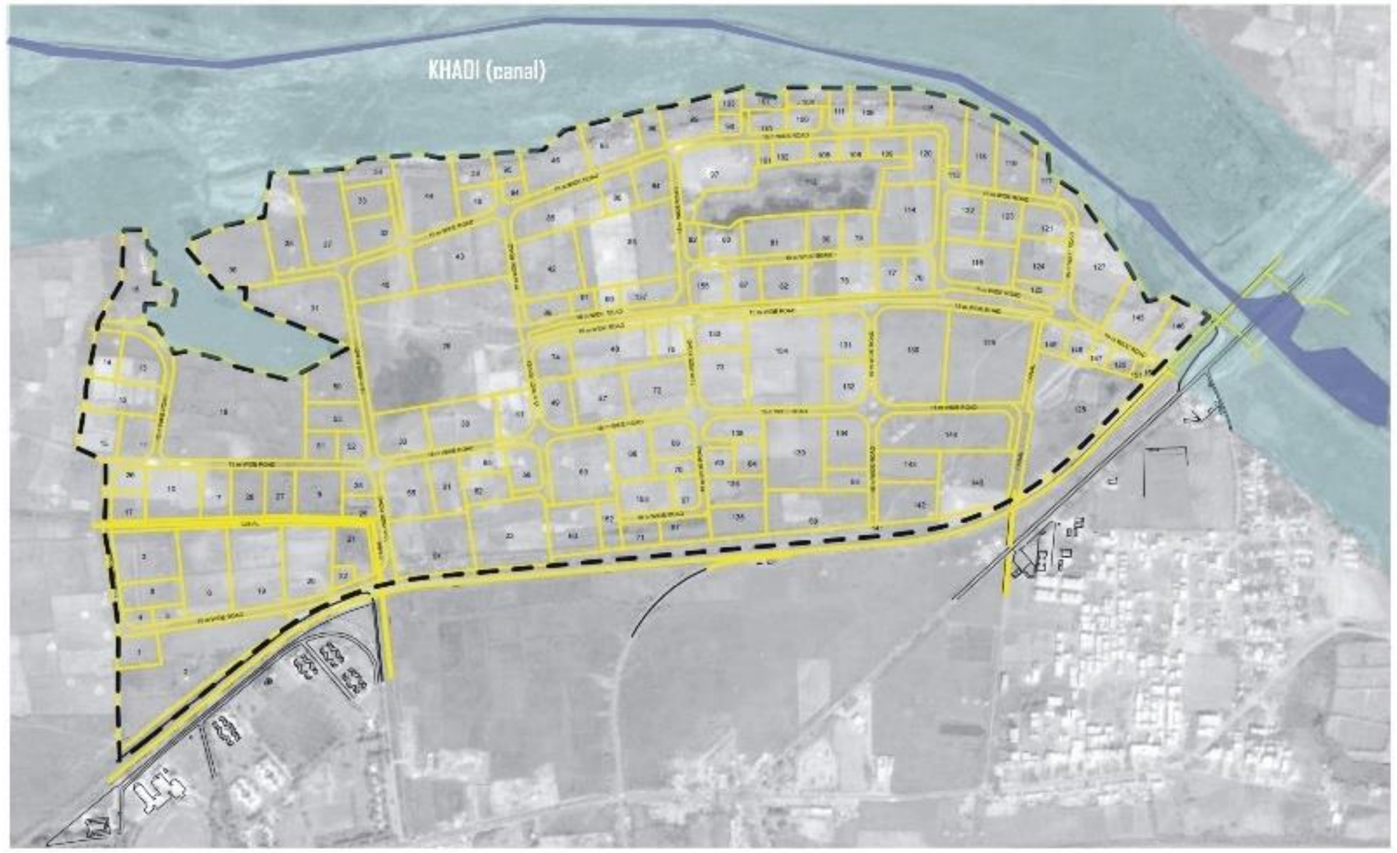
TRADITIONAL LAND-WATER NETWORKS AS STRUCTURING ELEMENT

CENTRAL UNIVERSITY OF TAMIL NADU, THIRUVARUR

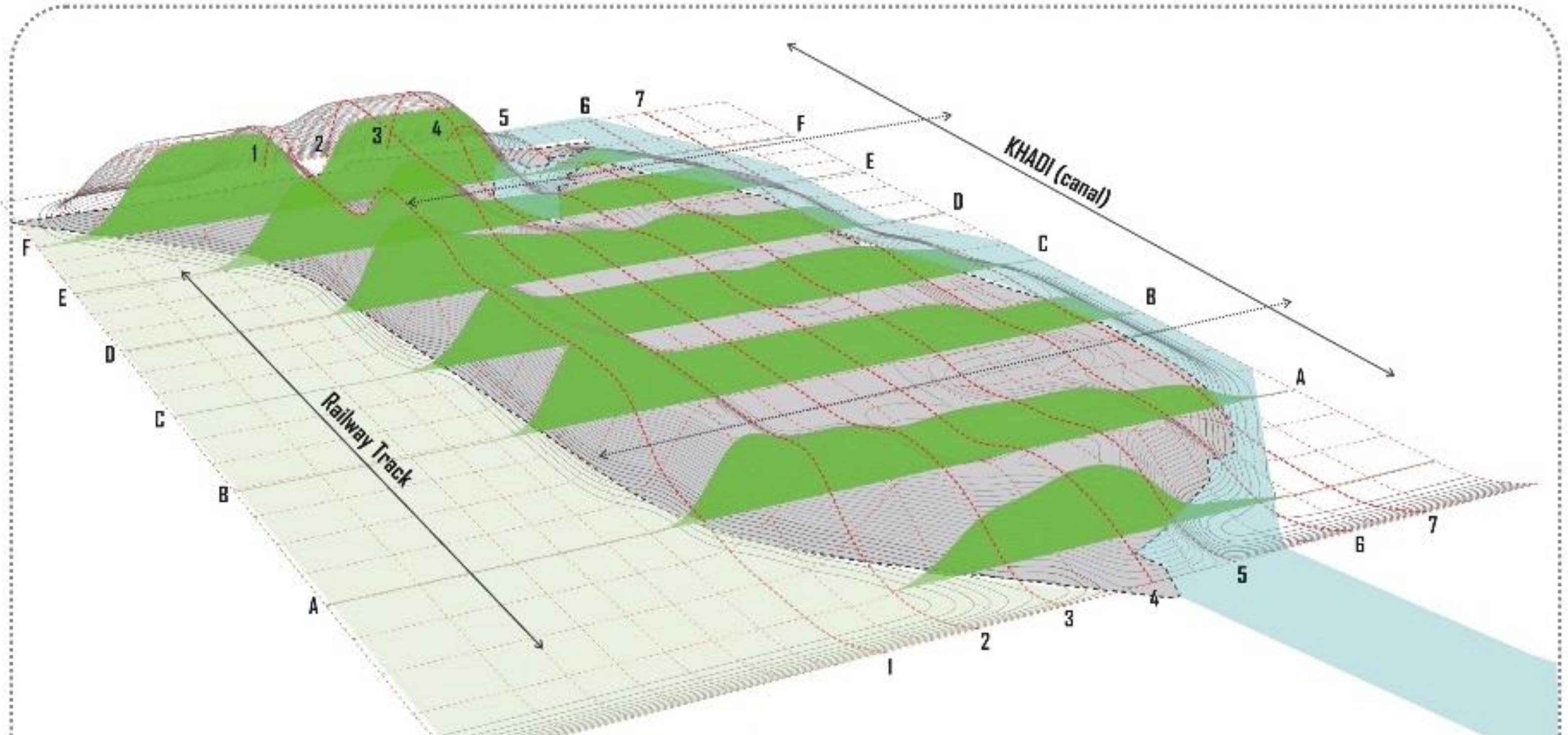


ADDRESSING VULNERABILITY TO NATURAL AND INDUSTRIAL DISASTERS

ICCHAPOR TOWNSHIP, SURAT

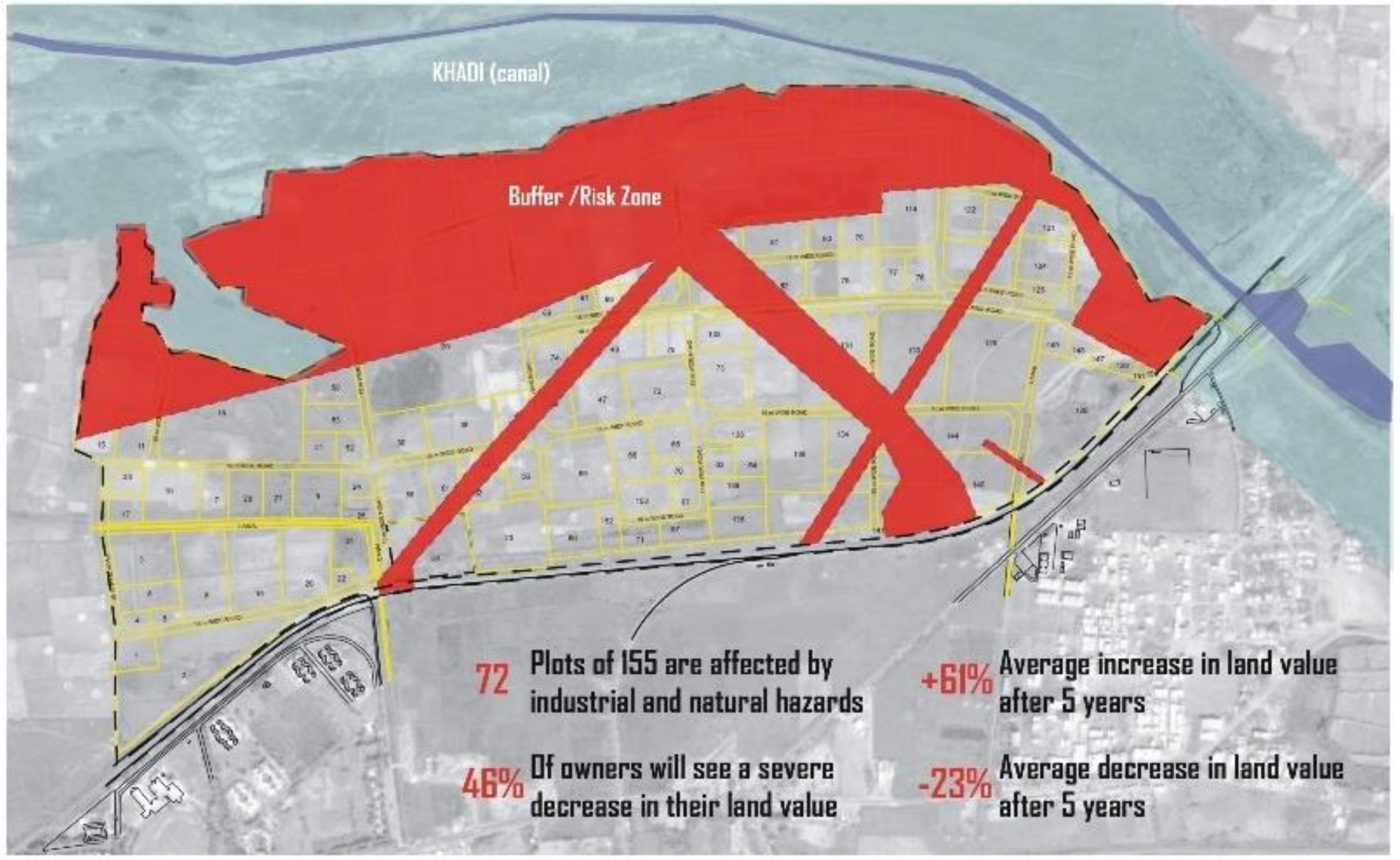


