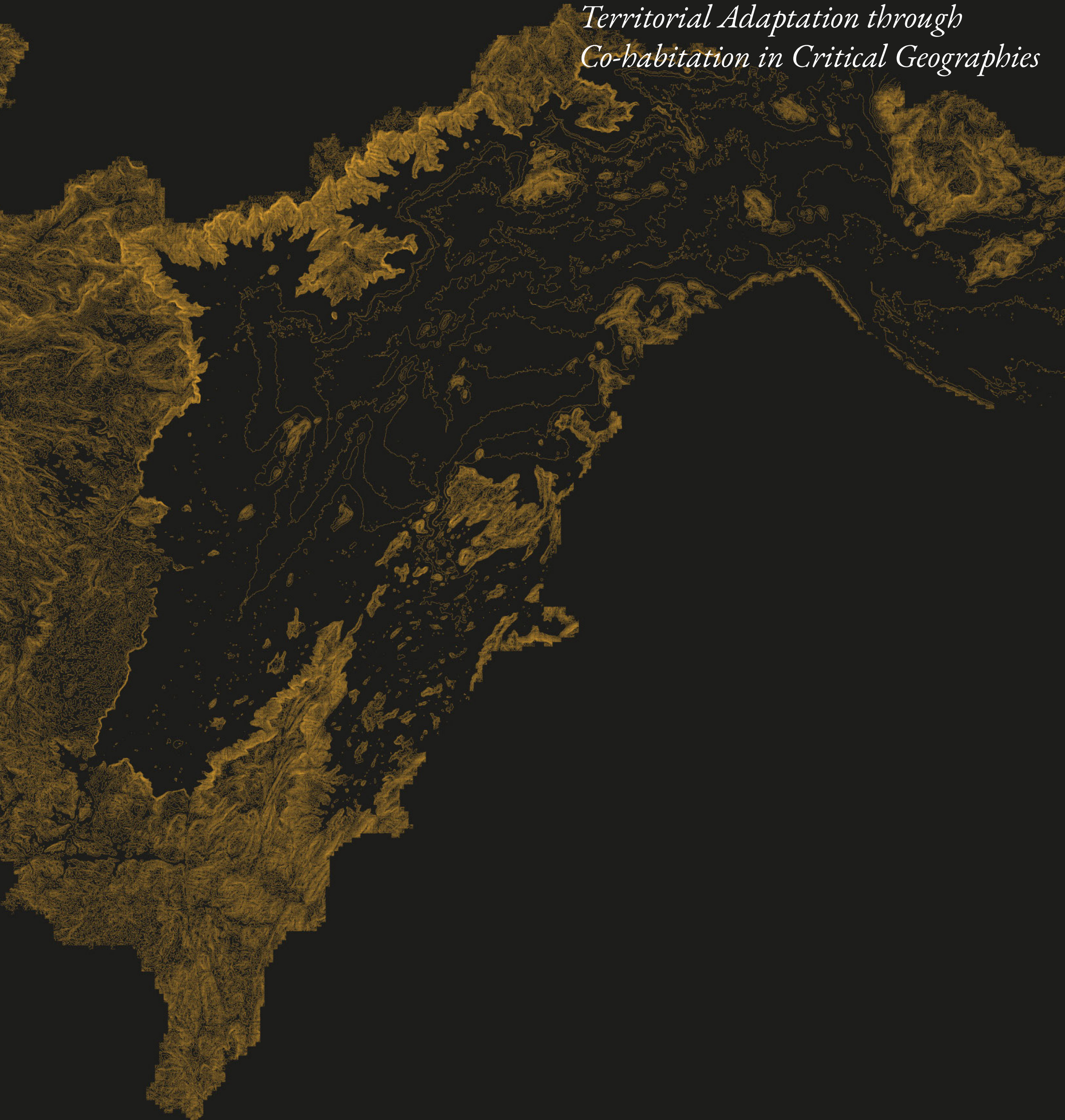
Monsoonal landscapes

Territorial Adaptation through Co-habitation in Critical Geographies



Colophon

Master thesis
P2 report

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Monsoonal Landscapes

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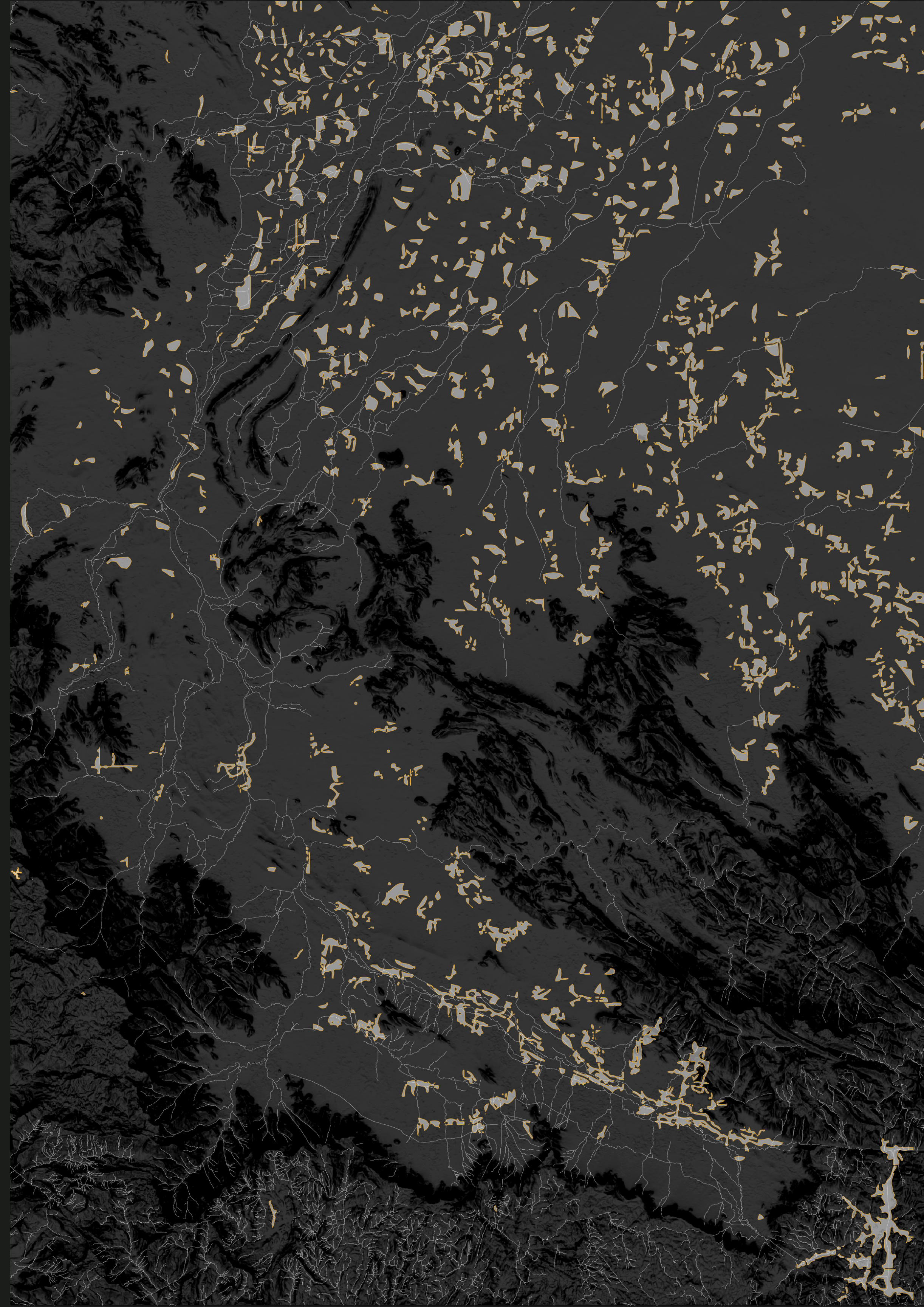

Fig 1 Map by Author

Chapter 01

Landscapes of the monsoon

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Fig 2 Graphic by Author

Abstract

Emergence of humans as the dominant species of the planet have come along with extreme manipulation of the earth's systems to sustain this dominance. The Anthropocene has lasted a little over 200 years has perhaps seen the most shift from completely natural systems to requiring an additional man-made system to aid exponential growth of our species. Among earth's systems, climate is one of the most complex factors determining energy balance of living organisms and determines energy gains and losses from organisms. India encompasses a wide range of complex territories with rich biodiversity living alongside some of the world's highest population densities. Historically the Indians have lived and adapted to these resource abundant terrains through traditional ecological practices that aligned with the ecological systems and governed the socio-cultural practices. The current globalised world has been built upon with technological, infrastructural, sociological political and capitalistic growth has wretched devastating effects on the environment that supports us. India being a colonised country and exploited for its resources for centuries still holds traces of it in the infrastructural and production systems, in this case in the Periyar-Vaigai river basins. The region characterised by complex terrain, excessive manipulation of landforms and alteration of its resource cycles especially in water cycles by storing water in multiple dams experiences excess water flows during monsoons, causing flooding on its western slopes and proves to be the only hope for drought prone region on its eastern side. Governing such complexities lies with arbitrary administrative borders dividing the control between different states and various different departments controls the flow and management of resource which often falls short of preventing catastrophes or just management of resources. Extreme weather events in the recent past has exasperated the effects in these fragile habitats, thus the project aims to firstly mitigate the risks associated with failing monsoon, further restore the balance of the ecological system in the region. By building back resilience through co-habitation of social-ecological systems, aligned to nature using human knowledge the design aims to place value on nature rather than exploit it. The project envisions the transition from a local adaptation towards building up the system on the regional scale. It deals with primary production, anthropogenic control, values and the role of ecosystems in maintain this balance. By synchronising these various systems the projects attempts at bringing back a dynamic equilibrium to this region, through methods like literature reviews, synthetic cartography and research by design.

Keywords: Periyar-Vaigai River Basins, India, Water Stress, Infrastructure, Regenerative Agriculture, Co-Habitation, Adaptive Planning, Dynamic Equilibrium

Introduction

For millions of years that life has existed on Earth, the physical and chemical composition of most of the planetary surface has never ceased to support life. The Gaia Hypothesis proposed by James Lovelock (1972) suggests that living organisms on the planet interact with their surrounding inorganic environment to form a synergistic and self-regulating system that created, and now maintains, the climate and biochemical conditions that make life on Earth possible. Earth's systems are inter-related, a paradigm shift in its life or its environmental composition results in imbalance of the entire systems. Among earth's systems Climate is one of the most complex factors determining energy balance of living organisms and determines energy gains and losses from organisms. Balance between life and the physical environment is delimited by climatic constrains and mediated by evolutionary adaptations by plants and animals to the basic physical energy properties that climate imposes upon them.(Reichle, 2020)

Emergence of humans as the dominant species of the planet have come along with extreme manipulation of the earth's systems to sustain this dominance. The Anthropocene has lasted a little over 200 years has perhaps seen the most shift from completely natural systems to requiring an additional man-made system to aid exponential growth of our species. This has resulted in conflicting natural and built environment's systems. The two major factors driving this geological age are the models of energy production from fossil fuels and the resource consumption. (Anthropocene: The Age of Human Impact on Earth, n.d.)

The growing population needs a greater use of natural resources that nowadays surpasses the capacity of the Earth to regenerate them. The anthropogenic-ally modified climate change has caused out of many things changes to the water cycle, ecological imbalance and destruction of marine and terrestrial ecosystems, disappearance of the forests etc. Extreme compounded weather event recently have exasperate the already fragile habitats in developing countries like India. IPCC projects higher precipitation during monsoon

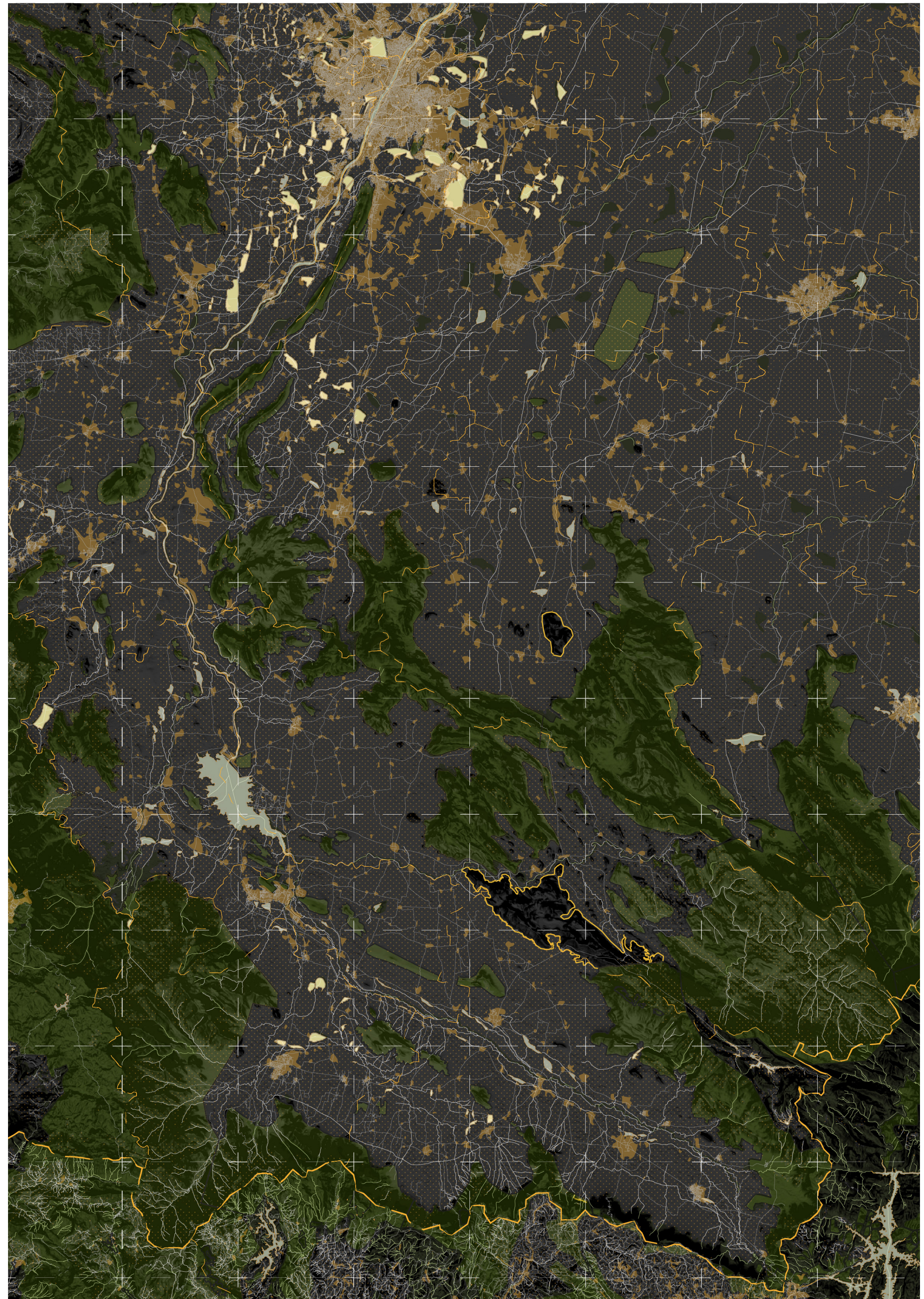


Fig 3 Map by Author

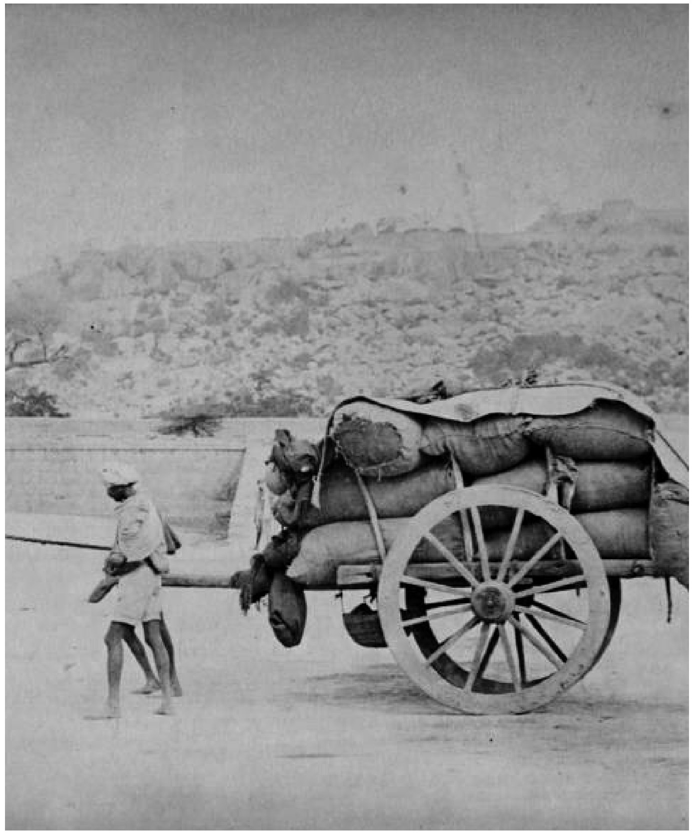
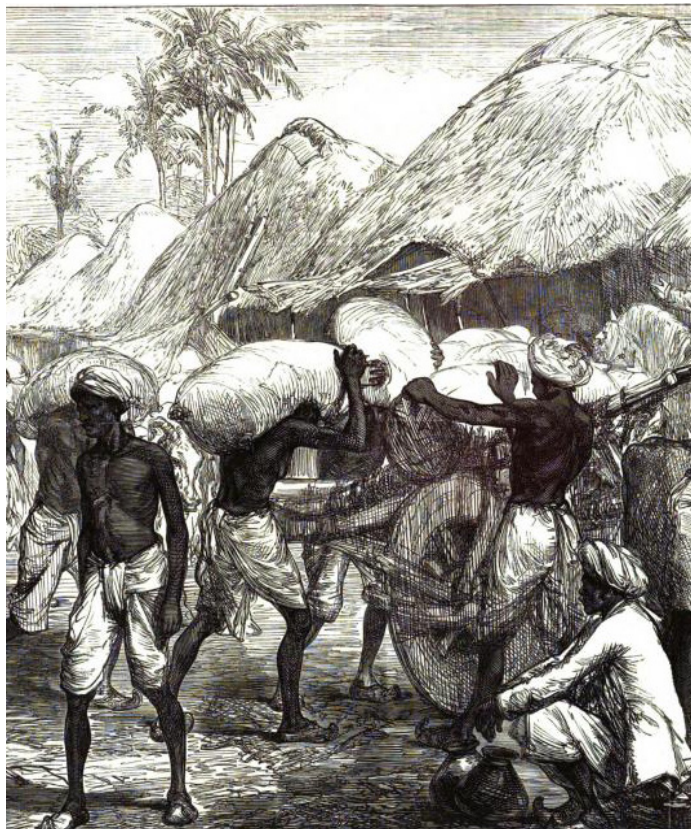
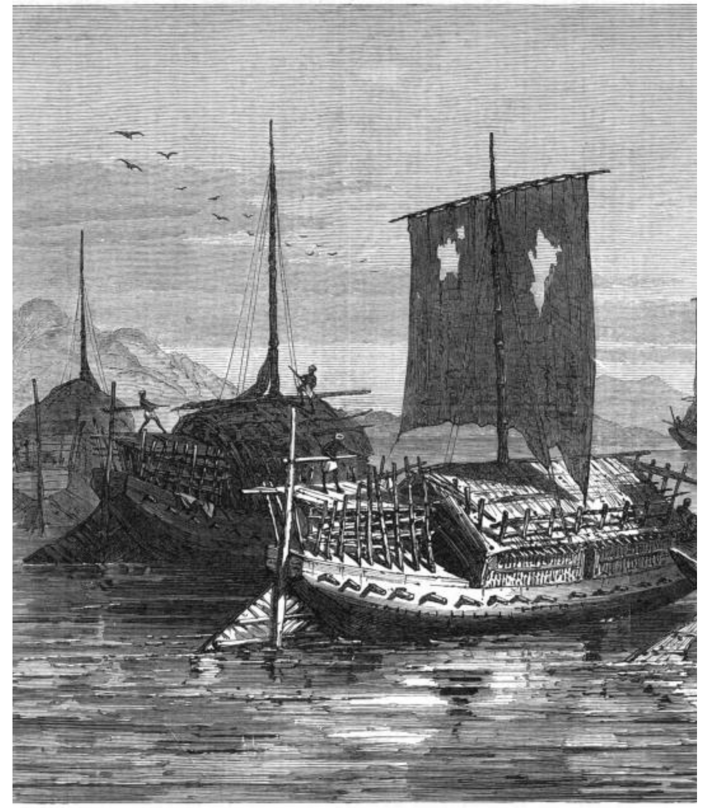




Fig 4 Images by https://www.environmentandsociety.org/

Globalisation

While globalisation has come into existence centuries ago, the sum of development only changes the scale and scope of globalisation, but not the intrinsic characteristics of the phenomenon itself.(Rennen & Martens, 2003) Yet there has been identified significant break points in history which led to the contemporary globalisations which fall under 5 predominant aspects such as capitalism, technology, politics, social and cultural life. As a starting point capitalism can be used to distinguish globalisation from international trade. Capitalism is the accumulation of capital through a production system in which labour adds value to a product (Marx, 1873) Where only labour that adds monetary value during production process is considered to be productive, unlike other economic systems that existed before. At this point the reward for labour changed from good or services to capital which meant one could accumulated capital using productive labour. This set of non-productive accumulation of reinvestment of capital, in a way enabling colonial empires to establish global trade networks.(Rennen & Martens, 2003) One such empire being India, previously existed with sustenance farming in small villages and surplus produce was stored for use in lean periods. Under the pressure of the British empire small land owners gave up their ownership and fell under the social elite class of zamindars who had the right to collect tax. This lead to the peasants having to pay certain amount of money every month to the tax collector, driving peasants into debt and indebted to the government for failed produce, eventually giving up ownership of land. At this point production systems changed from production for self-sustenance to production for colonial markets, giving rise to cash crops like indigo, opium, cotton, tea etc. As the demand increased India's agricultural production increased to about five hundred percent from 1859–60 to 1906–1907. This also lead to accumulation of food crops for export which was one of many reasons for frequent famines. This initial colonial trade expanded agricultural production, which subsequently expanded land for cultivation for over 200 years. Notably the shift from valuing all labour to deeming certain profit oriented activities as profitable led to the actual detachment of human systems from ecosystems in that we stopped valuing labour which enhanced ecosystem services.
Yet the invention of technology such as steam locomotive, telegraph, world bank, UN fertilizers, rockets, satellites, internet set pace to the transition to the global world.(Rennen & Martens, 2003) After the independence of India further motive to develop led to Green revolution encouraging widespread expansion of agriculture for establishing a powerful export oriented agrarian economy. The economic prominence of a country certainly gives higher purchasing power leading to accumulation of products and also importantly power. Thus gaining political prominence in the global world. In todays world capitalism still has a strong hold over the market, yet recognition to value labour beyond just the profitable ones are gaining recognition with the realisation of the eventual collapse of the worlds ecosystems. Thus in a way decapitalising through decolonising agrarian landscapes.

System collapse

The act of reducing CO_2 emissions have taken centre stage in the topic of climate change but little attention is given to the feedback mechanisms of land surface and the climate systems.
The Earth's climate behaves as a complex adaptive system, continually responding to numerous forcings and feedbacks across a range of spatial and temporal scales.(Foley et al., 2003; Levin, 1998). The earth's climate has significant role in the structure and functioning of terrestrial ecosystems and similarly the composition of terrestrial ecosystems have significant impact on the climatic conditions as well. (Foley et al., 2003) The extensive transformation of the land composition in the Anthropocene such as cropland, pasture and urban landuses has resulted in significant reduction in moisture recycling at scales of the landscape and biosphere and diminished the capacity of the system to buffer extreme weather events, increasing climate variability and climate change.(Bonan, 2008) Forests and woodlands by approximately 35% at the end of the 20th C also reduce sensible heat flux and contribute to increased atmospheric instability and convection that leads to the formation of clouds, which acts as buffer for climate variability. (Mcalpine et al., 2010)The interrelation between the terrestrial systems and the climatic systems are not often non-linear, meaning the changes in the land system is immediately not visible in the climate as it absorbs change and breaks abruptly causing shifts in the climate. This in turn impairs the ecological resilience of the system modifying or destroying the feedback mechanisms of the whole system.
Thus It is critical to adopt a broader perspective on the role of forests and other ecosystems in the climate debate and in climate policy mechanisms. This requires global and regional climate approaches which recognise the climate regulation function that forests and woodlands play through moderating regional(Mcalpine et al., 2010) In these systems patterns emerge from localised interactions and selection processes acting at lower levels, hence an attempt at reversal of such drastic modifications to this system by man could be by restoring the systemic functions from the local to the regional.

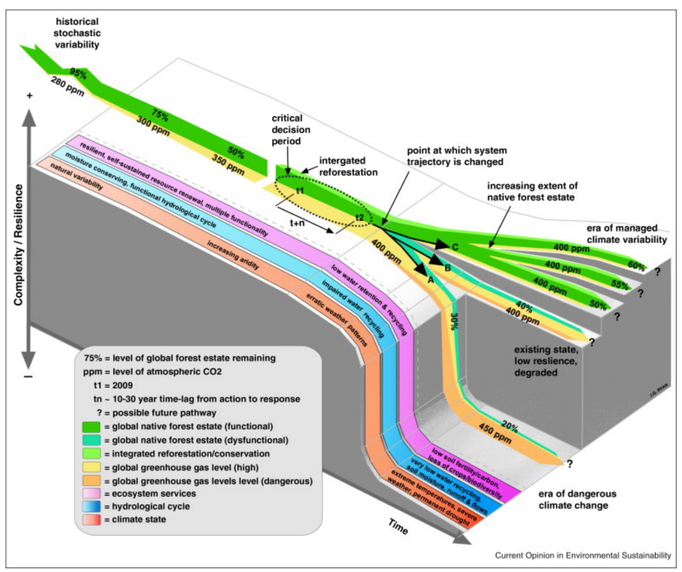


Fig 5 System collapse diagram by (Mcalpine et al., 2010)
Fig 6 Google earth images on the right

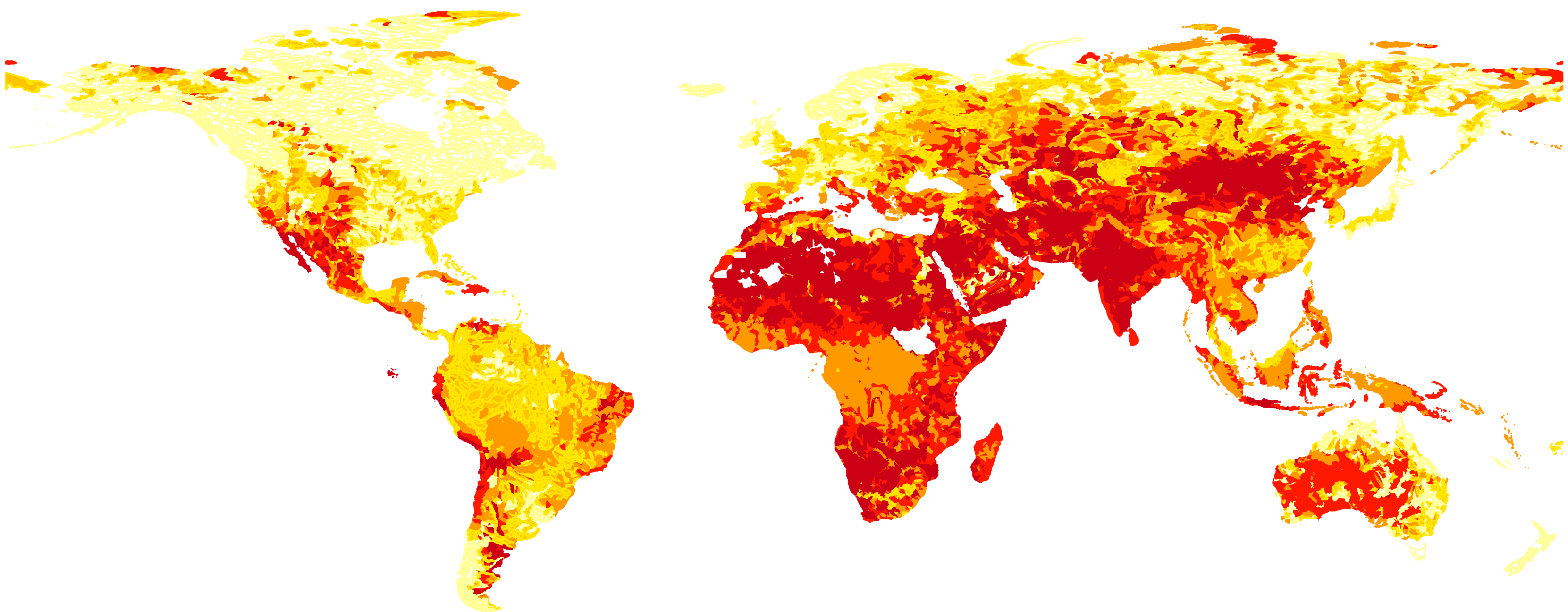


Fig 7 *Adapted from WRI Aqueducts water stress, 2019*

Water Stress

Water is essential for the survival of life on the planet. India ranks 13th in the world in extremely water stressed countries with its demand exceeding its availability and with poor quality.(WRI)
By combining all selected variables from the Physical Quantity, Quality, and Regulatory & Reputation-al Risk categories, overall water risk measures all water-related concerns. Higher values indicate higher water risk.(Fig4), (WRI,Hofste et al., 2019) . The country's groundwater resources are rapidly diminishing due to rising population and insufficient surface water. Water-stressed areas are home to more than a third of the country's population. Bhatia, Gurman (2019).

India uses more groundwater than China and the United States combined. Both of these countries like many others rely on surface water to meet their daily fresh water needs.

The available water is contested for domestic use, irrigation, industries and endless list of users, given this competition little is done to not pollute existing water resources. With increasing unpredictability of monsoon the water stress is only getting worse in the future.

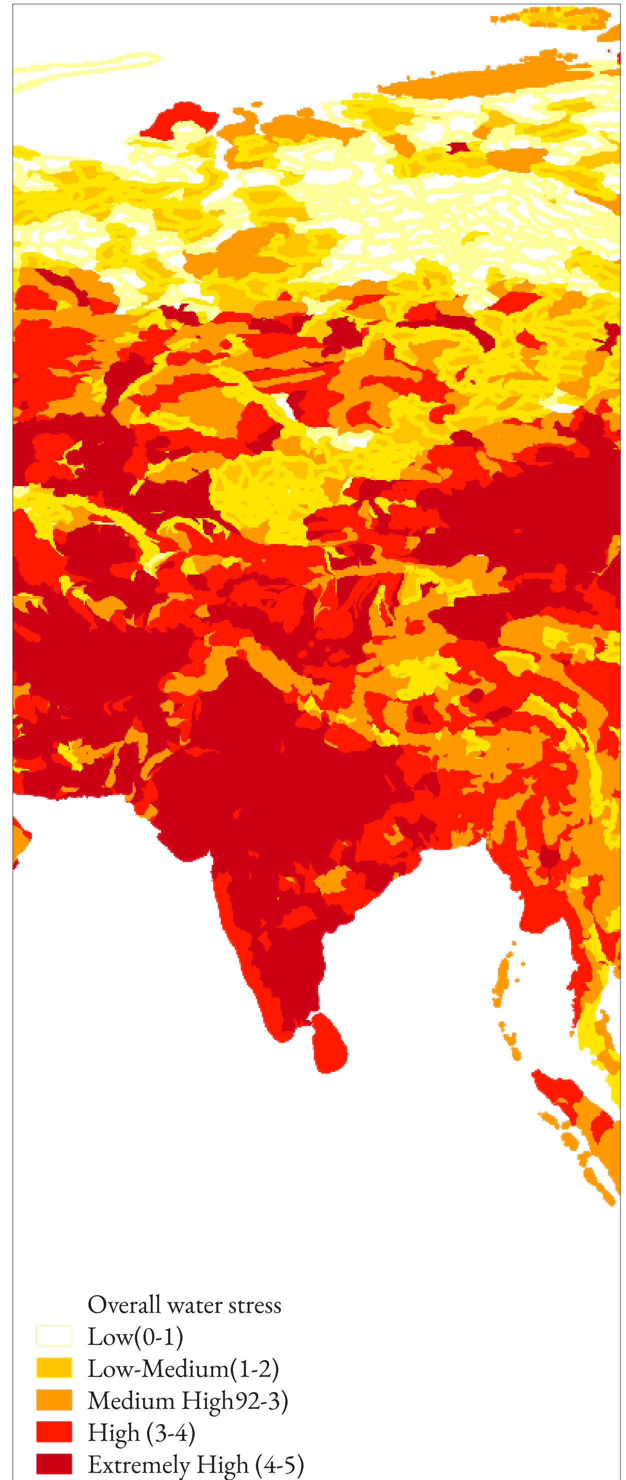


Fig 8 *India, Adapted from WRI Aqueducts water stress, 2019*

Problem Focus

India encompasses a wide range of complex territories with rich biodiversity living alongside some of the world's highest population densities. Indian have had an extensive cultural knowledge about the land that they inhabit and ways to manage them. With modernisation, India grew rapidly without formal planning leaving behind this cultural heritage that they valued immensely.

Urbanisation in India is still a sign of infrastructural development devoid of consideration of ecological well-being of the context. Resulting in capital being poured into grey infrastructure in an attempt to combat the negative externalities of capital-centric growth such as water stress, degradation of ecosystems, habitat loss. The already precarious status of the development in India from its colonial past and post-independence profit oriented development, is additionally taking a blow from climate variabilities. Extreme weather events have become frequent and intense testing the stability of the form of current development causing flooding, landslides and droughts etc.

India has shifted from a locally grounded management to centralisation of governance of people, natural resources, non-living components of the bio-physical world and everything in between

Which has resulted in control of commons with ideals of profit making, rendering local communities inaccessible to their rights to the commons. Restoring stability in these complex systems requires a democratic and sustainable re-imagination of ownership.

An extreme case which is a culmination of the above said problems is taken for the study region located in Western ghats along Idukki, Theni and Madurai districts. The region characterised by complex terrain, excessive manipulation of landforms and alteration of its resource cycles especially in water cycles by storing water in multiple dams experiences excess water flows causing flooding on its western slopes and proves to be the only hope for drought prone region on its eastern side. Governing such complexities lies with arbitrary administrative borders dividing the control between different states and various different departments controls the flow and management of resource which often falls short of preventing catastrophes or just management of resources.