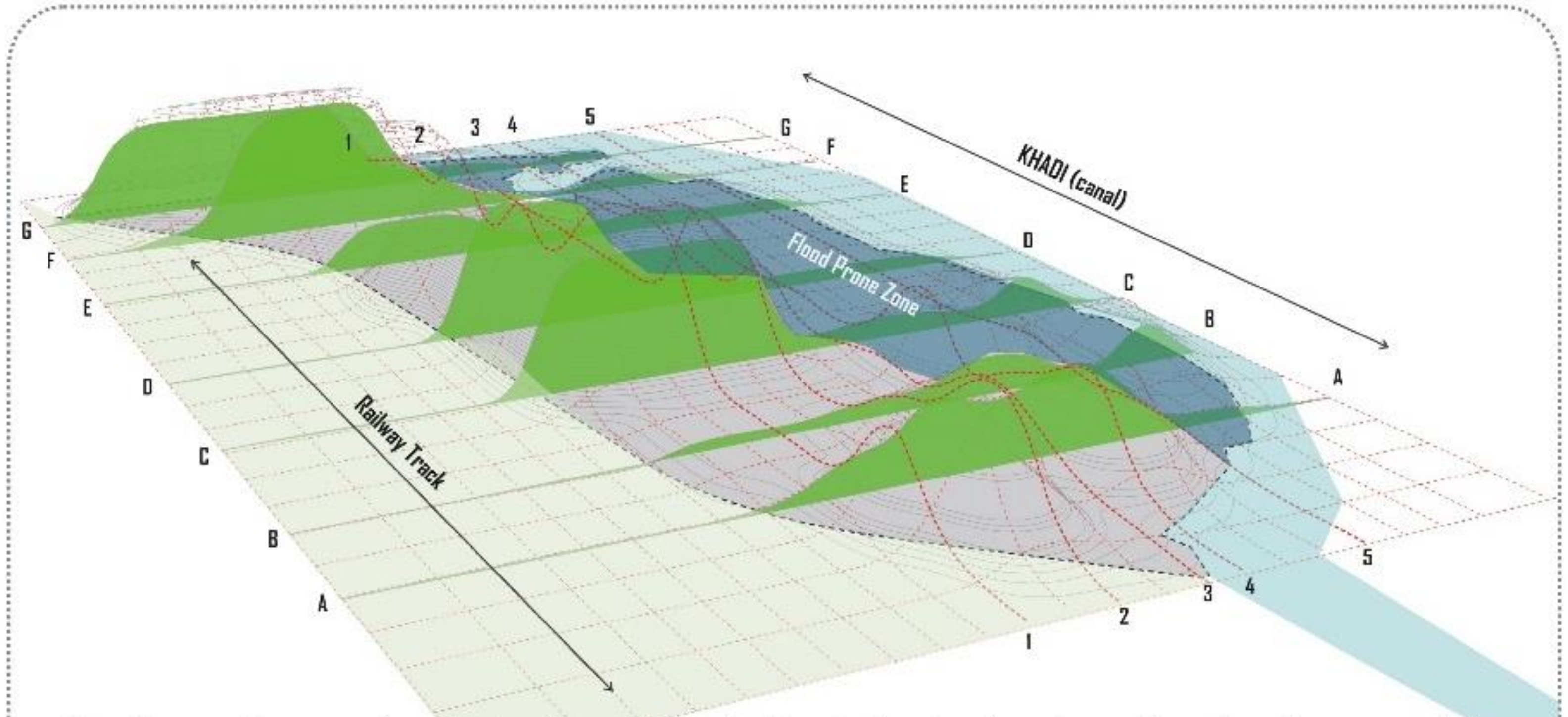
Ⓑ Redistribution of Plots as per Conventional TP scheme



The diagram illustrates the distribution of land value of the plots within the region which is higher near the railway lines(with better access) and gradually decreasing towards the Khadi (canal) area(with high flood risk).

Ⓒ Comparative Land Value Distribution based on TP scheme evaluation

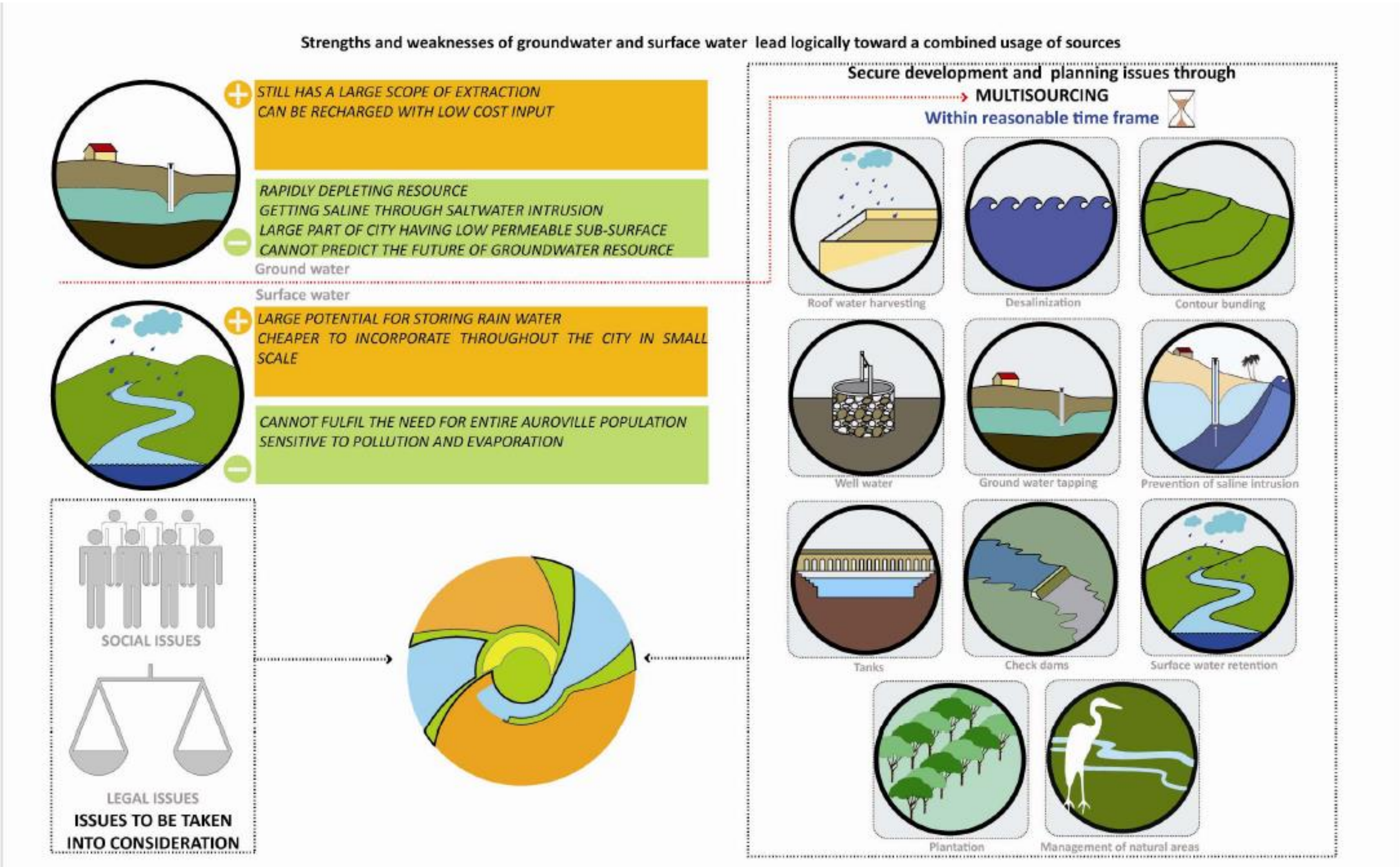




The diagram illustrates the relative change in land values in the site after determining the risk zones and the inequality of land value generated where plots outside the buffer are substantially higher than the ones prone to floods and are lying within the HT/Gas/Petroleum corridors.

MULTI-SOURCE RESILIENCE BUILDING FOR A CITY-REGION AGAINST CLIMATE CHANGE

AUROVILLE WATER SECURITY



CITY SCALE CLOSED LOOPS FOR ENERGY, WATER AND FOOD SYSTEMS

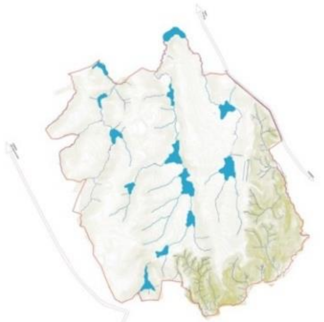
BAB ZAERS, MOROCCO

NATURAL CHARACTERS OF THE SITE

Understand the natural characters (geology, fauna and flora...), Consider topography, open-landscape and natural components before planning the project

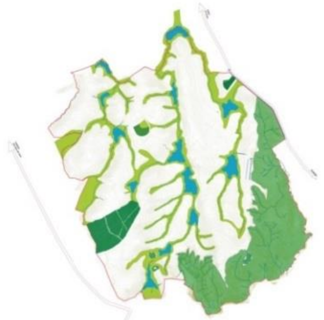
WATER NETWORK

Identify water resources and watershed. Design a network to collect, store, treat and distribute water.



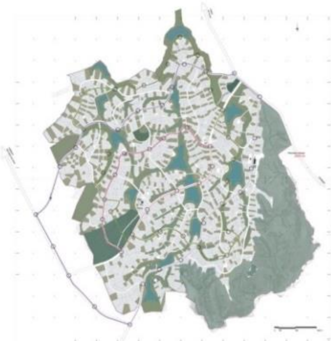
GREENWAY NETWORK

Develop green corridors to counter habitat fragmentation. Add landscape values to the water network. Link green areas in both ecological and recreational perspectives



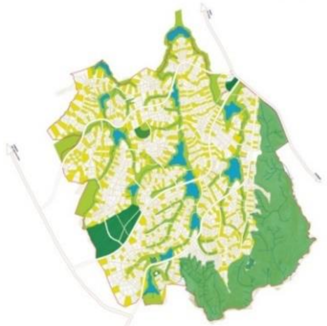
MOBILITY INFRASTRUCTURE

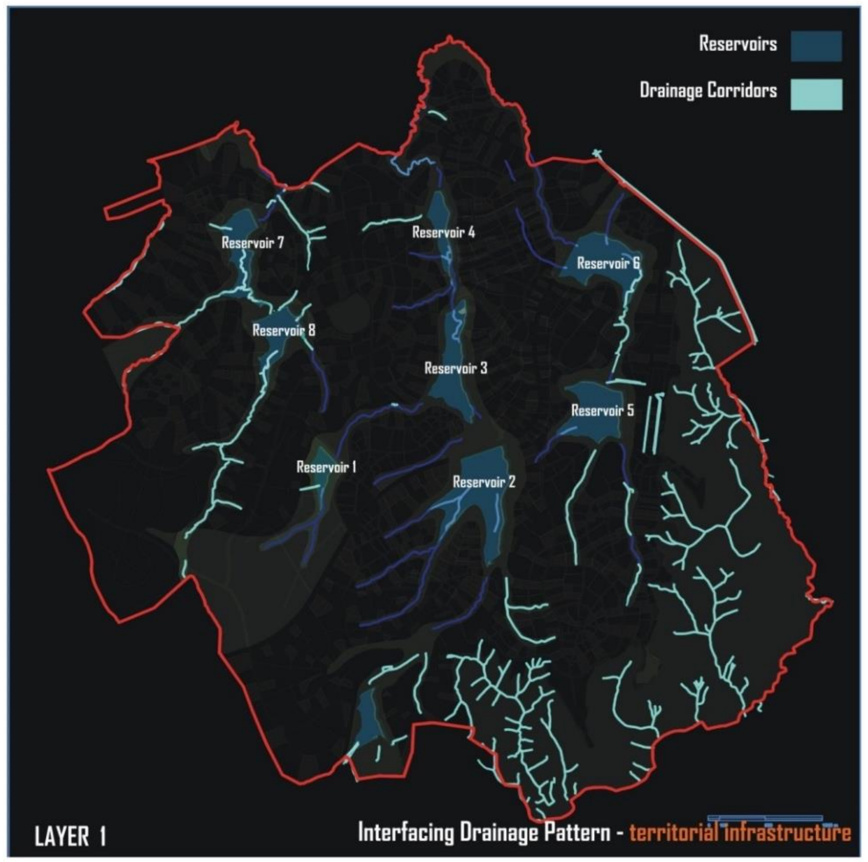
Design a legible, permeable and safe network for movement, Recognize priority for pedestriann and cyclist segregating them from vehicular movements Integrate transport public within the network