Fig 9 Map by Author, Western Ghats: Data source: Esri Terrain

Terrain

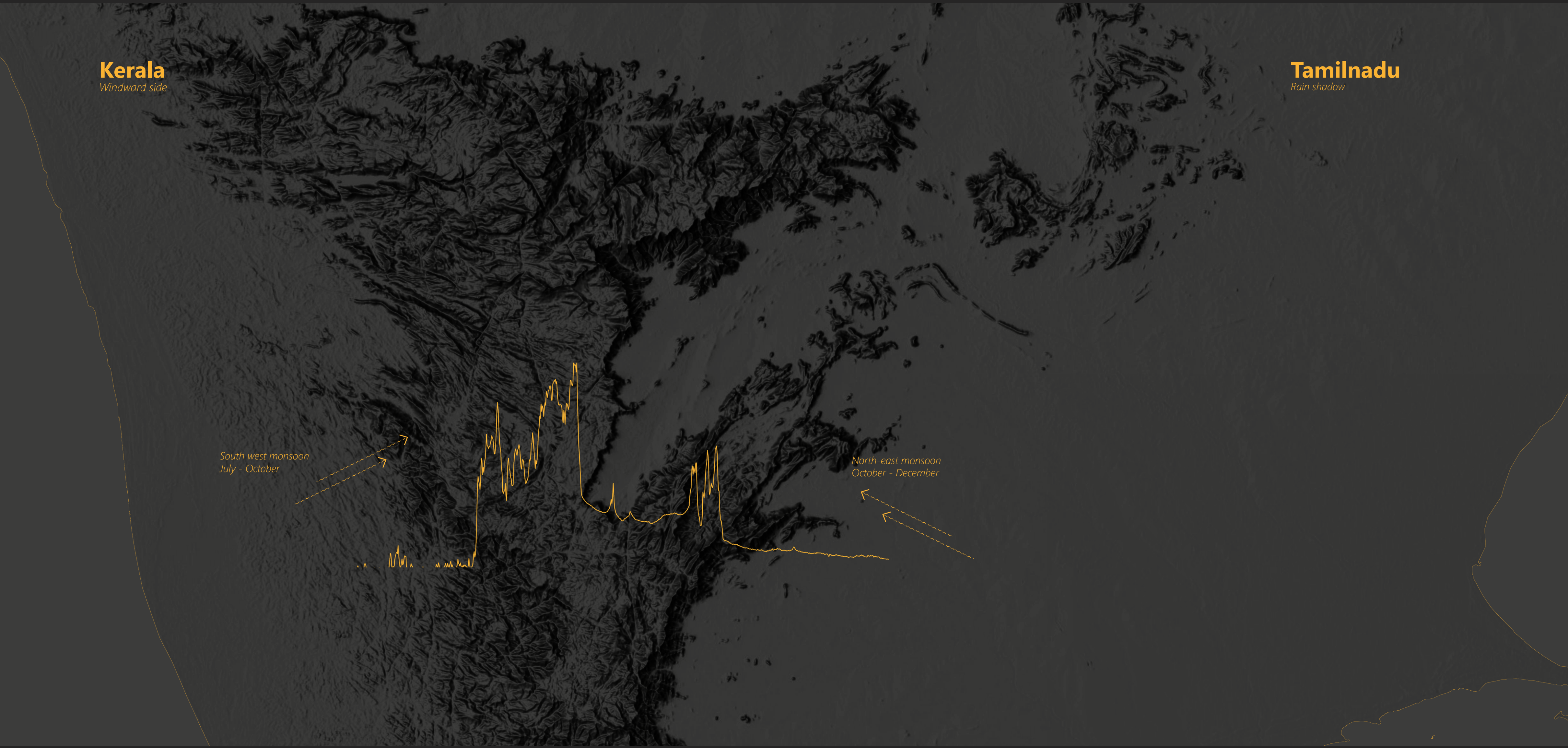
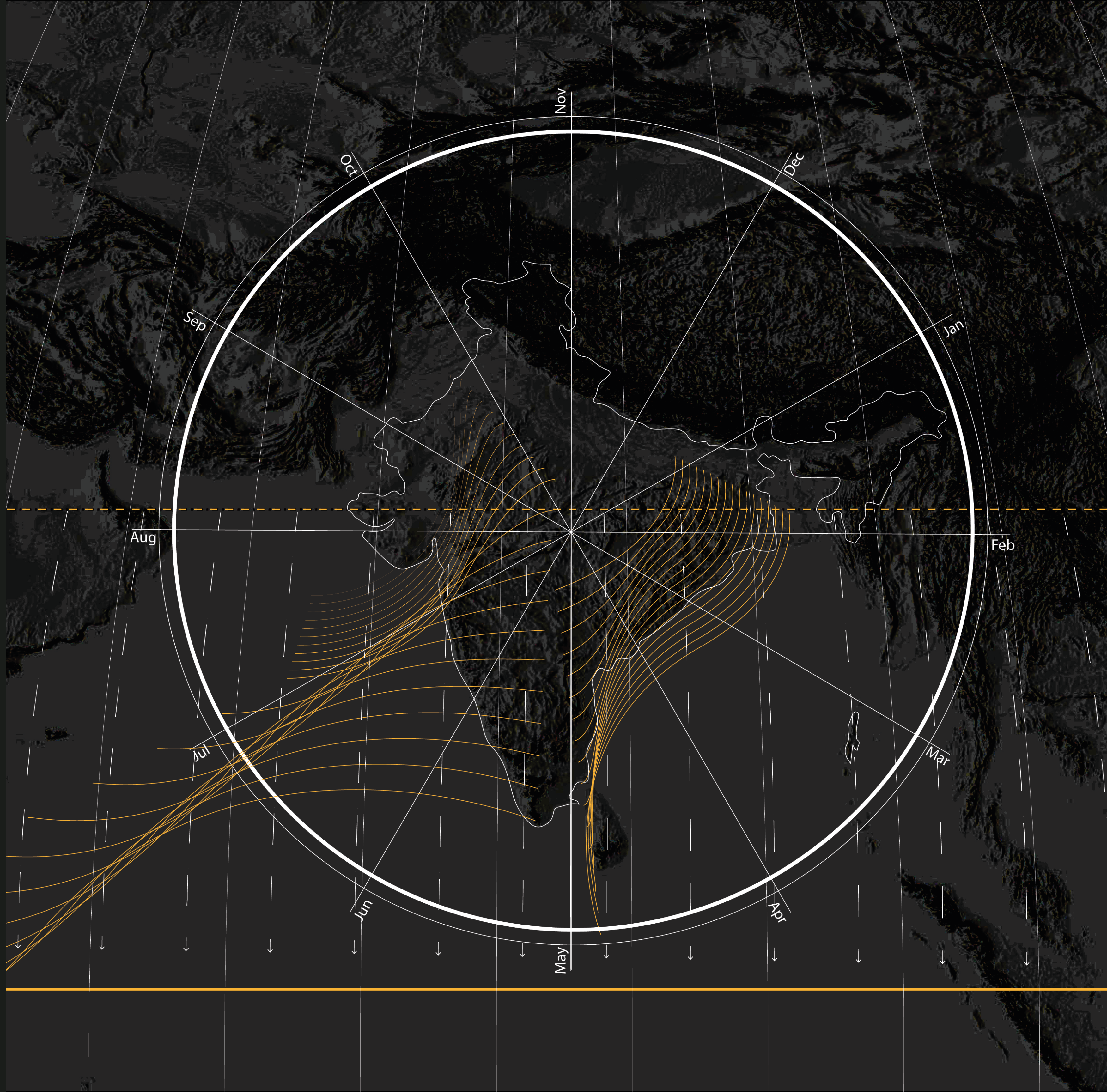


Fig 10 *Map by author, Data source: Esri Terrain*

Water is simultaneously feared and revered, in the context of the southern state of Tamil Nadu and Kerala owing to the complex geographies that regulate the distribution of monsoon. Topography of these region heighten the risk of landslides, flooding and drought.

Indian Monsoon

Water plays a vital role in the composition of this transect, with all of its water coming from the South west monsoon in the regions on the windward side and most of rain shadow region receives its water from `North east monsoon. Initially it was considered a phenomenon resulting out of land-sea temperature difference. But monsoon is a complex phenomenon influenced by global factors starting from the sun's role in heating up the earth's surface. The heating being maximum at the equator, results in hot air rising and creating a low pressure along the equator which pulls in winds from the poles called as the trade winds. As the trade winds move over oceans they pick up moisture and upon reaching the equator releases them as rain. This zone along the equator is called the Inter-tropical convergence zone and the cycle known as the Hadley pattern. Due to the varying tilt of the earth and the orbit of the earth around the sun, the zone where the winds converge varies. By the end of June the sun reaches the northernmost point which is around the middle of the Indian sub-continent near Bhopal. The sun is followed by the wind and the rainfall with a small lag and the monsoon reaches by July. This cloud band is constantly provided with moisture by northward moving winds from the oceanic cloud band which affects the persistence of showers in the monsoon season. The clouds as they move up the subcontinent are obstructed by the Western Ghats mountain range running parallel to western coast of India and hits the Himalayas mountain range. As the sun recedes the monsoon moves along with it showering over the eastern coast of the Indian peninsula. There are several other factors influencing the monsoon such as the sea temperature in different oceans, water vapour, the mountains (landforms), the amount of dust in the air, forest cover, the amount of moisture the air can hold. Etc. For example warmer air hold more water vapour and in turn releases



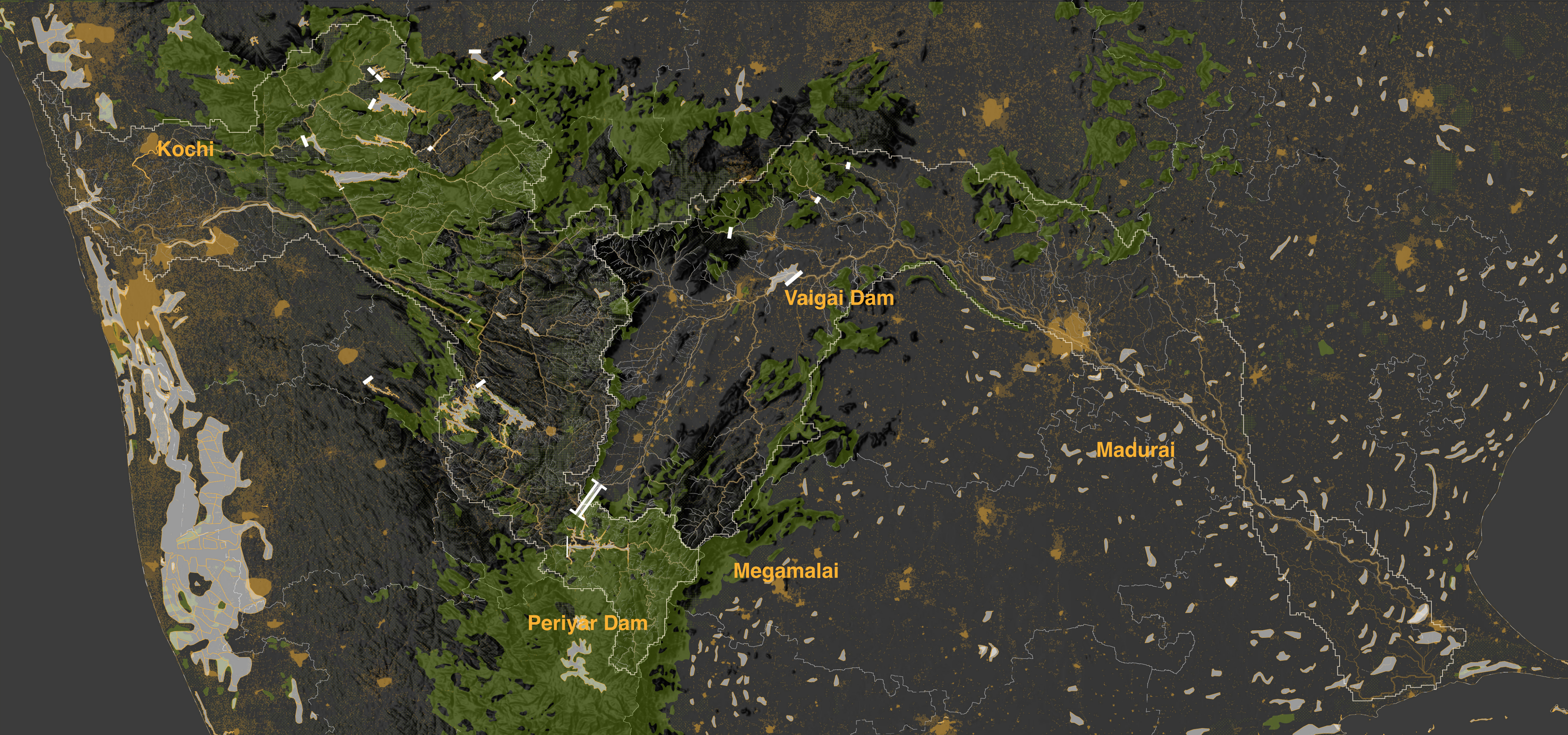
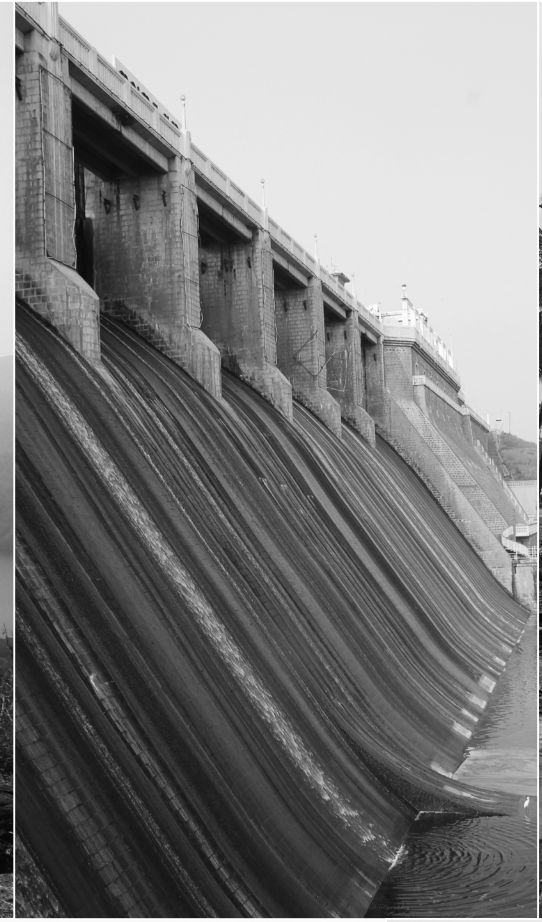


Fig 11 Map by author adapted from ESRI Topobathy

Map by author adapted from ESRI Topobathy

	District: Idukki	Mountain: Periyar/Megamalai	City: Madurai
	Flooding/ Landslides	Flooding & Landslides + Dams(externalities)	Drought
	Population growth	16,842,150 people	Population growth
	Urbanisation Agriculture	Deforestation/Habitat loss Agriculture Soil erosion	Urbanisation Agriculture

Western ghats is the world's 8th bio-diverse hotspots and is a UNESCO heritage site. Yet it is in a state of continous degradation. Which affects all other the nested system.



Problem Statement

Extreme weather event recently have exasperate the already fragile habitats in developing countries like India.

Temperature

Rapid growth has come with extractive exploitation, improper management of finite resources within a capitalistic approach ignoring traditional local management practices leading to socio-economic disparities.

Population growth

One of the systems which is at a state of extreme degradation is the water system. Disruptions in the hydrological cycles affects all other nested systems of life such as human settlement pattern, ecological systems, forest health, primary production, economic development, urbanisation .etc.

Resource exploitation

Water is simultaneously been feared off and prayed for in the southern state of Tamil Nādu and Kerala owing to the complex geographies that regulate the distribution of monsoon.

Excessive control of
natural systems

Topography of these region heighten the risk of landslides, flooding.etc.
Manipulation of natural hydro-geomorphology systems into large-scale mono functional infrastructural irrigation projects in both the Vaigai and Periyar river basins has increased the regions risk susceptibility and has aided to the degradation of ecosystems dependent on the rivers. These infrastructural projects along the western ghats have been ensuring water security for the population living in this transect [Kochi - Kumily- Madurai], but are increasingly vulnerable to extreme weather conditions.

Topography

Grey infrastructure
Centralised - but management

An event of failure of such projects have raised concerns about the safety of the population living downstream and also the water security of the population dependent on it. Conflicting interest in the management of dams between the states of Kerala and Tamil Nadu is one of the key reason preventing a resolution for this problem.

Risk resilience
Demand of water

It further question the feasibility of primary production, energy production sectors irrigated by the project affecting the everyday life of people living in these regions.

Agriculture
Energy production

Preposition

The current paradigm for development in the higher altitudes of the Western ghats are defined by operationalising landscapes with a view of nature as a commodity.

Grey infrastructure (Dams) designed on higher altitudes[500-1000m] planned without prior evaluation of its risks, socio-cultural and economic implications are now not capable of handling the pressures.

By building back resilience through co-habitation of social-ecological systems, aligned to nature using human knowledge the design aims to place value on nature rather than exploit it.

Research Questions

How can territorial adaptation through co-habitation of nested nature-human systems in critical zones restore a state of dynamic equilibrium?

Assessment Research Question

ARQ1. What are the ***systems*** that most influence the criticalities in the region? What are their ***limits***?

ARQ 2.How are these ***territories operationalised*** for their resources? To what extent are these susceptible to risk and causing risk?

ARQ 3. What are the primary ***drivers of change*** to the natural composition of the hydrological systems and who are the drivers?

ARQ 4. What are the hierarchical positioning of ***stakeholders*** responsible for the ***control of commons***? How does this affect the ownership of the commons? How are the commons currently valued?

ARQ 5. What are the planning and design ***tools*** involved in decision making of infrastructural projects in the region? What do they envision as future visions?

Design Research Question

DRQ1. How can we ***deign resilience for critical systems*** through ecosystem based adaptation?

DRQ2. How to design ***change the way we operationalise water*** without conflicting natural hydrological cycles? How to foster this just transition?

DRQ3. How to use v***ernacular cultural knowledge*** environmental management and how to adapt them to current context and can it be appropriated to multiple scales?

DRQ4. What are the ***multi-scalar territorial adaptation*** that foster alignment of production, consumption built environments with natural landscapes? How to re-organise externalities and trade-offs between interrelated systems?

DRQ5. How to ***place value on ecosystem services***, given its complexities? To what extant can ecosystem based adaptations provide economic benefit?

Research framework

Assessment Questions

AR1 — What are the systems that most influence the criticalities in the region? What are their limits?

AR2 — How are these territories operationalised for their resources? To what extent are these susceptible to risk and causing risk?

AR3 — What are the primary drivers of change to the natural composition of the hydrological systems and who are the drivers?

AR4 — What are the hierarchical positioning of stakeholders who are responsible for the control of commons? How does this affect the ownership of the commons? How are the commons currently valued?

AR5 — What are the planning and design tools involved in decision making of infrastructural projects in the region? What do they envision as future visions?

Methods

Risk assessment

- Water cycle
- Monsoon
- Topography
- Soil

Historical change: Time & space

- Infrastructure
- Landuse
- Cultural values

Stakeholder analysis

- Control-Governance

Policy frameworks

Outcomes

Defining risks Parameters

Projections : Future scenarios

Determining factors/ components changing : causing risk

Establishing protocols of care

Defining the elements composing/ determining the policy framework.

Design research questions

DR1 — How can we deign resilience for critical systems through ecosystem based adaptation?

DR2 — How to design change the way we operationalise water without conflicting natural hydrological cycles? How to foster this just transition?

DR3 — How to use vernacular cultural knowledge environmental management and how to adapt them to current context and can it be appropriated to multiple scales?

DR4 — What are the multi-scalar territorial adaptation that foster alignment of production, consumption built environments with natural landscapes? How to re-organise externalities and trade-offs between interrelated systems?

DR5 — How to place value on ecosystem services, given its complexities? To what extant can ecosystem based adaptations provide economic benefit?

Pathways of change

Evaluate

Recommendations & projections

Thesis path

Motivation | Relevance

Water stress in India

Problem Field

Water risk management
Incompatible natural and built environments

Thesis aim

To assess and establish the limits of the biophysical system in the region. To determine a way to move away from separating anthropocentric systems from the natural systems, towards multi-scalar synchronisation of the human and natural systems. To manage resources (water, land, forests) sustainably in a complex topographic area that respond to an interstate context.

Proposition

The current paradigm for development in the higher altitudes of the Western ghats are defined by operationalising landscapes with a view of nature as a commodity. Grey infrastructure(Dams) designed on higher altitudes[500-1000m] planned without prior evaluation of its risks, socio-cultural and economic implications are now not capable of handling the pressures. By building resilience through co-habitation of social systems, aligned to nature using human knowledge the design aims to place value on nature rather than exploit it.

Problem Statement

- Risk
- Topography
- Water stress
- Manipulation of natural systems
- Grey infrastructure
- Primary production
- Urbanisation
- Population growth

Methods

Research Questions

Assessment research question

Design research question

Site visit

- Data collection
- Interviews
- Cultural understanding
- Vernacular knowledge

Monographs

Critical mapping

Accumulation

Matter
Topos
Habitat

Geopolitics

Theoretical framework

- Landscape as infrastructure
- Cultural Landscapes
- Protocols of care
- Ecological economics

Conceptual framework

Design positioning Pathways of change

Monographs

Critical mapping

Clearance

Matter
Topos
Habitat
Geopolitics

Territorial Adaptation through Co-habitation in Critical Geographies

Evaluate

Recommendations and projections

Chapter 02

Monsoonal Palimpsest
Accumulation

Matter

The role of climate variability affecting the regions stresses are analysed.

Topos

The objects operationalising the landscape and their effect on the water systems are analysed.

Habitat

Interdependencies of people and water systems are analysed in varied topography and regions of diverse accumulation of population

Geopolitics

Control of water commons of the region are analysed

Matter Composition

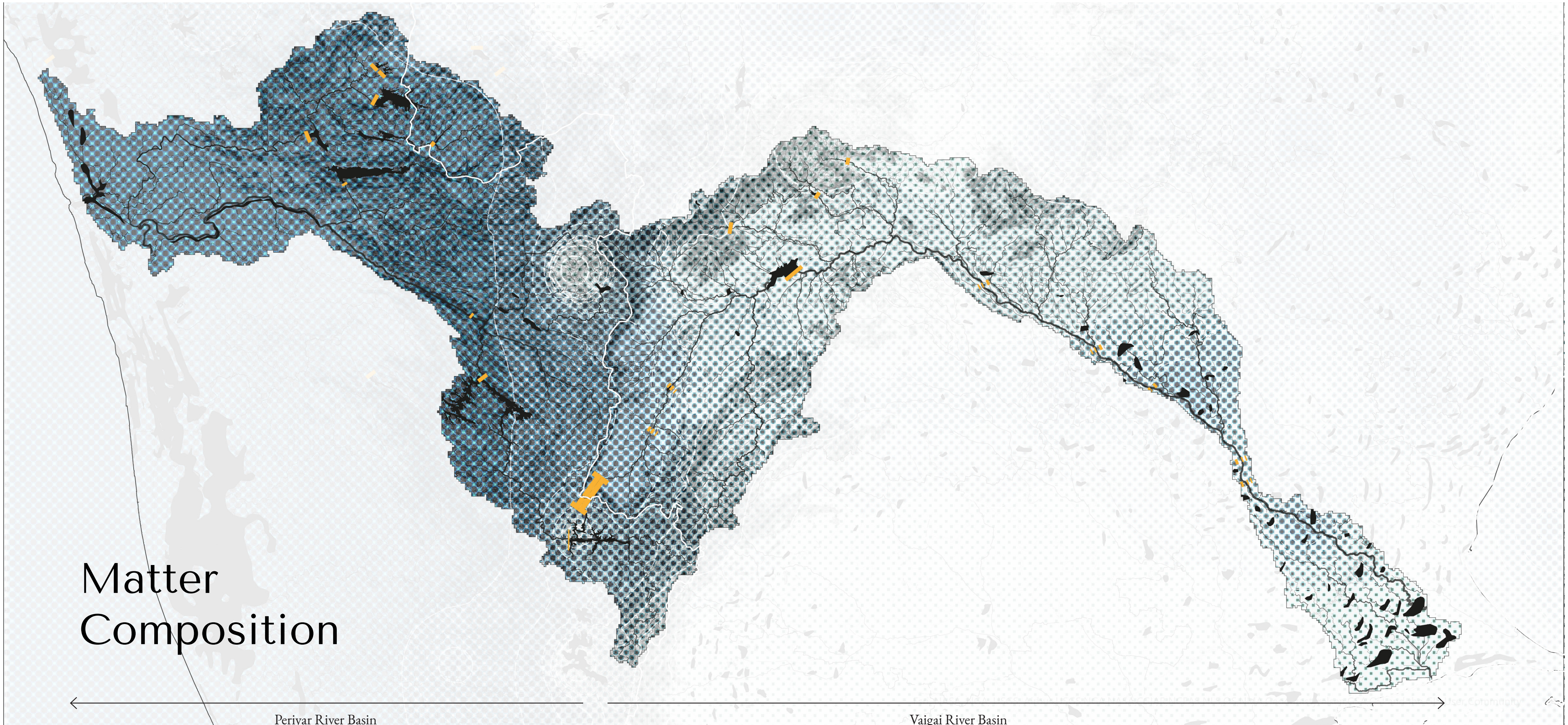
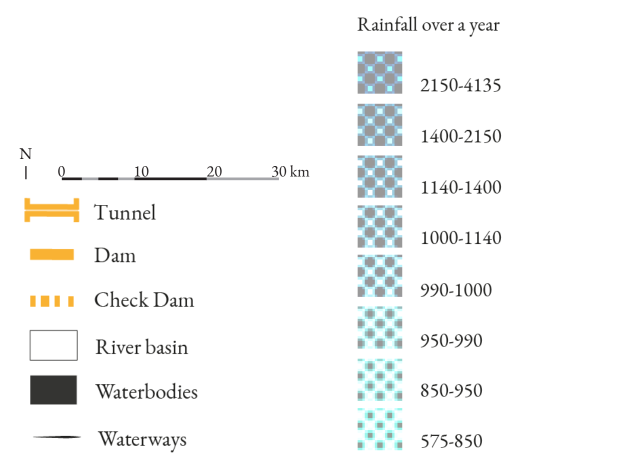


Fig 14 Matter Composition, Made by Author,
Data source: CRU time series by University of East Anglia (UK)

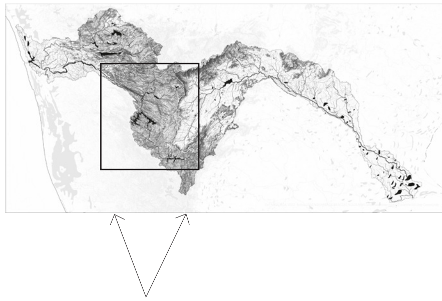
At the regional scale the pattern of accumulation of water in the surface, sub-surface while it transcends from the atmosphere is determined by the complex geographies of the western ghats mountain range and the forest it adorns. Flowing down from the mountains are the Vaigai towards the Bay of Bengal and Periyar river towards the Arabian Sea.

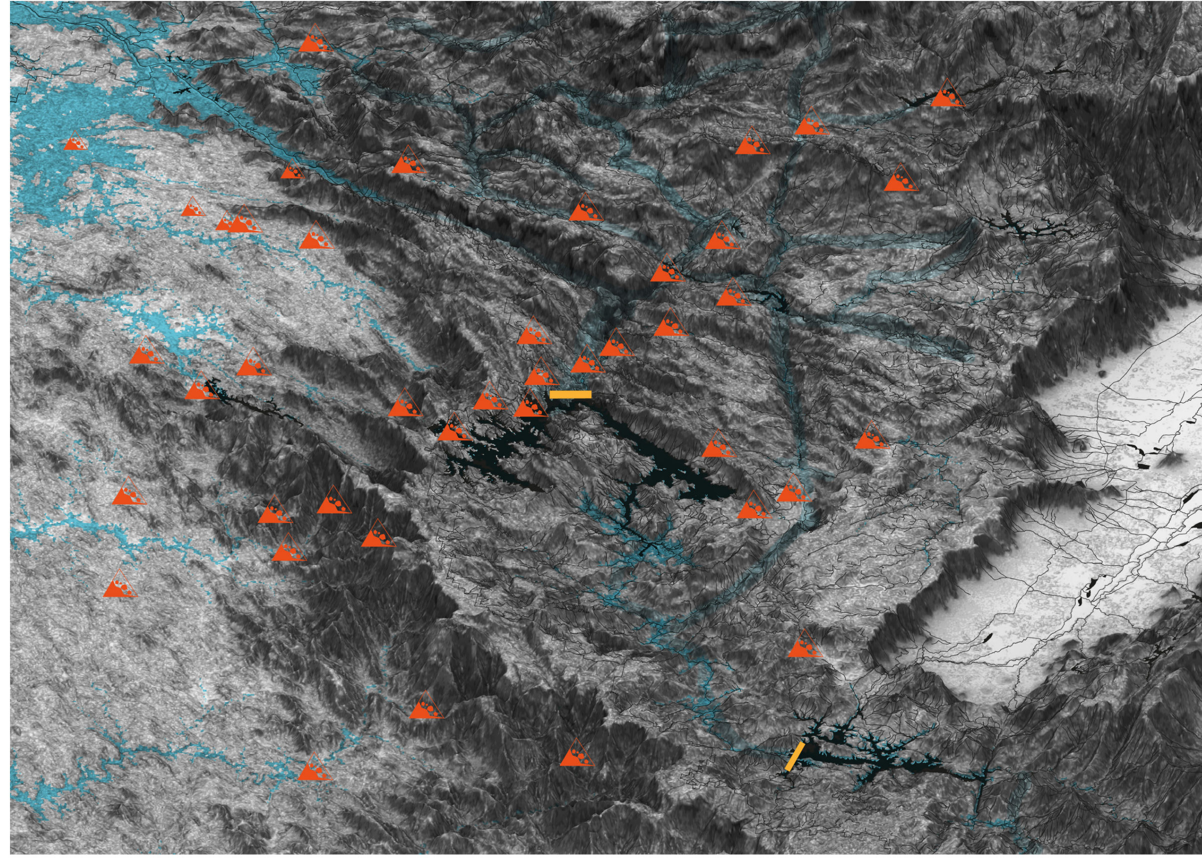
The districts of Idukki, Palakkad in Kerala receives abut than 4000mm of rainfall a year, while the districts on the eastern sides namely Madurai, Theni receive a average annual rainfall of about 800mm.(CRU time-series Data) Such drastic contrast in rainfall attributed by the topography also defines the nature of the water bodies. Further these water systems are manipulated and controlled by humans to foster the needs of the adjoining settlement and the influences the agricultural practices in this region.

Major dams including Periyar, Vaigai, Idukki, Idamalaiyar. Etc. of which Periyar dam is the artificial link between the two rivers, with a gross storage capacity of 443,230,000 m3 was built to divert water towards the Vaigai river basin in 1887 and 1895 by John Pennycuick a British Army Engineer. While it has been hailed by people in the Vaigai river basin from being able to irrigate their agricultural field, people in Kerala fear for their life owing to the structural instability of the 125 year old dam.



Matter Alteration



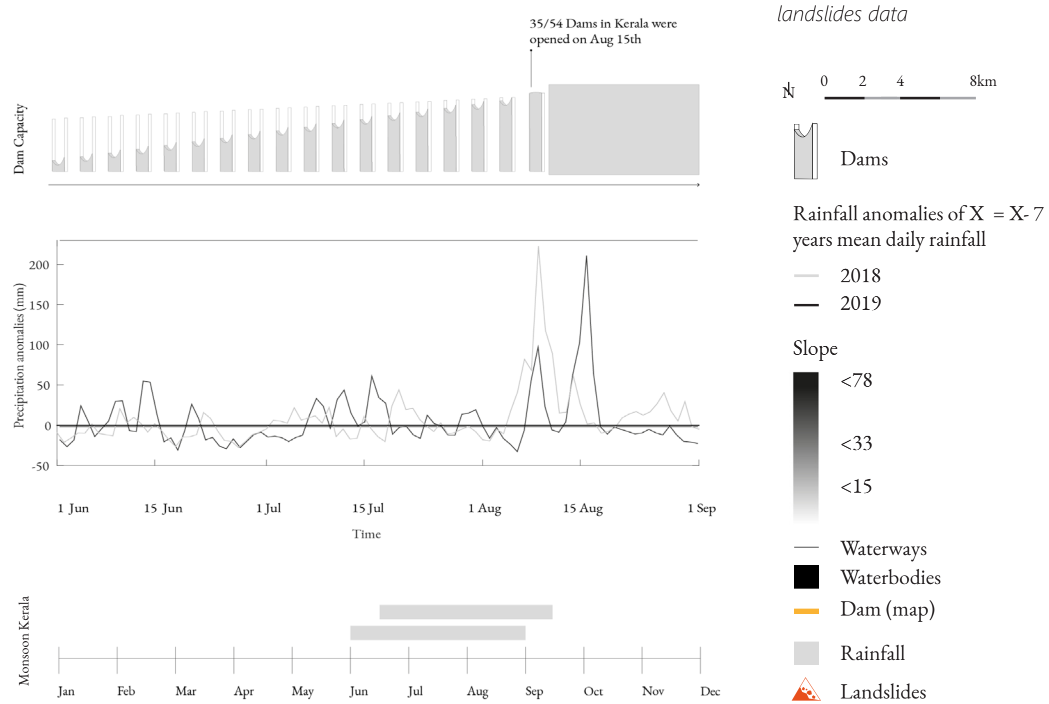


The increasing variations to the components of the monsoon is making the system extremely unpredictable in terms of its intensity and frequency. The Alteration diagram tries to capture the consequences of one such uncertain weather event. The Southwest monsoon pattern, which is usually from June to September has increasingly been postponed by 15 days, for example in the years 2018 and 2019, rainfall fluctuated extensively from a 7 years mean. Water stored in 35 dams out of total 54 for summer had to be released on Aug 15 after receiving 116% more rainfall, which lead to widespread flooding and landslides in Central regions of Kerala.

Seasonality of the monsoon used to be embedded as empirical knowledge in the cultures that populated these river basins. Madurai, one of the oldest settlements in southern India with over 2000 years of history survived these arid regions with seasonal rainfall by buildings tanks and optimising the use of water. According to the University of East Anglia Climate Research unit in the UK, there is a characteristic surge in temperature after the last decline in 1945 to 1973(Brohan et al., 2006)This exponential growth is considered to be caused by urbanisation and carbon emissions. This increase in global temperature has reciprocal effects on the rainfall distribution.(Loo et al., 2015). The change in the average precipitation over India has increasingly become intense and negative precipitation anomalies from 1960 to 1970 has become more recurrent.(NOAA-NCDC, 2010)

The increase in temperature in the 21st and 22nd Century will change the frequency of the monsoon by 70% below normal and also delay the onset by 15 days(Ashfaq et al., 2009). This means that the summer monsoon that brings 75% of the rain to the subcontinent is reduced.

Fig 15 Matter alteration, Made by Author
Data source:Esri Terrain, NASA landslides data



Matter Limits

The change in the rhythm of the rainfall patterns is perceived for 100 years shown in Fig 12. The data on the left corresponds to Kerala and the ones on the right half of the semi-circle represent Tamil Nadu. Significant fluctuation is seen in the last two decades.

Year 2018 saw above-average rainfall in Kerala, with the southwest monsoon contributing an excess of 36 percent of the year's total rainfall till August 29. The satellite imagery indicates a 90% increase in water cover was observed due to flooding. Low lying coastal plains of Kuttanad and the Kole lands of Thrissur had a rise of water up to 5-10m respectively.(Vishnu et al., 2019). While Vaigai river ran dry in the year 2019 following failure of monsoon in the previous 4 year.(River Vaigai In Tamil Nadu Dries Up Due To Intense Heat-Wave, n.d.) The region has been experiencing frequent droughts for all months of the year with sever droughts in 1985, 2004, 2006.(Janapriya et al., 2016) These droughts affected domestic water supply and agricultural irrigation.