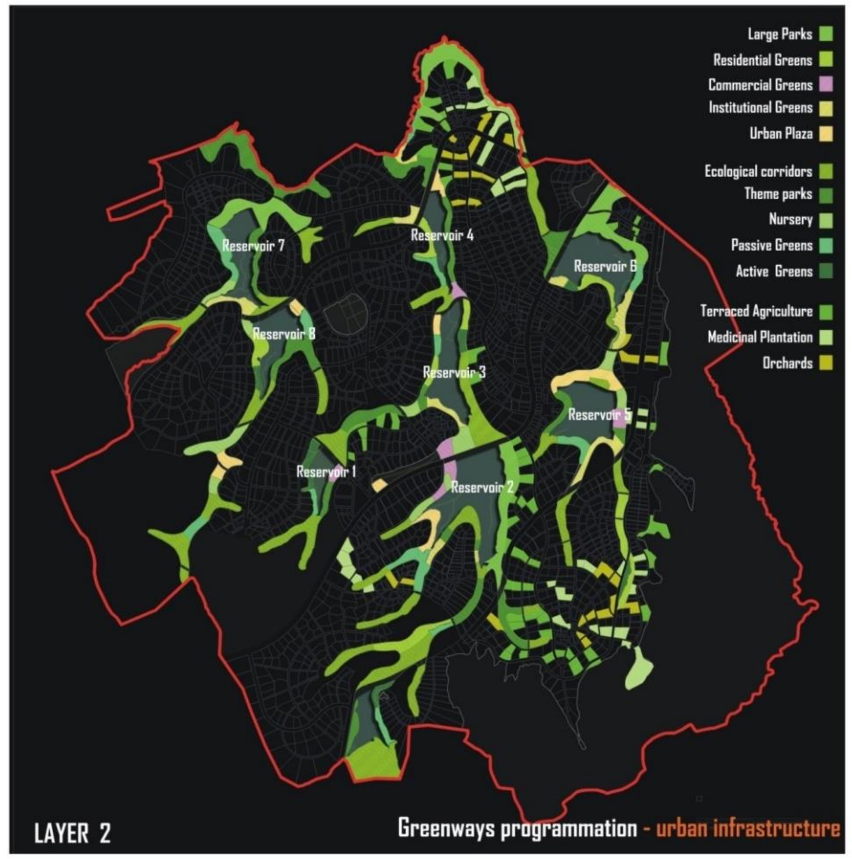


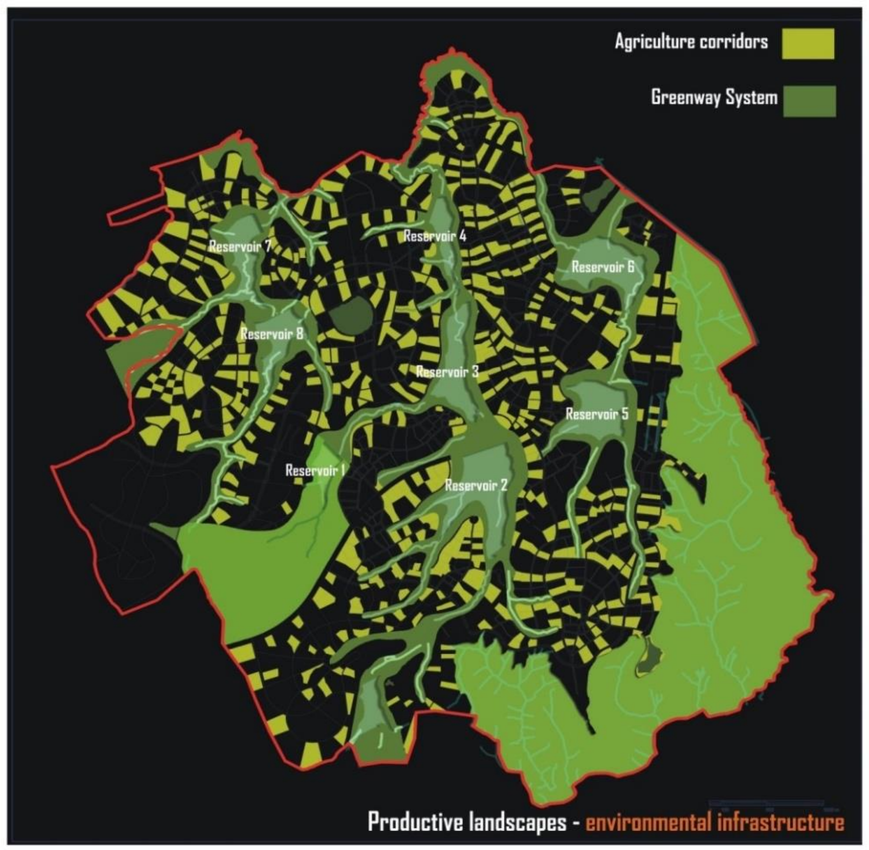
AGRICULTURE NETWORK

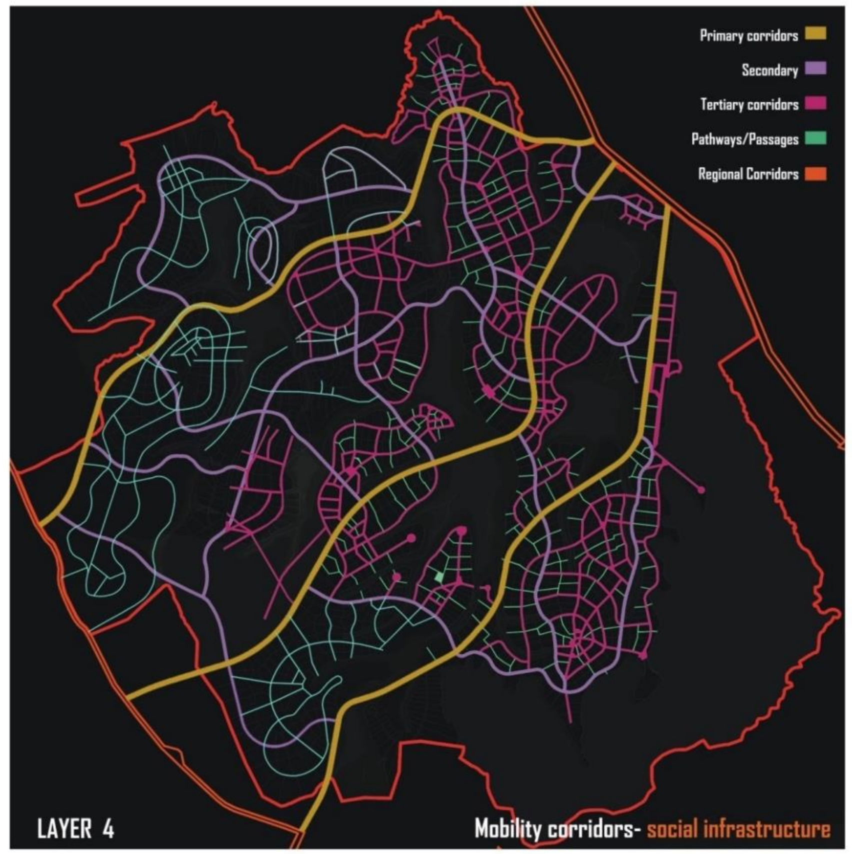
Include agriculture to the urban structure, Create a food system integrated within the city which ensures food security





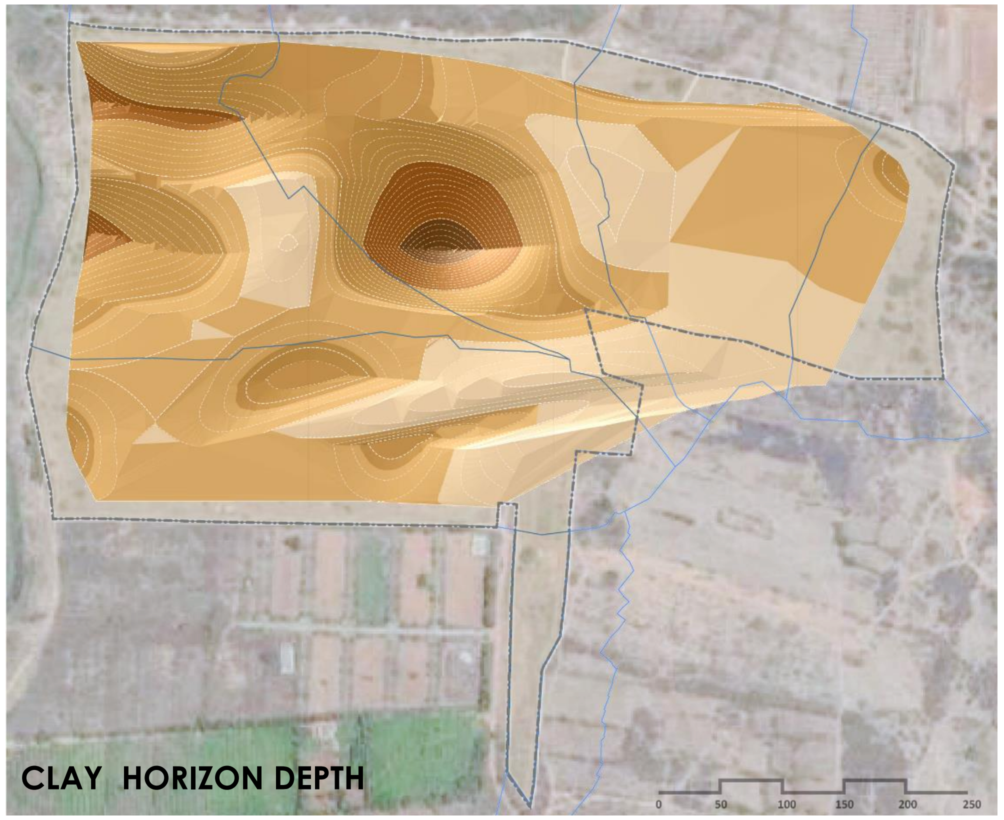


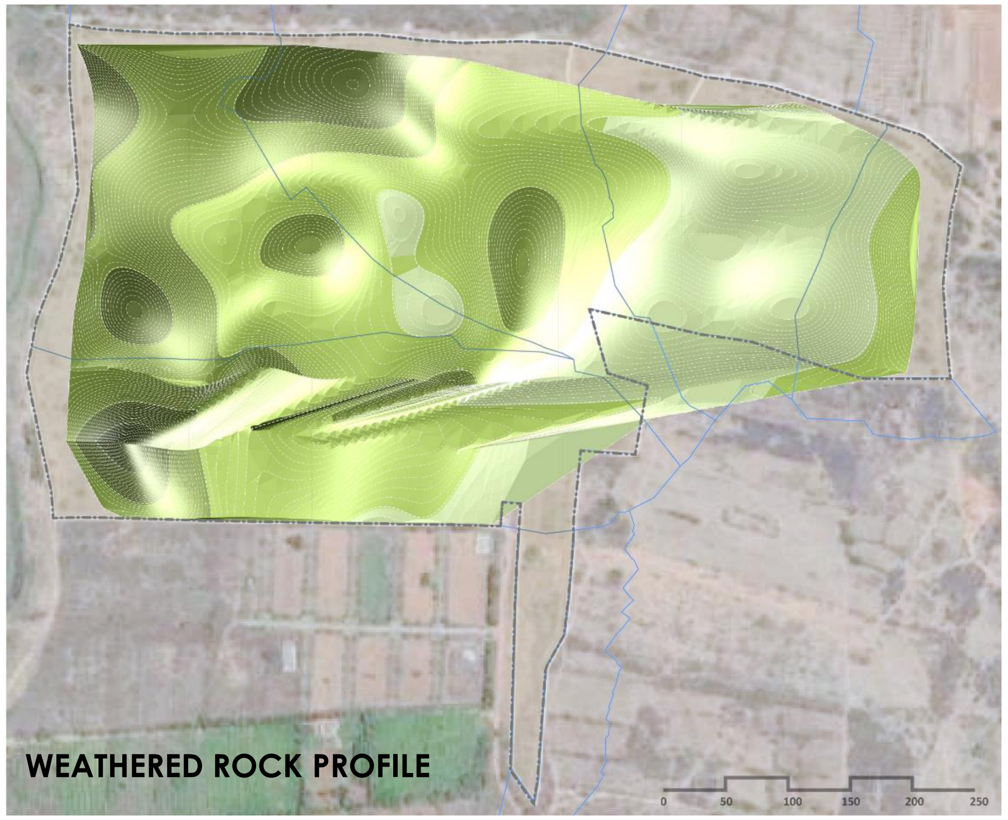


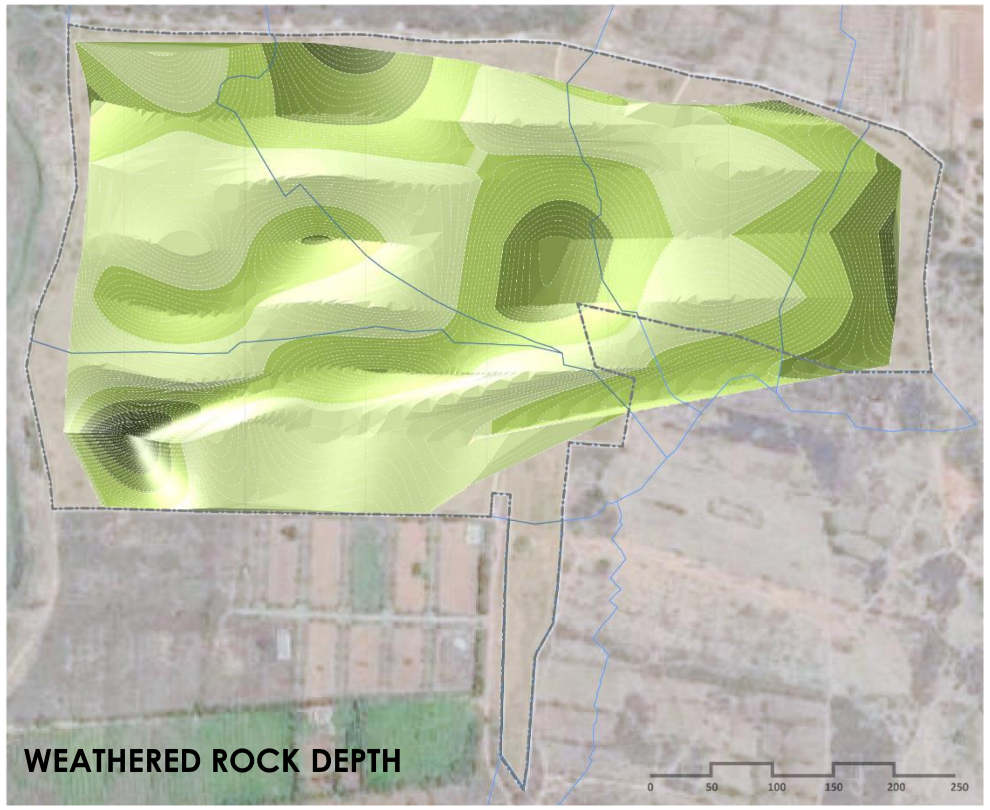


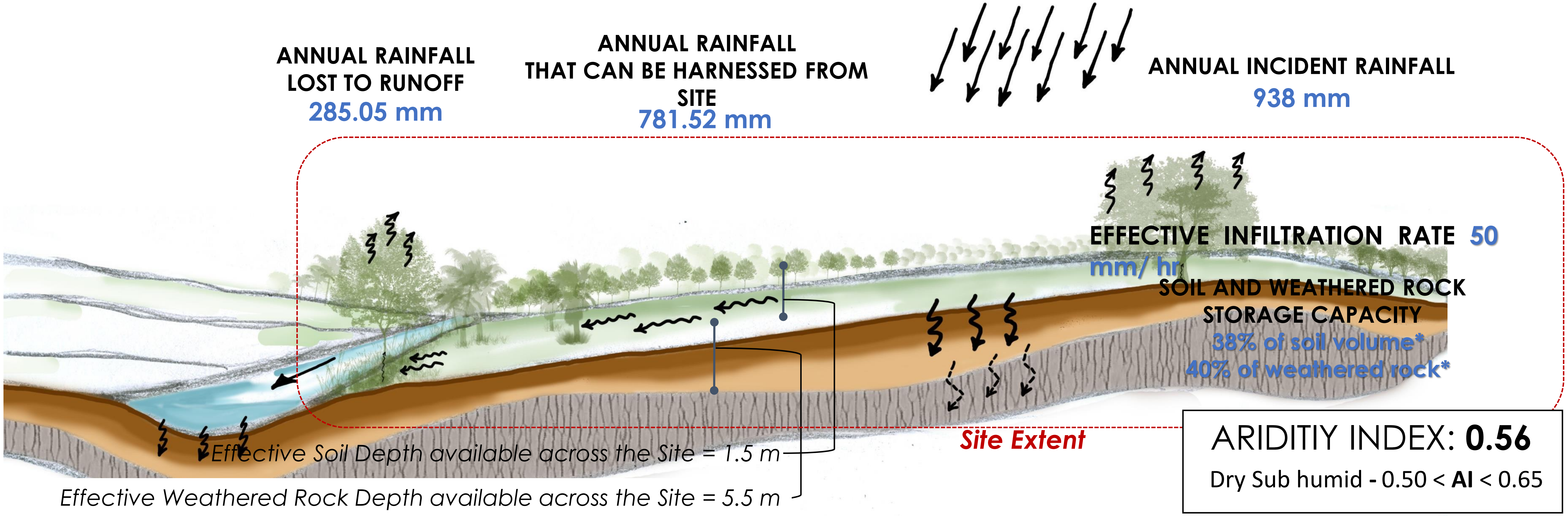
URBAN CAMPUS WITH CLOSED LOOP FOR ENERGY, WATER AND WASTE

INDIAN INSTITUTE OF HUMAN SETTLEMENTS, BANGALORE









ARIDITIY INDEX: **0.56**

Dry Sub humid - 0.50 < **AI** < 0.65

*As per data on porosity of soil and weathered rock

URBAN CAMPUS WITH CLOSED LOOP FOR ENERGY, WATER AND WASTE

INDIAN INSTITUTE OF HUMAN SETTLEMENTS, BANGALORE

MICRO INTERVENTIONS IN NATURAL PROCESSES FOR RESILIENCE BUILDING

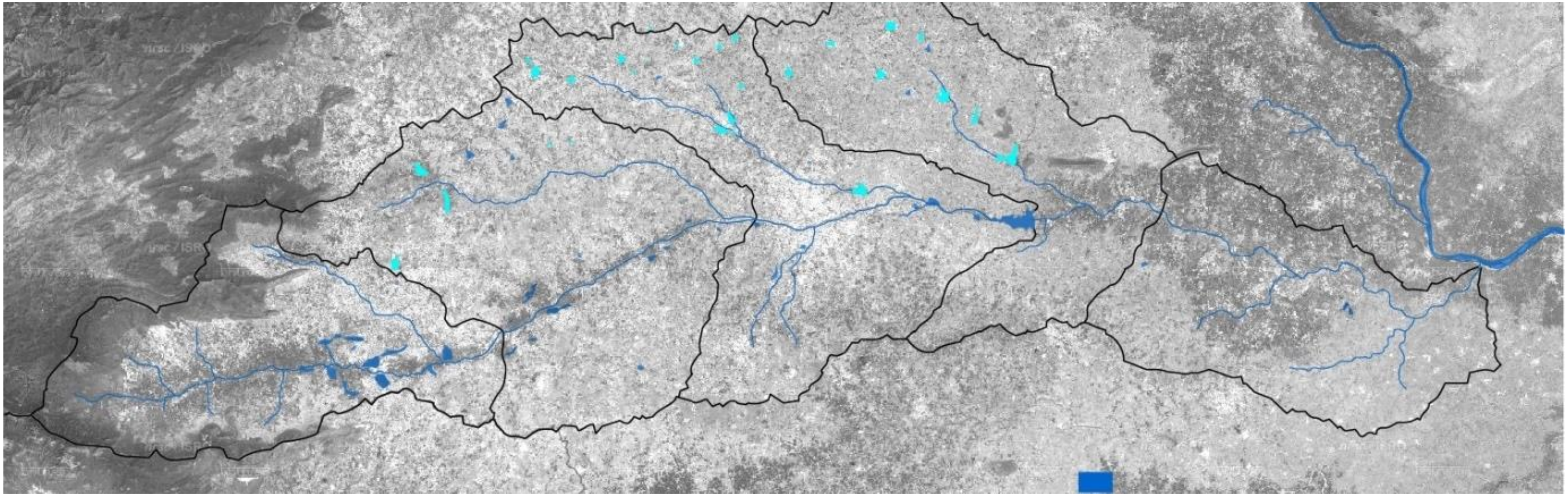
VALLEY SCHOOL, BANGALORE

MICRO INTERVENTIONS IN NATURAL PROCESSES FOR RESILIENCE BUILDING

VALLEY SCHOOL, BANGALORE

BUILDING RESILIENT COMMUNITIES