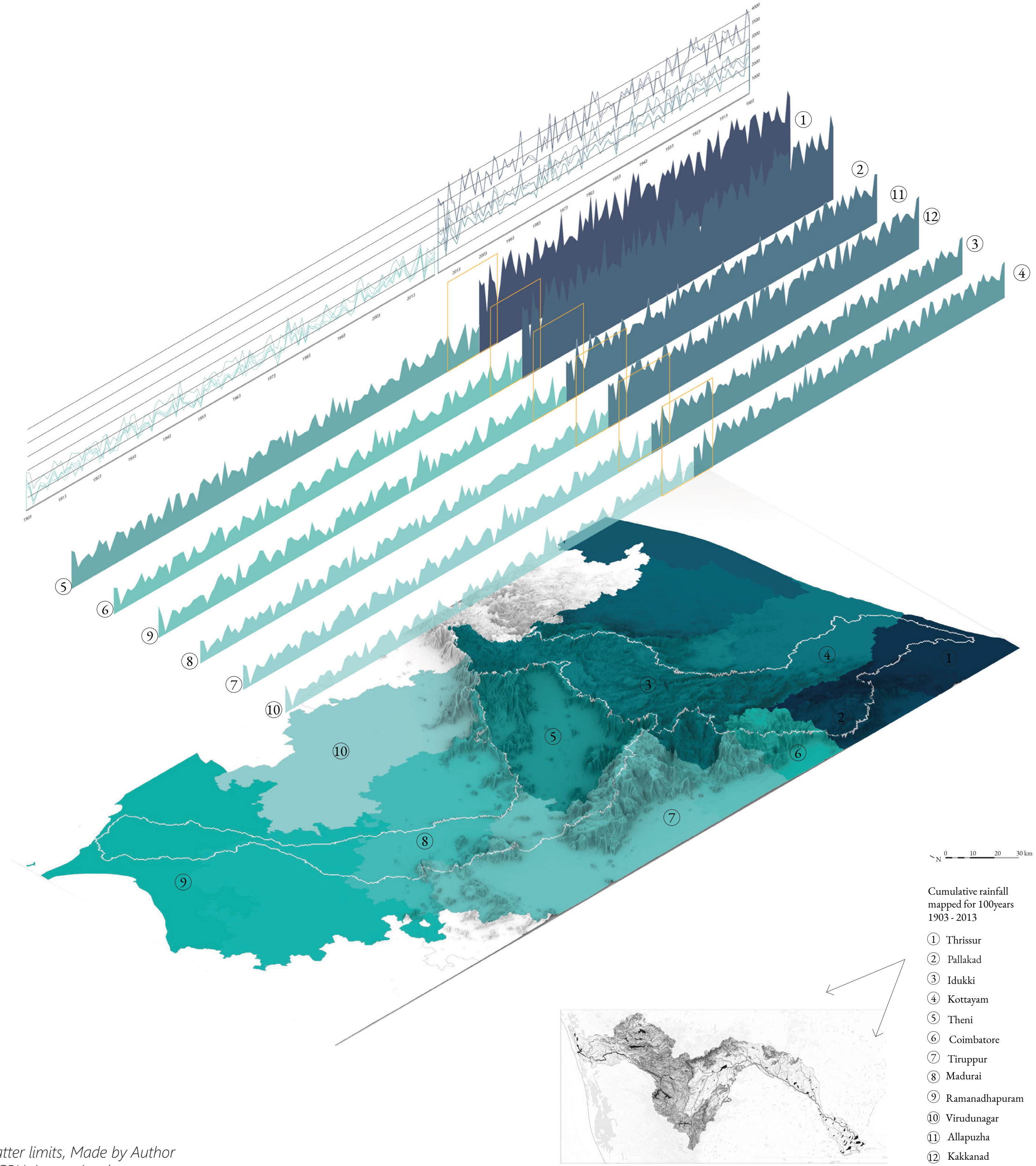


Fig 16 Matter limits, Made by Author
Data source: CRU time series data

Topos Composition

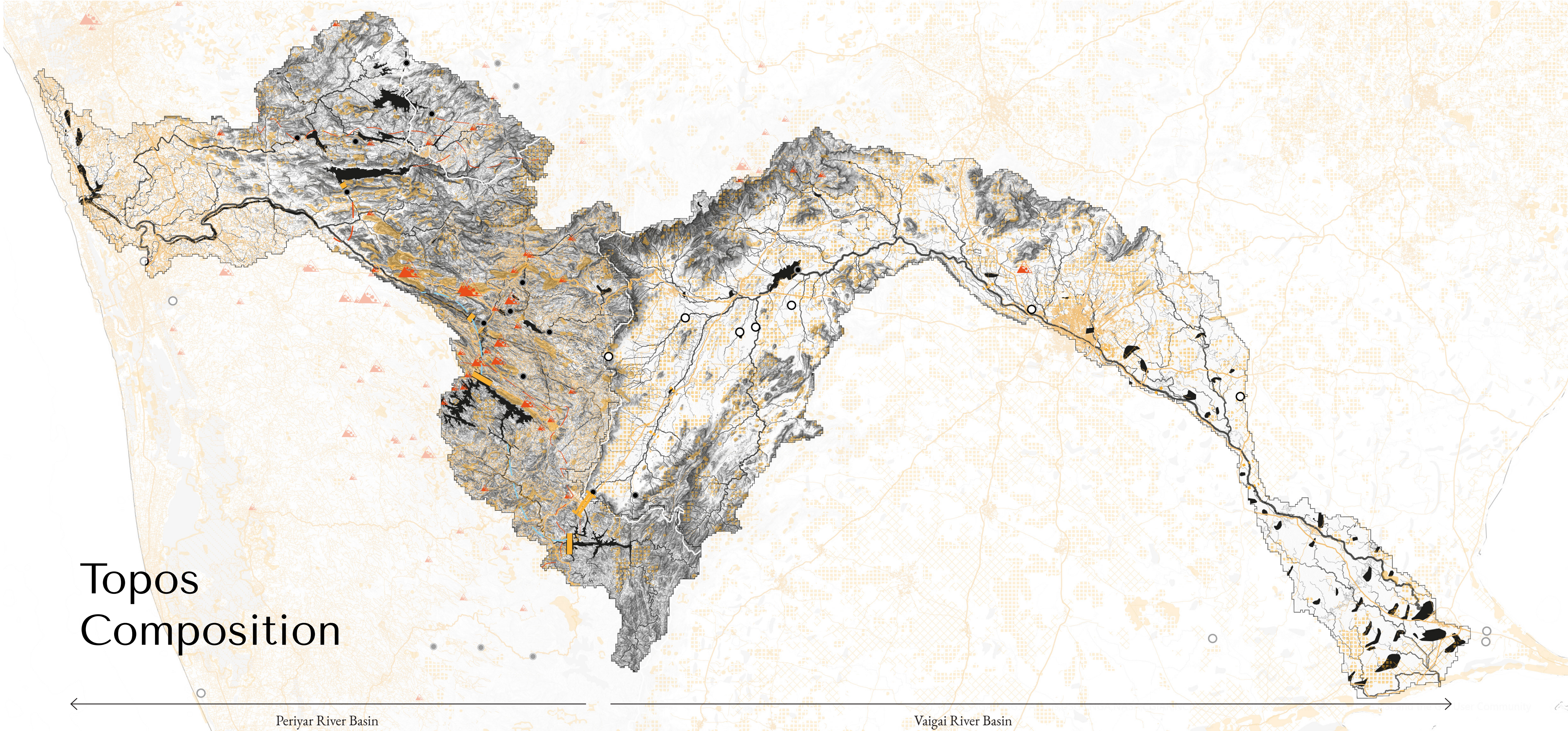
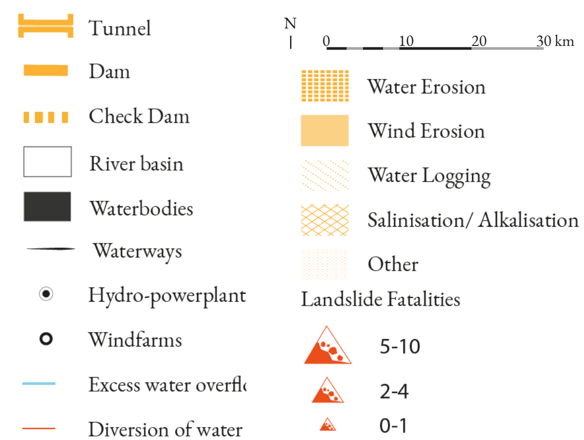


Fig 17 Topos Composition, Made by Author,
Data source: OSM, Bhuvan, NASA landslides data

The line of extraction of water starts upstream higher in the altitudes by damming huge expanses of land(Periyar Dam, Idukki dam, Vaigai dam), typically having catchment areas embedded forest of Periyar National park, Srivilliputhur and Megamalai tiger reserve, Idukki wild life sanctuary. Further changes into check dams, ponds, harvesting pits downstream. The Periyar river basin measures 244km and a total catchment area of 5398 sq. km.(Of which 114 sq. km falls under Tamilnadu). The rivers annual discharge as estimated by Water Resources of Kerala is 11600mcm. It is one of the few perennial rivers in the region.
The Periyar river basin has be operationalised to the extent of building 14 dams and 2 check dams by Kerala and Tamil Nadu has built one dam and a weirs. The basin is responsible for 59% Kerala's total hydro power through power houses at 9 points along the river by Kerala and one by Tamilnadu. These dams holds 25% of annual flow of the river which is 2930mcm. Out of the 14 dams situated in the 4 sub basins, water from major larger projects such as Mullaperiyar, Idamalaiyar is diverted to Tamilnadu. While water from Idukki reservoir is diverted to Muvathupuzha river basin.(Understanding the 42-Year-Old Idukki Dam Which Is Now Saving Kerala, n.d.)

The MullaiPeriyar dam which dates back to 1888-1895 built by John Pennycuick with a capacity of 443.23 mcm. Further a hydroelectric projected was commissioned from 1958 to 1965 with a total installed capacity of 140mw. The dam has been vital to people living in the drought-prone districts of Theni, Dindugal, Madurai, Sivaganagi and Ramanathapuram of Tamil Nadu. It irrigates about 220,000 acres of land and supplies drinking water to Madurai city and smaller towns.
Similarly Idukki dam built in 1976 has a capacity of 1460mcm and produces 780MW, while Idamalaiyar built from 1970-1985 has a capacity of 730mcm.



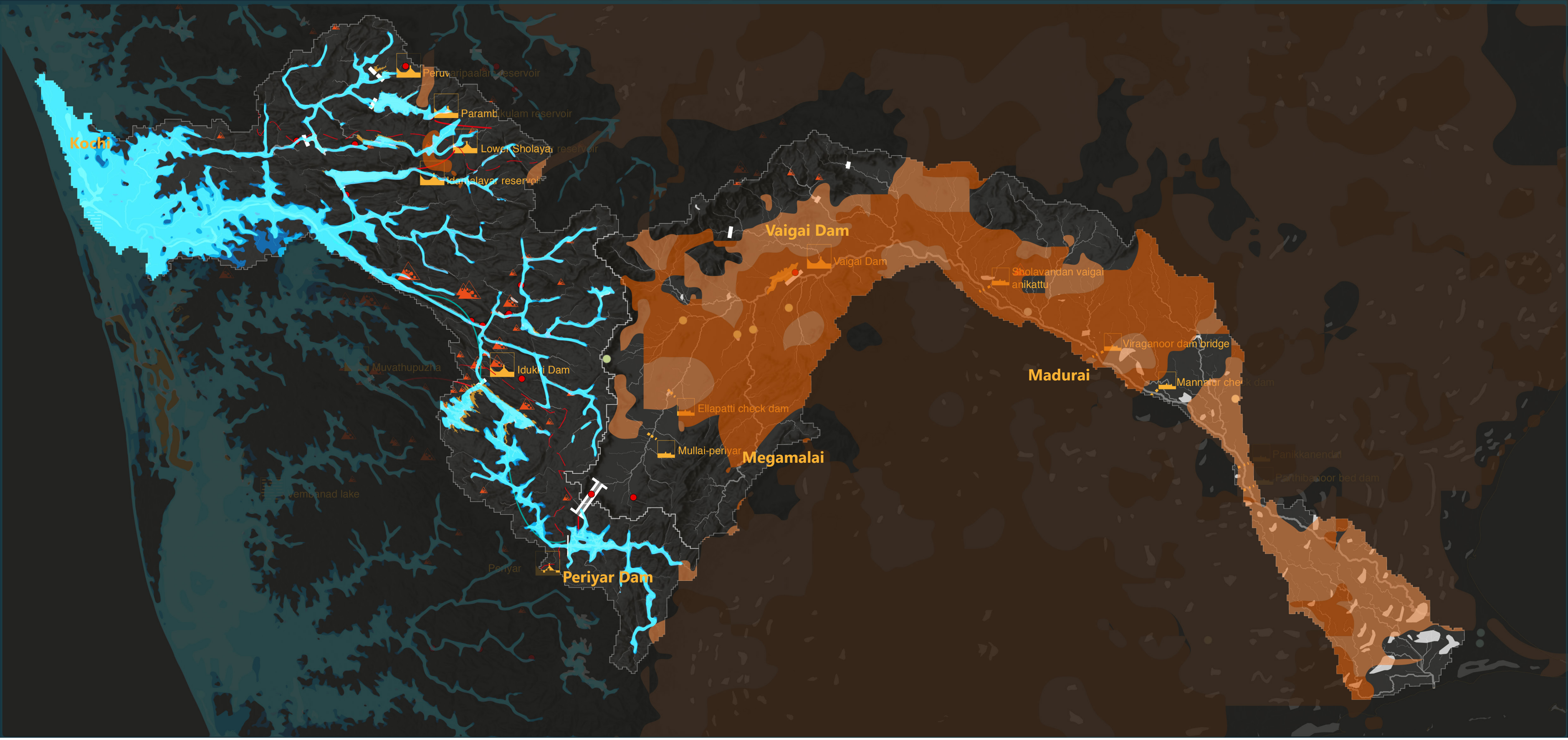
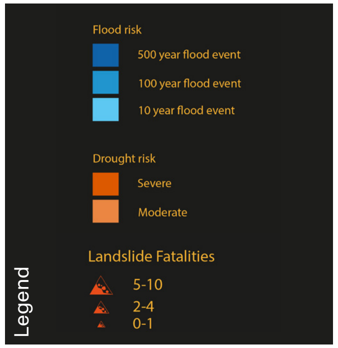


Fig 18 Topos Risk Composition, Made by Author
Floodrisk 2018 periyar, Drought: Chandrasekar et al., 2009

Topos Composition: Risk



VAIGAI RIVER BASIN

The length of the Vaigai river is 258km originating in the Vasundara hills confluences in the Bay of Bengal. Tributaries of Vaigai includes Suruliyaru, Mullaiyaaru,Varaganadi, Majalar, river Kottagudi and Kridumaal. Vaigai was once a perennial river and has now become seasonal to the extent of the river bed drying up more often than it carries water. It is also the reason why there is only one major dam on this river basin, namely Vaigai dam and 15 check dam to control/ manage the available water.

Beyond these infrastructures solely built aiming for the control of water, multiple other systems of mobility infrastructure, urbanisation on floodplains and encroachment on rivers, etc. exists as hindrance to the flow of the rivers.

Fig 19 Risk stock images from Kerala and Tamilnadu

Topos Alteration

The infrastructural alteration in these river basins for sustaining human life has lead to the total collapse of the hydrological cycle in the Vaigai river and the Periyar shows signs of extremely stressed systems not capable of handling varying precipitation. The question is how did a river such as Vaigai which sustained life for more than 2000 years go dry within a span of 50 years? To figure out, the changes in control of hydrologically have been analysed. Droughts are common in the arid and semi-arid parts of the southern Indian peninsula. Many water recharge structures, such as tank cascade systems, have been built in the past to this. However, in recent years, the effe of these tanks has been limited, partic irrigation and groundwater recharge, & Chinnasamy, 2021)loss of some of these tanks are also evident.

From a natural state of the hydrological flow of water, humans have appropriated these systems through time. Starting from the 12th C inscriptions found along the river Vaigai talk about the efficient water management systems devised by the Pandiya Kings. The Pandiya Kings constructed many check dams across

Fig 20 Topos Alteration, Made by Author

1 Vaigai and periyar river watersheds.

2 12C - Introduction of system tanks by Pandiya Kings

3 2022 : River in current condition

Waterways

Waterbodies

Dam infrastructure

Vaigai river, some of it recorded in inscription in temples. They understood the importance of water management living in a largely agrarian society.(The History of Water Management - The Hindu, n.d.)

Olden days exclusive groups were formed to maintain and manage these water bodies. These were the Yeri variyam(lake board) and kalingu variyam (sluice board). Riparian rights of lower ayacut farmers were established by Sri Vallabha Pandiyan, as noted in 'Vaiyai thadam Thedi'. Kings created waterbodies and collected tex from people. Pallavas constructed lakes across their kingdom, appointed guards to stop people from polluting and created corpus funds for the maintenance of water bodies which was used to de-silt the lakes and as relief for victims of floods. They let contract for fishing and for ferrying people on coracles to generate funds.(The History of Water Management - The Hindu, n.d.)

They constructed sluice gates such as Pulikan madai and Srivilliputhu with multiple gates to release water in a controlled manner. Cascading tanks system as viable infrastructures, they store water , percolate into the ground and are connected with a series of other tanks which are linked through canals. Surplus water from river overflows into the tanks filling them up from upper tanks to lower tanks. Traditionally, one can find temples at the base of the last tank where people would celebrate the filling of the last tank before starting to extract water from upper tanks. Thus ensuring water availability for all.

The construction of the Mullaperiyar dam in 1890s linking the Periyar and Vaigai river basins to supply additional water required for irrigation and domestic purposes. Further the British era brought in a significant change by bringing in macro-level planning and management of water resources, stripping the relationship people had with the water bodies and disrupting the functioning of the tank system. Post-independence the construction of Vaigai dam in 1959 led to the reduce flow of water to the network of tanks downstream and water became increasing inaccessible and centrally managed. The period of 2003 – 2004 saw severe droughts in Theni, Madurai and other districts along the Vaigai river leading to loss of cultivation and . To combat similar situations in the future, the Tamil Nādu government introduce a mandatory policy of rain water harvesting in the state. Which proved effective for short while. Owing to poor management most of these systems are not functioning today and does not allow percolation of water into the soil.

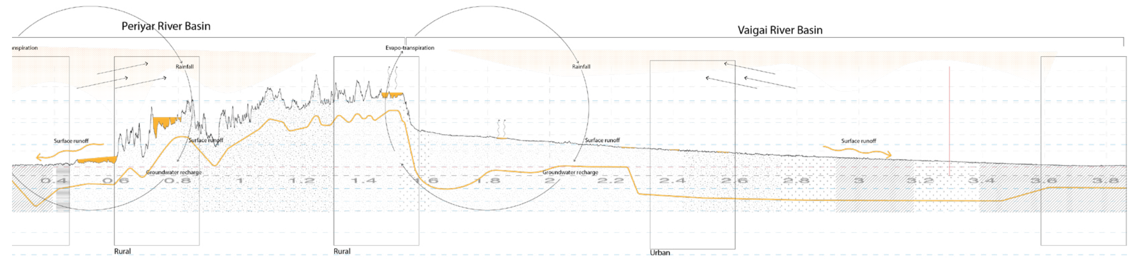


Fig 21 Natural hydrological flow, made by author

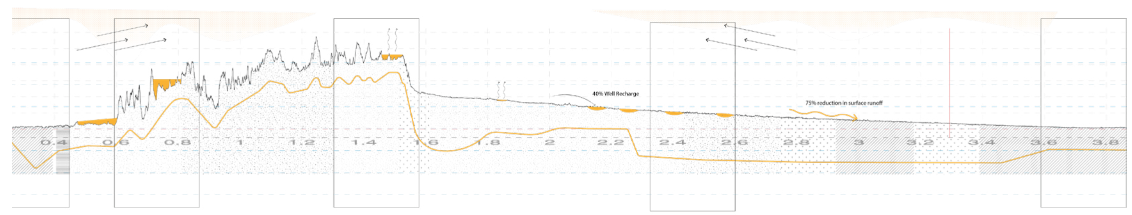


Fig 22 Modified by kings, Cascade system, made by author adapted from history

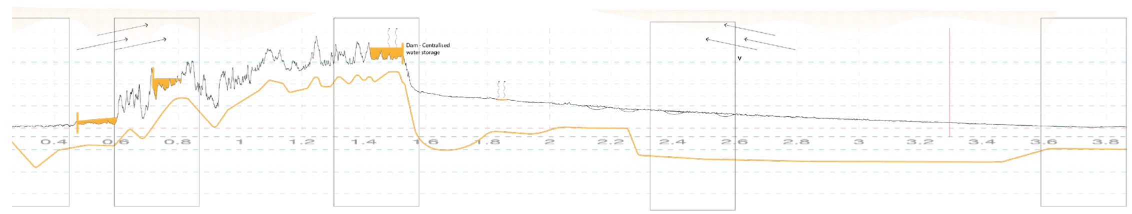
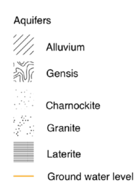


Fig 23 Modified by modern Infrastructure, made by author adapted from history

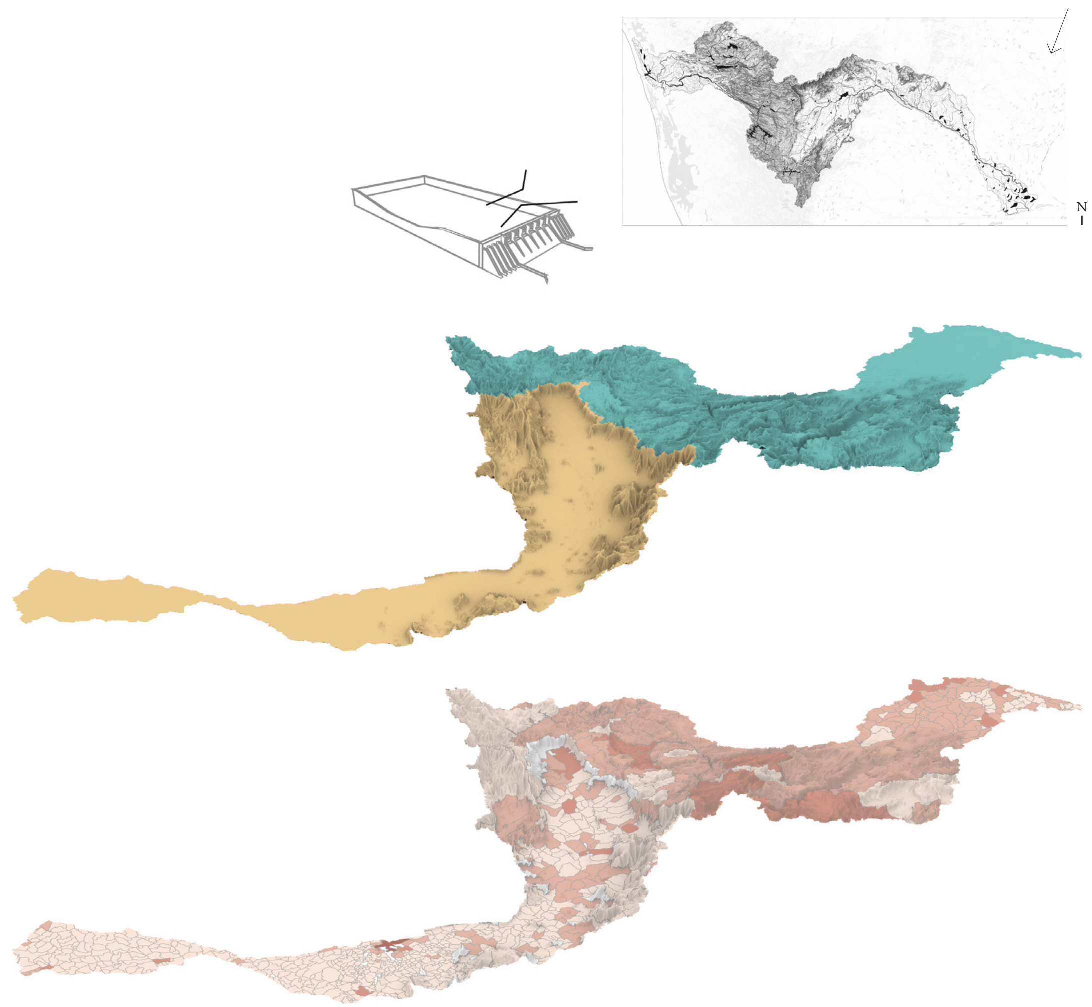


Topos Limits

There exist two different visions for the interconnected hydro systems of Periyar and Vaigai river basins and control over them is always a source of conflict between the two governing states of Kerala and Tamil Nadu. Following flooding in 2019 in kerala, the dam was designated as one of the world's large dams that needed to be decommissioned in a UN study issued in 2021 because it was "situated in a seismically active location with significant structural problems and poses risk to 3.5 million people if the 100+ year old dam were to break."(Kerala's Mullaperiyar Dam Is like a 'Ticking Time Bomb Waiting to Explode,' n.d.).

Decommissioning the Mullaperiyar dam has been in critical discussion between the states since the lease agreement of former British government (madras) to the then Travancore maharaja for a period of 999 years. Kerala's argumentation lies entirely in protecting the safety of the population downstream and Tamil Nadu concern for water availability for people in Theni, Madurai, Ramanadapuram etc. While the current vision for the region aims at building a new dam in place of the old one, the problems that the hydrological systems face is going to be persistent. Hence there is a need to visualise and design new ways of water management in this region which supports both the extreme context by bringing back the balance between human extraction and natures capacity to replenish the system.

While this exist as a politically evident, economically important conversation the effect of exploitation of groundwater sources through bore wells, tube wells are causing greater stresses in the region with settlement in Theni and madurai going under critical status of water scarcity. (Palanisami et al., n.d.)



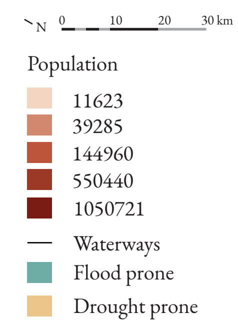


Fig 24 Topos Limits, Map made by author

Habitat Composition

Fig 25 Habitat Composition, Map made by author
Data source: Bhuvan landuse

N— 0 10 20 30 km

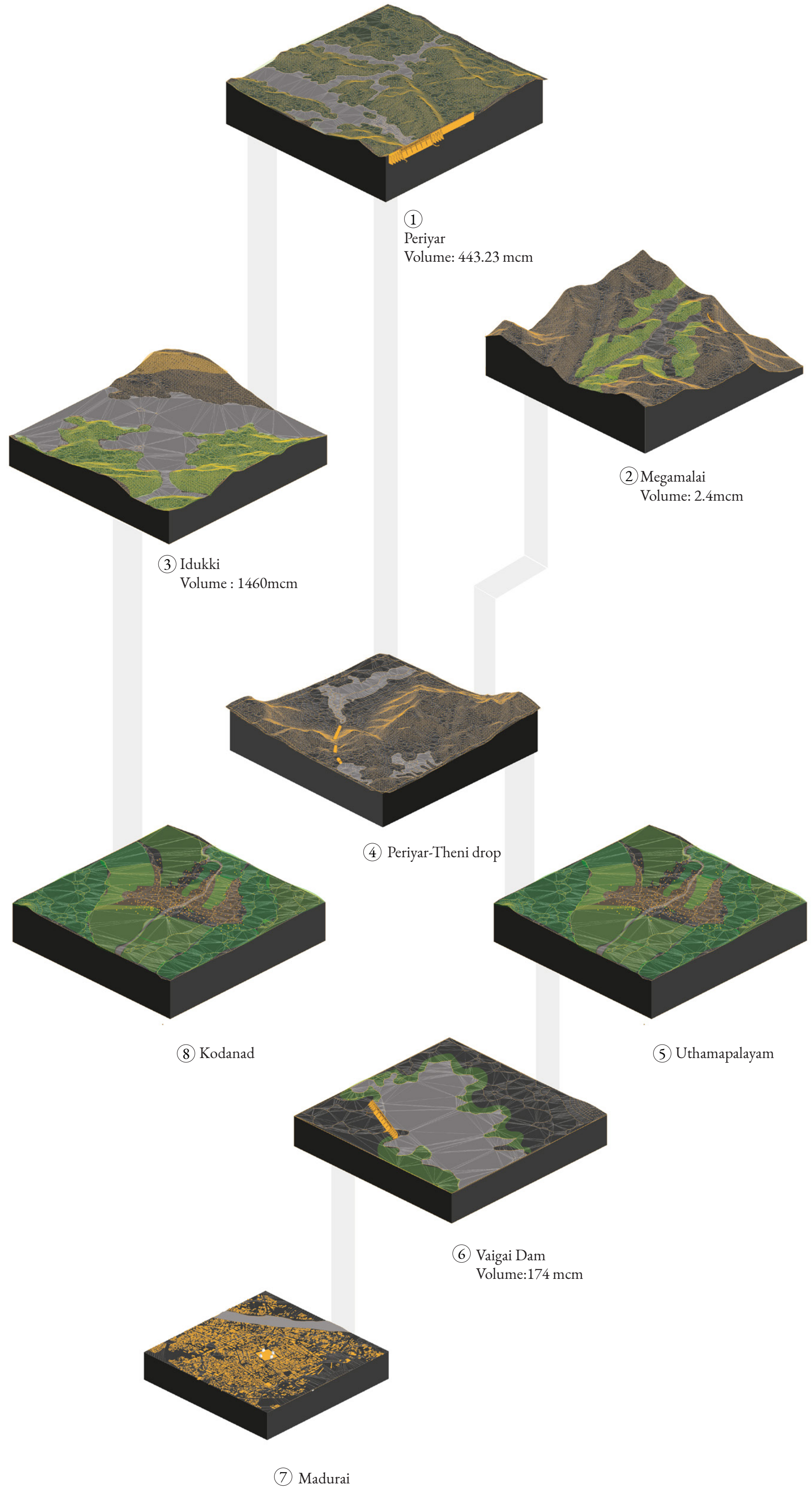
River basins
Waterways
Water bodies
Landuses
Crop land
Plantation
Forest Plantation
Forest Evergreen
Forest Deciduous
Crops
Tea
Cardamom
Pepper
Rubber
Banana
Cotton
Ginger
Paddy
Coconut
Grapes
Jasmine

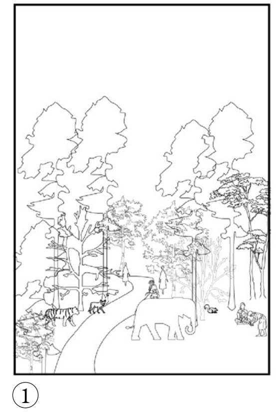
Water systems along with the topography of the region dictates the pattern of settlement in the region. This region is a UNESCO World Heritage Site and is one of the eight biodiversity hotspots in the world. Starting at the origin of the river the is populated with forest areas, plantation and tourism related industry upstream followed by a series of agrarian land uses in the valley's and plains and is dotted with cities in the plains, where the topography is almost flat.
This line of enquiry explores the demand and supply balance of water to understand the water stress in the region based on different land use types.

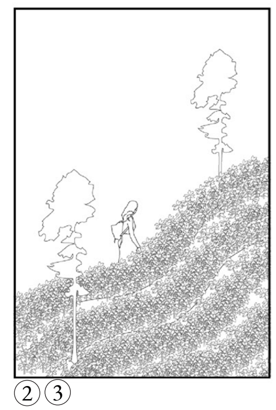
The major crops of exports are spices, tea, rubber in higher altitudes of Kumily, Kattapana, Munnar and Megamalai. While the valleys of Theni and Madurai cultivate Coconut, cotton, rice, sugarcane, vegetables and fruit. Of which Jasmine flowers grown in Madurai district, Tea, pepper, cardamom grown in Idukki district hold higher export value than other crops.

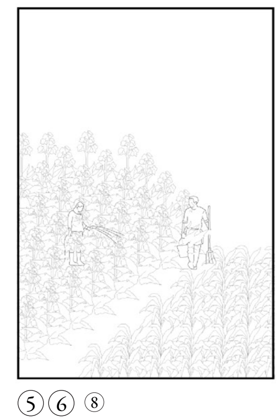
The tourism industry on top of the mountains play a major role in the economy of the upstream areas, large landmasses have been converted to hotels and resorts and have been extensively modified for accomodating thousands of national and international tourist who flock to the mountains during summer.

The productivity of land depends on largely two factors, viz renew-ability of nutrients by sediments and availability of water in addition to climatic conditions. From statistics it is seen that the region is exhibiting exploitation of its groundwater which is seen at a range of Safe to Critical in the adjacent diagram.
To further understand the relationship of people to the landscape and water systems stories from site have been of great use.









Composition of flow of water accross different topography and diverse settlements.
Water discharge at each level is yet to be calculated.

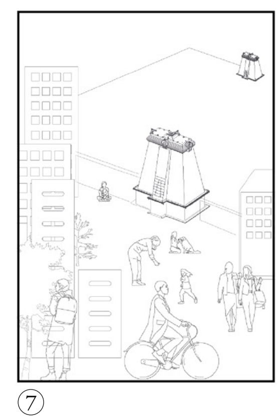


Fig 26 Habitat Alteration , Figure by author

Economic composition

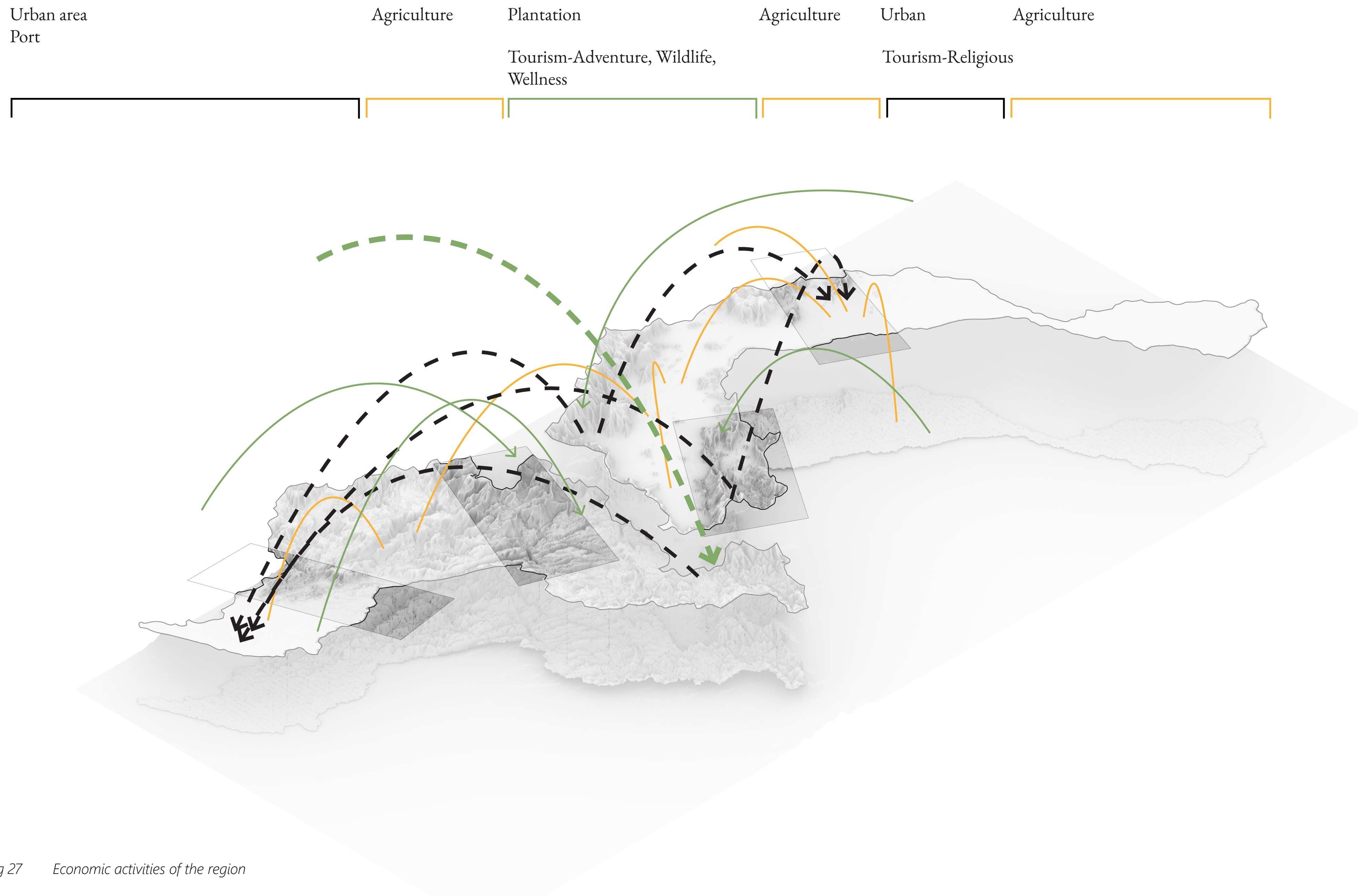
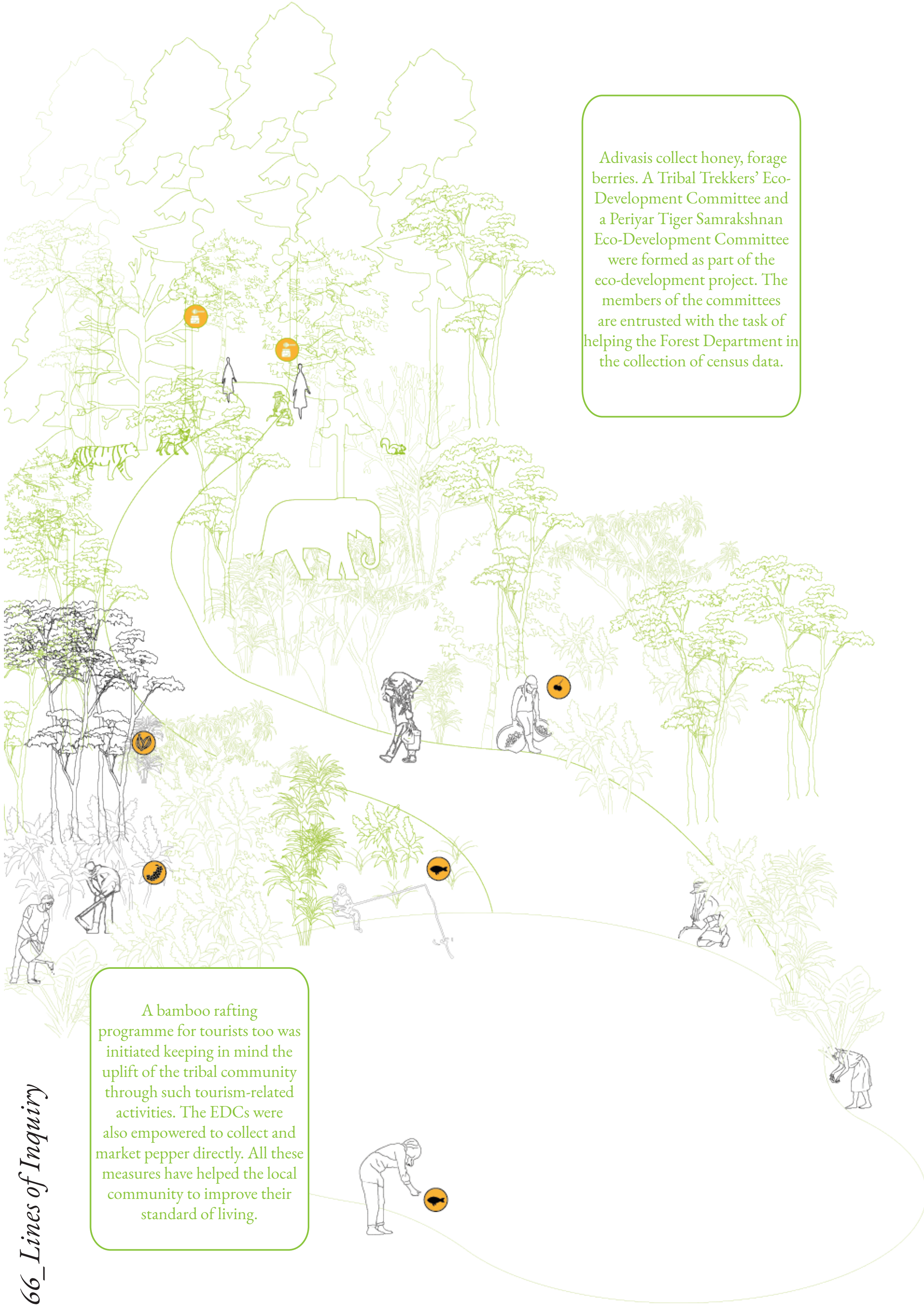


Fig 27 Economic activities of the region



Periyar

The Adivasi's(tribes) Mudhuvan and Paliya indigenous to the forests surrounding the Periyar river originally lived in the forest foraging, fishing and hunting for their existence. While Mudhubvan tribes were stationary in their location, cultivating on small pieces of land, the Paliya tribe were nomads who cultivated on a piece of land for a season and left it after harvest to another area to allow the land to replenish itself. They consider the forest as their god and have yearly rituals thanking the bounty of the forest.

The Mudhuvan tribe lived in higher altitudes in locations now known as malapara, then moved to aruvi, irukutti and thondayar. Around 80years ago they used to cultivated tapioca and rice on small patches of land. In 1934, the British established the forest as a Nellikapatti game sanctuary for leisure hunting, forcing the adivasis to move out of the forest. The leader of the communities along with Ramanrajamannar tribal king of 32 other settlements like these spoke to the Amma maharani(Queen of Travancore) and eventually got a small piece of land close to the forest for these communities to survive.