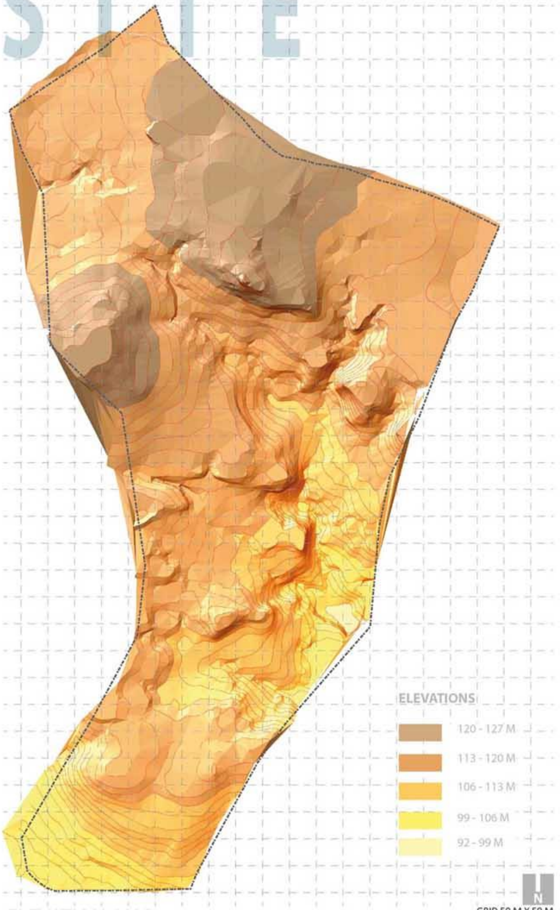
LEVERAGING COMMONS TO ADDRESS MARGINALIZED SOCIETIES



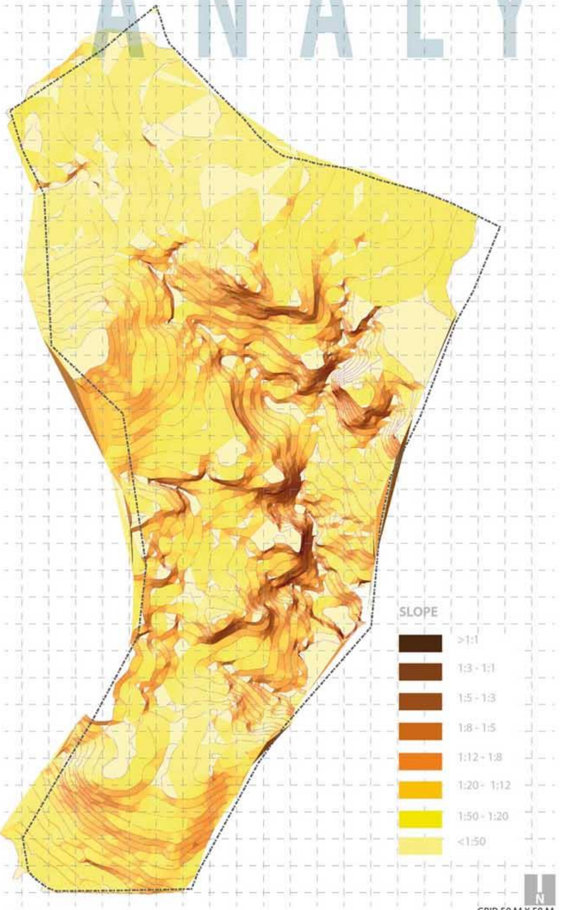
BUILDING RESILIENT COMMUNITIES

MITIGATION OF ENVIRONMENTAL RISK AND VULNERABILITIES

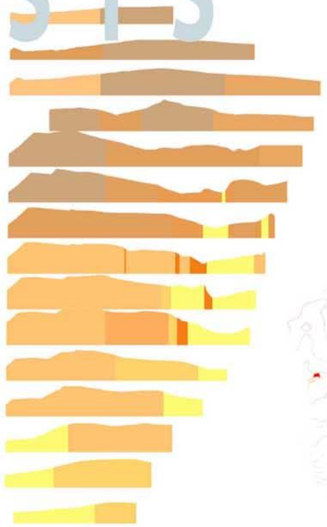
SITE ANALYSIS AND CHALLENGES



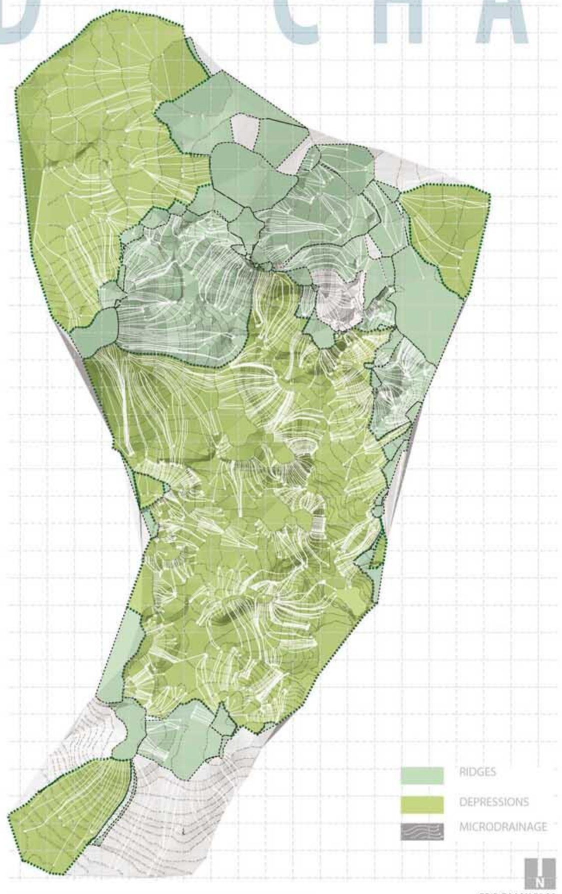
ELEVATION MAP



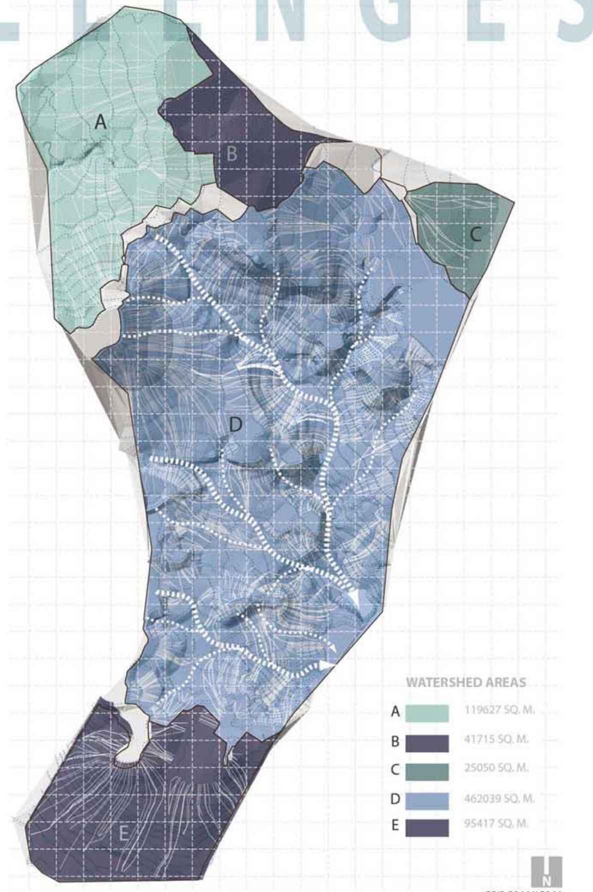
SLOPE ANALYSIS MAP


SITE SECTIONS


PARTS OF SITE NEEDING SLOPE TREATMENT



DRAINAGE AND MICROWATERSHED MAP



MAJOR DRAINAGE AND WATERSHED MAP

LANDSCAPE PLANNING & DESIGN STRATEGIES

PLANTING DESIGN

The site has been divided into regions based on topography, slope, soil structure, access to water and its benefit to wildlife. Water channels and valleys have easy access to surface and ground water but the difference in their soil structure moderates the kind of vegetation proposed. Vegetation with roots that bind soil have been proposed for areas with steep slopes. Drier highlands have been proposed with plants that can survive minimal access to ground water and rocky soil surface. Existing vegetation along the southern end of the site forms an ecotone between woodland and scrub forest that creates a transitional corridor for ungulates like sambar, chital, chinkaras etc. Palatable shrubs and undergrowth trees for these browsers have been proposed in this part of the site. Rest of the flat lands can have the general forest flora with three tiers - I storey, II storey and undergrowth vegetation

SOIL TYPOLOGY

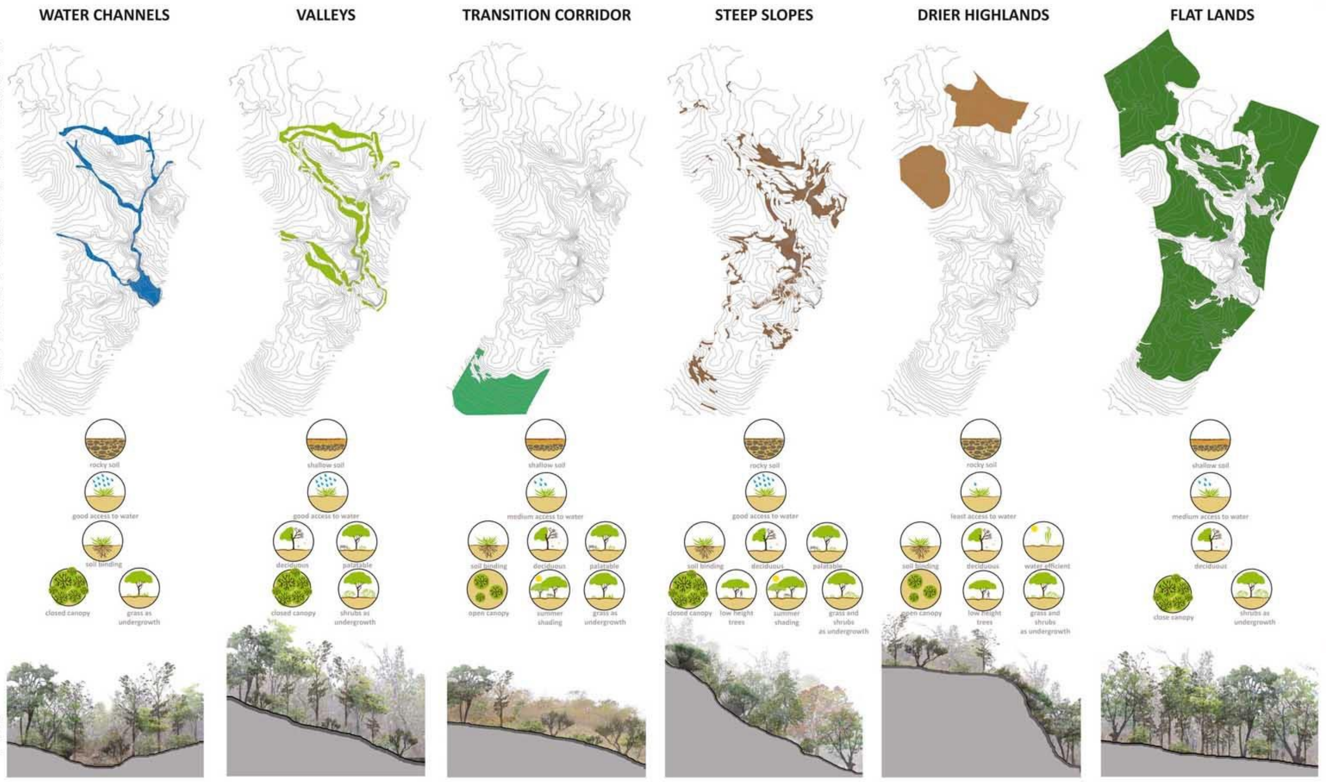
WATER AVAILABILITY

PLANT CHARACTERISTICS

FOREST CHARACTERISTICS

SECTIONS

The following sections represent the various kinds of vegetations possible on the site based on various factors enlisted above.



PLANTING STRATEGY FOR HABITAT DIVERSITY

BIODIVERSITY

The forest of Panna has a mixed population of deciduous species with three tiers:

<u>I storey</u> : Maximum height of 20-25 m

<u>II storey</u>: Small trees of 10-15 m

<u>Undergrowth</u>: Large shrubs and is generally devoid of grasses in the best closed stands.

FLORAL STRUCTURE AND DIVERSITY

PHASE 1 - SITE STUDY AND VISUAL ANALYSIS

The initial step before intervention was instituting a detailed study of the site and the larger region with precise visual and physical documentation to understand land characteristics, soil and vegetation topology, and most importantly aspects of site that needed immediate attention and protection. In some parts of the site, invasive wild growth had to be removed to initiate these aspects and works executed.

PHASE 2 - SOIL AND LAND MANAGEMENT STRATEGY IMPLEMENTATION

Based on the site study and further studio analysis, the next critical phase was to develop design strategies to be executed on site especially to control soil erosion by identifying zones within the main valley where small check dams were built using boulder packed in dry joints. Each structure of the check dam was detailed based on the slope condition, width of the valley and integrating existing vegetation.

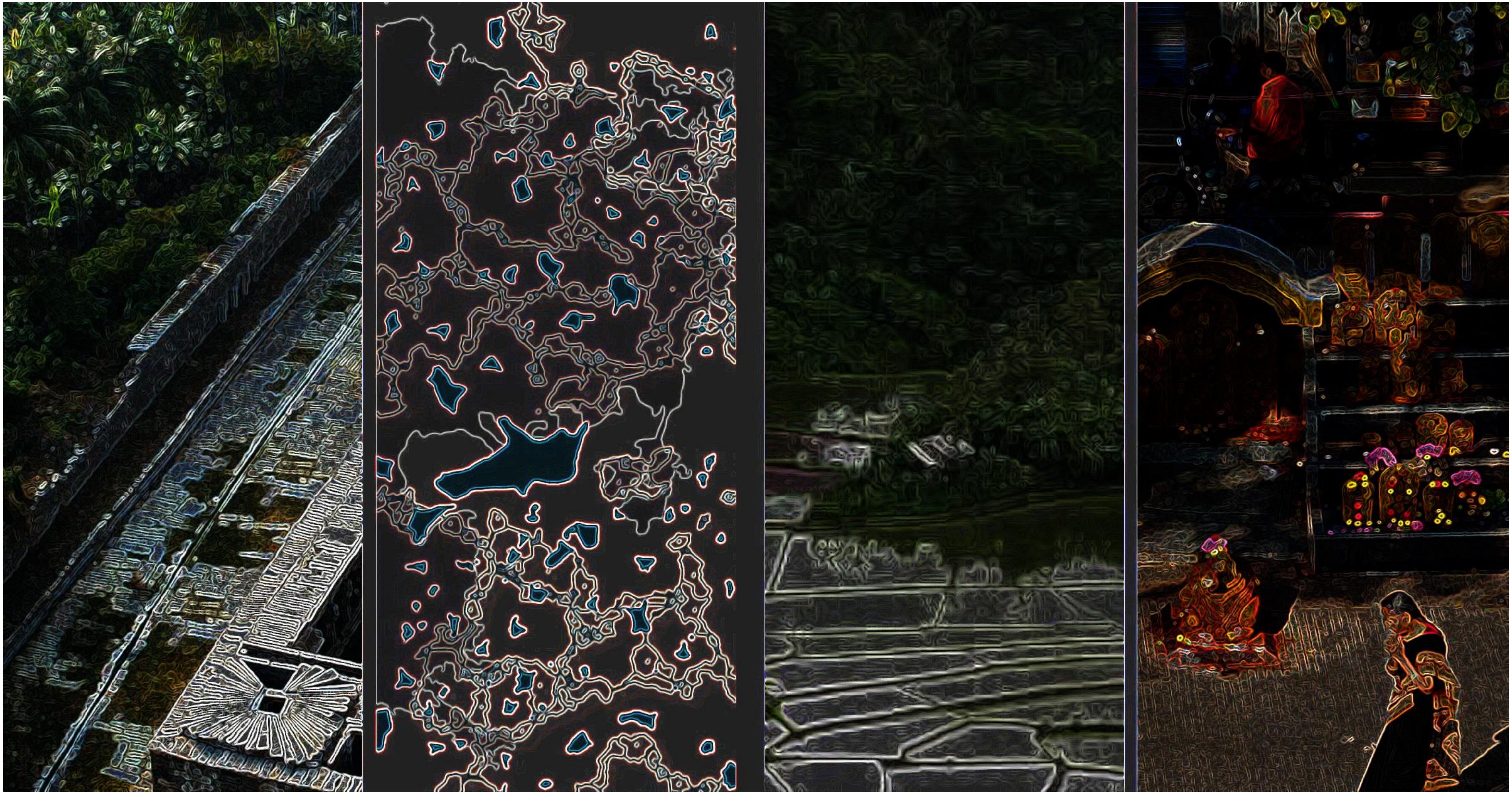
PHASE 3 - LAND HEALTH MATURITY AND SOIL IMPROVEMENT

This phase witnessed natural management and gradual improvement of site conditions. Due to the presence of check dams along the drainage channels, soil moisture along the valleys increased dramatically. Resulting in enhanced natural growth of vegetation. This in turn reinforced protection of top soil and channelized the surface flow by reducing water velocity towards the natural lake zone within the site.

PHASE 4 - LAKE RE-JEUVENATION

In parallel to the above land maturity and soil erosion measures initiated, the natural depression of the site was modulated to behave as a natural lake that in its initial seasons harvested much of the incident monsoon run-off. Over time, with strengthening of the surface run-off characteristics of the site as well as modulation of lake bed, the water body now holds water even in the peak of summer. This has resulted in the overall strengthening of the ecological systems in and around the site as well as improved bio diversity of both flora and fauna within and around the site

SITE WORKS- LAND HEALTH MANAGEMENT VISUAL DOCUMENTATION



DIGITAL LANDSCAPE ARCHITECTURE CONFERENCE - DLA 2021

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MOHAN RAO
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