They also gained permission to forage and fish in the Megalaiva lake within the forest. Yet, as the land was on lease all agricultural produce was given to the kingdom leaving them nothing. Eventually the identity of tribal communities were recognised by the Government of Kerala in 1996 and established

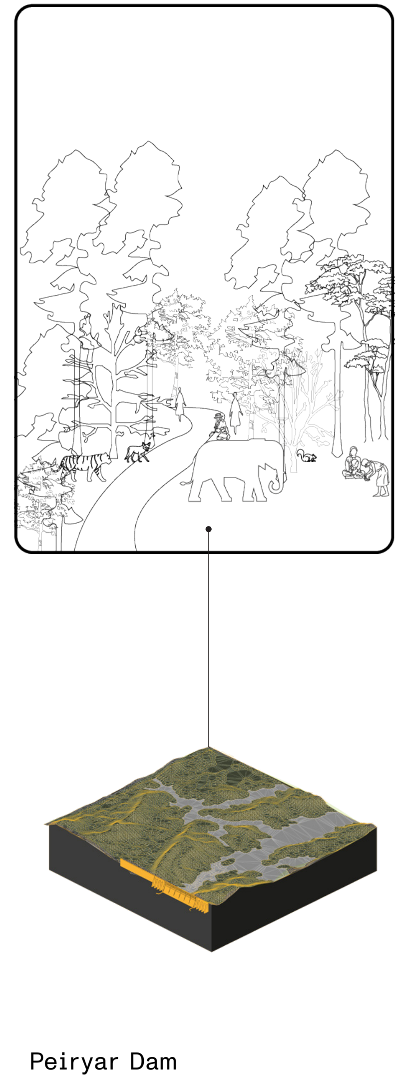


Fig 28 Adivasi community diagram, Made by Author

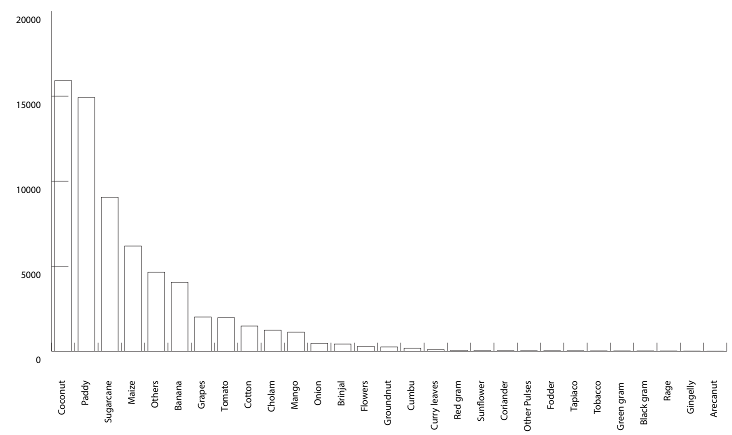
Fig 29 Photographs by Author

Theni

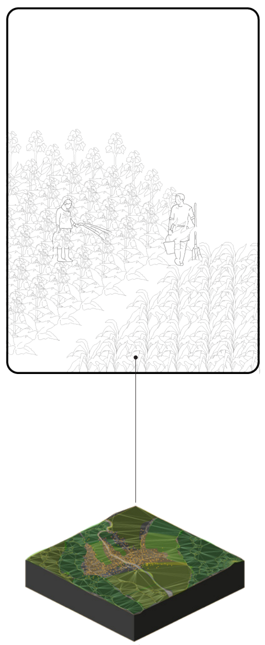
Area	2889.23 km²	
Population	10,49,323	
Density	363/km2	
Landuse	i. Forest area	1037.18
	ii. Net area sown	1115.99
	iii. Cultivable waste	39.84
Major occupation	Agriculture	

1. Paddy - 15694Ha – 24%
2. Oil seeds – 18935Ha –26%
3. Vegetable– 5743Ha – 11%
4. Sugar cane – 7510Ha – 11%
5. Non food - 32501 Ha – 31%

Major Irrigation sources			
	Dug wells	24706	36570
	Tube wells	-	4935
	Tanks	212	1949
	Canals	107	12264



Theni district is filled with agricultural fields growing Coconut, rice, cotton, jasmine, maize, sugar cane .etc A visit to one such field showcased 5-6 different types of crop (Cotton, Rice, Corn, Jasmine, Maize and other vegetables). Theni district is surrounded by mountains and acts a bowl for water flowing down, thus it can currently afford to grow water intensive crops like Coconut. Here coconut grooves are filled with banana to occupy the lower portion of the land.
A farmer owing 3-4 acres of land in Usulampatti when question about the pattern of crop-rotation in a year said he would change his pattern according to the rainfall that year, while grows jasmine for over 40 years since the plants durability and the profits he can make out of it. Fed by Vaigai river these regions receive water only when the water is released from the dam, which does not have a reliable frequency. Hence additional irrigation is done through dugwells placed close to the farms.



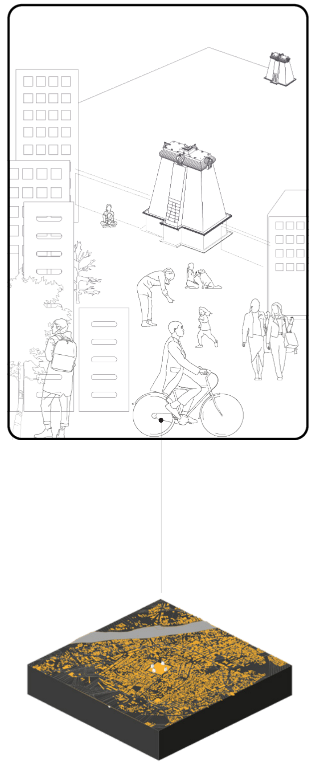
Uthamapalayam





Fig 30 Photographs by Author

Madurai

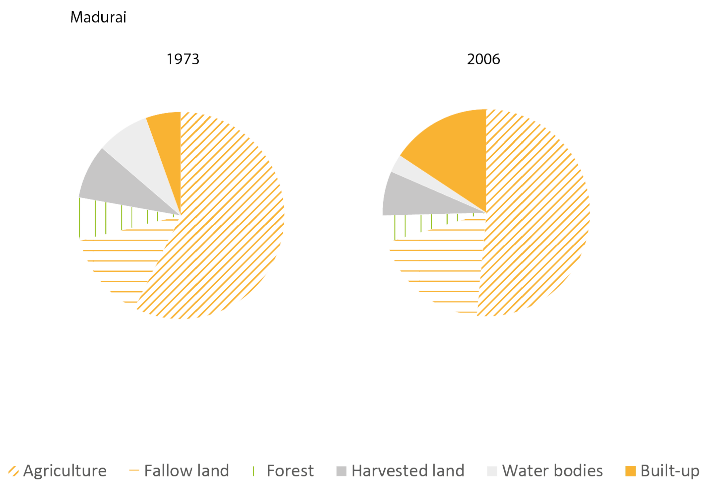


Situated on the banks of the Vaigai river Madurai has a history of over 2000 years and is home to Meenakshi Amman kovil (Temple) with approximately 50,000 people visiting the temple everyday. It is the cultural capital of Tamil Nadu and third most populous urban agglomeration in Tamil Nadu according to the 2011 census. It is traditionally an agrarian society, with rice and paddy as the /main crop, along with jasmine. Paddy fields dotting the Vaigai river across Madurai North, Melur, Nilakottai and Uthama-palayam are known as "double-crop paddy belts. After 1991 the economy is shifting towards small scale industry processing and manufacturing primary produce from the region. It also house the main markets to which local produce of the region are brought and distributed to various regions in the state and outside. Historically Madurai had trade connections with South-east Asia and Europe. More recently the economy is shifting towards IT and automobile manufac-turing industries.

Elevation	Madurai	391 m
Area		6.58 km2
Population		1,766,000
Density		10000/km2

Major occupation	Agriculture	Paddy, Coconut, Groundnut, fruits and vegetables

Fig 31 Photographs by Glasshouse Images / Alamy Stock Photo



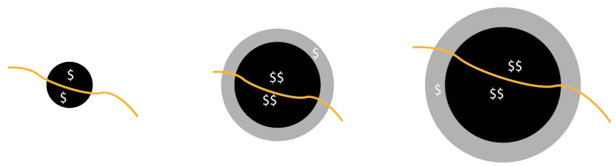
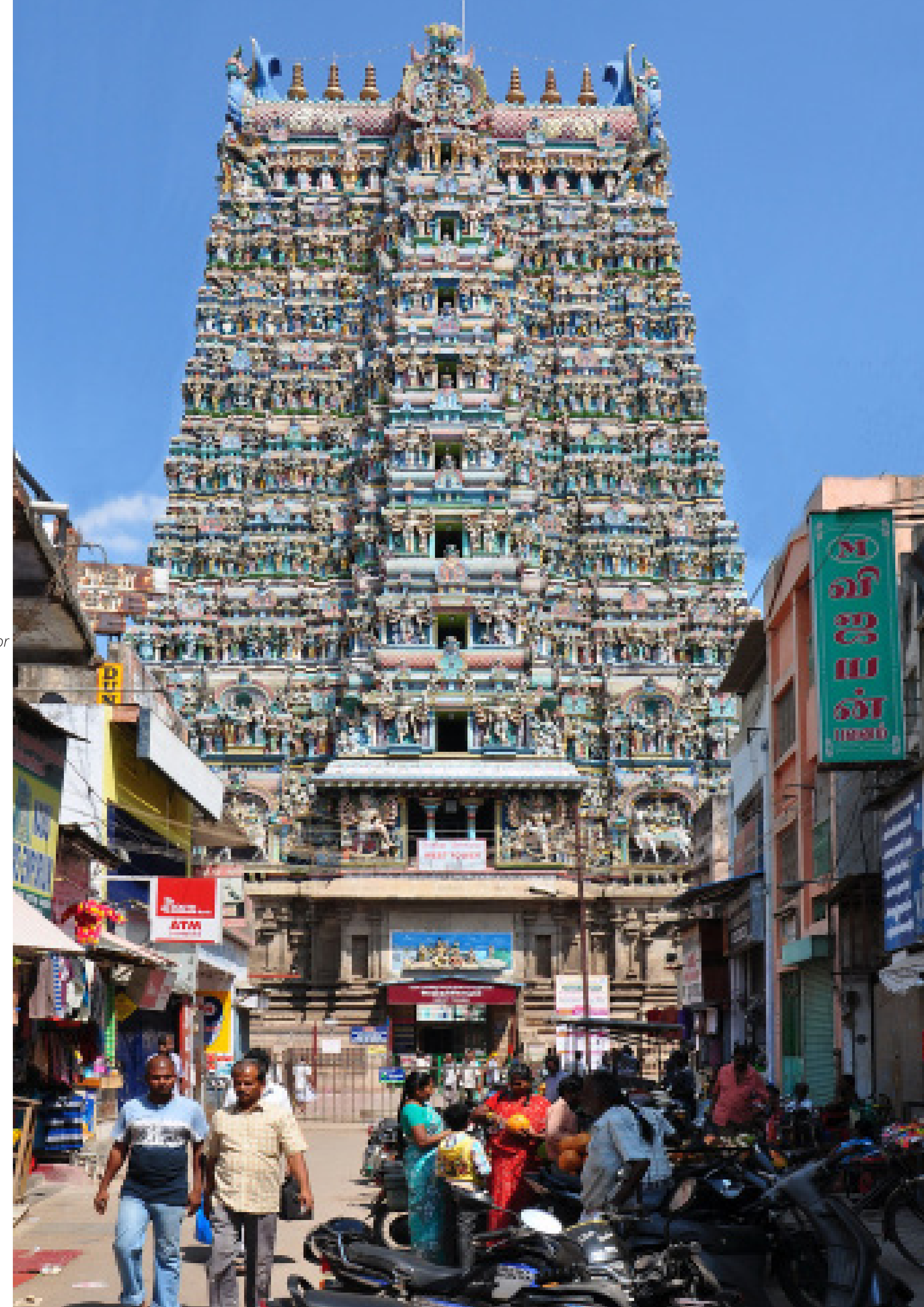


Fig 34 Habitat Limit, Made by Author
Data source : Madurai statistic

Fig 35 Firgure made by author
Data source : Madurai statistic

Fig 33 Right: Stock images

Fig 32 Below:Photographs by author



Habitat Limits

The trend of change in land uses as show in the chart indicated that they are economically driven, with more profitable land uses take over the other types l Increasing requirement of land for urban growth which is more profitable than agriculture, pushing agricultural lands further into forest areas which is not economically profitable.
Sand mining encroaching of urban developments on river beds, further reduces the quality of the river and the capacity od the river to replenish during monsoon. Unless the eco-services of the forest in recharging the hydrological cycle, the role of sediments from the river is economically valued the change in land uses will continue in the future. Thus the design calls for aligning human systems such as agriculture, built environments to align with the natural system by using humans as stewards of nature and aligning the systems: agriculture to agro-forestry to maintain dynamic equilibrium.

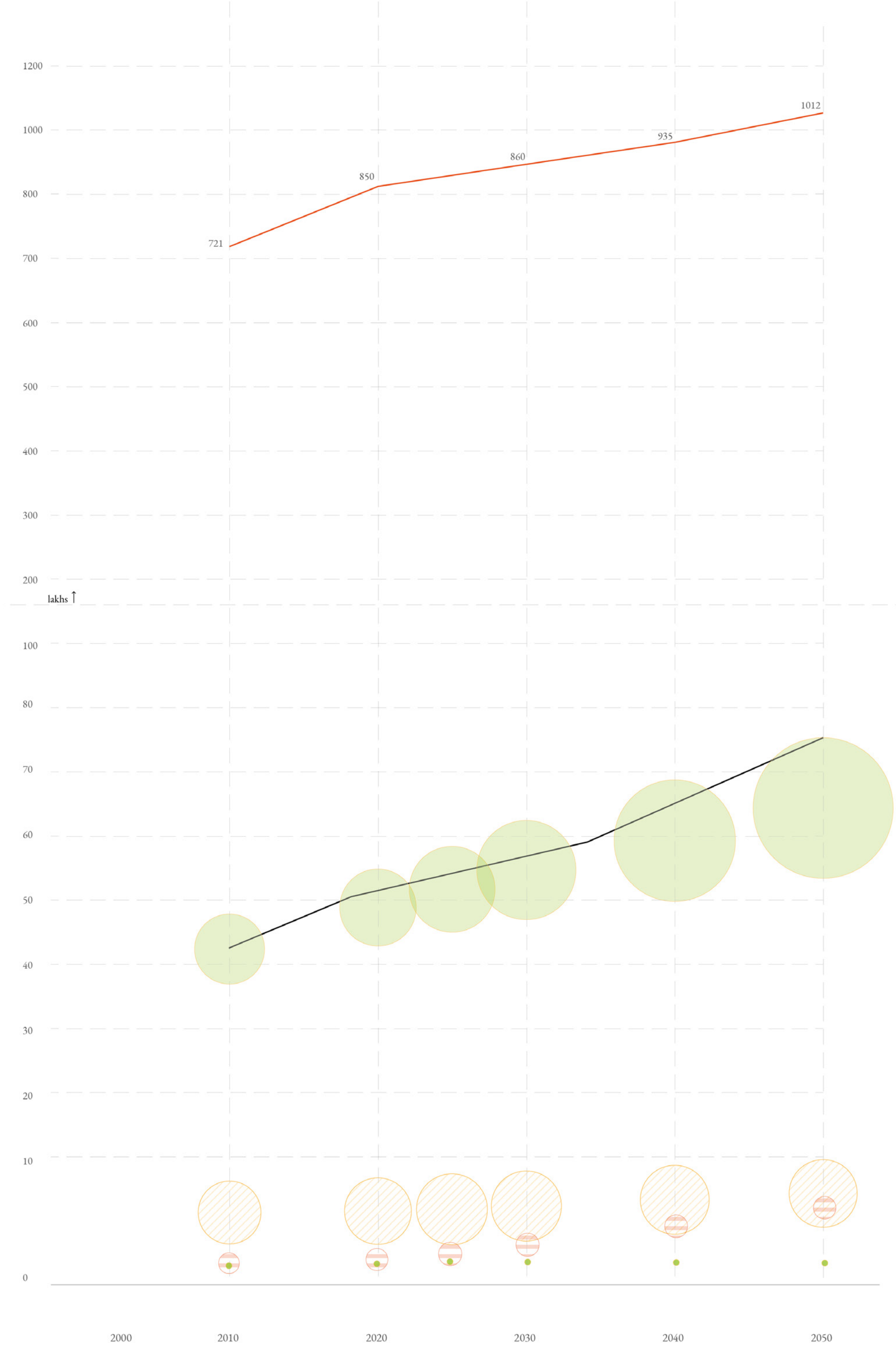
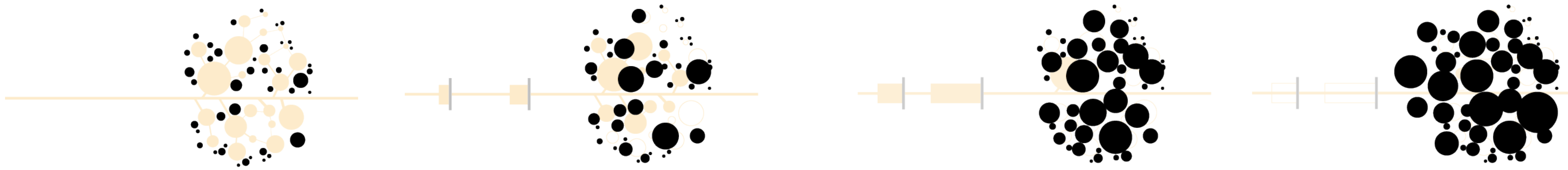


Fig 36 Figure made by author

Irrigation
Induatry
Domestic
Live stock
Total
Population

Urbanisation



Pattern of villages arranged around large tanks.

Initiation

Slow transformation of vacant tanks into urban and expansion of urban

Exploitation

Explosion of urban areas with rise in population and people moving to the city,

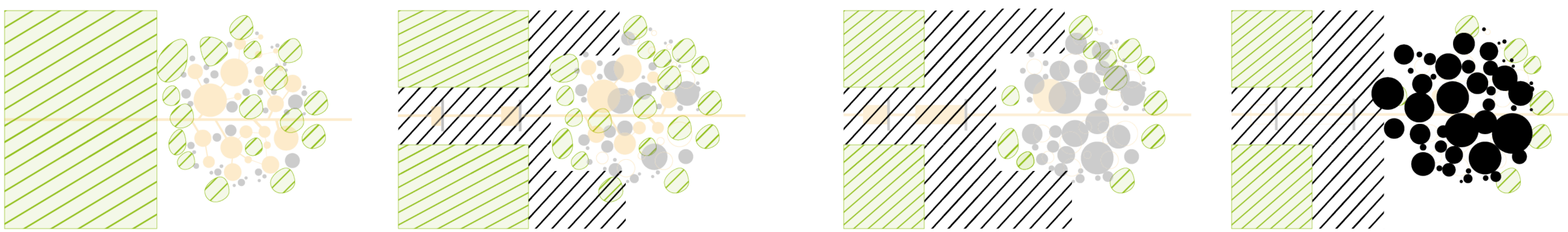
Exploitation

Urbanisation taking control of the landscape and rapid land transformation.

Exploitation

Time of change - <60 years

Forest/Green cover



Pattern of forest and green co-existing with human settlements

Dam-infrastructure causing disruptions in the forest and making land available for production

Initiation

City grows and need for resources grow. Production landscapes eat up forest areas

Exploitation

Land use of least economic value is always transformed into profitable landscapes.

Exploitation

Time of change - >200 years

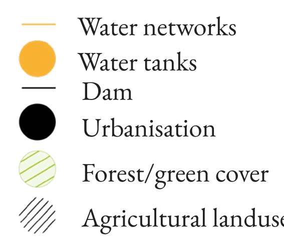
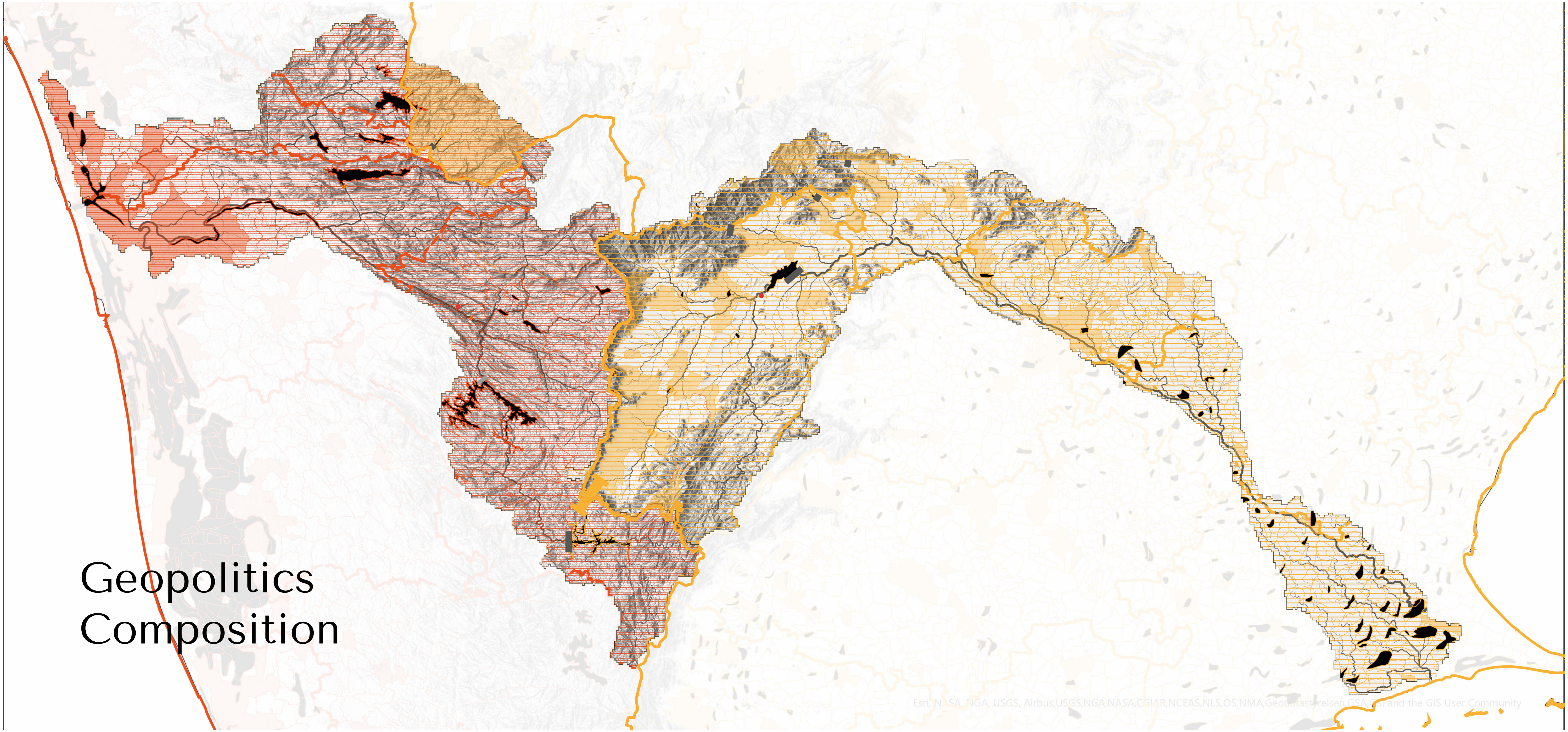
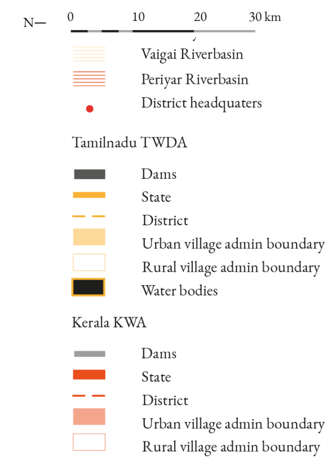


Fig 37 Habitat Limit, Made by Author
Data source : Madurai statistic



Geopolitics Composition

Fig 39 Geopolitics Composition, Map made by author



The region is governed by 2 state administration bodies: Kerala and Tamil Nadu, governing independently without acknowledging the interdependencies of the natural systems, geographies that traverses them. People living on the western slopes speak the language of Malayalam while on the eastern side they speak Tamil, which also adds as to the complexity of communication. Watersheds exist as natural boundaries for administration of interdependent systems, which is not considered in traditional governance practices.
According to government of India the governance of water bodies lies with the individual states who are responsible for the development and management. While the Central government provides financial resources to the state governments for execution of national level projects the state while the projects within the administrative boundaries are the states responsibility. There exist a hierarchy of water management and differs between these two states with different governing bodies at rural and urban scales.
Water utilities are underperforming in India despite investment in infrastructure and capacity. Most of the households in this region do not receive water 24/7 and women are primarily on the losing side, as they fetch water from tanks or local wells afar greatly affecting their productivity. (Seaforth, 2001)
65% of rich have access to piped water supply while only 2 % of the poor people enjoy the same.(Water: Towards a Paradigm Shift in the Twelfth Plan on JSTOR, n.d.). India is currently committed to UNs SDG, of which SDG 6 includes water and sanitation related goals.
The Indian government aims to involve several departments of water management at the central and state level to envision this goal.(Ahmed & Araral, 2019).

Geopolitics

Kerala | Tamil Nadu

Kerala			Period	Tamil Nadu	
			Pandian empire 1223	Pandiyas	Cascading system of tanks
	Farmers in Kerala had empirical knowledge on meteorological events that influenced the agriculture	Irrigation by local collective			Check dams Eri, kanmai's, kullam, temple tanks, anaikattu
Macro-level planning	Concentration of decision making and management of irrigation				
Economic returns for the state	Shortage of food-grains in - second world war		British period 1757 -1947	Superintendents of Tank repairs-1809	Repair of tanks for better irrigation
	Restrictions on the movement of rice	Fall of Burma		The Inspector General of Civil Estimates-1825	
	Efforts to increase Rice production & attain self sufficiency			Construction os Anicuts	Dowleshwaram Upper Anicut - Cauvery
	Massive investment in irrigation projects			John Pennycuick	Dams canals
	Large stretches of forest land to be converted for cultivation of food crops - paddy and tapioca	Travancore - Cochin gov		Madras gov,	The engineers of the Madras government started planning a few medium and small irrigation projects in Palakkad and nearby areas during the late 1940s.,
			20th century Post independence		
	Travancore, the governmental organization responsible for the maintenance of irrigation projects in Nanchilnadu	Travancore - Cochin gov			
In 65% of land sustaining paddy fields	To- achieve self sufficiency	Around 10 irrigation projects	1940		
			1950	First Irrigation commission	water power supplies, irrigation and canals, drainage and embankment, water storage and water power
	In an evaluation study conducted by the State Planning Board in 1975, it was suggested that inflating the size of command area to meet the 'unrealistic criteria adopted for sanctioning the scheme led to the non achievement of the estimated targets.		1957		
Decline in paddy output after 1974-1975	Share of Paddy from 38% to 31%	The annual investment in this sector during the early 1990.0s was about Rs 850 million	1975	Second Irrigation commission	
Decline in profitability- major reason					
The expectation that the constitute of irrigation projects would eventually lead to the achievement of this target that was used for keeping up the hope of self-sufficiency continuing for three decades.	Once investment starts in a sector, then the level of tie investment never decreases. Moreover certain exigencies cause investment decisions (which are tuned more to the needs of the respective organization	7916.1 82% of total(9645.7mil) irrigation in major and minor irrigation projects	1990-91	State irrigation projects 1995	Drought
					Rain water harvesting

Geopolitics Limits

Within the context of governance and management of water in the region, historically there has always been investment allocated for water resource management and irrigation projects. Yet the state of the water bodies and its supply to the people is inadequate.
To understand the evolution of control of water bodies and the investment in this sector a timeline of events in Kerala were mapped, adapted from (Planning Kerala's Irrigation Projects: Technological Prejudice and Politics of Hope on JSTOR, n.d.). Inferring from the timeline of events and the investment in irrigation conclude that the funds allocated for irrigation projects have not been utilised effectively to improve water management.
The state which receives rainfall for 8 months in a year requiring such a huge amount of investment for irrigation projects is problematic at its root.
Tamil Nadu has history dating back to Sangam era in managing water resources owing to its arid and semi-arid conditions. Starting from Kings constructing tanks, canals to British building dams, setting up of irrigation boards and now new authorities of Central water management Boards to manage water systems, huge amounts of time and investment has been poured in. The timeline of the events have been mapped but the amount of investments are yet to be analysed.

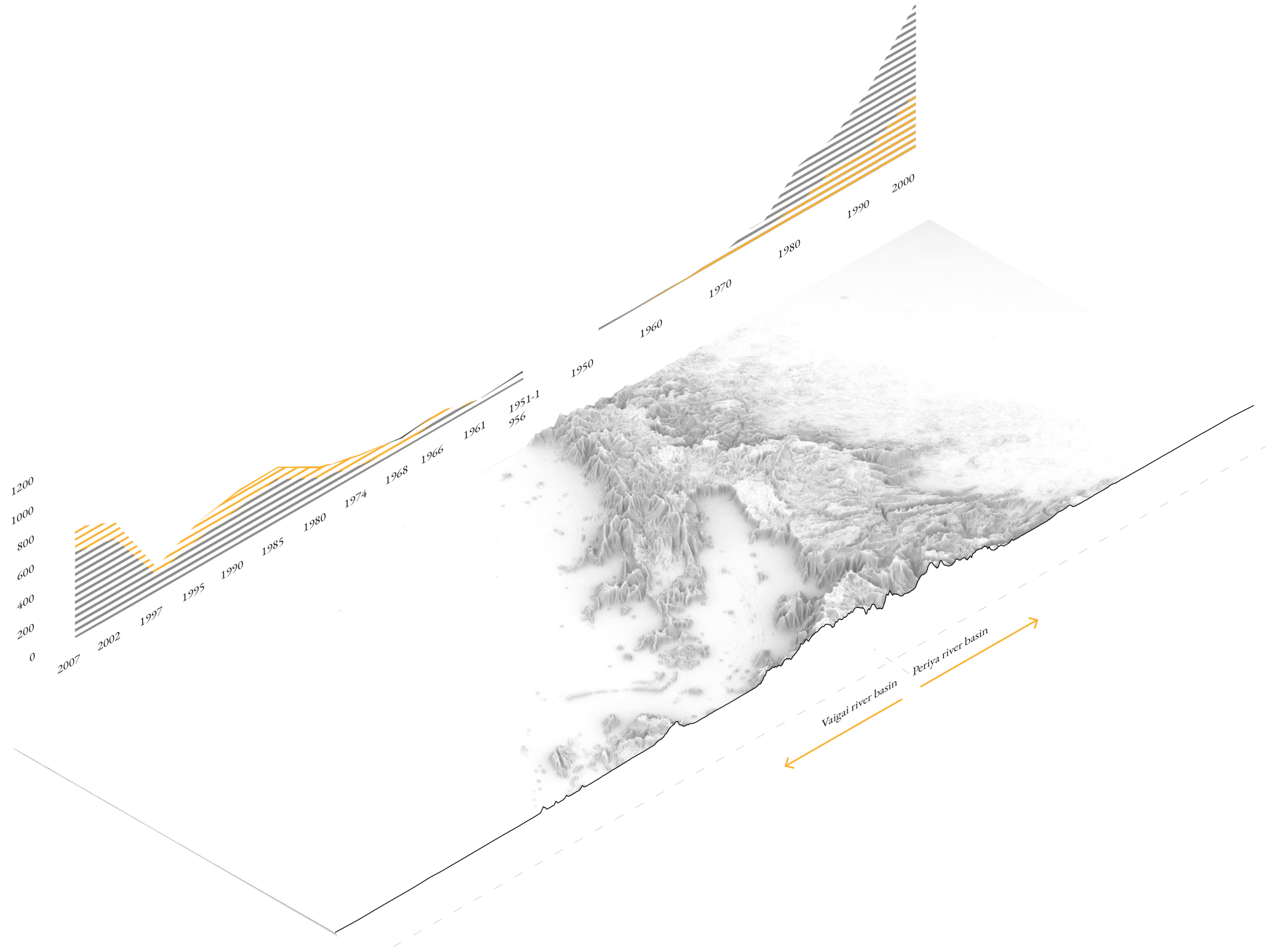
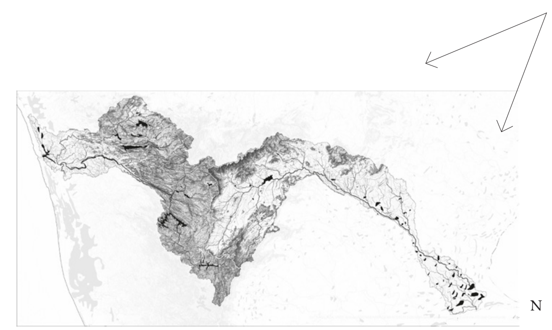


Fig 40 Geopolitics Alteration
Map made by author

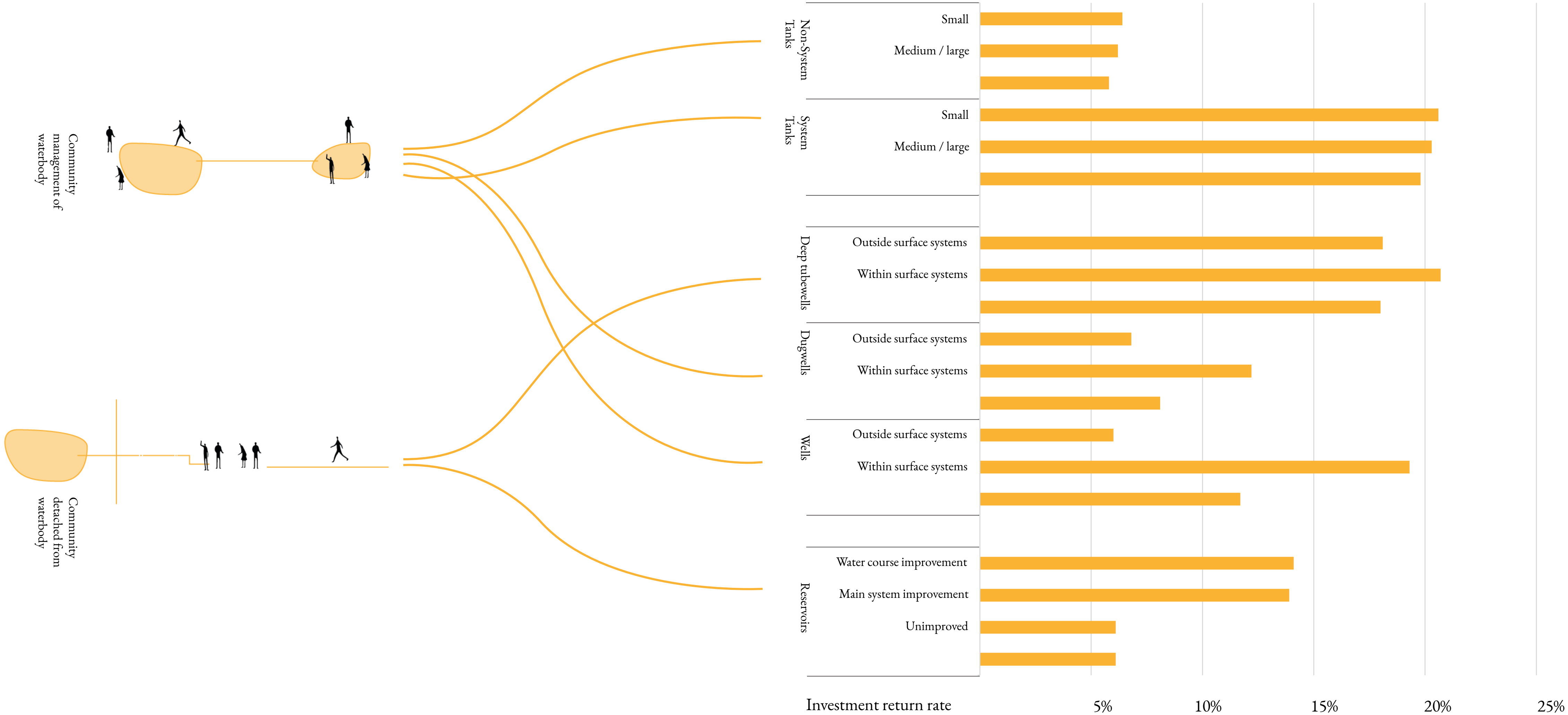


N 0 10 20 30 km

Investment in million USd

Major/Medium projects

Minor projects



The return on investment of such large scale expenditure on irrigational projects is necessary to predict the pathways of future water resource management. This is understood by study done on different kinds of infrastructure projects in Tamil Nadu by Palanisami et al., n.d.

The internal rate of return (IRR) clearly shows the rates of return for various investment kinds, with small system tanks tend to have the highest rate of return (20.6 percent), followed by large system tanks (20.3 percent). In general, system tanks provide a 19.8% return on investment. Tube wells with a shallow depth There is an IRR inside the surface command and dug wells within the surface water command respectively, of 20.7 percent and 19.3 percent. Within the surface command, the IRR for excavated wells are at 12.2% of the population Improvements to water courses and major systems will yield returns of 14.1 and 13.9 percent, respectively. In comparison, unimproved kinds yielded a 6.1 percent return on investment. Improvement is the same way. The development of water courses might provide 13.4%, followed by the improvement of the main system (13.2 percent) and kinds that have not been improved (6.2 percent)
Thus one can conclude that Tanks and system tanks are suitable for these conditions more than large scale irrigation projects. Additionally the tanks systems can be locally managed by communities and easier access to water while reservoirs and dams are complex systems inaccessible to the community.

Fig 41 Geopolitics Limits Figure made by author

Clearance

Monsoon as an Activator

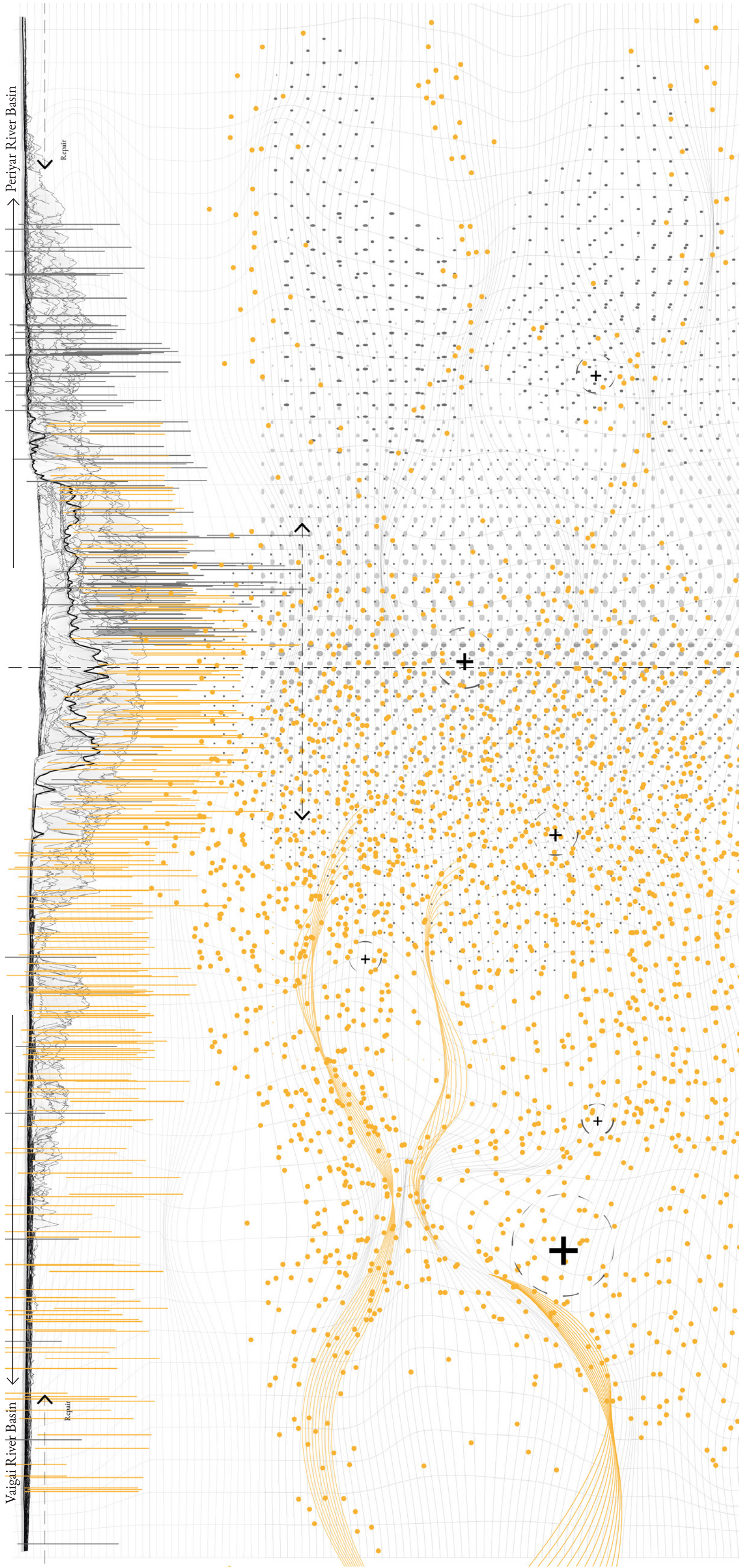
Clearance

Historically India has been a land of culture, people and diverse mix of geographies from mountains to the vast oceans with knowledge about its context embedded in its culture over thousands of years.

Extreme weather events recently have exasperated the already fragile habitats in developing countries like India. Rapid growth has come with extractive exploitation, improper management of finite resources within a capitalistic approach ignoring traditional local management practices leading to socio-economic disparities. One of the system which is at a state of extreme degradation is the water system. Disruptions in the hydrological cycles affect all other nested as human settlement pattern, ecological systems, forest health, primary production, economic development, urbanisation .etc.
Water is simultaneously feared and revered in the southern states of Tamil Nadu and Kerala owing to the varied changing weather patterns, governance, spatial composition and environmental degradation. Additionally, the topography of these regions heightens the risk of landslides, flooding, drought etc. The complexities of the region and the urgency of the impending crisis requires extensive planning to steer towards a sustainable,just, viable future. This graduation project aims to assess these uncertainties to establish a scheme of adaptive pathways acknowledging hazards and to envision a resilient, inclusive sustainable model of co-habitation. In response to the accumulation findings from each line of inquiry, corresponding pathways towards design have been attempted as an initial step to transition these territories.
The major source of water in this region is the monsoon, but an attempt at stabilising the monsoon it is far from the scope of a single project. Improving the hydrological cycle, restoring other components, such as rain-forest cover, within the given context could increase the reliability of the system. This is attempted by improving the health of upstream ecosystems consisting of rainforest and also by regenerating lost forest area through reforestation practices. Thus, the design aims to increase precipitation on the eastern side (Vaigai river Basin) and regenerate soil strength to combat drought and flooding/landslides on the steep slopes of the Periyar river Basin. The Matter Clearance diagram highlights potential areas of reforestation (along the slopes of mountains in the Vaigai river basin) that would thereby restore the water flowing through the river.

The transition to cohabitation of humans and non-humans requires us to share our resources and, more importantly, allow them to adapt and align to the natural cycles. Using strategies of landscape as infrastructure, the design will aim at building water systems that align to the natural hydrological cycle. An ideally designed infrastructure would function as if it were a part of nature, rather than restrict its mechanisms. These strategies will be multi-scalar and will aim to restore nested interdependent systems. The Topos clearance diagram shows the clearance of grey infrastructure, retaining walls, bore wells and its replacement with check-dams, system tanks, soil-strenghtening trees etc.
Such a transition to green infrastructure and reforestation needs to be managed by the community and should be embedded in their culture to create awareness on the value of the services that a well-functioning ecosystem provides. The design aims at the adaptation of human settlements, production systems to nature through Nature Based Solutions, envisioning a scheme of adaptive pathways for transition. By incorporating indigenous knowledge for future transitions, for instance, the Eco development project in Periyar Tiger reserve. At each typology of settlement the design aims to perceive a form of cohabitation through sustainable management of water to provide for human needs and also maintain ecological flows (shown in the Habitat Clearance drawing).

Finally, through the section of geopolitics the project stresses the importance of placing value on ecosystem services by envisioning a new and flexible economic structure that encourages people to become stewards of nature while valuing eco-services work of interdependent communities. Thus, the design transcends beyond spatial organization, management of resources and aims to establish protocols of care for the effective functioning of the water system.



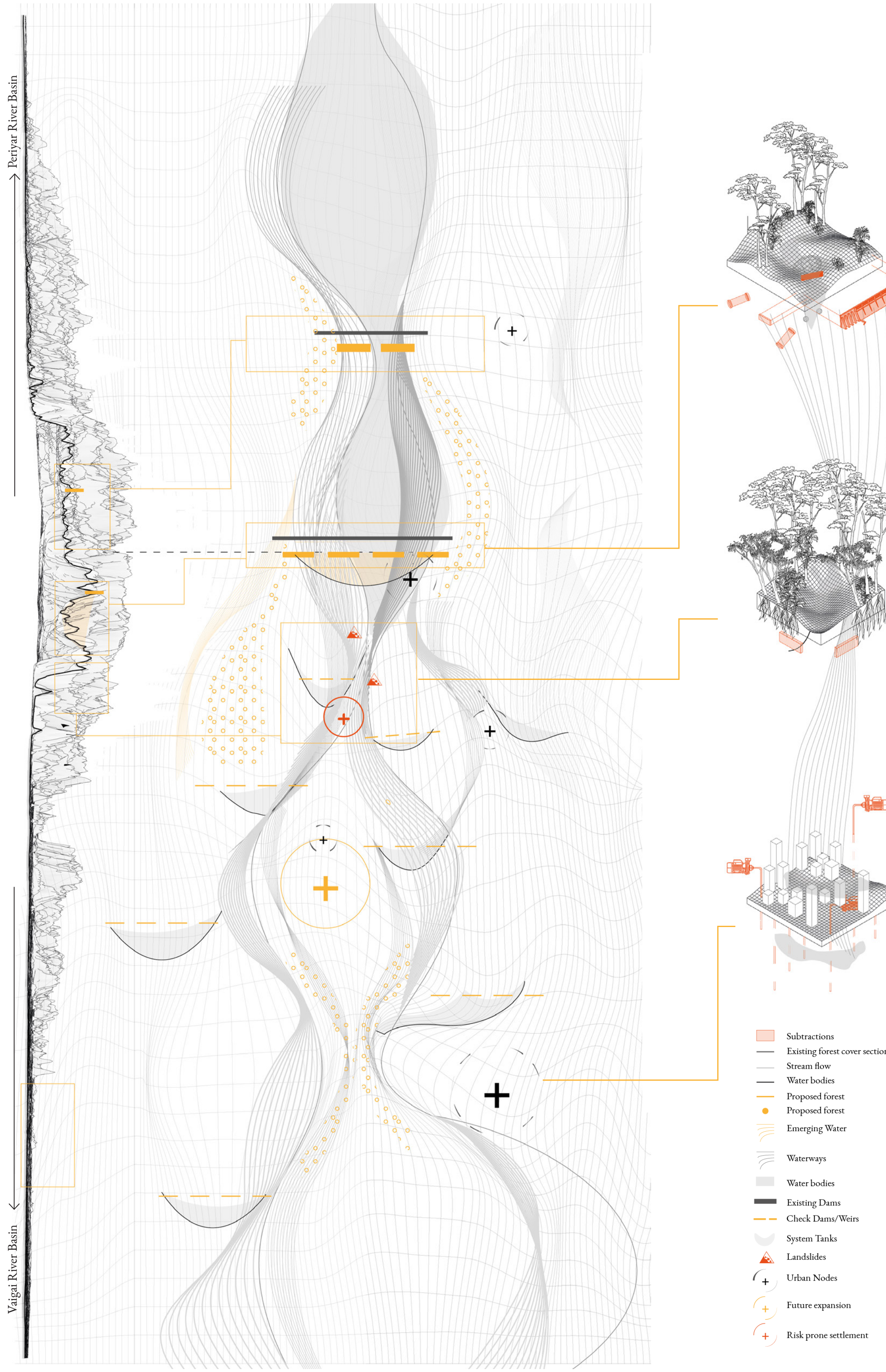


Fig 43 Right: Topos Clearance, Figure made by author

Fig 42 Left: Matter Clearance, Figure made by author

Existing forest cover plan

Dense

Thin

Subtractions

Existing forest cover section

Stream flow

Water bodies

Proposed forest

Proposed forest

Emerging Water

Waterways

Urban Nodes

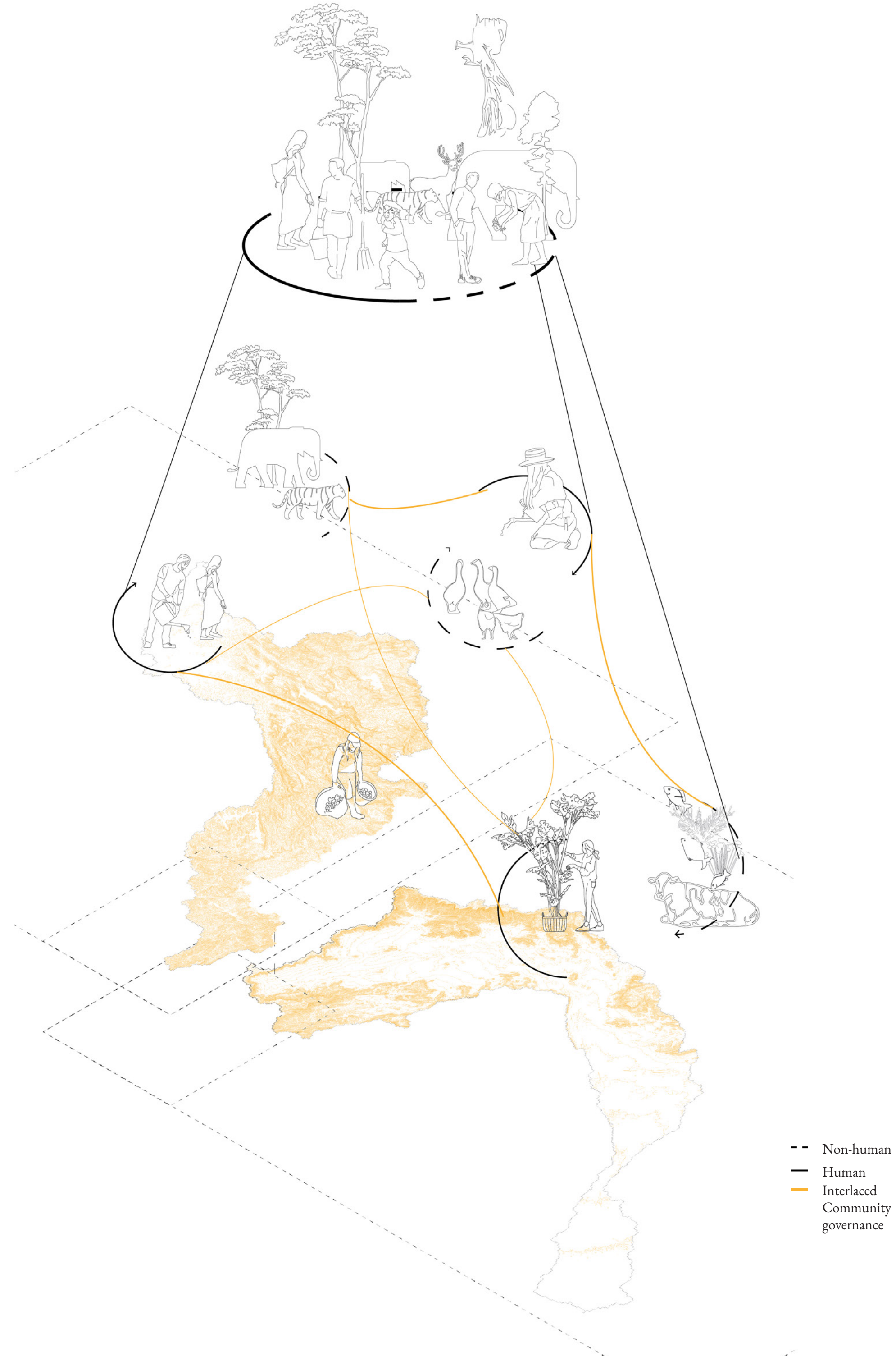


Fig 45 Right: Geopolitics Clearance, Figure made by author

Fig 44 Left: Habitat Clearance, Figure made by author

Existing forest cover plan

Dense

Thin

Subtractions

Existing forest cover section

Stream flow

Water bodies

Proposed forest

Proposed forest

Emerging Water

Waterways

Urban Nodes

Chapter 03

Monsoonal methodology

1. Theoretical framework
2. Conceptual framework

Theories

Current paradigm

Infrastructure of the 20th Century has been perceived as an invisible background of our anthropogenic ways, from roads to highways to power plants and landfills.
"Infrastructure does not exist in a disciplinary vacuum nor does it remain separate from its surrounding; Infrastructure is not asocial nor is it apolitical. It divides as much as it connects. It is fragmented while remaining continuous. Nor is infrastructure neutral. It excludes as much as it integrates; It is open with outlets and exits, but simultaneously closed by caps and controls; It produces axes of transmission, but can also produce zones of occupation."-(Bélanger, 2016)
Infrastructure in the last century has been predominantly designed by engineers and master planners having an overarching strive to achieve efficiency, precision, permanence, growth at the expense of ecological degradation and in a way driving the economy. As Pierre Belanger write, infrastructure = economy. As seen in the large scales infrastructures seen in the context of Periyar and Vaigai river basins and the amount of funding that went into building them. (Topos, Geopolitics discusses these lines in the context.).
Beyond the economic impacts of such centralised infrastructures, their perceived permanence is a far from truth and is more evident through collapsing dam and cities flooding in the recent past.

Landscape as infrastructure

While form and function are backbones of the engineering models, Berlanger's Forms and functions to follow flows and fluidities suggest a transition from networked systems(closed) to ecological systems which are open. This perspective of ecological thinking is applicable to complex, indeterminate conditions, risk, and hazard. (Bélanger, 2016) It also questions the centralised single-purpose infrastructures, followed by single purpose landuse planning and ultimately the city structure itself. He also suggests that we need to shift from a centralised to a distributed patterns of organisations. This pattern of decentralisation also echoes in social, economic and cultural realms. From the old paradigm of control and containment of engineering-based practices, the active deployment of living, dynamic processes becomes synonymous with the design of relationships, association, synergies, reciprocities, and contingencies expressed in the configuration of the ground and the programming horizontal surfaces.
Landscape as infrastructure entails both the design and un-design of urbanisation through new faculties and facilities...
Working to integrate different flows and envisioning flexible production bears the potential for transitioning from a linear, mono functional structures into circular, poly functional infrastructures, where temporal pace and spatial synchronisation of materials play an important role. Landscape as infrastructure suggests ecologies as infrastructures and systems of urbanisation to be perceived or designed as ecological systems with the complexities of resource flows, waste feedback loops etc. which extends beyond the footprints of the cities.
Finally the understanding the embedded human values of engineering practices is of significant importance, where by we can understand that the former approach is driven by profit at the expense of planet and to move towards an ecological systems based planning requires a fundamental shift in the way we value ecosystem services and their capacity to cope with future uncertainty.

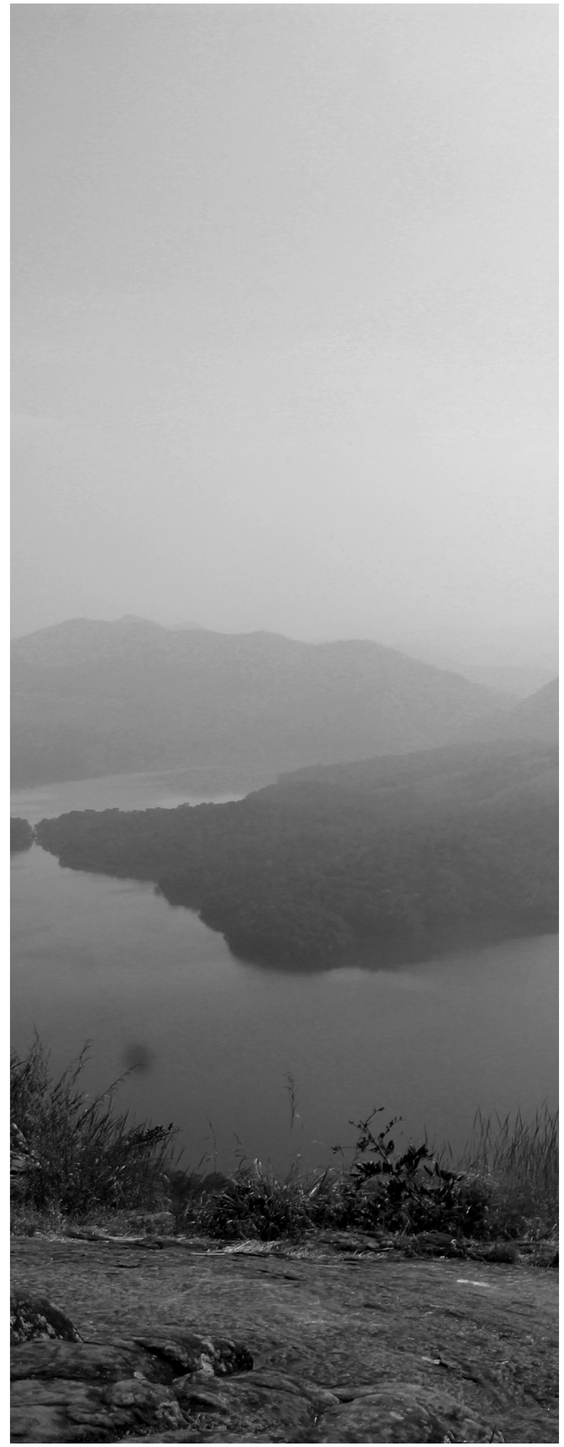



Fig 46 Photographs by author

Conceptual Framework

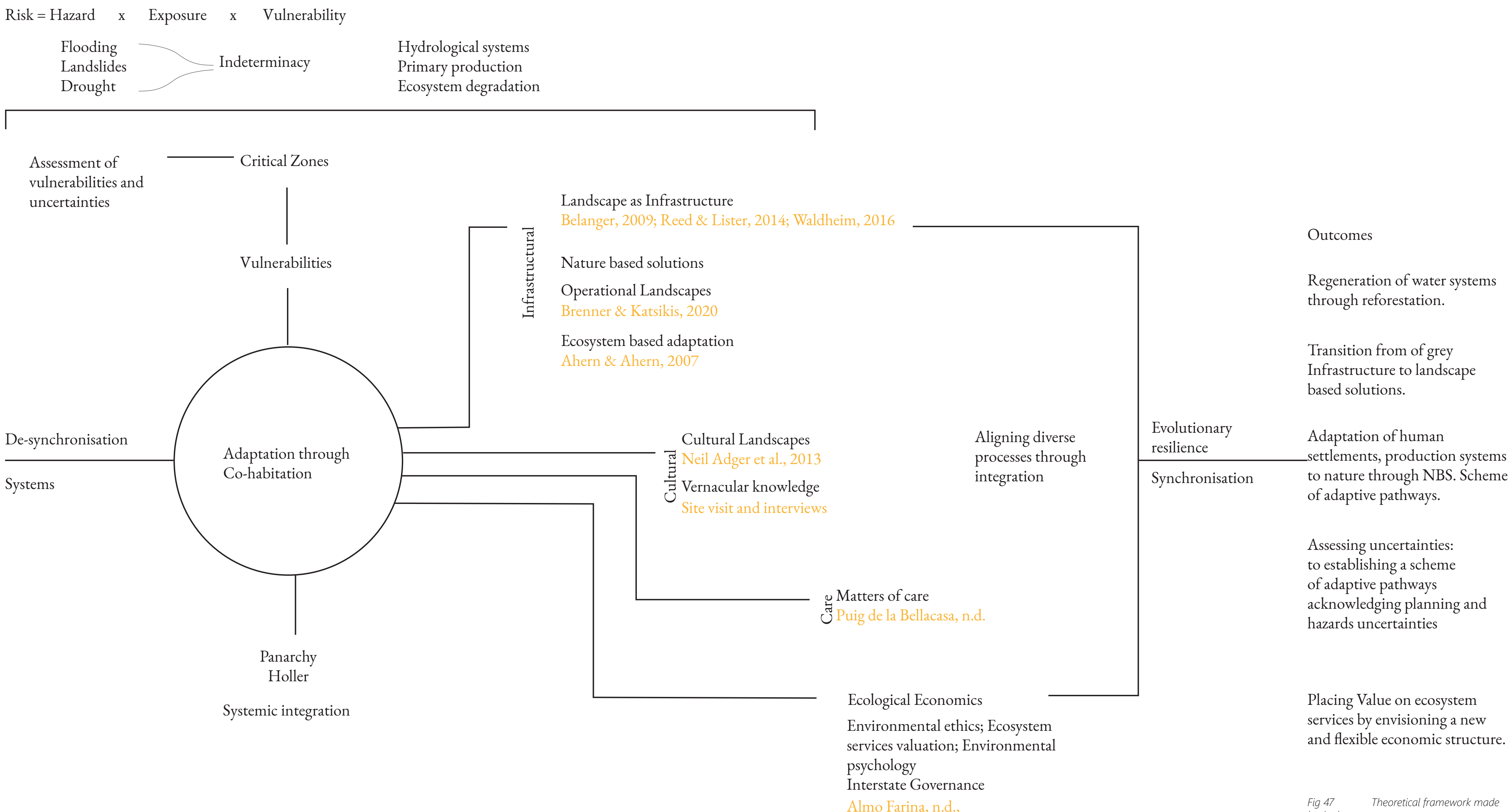


Fig 47 Theoretical framework made by Author

System

Ecology and planning

Theory

To comprehend the complexity of the region, a systemic understanding of the region proposed by of C.S.Holling and M.A.Goldberg is chosen. Both ecological systems and complex urban systems exhibit four distinctive characteristics which include their functioning as *interdependent systems*, their dependence on a succession of *historical events*, their *spatial linkages*, and their *non-linear structure*.(Holling & Goldberg, 2007) A key take away from the analogy between ecological and urban systems lies in the similarity of the structure of the entire system and not in their parts or processes.

1. These systems are characterised not only by their parts but also by the interaction among these parts, emphasising that fragmented understanding or designing of a particular isolated area may prove detrimental to another interrelated area.

2. Ecological systems are not a first outcome of a design process, but have evolved out of multiple iteration and cycles of change which are defined by their past. Ecological systems react to change through stages of succession through time. Sometimes evolving into completely new states of a stable ecosystems, in a way encompassing the learning of the past to evolve into a resilient system capable of absorbing further change in the future.

3. Complex ecological systems have substantial spatial interactions, they are affected by events over space and scale.

4. Ecological systems are bound by structural properties of process that interrelate various components of the ecosystem.

Context

1. In the of case of the Periyar and the Vaigai river basins, the water systems which traverse through the southern peninsula of India encompass a diverse range of people, their occupation and their practices. A practice of extraction of water upstream has a detrimental impact on agriculture downstream. Thus an isolated project in either one of these areas may not be able to respond accurately to the whole. Hence, an approach of interdependent systems is taken.

2. These river basins have been occupied and were able to sustain civilisations for over 2000 years due to their embedded understanding of the ecological systems and indigenous practices that have been tested over time. The management of our systems solely through extraction and exploitation has proven to be extremely disastrous as seen in the Topos mapping in the previous chapter. Thus an understanding of the indigenous practices of water management and way of living is taken into consideration to project to the future scenarios.

3. Deforestation of rainforests upstream and their consequent impact downstream, similarly construction of large scale dams and obstructing the biological flow of water downstream causes the deterioration of the ecosystem. Thus the project aims to work with these events over space and scale.

4. Water in these systems are dependent on atmospheric, surface and sub-surface components. Topography, soil, temperature, monsoonal winds and on top of these anthropogenic land-use changes, management of water, pollution of these resources affect the system and thus an holistic understanding in a non-linear structure is necessary.

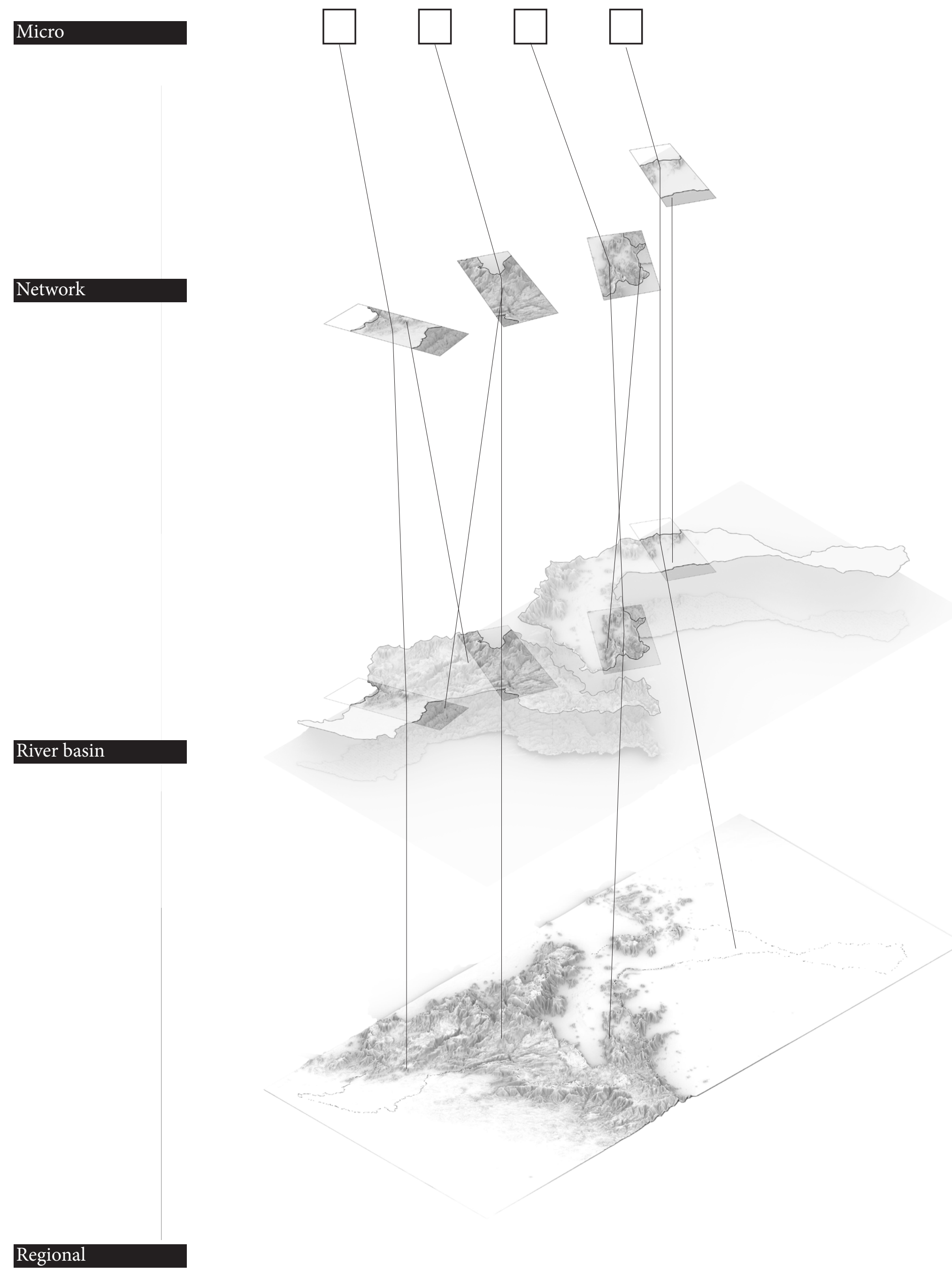


Fig 48 Photographs by author

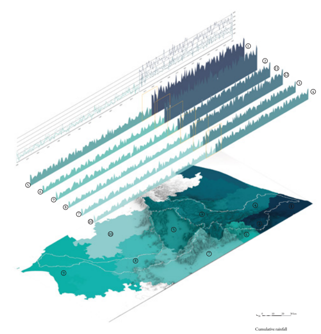
Indeterminacy

Theory

An initial understanding of the concept of stability in ecological systems was needed. Unlike engineering systems where stability is a fixed equilibrium state between the upper and lower limits of the systems, ecological systems exist in highly variable physical environment, the equilibrium point itself is continually shifting and changing over time and its components attempting to track the equilibrium point. Also, there exist this variable versions of these stable systems, adapting continuously and moving towards a different state maybe never returning to the previous state. Ecological succession, generally is seen exhibiting such conditions. (Holling & Goldberg, 2007)
While the stability of such systems exist in between these extremes, their exact state is unpredictable.
Deriving from landscape and architecture, OMA's Parc de la Villette focusing on designing with dynamic program, in a way equipping the city with a framework for developing flexible uses as needs and desires changed. Geuze's idea of the city as the domain and the user capable of figuring out his/her own programming give an insight into the realm of designing for an indeterminate future.

Context

The 100 year precipitation (Matter: limits) index in this region has made evident the fluctuating character of the monsoon, notably extremes in the last 20 years. Designing for the extreme flooding scenario or the extreme drought scenario in this region is not sufficient, we cannot predict the future monsoons. Hence an approach which creates a framework for varying program appropriate for the available resource in the future, in this case the extreme fluctuations of the monsoon is the indeterminate parameter. By adapting the landscape to exist in between the extremes of risk of flooding or risk of drought, the project seeks to incorporate a set of dynamic programs that are appropriate and respond to the rhythm of the changing monsoons.



Design framework

Seasons

Summer

Monsoon/Rainy season

Winter

Domain of stability

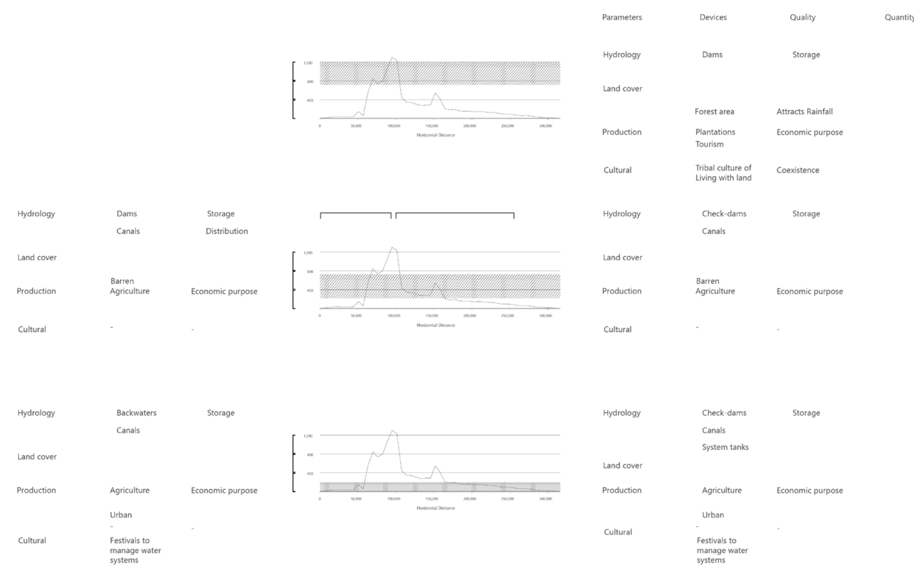
Risk | Extreme precipitation event

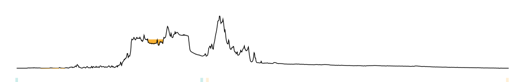
Stability | High

Stability | Average

Stability | Low

Risk | Extreme scarcity





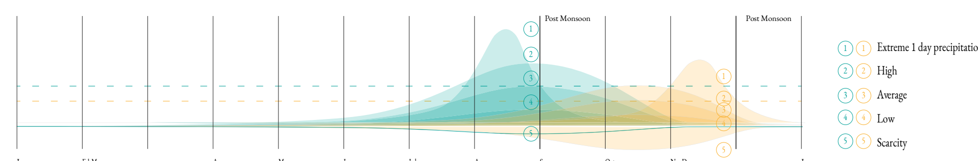
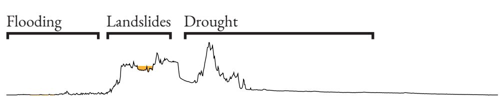


Fig 49 *Indeterminacy, figures by author*

Risk

Theory

Risk = Hazard x Exposure x Vulnerability



Context

Risk = Hazard	x Exposure	x Vulnerability	
Flooding Landslides Drought	Formulating Risk zones to prepare for hazard.	Communities equipped with awareness of exposure.	Reducing vulnerability through adapting systems to cope with change.

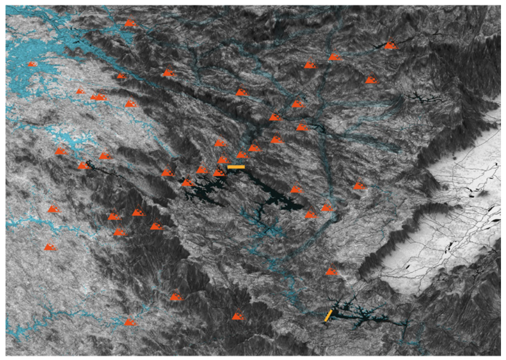
Evolutionary resilience

Theory

Evolutionary resilience or socio-ecological resilience argues in favour of ‘people and nature as interdependent systems’. (Folke et al., 2010).Rather than perceiving resilience as ‘a return to normalcy’(Pendall et al., 2010),this perspective interprets it as the ability of complex social-ecological systems to change, adapt or transform in response to stresses and strains.(Davoudi et al., 2013) Davoudi suggests that evolutionary resilience is a conceptual frame work incorporating dynamic interplay between persistence, adaptability, transformability and preparedness. Which in the face of either sudden or slow burning disturbances, complex adaptive socio-ecological systems are capable of becoming more or less resilient depending on their social learning capacity, resisting disturbances, absorbing disturbances without crossing a threshold into an undesirable and possibly irreversible trajectory and moving towards a more desirable trajectory.(Davoudi et al., 2013)

Context

In a region which is experiencing extreme weather events induced by anthropogenic climate change, failing infrastructure, unprepared for risk and management practices fail to cope with these disturbances. Hence, the project envisions a adaptive framework for the region which takes into account the possible deviations from the average year, to project multiple adaptive pathways for the system. These pathways are envisioned at the local scales of the system following different yet interrelated time cycles.



Theories for transition

Landscape as infrastructure
Nature based solution
Indigenous knowledge
Cultural landscapes
Matters of Care
Ecological economics

Fig 50 Photograph in Periyar dam by author

Panarchy

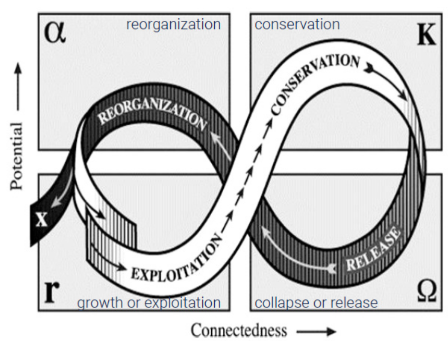
Theory

Adaptive cycles are nested in a hierarchy across time and space which helps explain how adaptive systems can, for brief moments, generate novel recombination's that are tested during longer periods of capital accumulation and storage.
Interactions across scales are fundamentally important in determining the dynamics of the system at any particular focal scale.(L. Gunderson & Holling, 2002)

Adaptive cycles have 2 distinct connections, namely revolt and remember. The smaller, faster, nested levels invent, experiment and test, while the larger, slower levels stabilize and conserve accumulated memory of system dynamics.

Moments of experiments open briefly but they do not trigger cascading instabilities of the whole because of the stabilizing nature of nested hierarchies. In a way the large and slower components of the hierarchical cycles provide the memory of the past and of distant to allow recovery of smaller and faster adaptive cycles. In this way, the slower and larger levels set the conditions within which faster and smaller ones function.

The adaptive cycle explicitly introduces mutations and rearrangements as a periodic process within each hierarchical level in a way that partially isolates the resulting experiments, reducing the risk to the integrity of the whole structure.A nested hierarchy of adaptive cycles represents a panarchy.(L. Gunderson & Holling, 2002)



Context

With the understanding of adaptive cycles set in nested hierarchical systems, the territorial transition of the region is envisioned along those lines. A bottom-up approach to design is intended, initially by changing, testing adaptive landscapes to transition the local context towards resilience. Secondly by incorporating flexible anthropogenic program to align with these adaptations.
The parameters suitable for a transition towards an evolutionary resilience were found to be Hydrological cycles, Land-uses and ecological cycles.

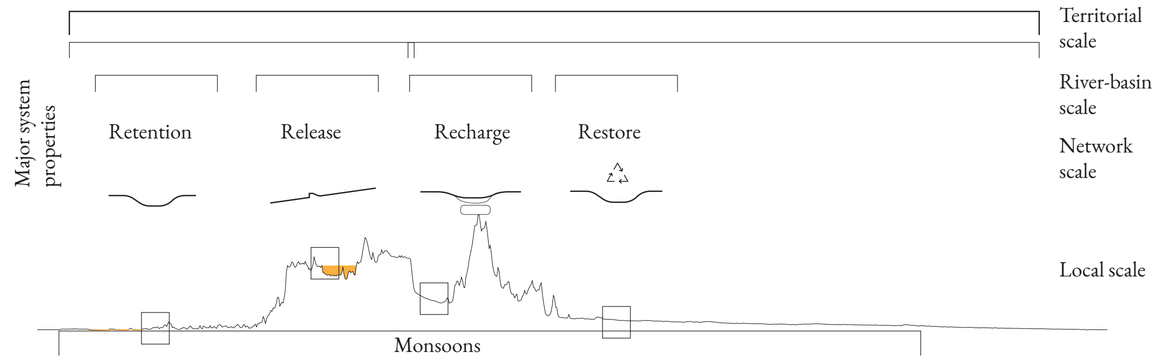
The programs and practices exists in their respective local scales following their own adaptive cycles, yet are interrelated through their flows and interdependent functionalities. The functioning of each of these parts of the water system are different(retention, release, recharge, restore) yet they contribute or are components of the larger same system. When combined with other cycles, such as production cycle, ecological cycles and human/non-human habitats creates complex web of systems.
The project proposes to maintain these system functions(e.g. retention) for its respective local sites, but imagine a dynamic programming which would respond to the fluctuating availability of water.(Monsoons)
Such a dynamic programming arising out of varying precipitation gives rise to adaptive pathways which strives to synergies the different parts of the system towards a state of dynamic equilibrium.

Fig 52 Right: Panarchy diagrams by author

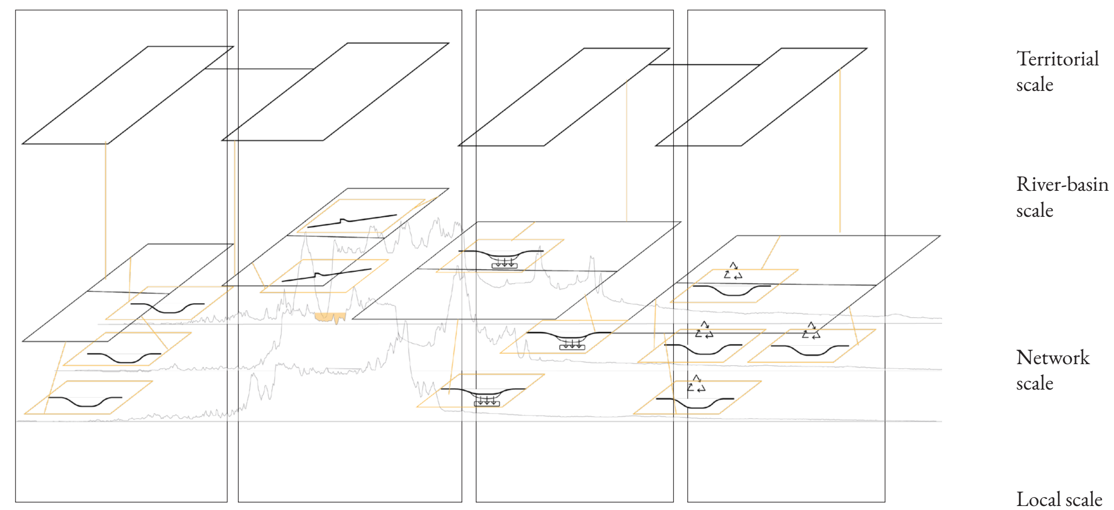
Fig 51 Panarchy, L. Gunderson & Holling, 2002

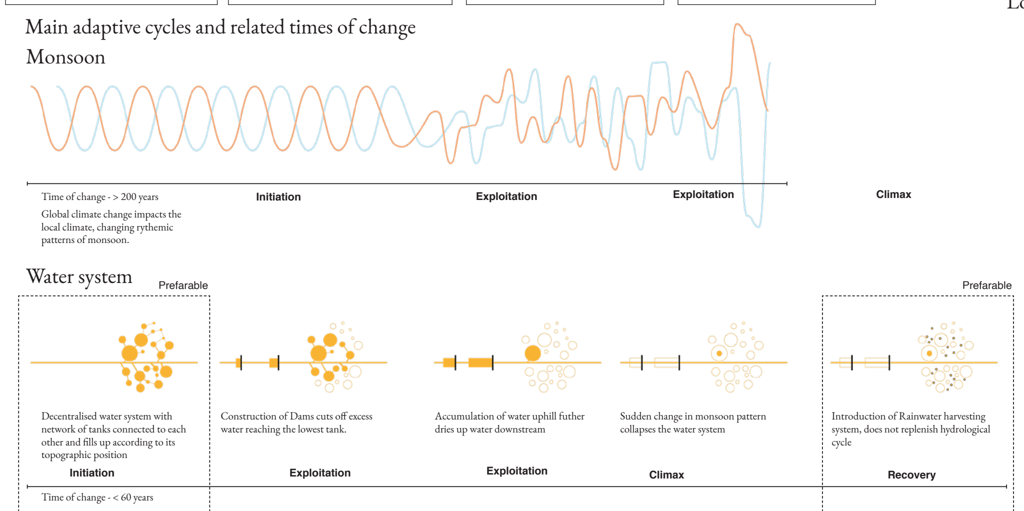
Scales of the adaptive cycle

Water cycle



Nested adaptive cycles





Chapter 04

Monsoon as an Activator

1. Design Framework

Vision

The region exhibiting the extremes of water stress from flooding and drought is seen as the extremes of the domain of design. And calls for a framework of design which can fluctuate between scenarios. To tackle such a territory with complex topography, initial analysis from the lines of inquiry were most crucial. Delving into the designing required understanding the site from multiple scales and suggesting appropriate actions at each scale.

The vision for the region starts by aiming to achieve water balance throughout the territory. To achieve a water balance the inquiry transcended into the realms of primary production, anthropogenic control, values and the role of ecosystems in maintain this balance.
Thus the design seeks to organise a system, equip communities which are
1. Resilient enough to absorb change
2. Flexible enough to function with and during change
3. Aware enough to value the role of ecosystems (regenerative cycles)
4. Sensitive enough to care for the systems health.

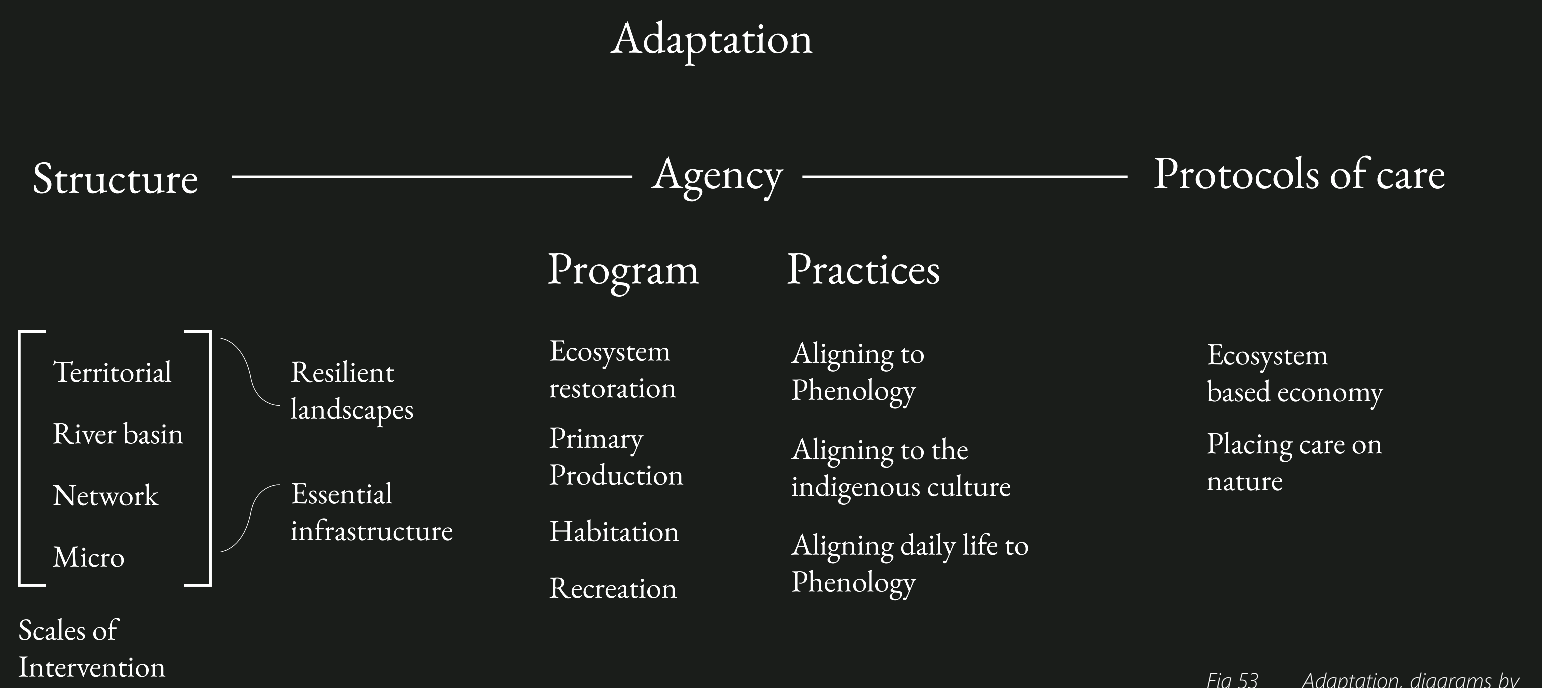


Fig 53 Adaptation, diagrams by author

Deriving from this position for the territory, appropriate adaptation steps to reach this goal were envisioned:

1. Structural adaptation:

a. Resilient landscape : Firstly to take the region out of risk and identify strategic safe locations for anthropogenic activities.

b. Essential Infrastructure : To facilitate the local region with necessary safe structures, living ecologies which are productive yet learn and evolve to change.

2. Agency

a. Program : To formulate a set of programs relevant to the context(soil, topography, communities, production) which are hierarchically catalogued ranging from extreme precipitation to extreme scarcity.

b. Practice : To re-establish the relationship between the communities, their embedded indigenous knowledge about their commons, production and way of living with respect to the ecological cycles.

3. Protocols of care

a. Economic : To imagine an economic structure that would value the regenerative cycles of ecosystems and incorporate externalities of current paradigm of human habitation on earth.

b. Social : To recognise environmental stewards for their role in maintaining the health of ecosystems and also recognise the externalities of big-players, a top down implementation of single purpose infrastructure.

Design framework

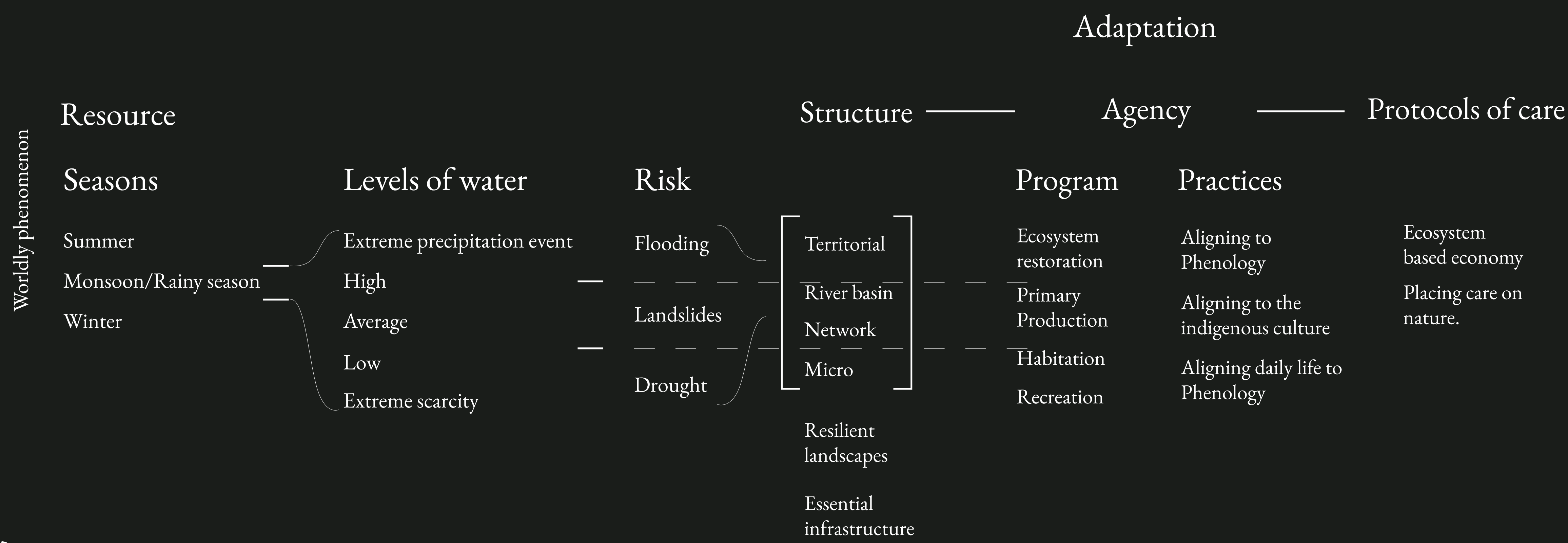


Fig 54 Design Framework, diagrams by author

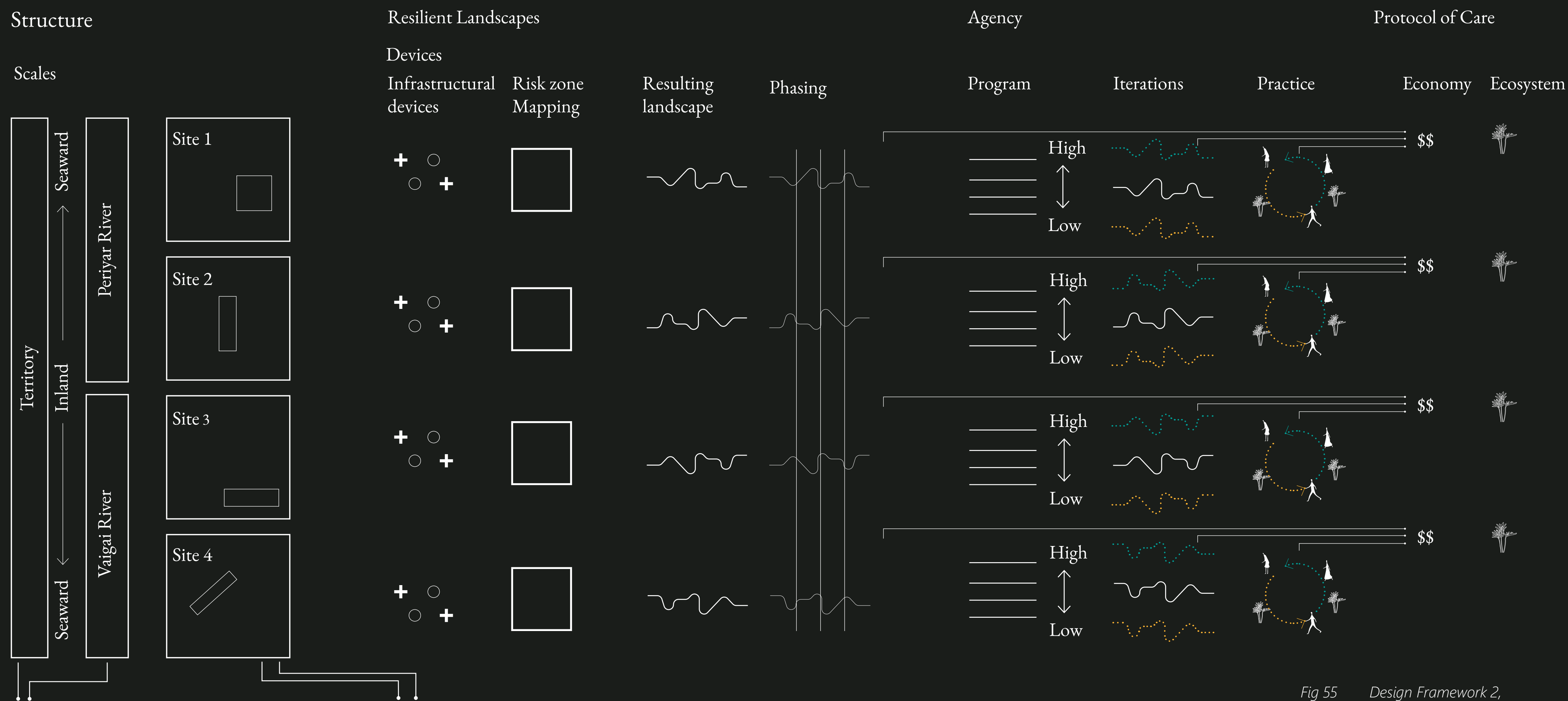


Fig 55 Design Framework 2, diagrams by author

Territory

At the territorial scale the structural adaptation of the landscapes are based on the necessary systemic functions of the water cycle to achieve a water balance between the two inter-related systems.

River basin

At the river basin scale resilience of the basin is considered a key factor to shape the landscape. In case of the Vaigai, systemic transition towards rejuvenation of the river and in case of Periyar flood risk management are key drivers.

Network

The network scale shows the patterns of territorialisation through networks of production and habitation. Adaptation based on the interdependencies within the river basin is established.

Local

The local scale the transition towards a resilient landscape is achieved through

1. Defining a set of landscape as infrastructure devices relevant to the site
2. Mapping risk zones, there by finding potential zones of habitation.
3. Formulating a catalogue of programs ranging between high and low precipitation specific to the site.
4. Organising Cyclic programming based on Phenology and re-establish community practices.
5. Incorporating cost of regeneration and other ecosystem services in profit index.

Since the design intervention are at the local scale, the project starts from the local scale and build back to the territorial scale.

Chapter 05

Emerging monsoonal ecologies

Structure : Territory

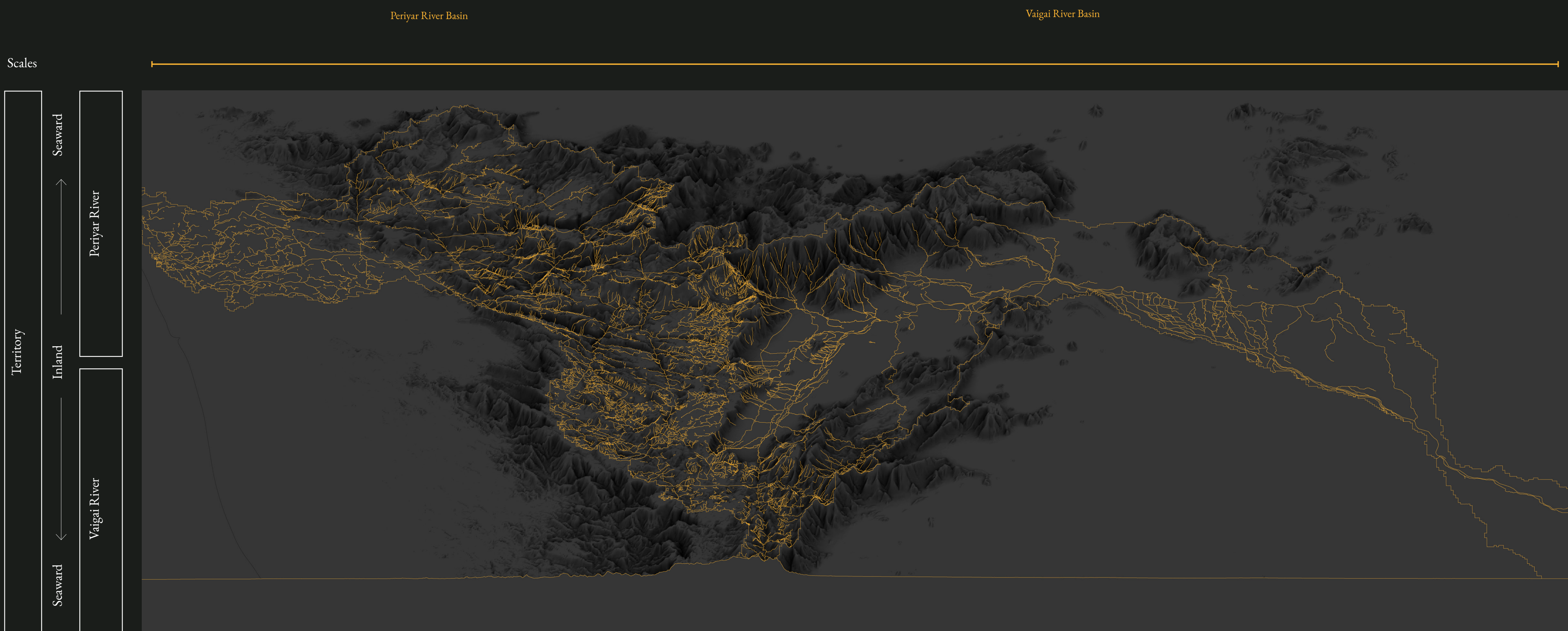


Fig 56 Territorial key map made by author

Goals : Towards a decentralised system

1. Water Balance

2a. Re-naturalisation : Transitioning intensive monocultures to dynamic production landscapes aligned to natural cycles

2b. Re-introducing nature in cities.

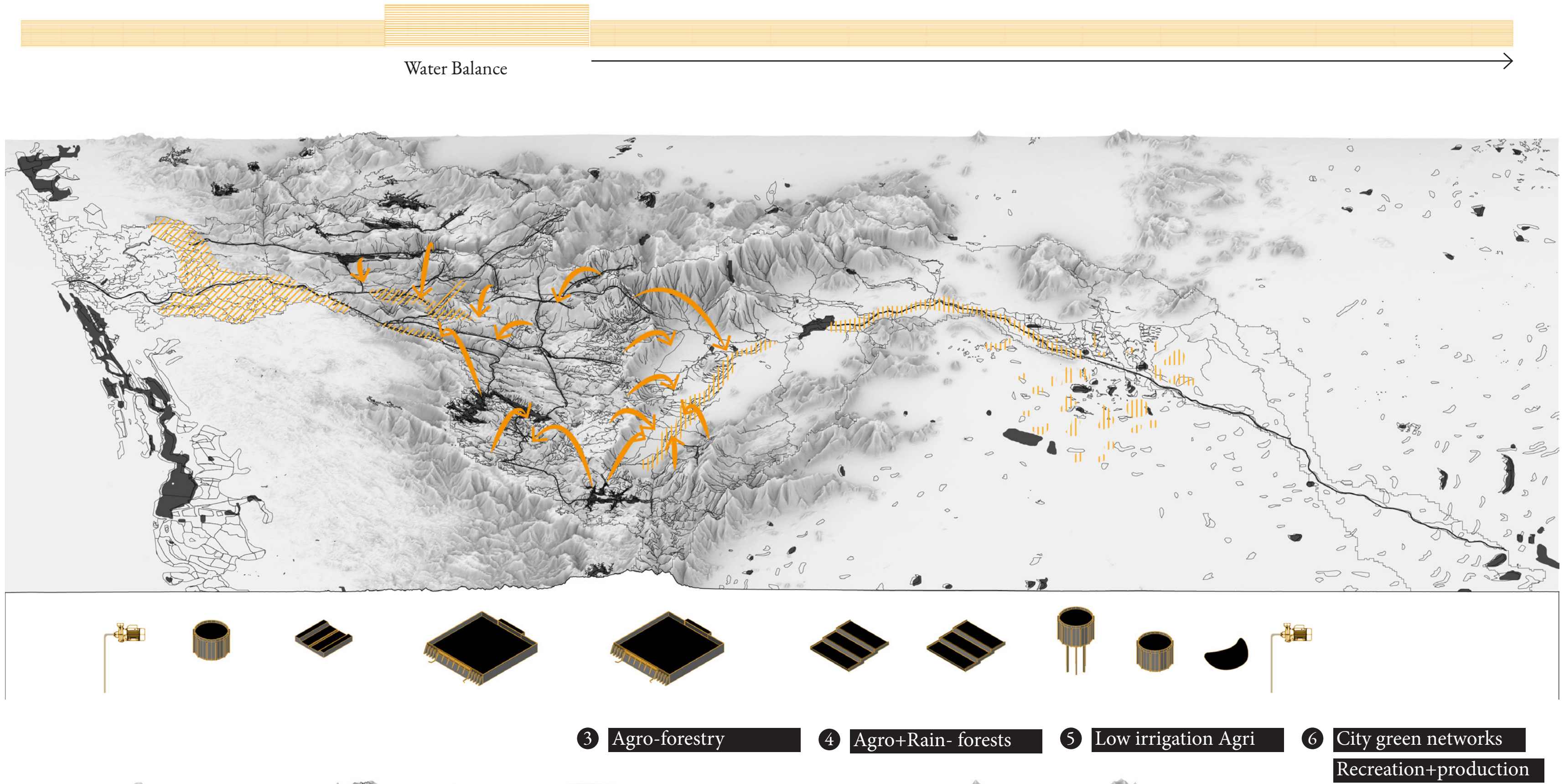
Territory

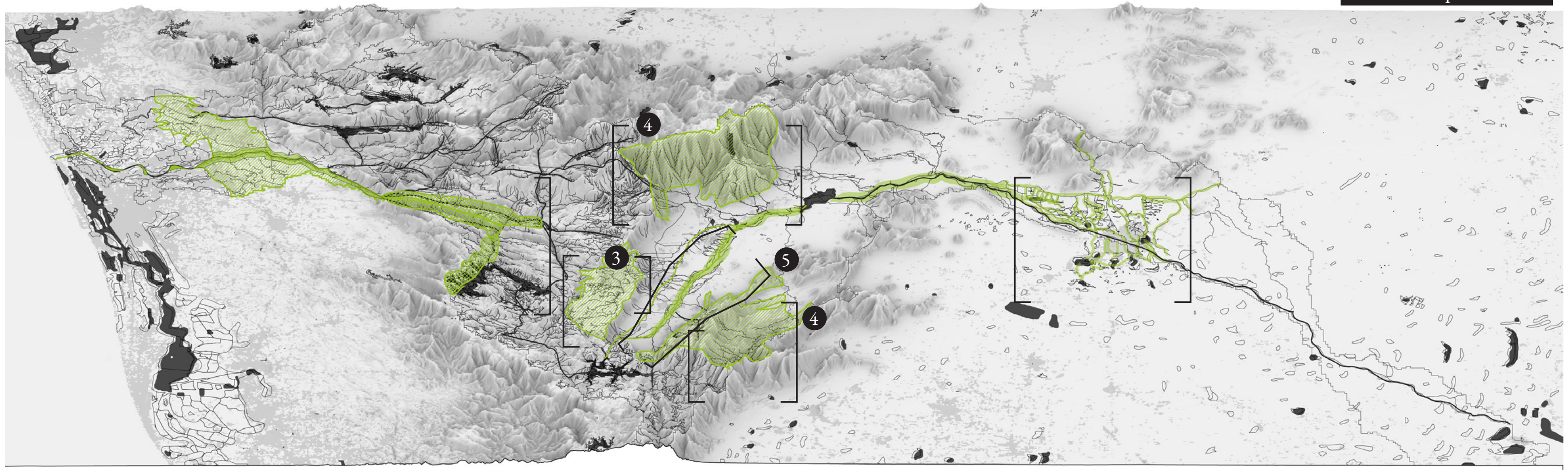
At the scale of the territory as discussed before the goal is to achieve a water balance between the two river basins by restoring the system functions of the hydrological cycle. This is done through

1. Releasing stored up water from the large scale dams by loosening our control over it, allowing the river to maintain its ecological flow to restore ecosystems that are dependent on it downstream. Thereby we can restoring the functions of the hydrological system. This requires multi-scalar analysis to determine the areas of retention, release and recharge, which is done at the river basin scale.

2. By transiting primary production such as intensive plantations upstream, intensive agricultural monoculture downstream by re-naturalising production. Allowing time for regeneration of the soil and sustainable methods of cultivation for example Agro-forestry with intensive Tea plantations.

3. Equipping the human habitats(urban centre's) with ecosystem functions by re-introducing the nature back into the cities. Making room for the river, urban agriculture thereby de-constructing the notion of cities as centre's of consumptions. Cleaning polluted water by using nature-based cleaning methods where ever possible.





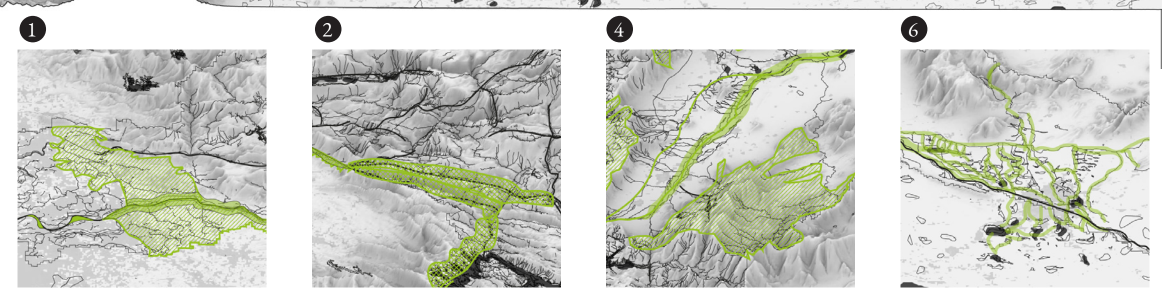
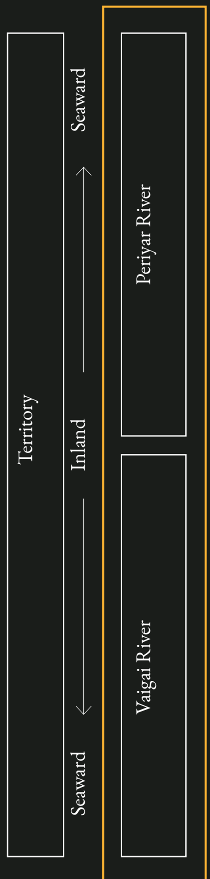


Fig 57 Vision Maps 1 & 2 by author

Structure : River basin

Scales



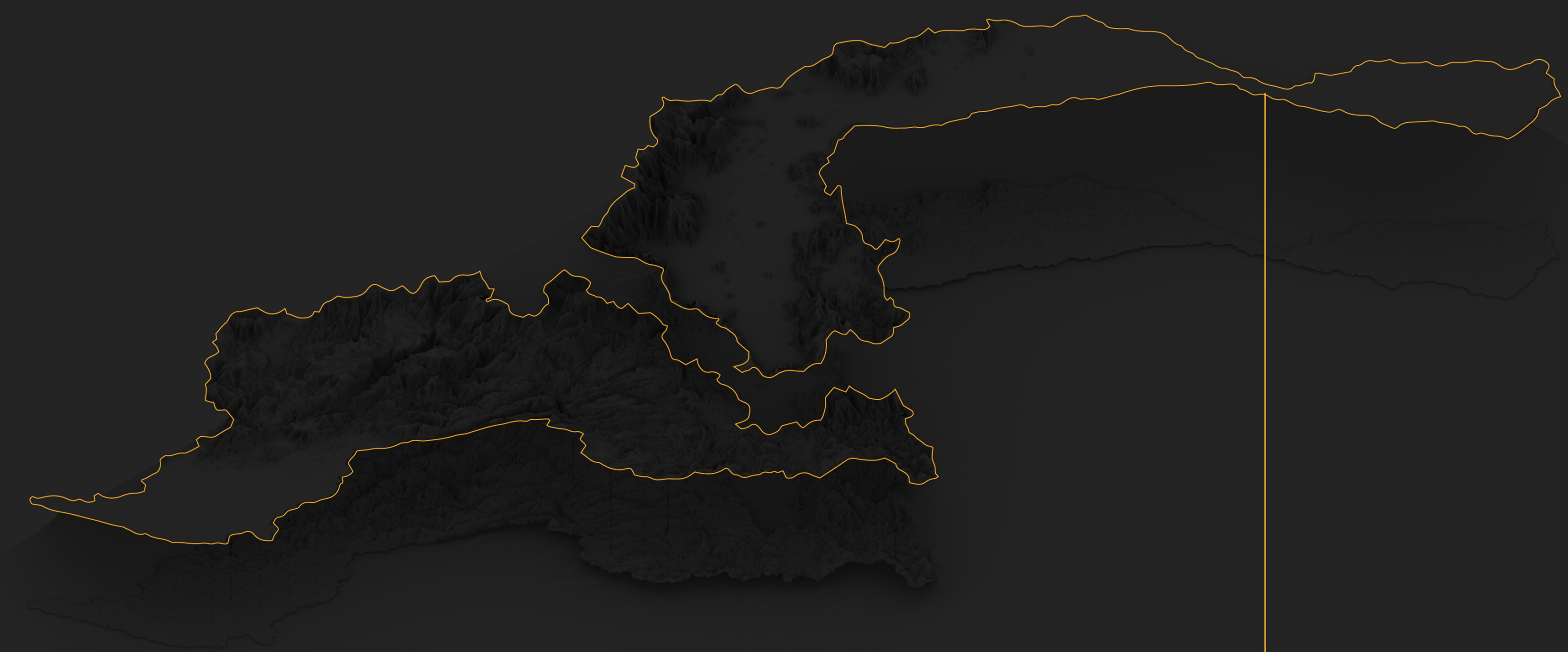


Fig 58 Riverbasin key map made by author

Goals

1. Water Balance

2a. Re-naturalisation : Transitioning intensive monocultures to dynamic production landscapes aligned to natural cycles

2b. Re-introducing nature in cities.

Goals : Periyar

1. Resilience for flooding and landslides.

2. Connecting back the river to the basin.

3. Sustainable production zone

Goals : Vaigai

1. Resilience for drought.

2. Rejuvenate the river.

3. Sustainable production and consumption.

Periyar River Basin

At the scale of the river basin the project strategies firstly from the stand point of the resilience. Hence identifying strategic sites of intervention to build resilience as well as improve the local conditions.
The Periyar river basin existing as the sole water source for more than 6 million people considering the water it shares with the 4 other river basins, has abundant resources and is responsible for 59% of total hydro energy. But, as seen from the analysis, the implications of such practices prove detrimental for the survival of the ecosystem.

Site selection :
1. Initially the possible areas to re-distribute water were identified by superimposing maximum of 500 year probability flooding along with population and slope of the region. The area below at the base of the mountain before the city was found to be suitable for a water retention area and owing to its agricultural land typology is an interesting case for designing flood-able production landscapes.
2. Secondly strategic site for landslide resilience was identified by superimposing slope above 15 degrees, landslide prone areas from NASA. Combining this along with areas susceptible to flooding gave rise to the site next to the Idukki dam having mostly recreational and production was chosen.

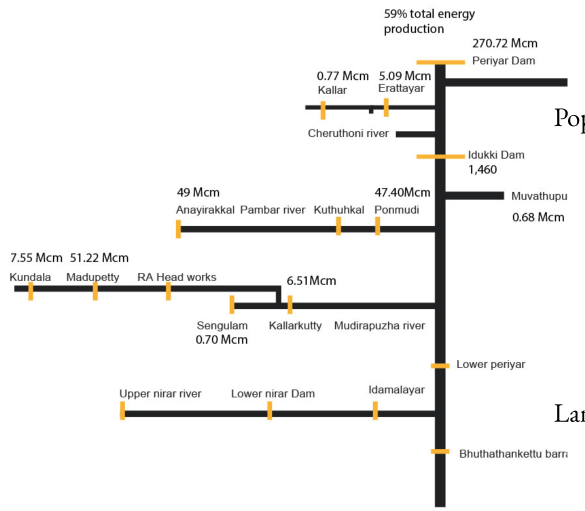
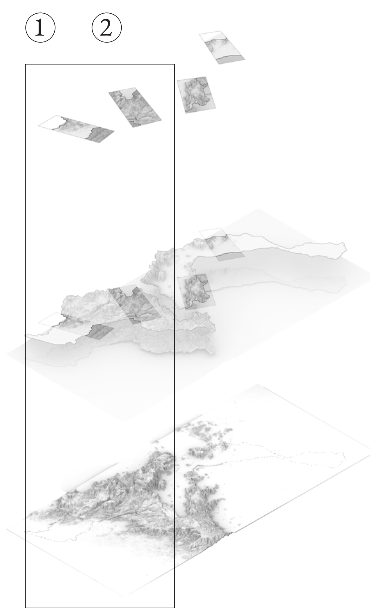
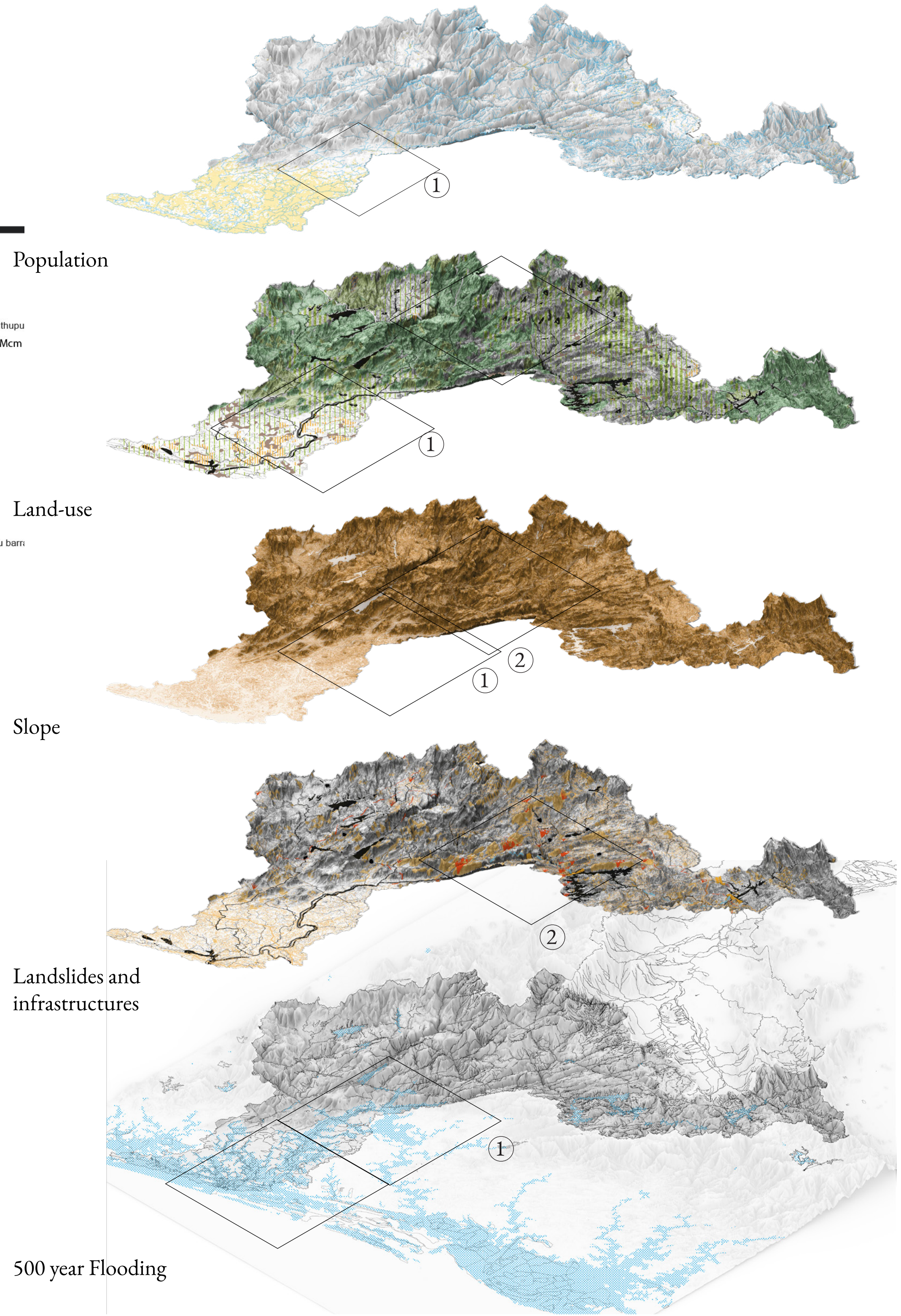


Fig 59 Site selection, Periyar by author





Vaigai River Basin

The driving force in the Vaigai river basin is to rejuvenate the river to its perinial river status. Hence identifying strategic sites of intervention to bring back water to the river through reforestation, appropriate sustainable irrigation patterns for agriculture in semi-arid region and sustainable water management in overconsumption zones.

Site selection :

1. Initially the possible areas to reforest were arrived at by overlapping production zones and existing forest area. The regions around Megamalai(Source of the Vaigai) showed considerable amount of intensive monoculture in what used to be a forest area. Hence it is taken as a pilot site to start the process of reforestation through agro-forestry.

2. Secondly the sites of intensive production,urbanisation were considered for development of sustainable water management. Although many sites along Theni up until Madurai fit the criteria for over-exploited ground water systems, the city of Madurai was an interesting case to bring in the significance of urbanised areas in the process of degradation of the water systems.

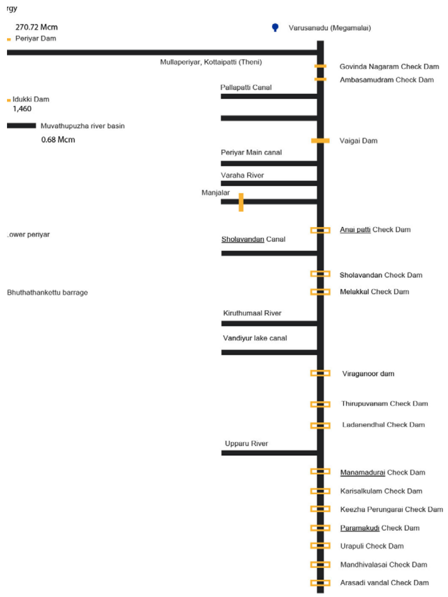
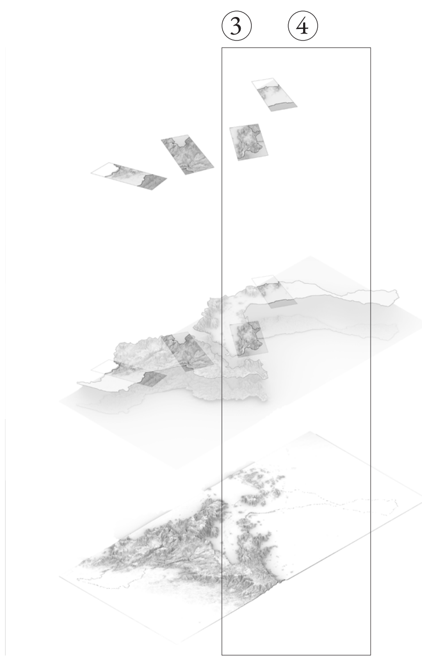
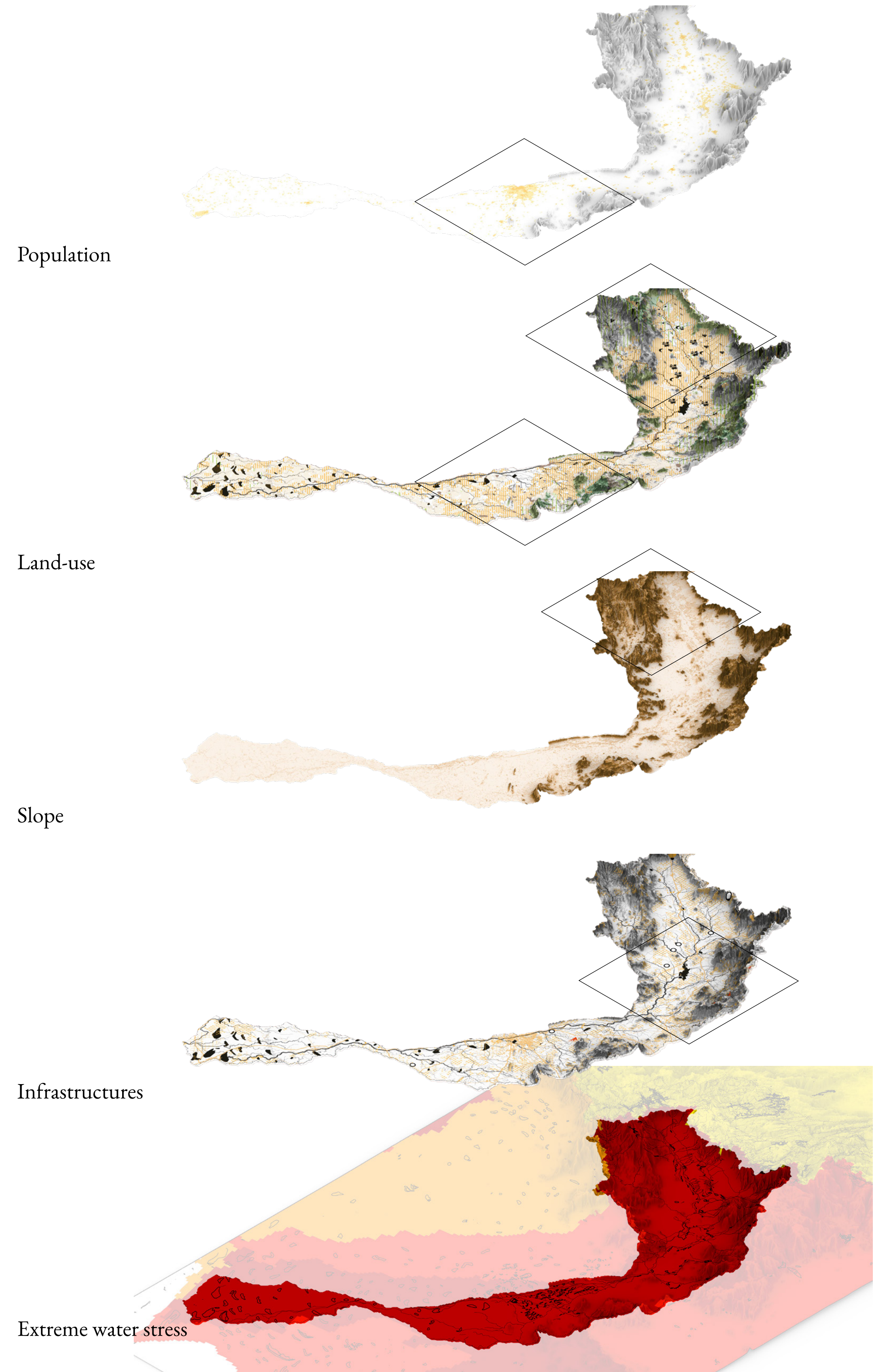


Fig 60 Site selection, Vaigai by author





Structure : Network scale

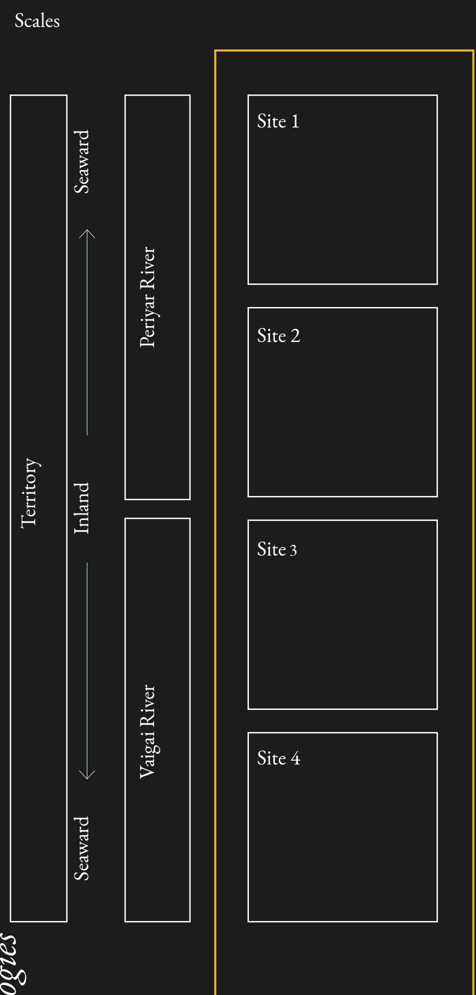


Fig 61 Networkscale key map made by author

Goals : Sponge

1. Water retention
2.Regenerative agriculture.

Goals : Passage

1. Slope stabilisation
2. Agro-forestry
3. Eco-tourism

Goals : Interception

1. Reforestation
2.Agro-forestry
3.Eco-tourism

Goals : Mediator

1. Riparian restoration
2. From consumer to producer

Network scale

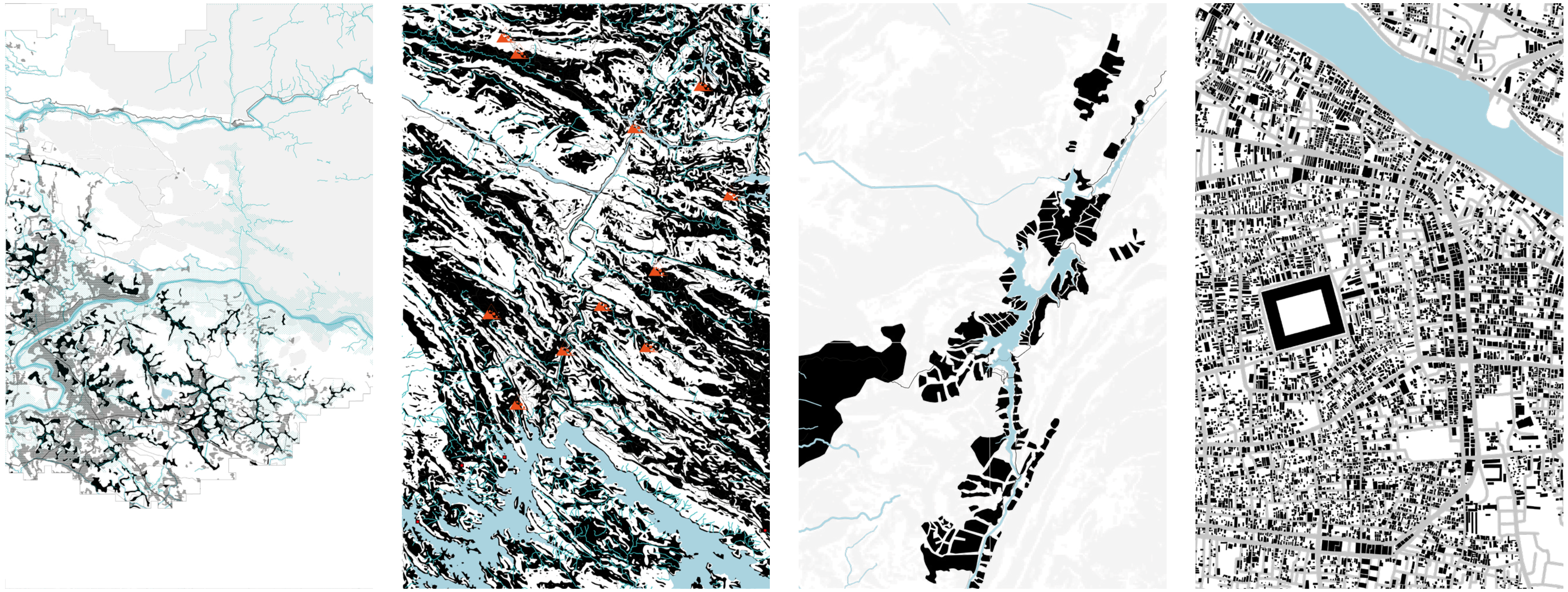
The network scale tries to figure out the pattern of territorialisation which is based on the morphology of the landscape, i.e topography, floodplains, existing urban fabric, along with the productivity of the local scales.

Four different patterns of territorialisations were determined for the 4 different smaller scales.

Site 1 : Agricultural land in the foothills of the mountain follow the flood probability in 500 years, branching out along the creeks. Risk zones are identified and possible new habitation areas identified. The creeks flow through these low-lying lands which are taken up to test as a water retention area with wet agriculture.

Site 2 : Identifying safe slopes for inhabitation leaves island like structures in the mountainous terrain inhabited by tourist and local communities working for the tourism industry. Testing micro-storage of water along the riverbed coupled with landslide retention structures.

Site 3 : At the source of the Vaigai river in Megamalai, tea estates growing like fingers along the river streams are taken to be tested for agro-forestry and introduction of less-invasive camping structures as opposed to bungalows and resorts are envisioned.



Site 1: Kodanad

Site 2: Idukki dam

Site 3: Megamalai

Site 4: Madurai

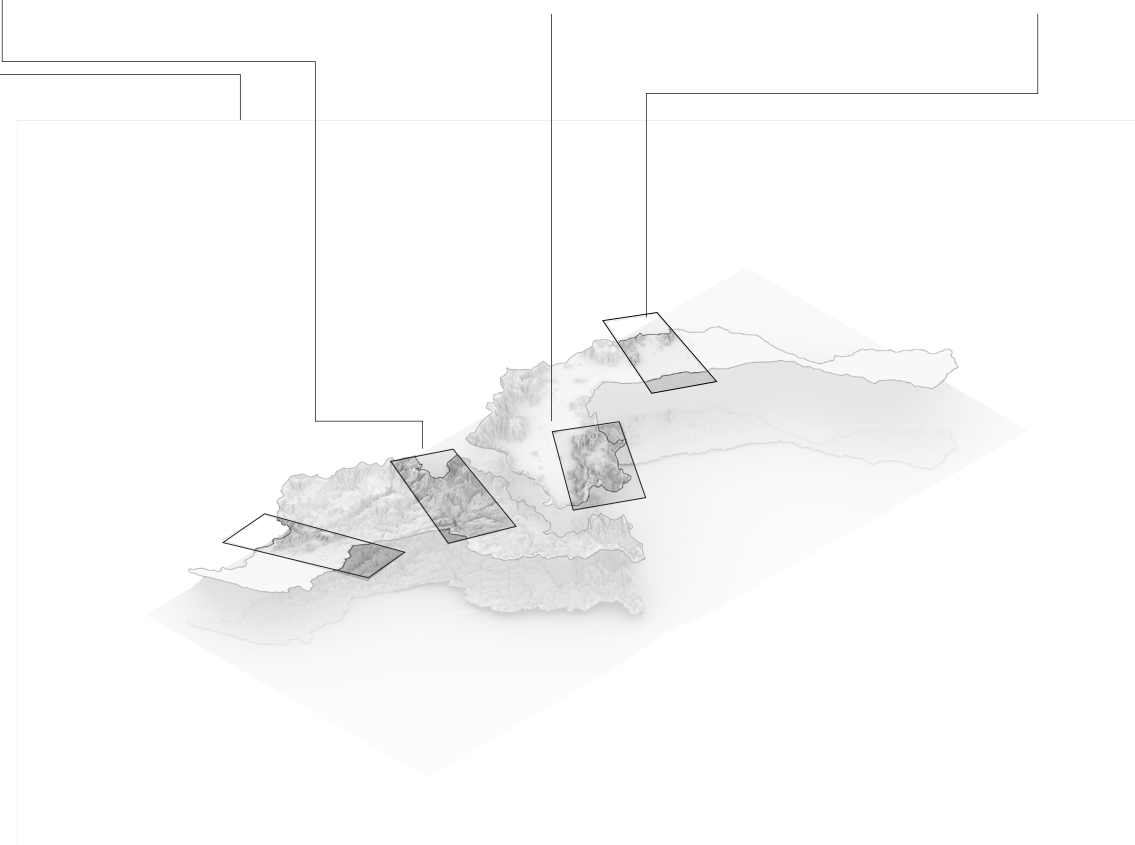


Fig 62 Network scale mapsby author

Site 4 : At the city of Madurai, open spaces such as bus stands are identified to open up areas for green networks and roads for blue networks. Further reviving the river by getting rid of debris, formulating urban agriculture at its edges, thus connecting back the heritage of the city as a major agricultural hotspot. System tanks in the agricultural regions are symbolised here by creating small connecting water squares extending from the river to the temple at the core.

Structure

Agency
Program

Structure

- Territorial
- Riverbasin
- Network
- Micro

River	Zone	Structure	Devices		Resilient infrastructure	Production	Built environment
Periyar River	Seaward	Sponge Terraces	01.Sediment Accretion	02.Terraced Cultivation	Water Retention Floodable landscape Terraced water tanks	Aquaculture Plaudiculture Fishing Sewage treatment	Settlement pattern Road networks Production units
Periyar River	Inland	Passage Islands	03.Slope management 05.River water storage	04.Agro-forestry Infiltration/ support	Removing barriers Slowdown flood waters Water retention in river bed	Cash crops Plantations Fishing Eco-tourism Water sports	Settlement pattern Road networks Production units
Vaigai River	Inland	Interceptors Fingers	06.River water storage	07.Agro-forestry Rain-interceptors Circular shade tree forestry	Removing barriers Afforestation Water retention	Plantations Eco-tourism	Plantation pattern Road networks Production units
Vaigai River	Seaward	Mediators Add-ons	08.Aquifer water retention	09. Road + Water	Removing barriers Aquifer recharge pits System tank network River edge renewal	Dry agriculture Urban Agriculture Water/dry parks	Road networks Production units

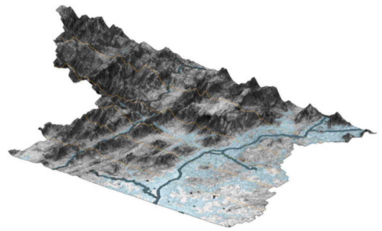
Kodanad

Site 1 : Agricultural land in the foothills of the mountain follow the flood probability in 500 years, branching out along the creeks. Risk zones are identified and possible new habitation areas identified. The creeks flow through these low-lying lands which are taken up to test as a water retention area with wet agriculture.

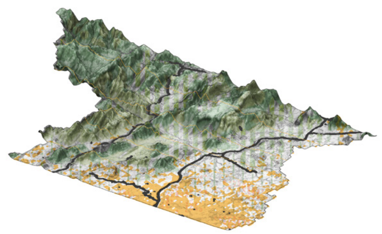
The process of transformation in this area starts by allowing the land to flood during the monsoon season. This would also set in the regeneration of soil as well as set the tone of programming through the year.

This would result in submergence of certain settlements, which is resolved by relocating them to nearby higher ground within 1 km.

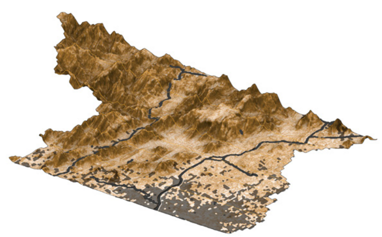
Similarly, essential infrastructures are rerouted to find a safe route even during peak monsoons. The program of these settlements will way from Aquaculture to rice cultivation based on the availability of water.



500 year flooding



Land-use



Slope

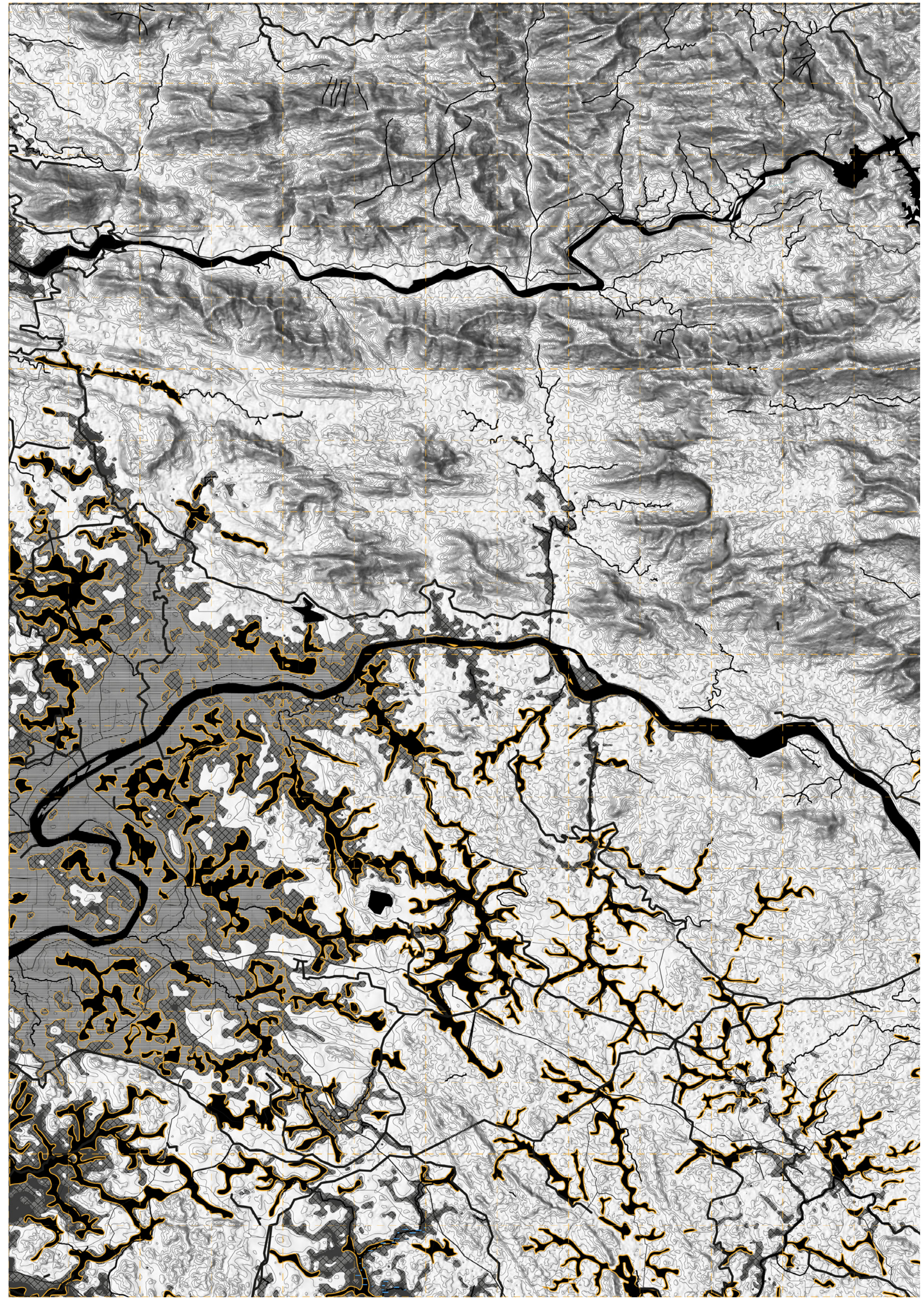


Fig 63 Kodanad Map by Author

Sediment Accretion

The river currently is bound by bunds at the edges to prevent it from flowing into the agricultural areas. The design proposes to allow these areas to flood by building sediment bunds using wooden poles at the intersection between the river and the creek to divert water inland.

Terracing :

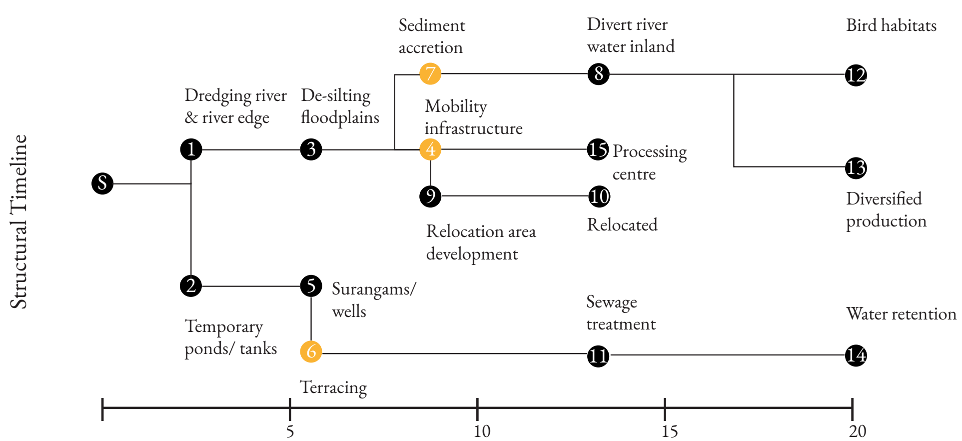
To make the most of the slope between the settlement units and the agricultural areas, the landscape is terraced to perform different function at each step. For instance water flowing from the higher grounds are captured in the first terrace, to be used as fresh water storage. In some instances they could be also used for sewage treatment for a community.

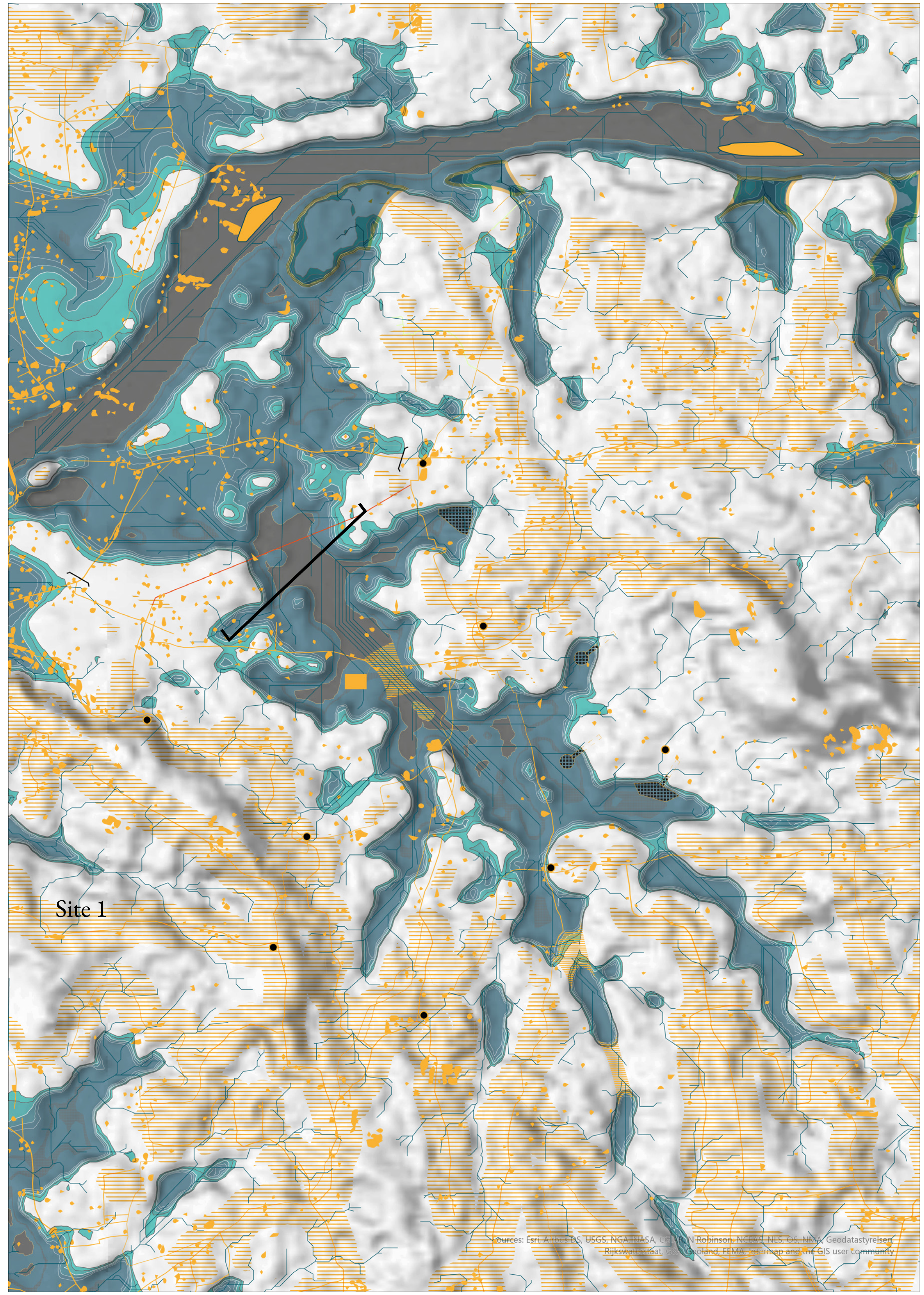
Aquaculture + Agriculture :

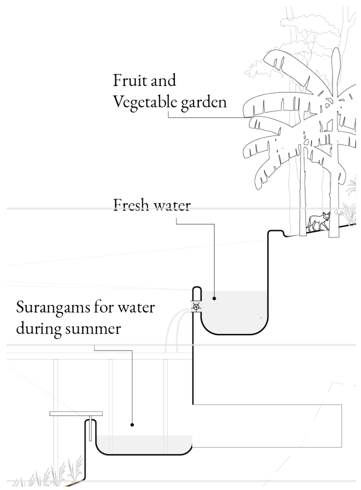
Based on the precipitation levels, the lowest levels of the terraces could alternate between aquaculture and rice cultivation.

Water retention areas
Aquaculture areas
Floodable agriculture
Future Settlement
Built
Highways

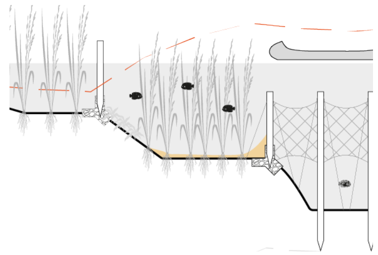
Fig 64 Kodanad 2 Maps by Author
Fig 65 Below structural timeline kodanad made by author



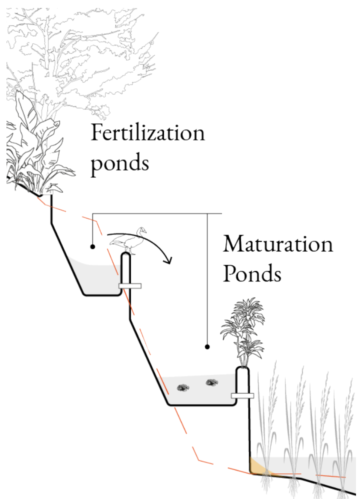




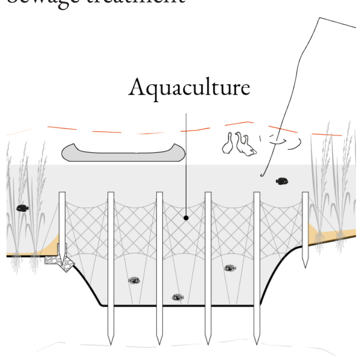
Water storage



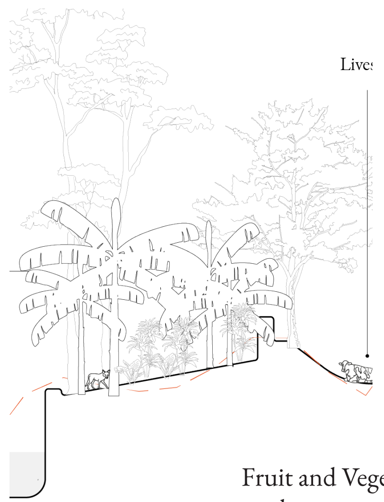
Rice cultivation



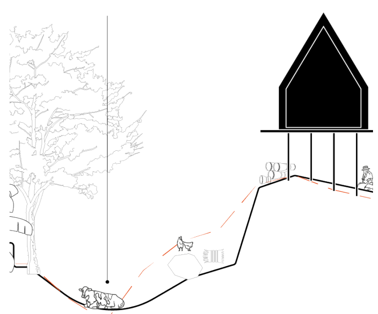
Sewage treatment



Aquaculture



Fruit and Vegetable
garden



Processing Unit

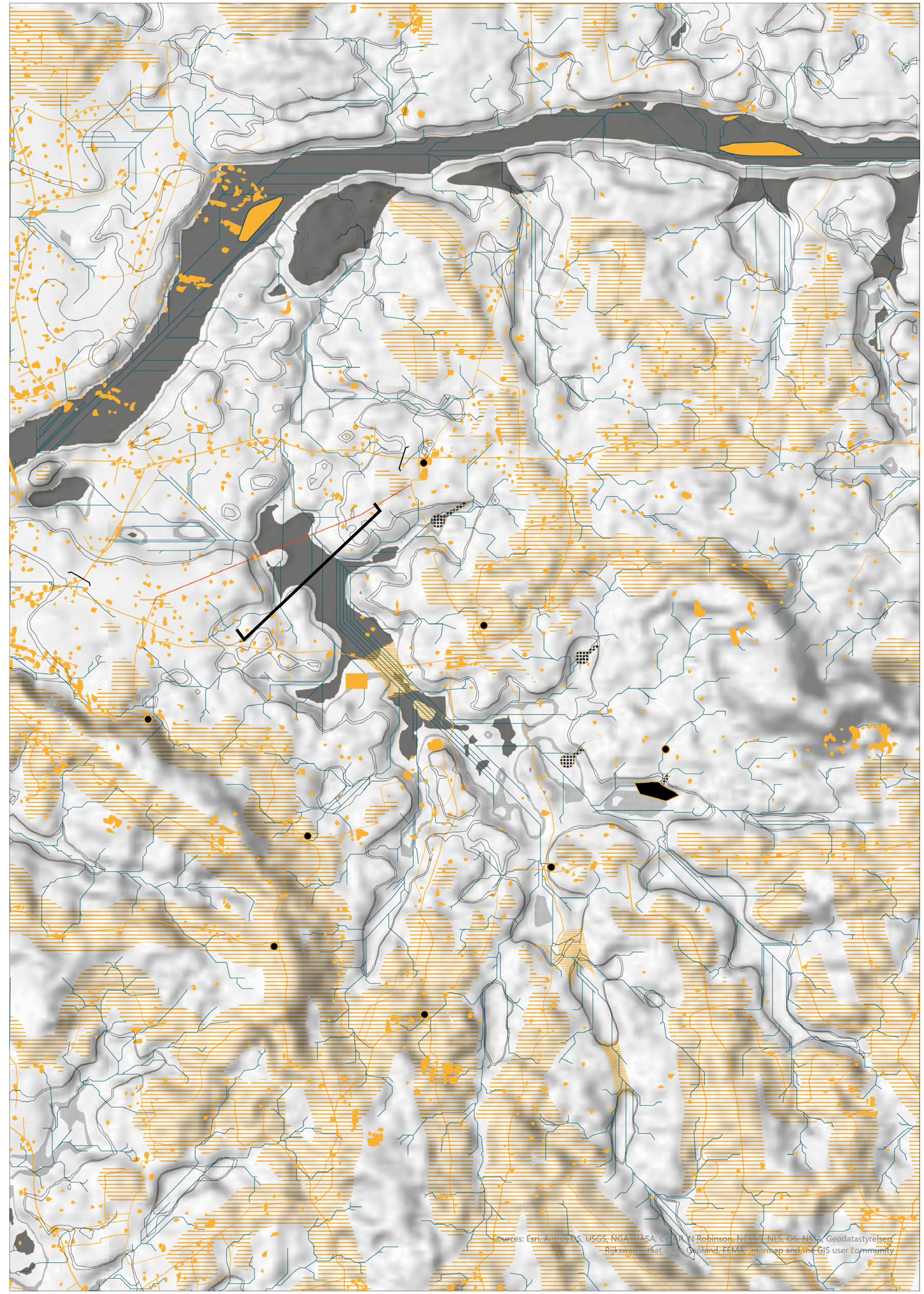
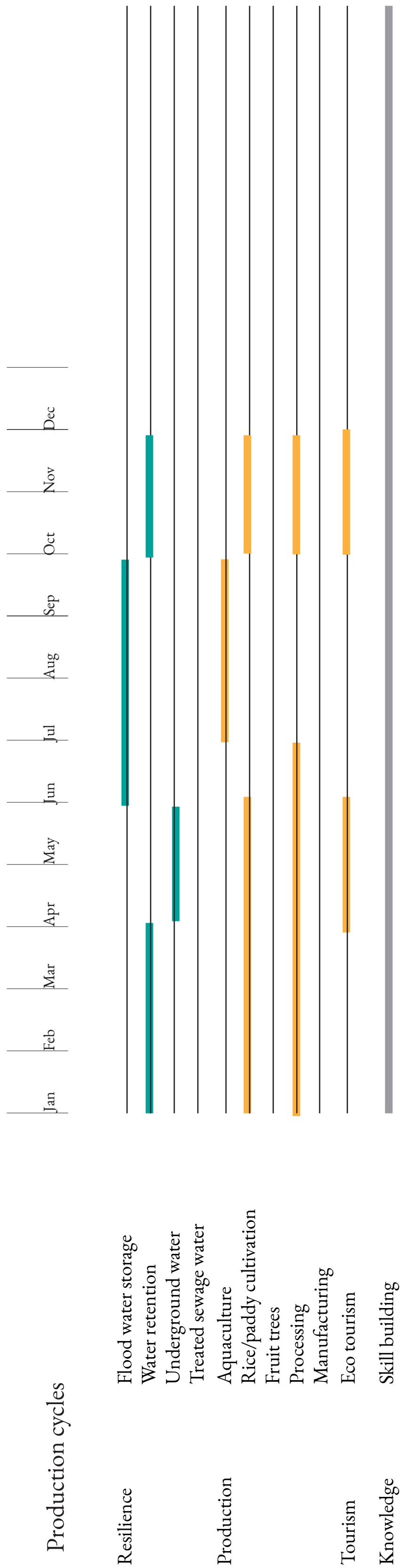
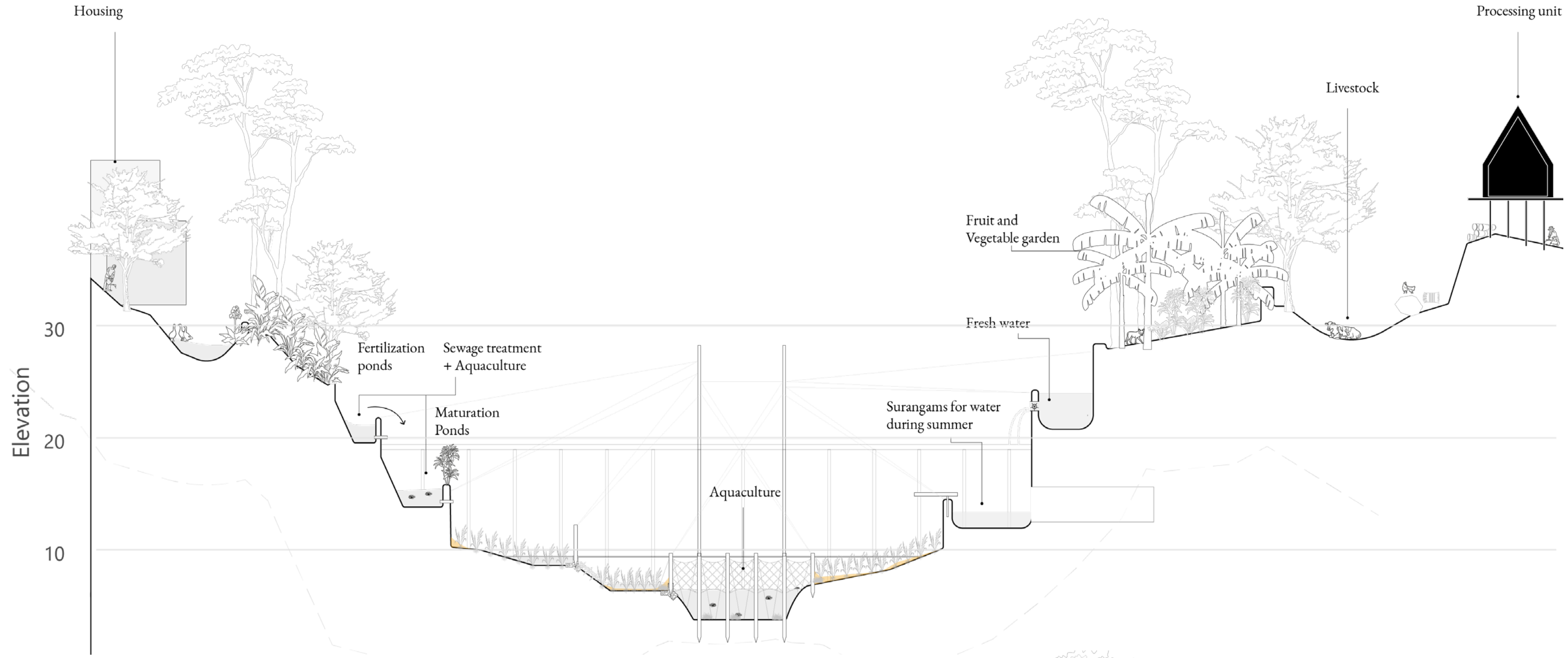


Fig 66 Right Kodanad 3
Maps by Author
Fig 67 Above structural timeline kodanad





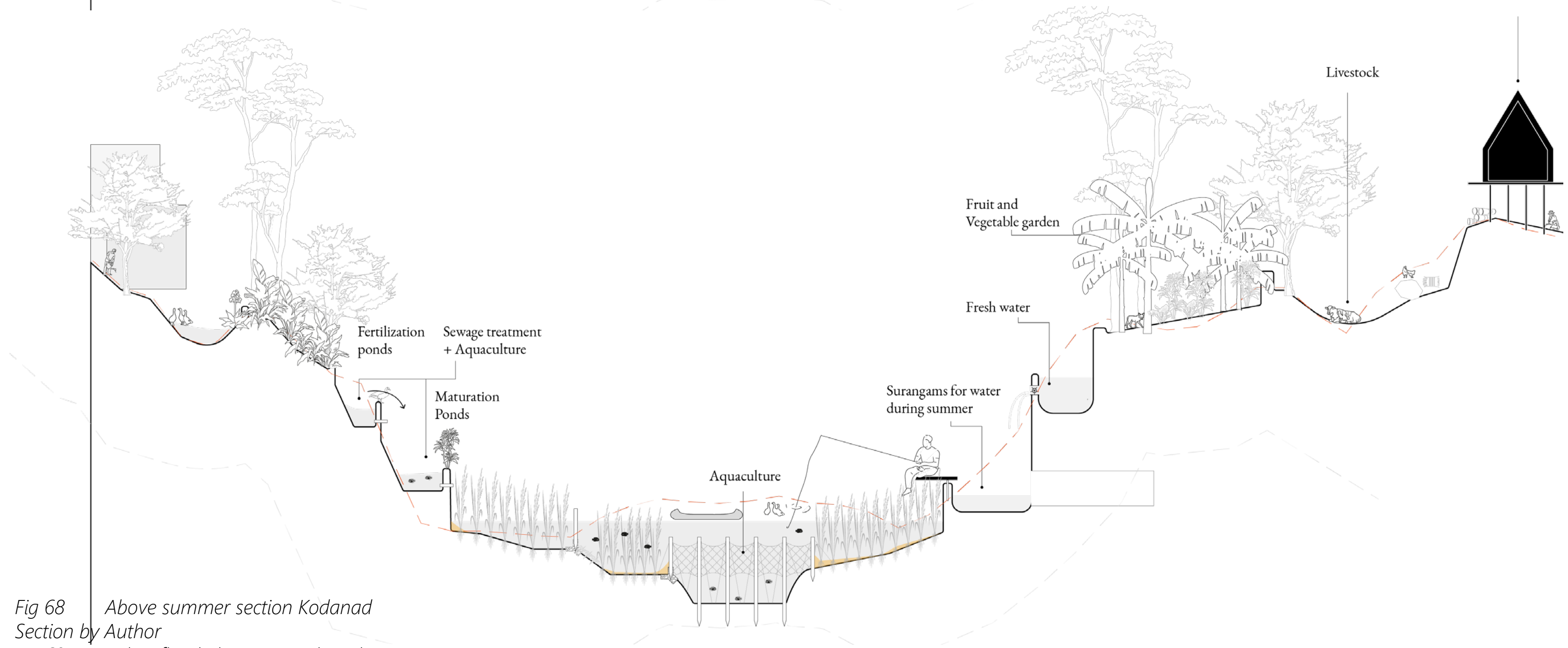


Fig 68 Above summer section Kodanad
Section by Author
Fig 69 Below flooded section Kodanad
Section by Author
Fig 70 Left structural production cycles
kodanad made by author

Fig 71 Flooded illustration Kodanad by author

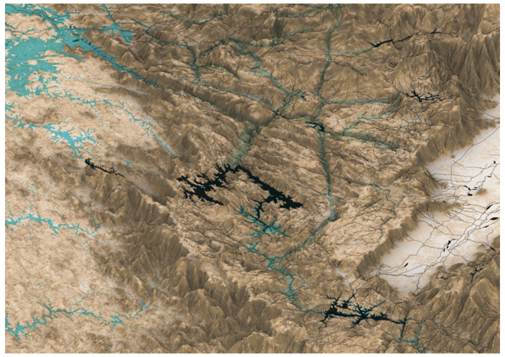
Fig 72 Summer illustration Kodanad by author

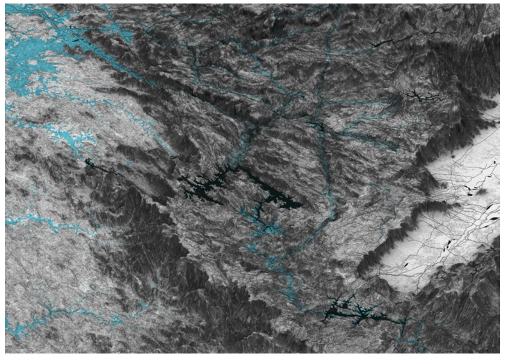
Idukki Dam

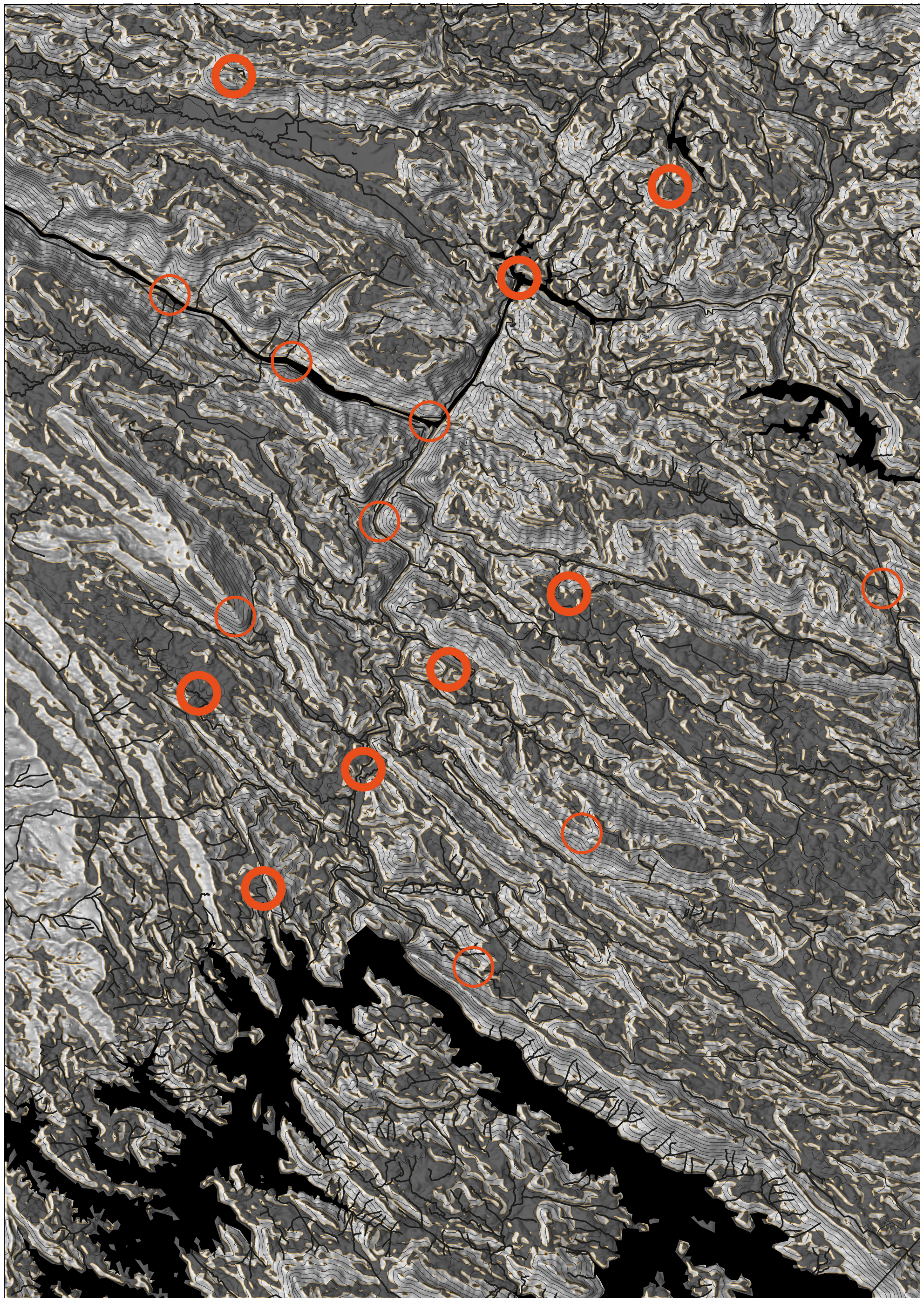
Identifying safe slopes for inhabitation leaves island like structures in the mountainous terrain inhabited by tourist and local communities working for the tourism industry. Testing micro-storage of water along the riverbed coupled with landslide retention structures.

The design focuses on the settlements in proximity to the dam and devices zone for further inhabitation derived from combining highways, slopes less than 15 degrees and above riverbed. Slopes susceptible to fail are fitted with gravel piles and structural hardwood trees.

Secondly, areas with the lowest contour close to the rivers edge are identified and built with water retaining boundary walls made of living blocks alternated with water retaining meshes to use as fresh water storage and also small scale fishing, energy production units.







Living water storage units :

After establishing the risk zones, the infrastructure necessary for mico-storage are introduce. Living modules are used to construct the walls of the water storage units to allow for plant and animal growth which would enhance the riparian biodiversity.

Landslide prevention :

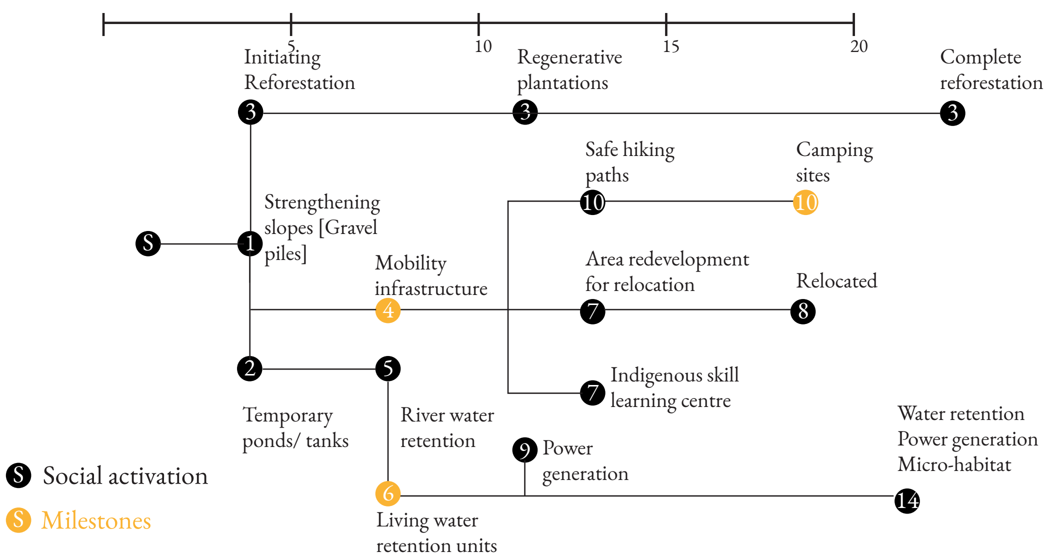
Gravel piles are introduced in risk prone areas to stabilise the bottom and the top of the slope. By introducing meshes of natural fabrics, the sediments which get captured during monsson between the pile can be used for growing structural trees which would later replace the gravel piles and become a self stabilising slope systems.

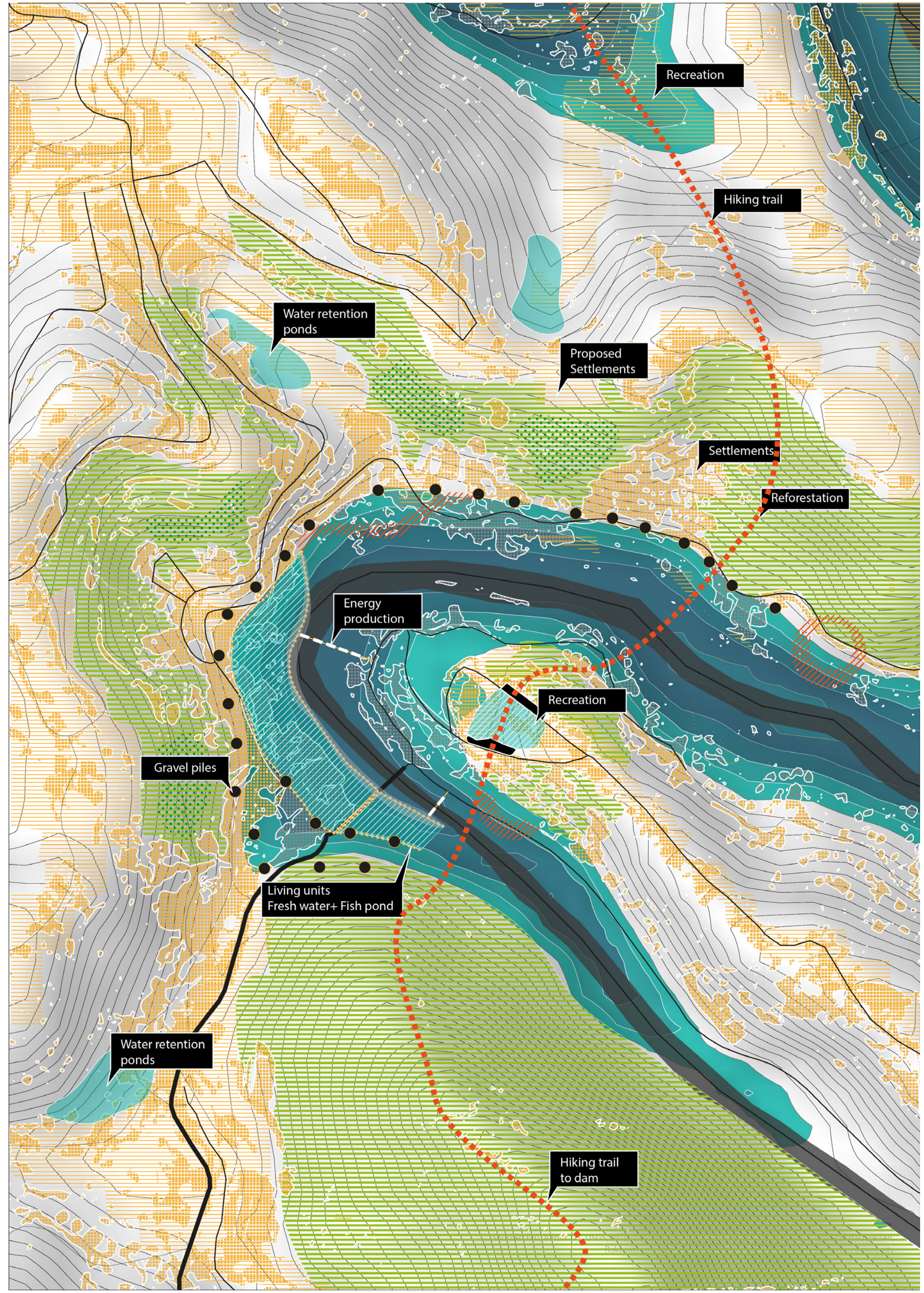
Floating Roads:

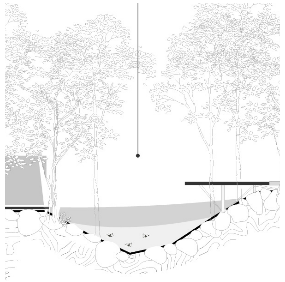
Strategic road which act as main connection between two areas are planned to float, so that they are still functioning if the water level raises.

Floodplain
Water retention infrastructure
Hardwood trees
Gravel piles

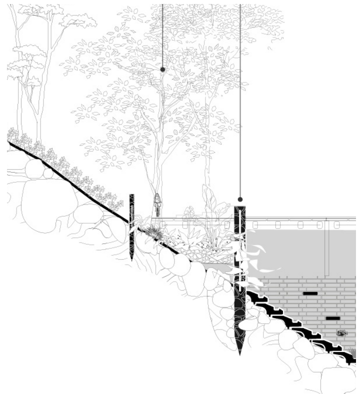
Fig 73 Right: Idukki Map by Author
Fig 74 Below: Structural timeline Idukki made by author



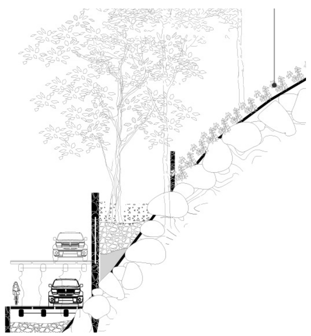




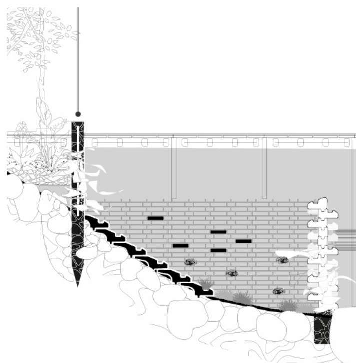
Recreational area



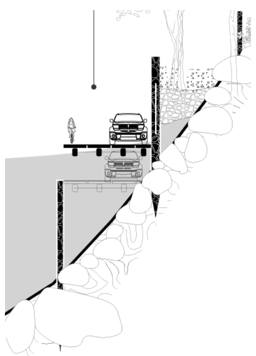
Gravel piles for slope stabilisation



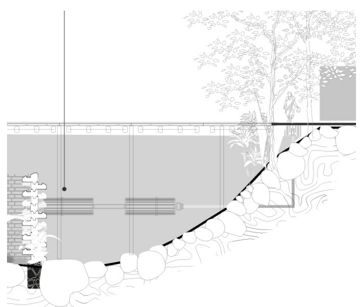
Slope stabilisation and agro forestry



Living units



Floating roads



Energy generation

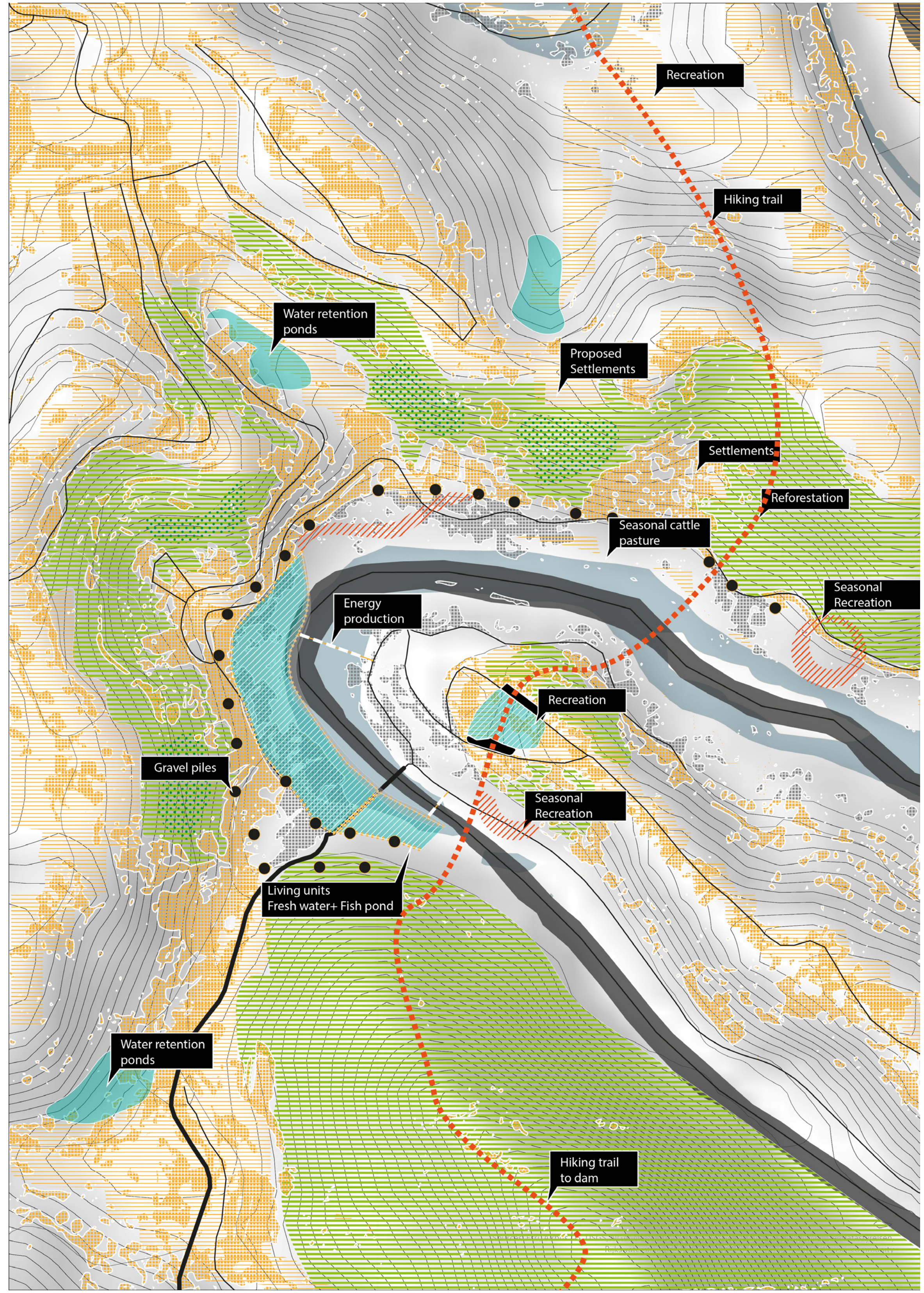
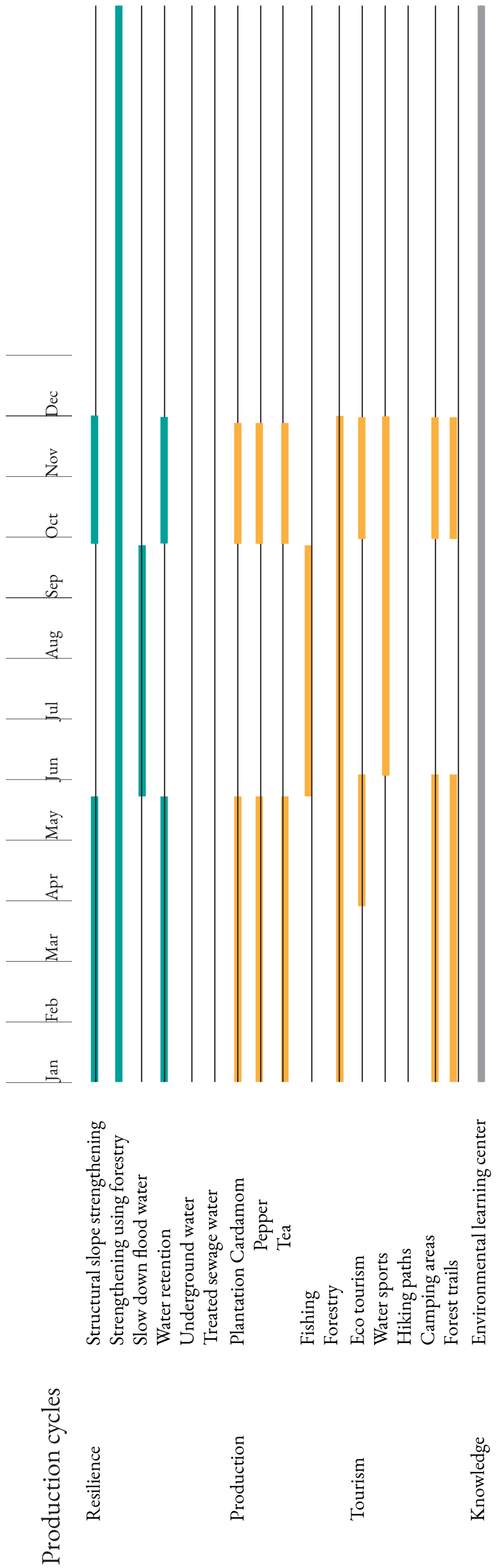
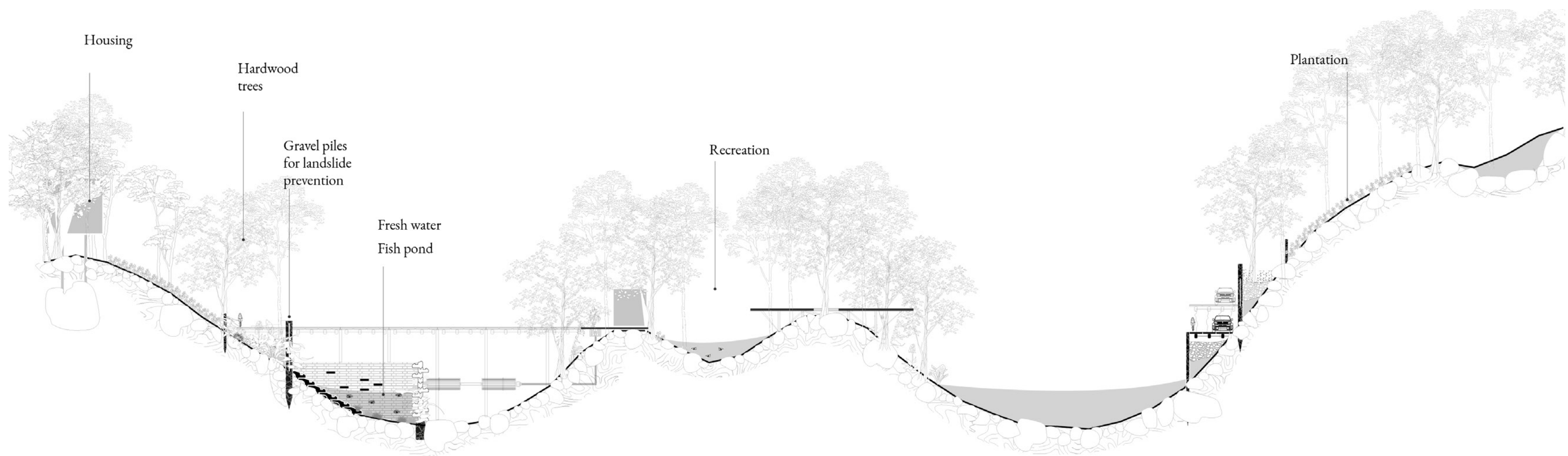


Fig 75 Right: Idukki Map by Author
Fig 76 Above detailed sections made by author





Flooded section

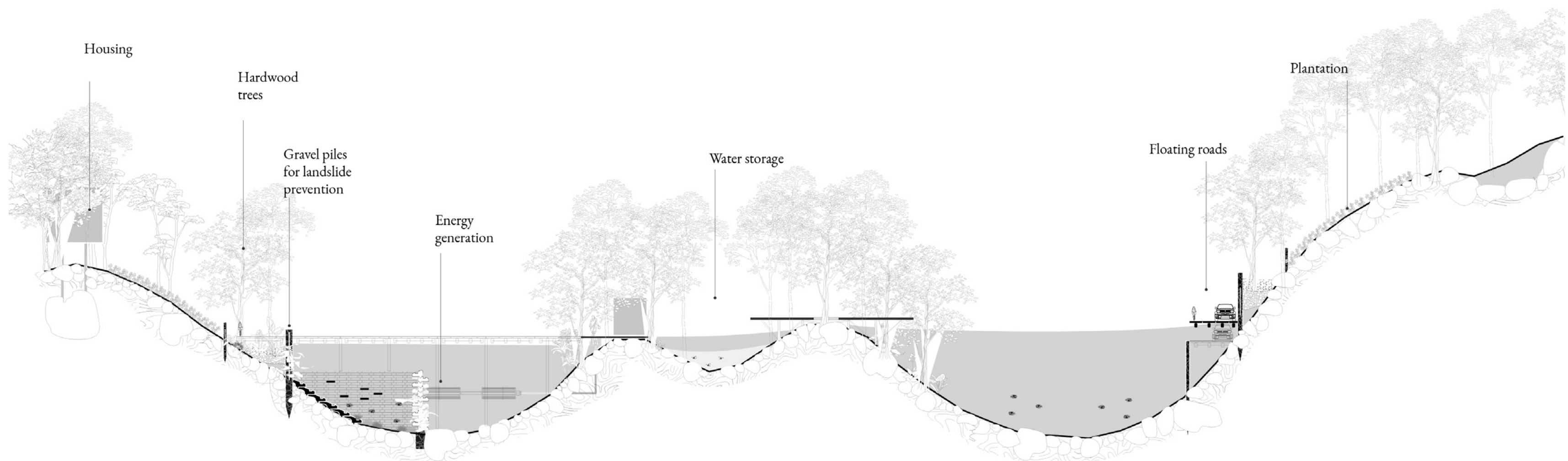


Fig 77 Above summer section Idukki Section by Author
Fig 78 Below flooded section Idukki Section by Author
Fig 79 Left structural production cycles Idukki made by author

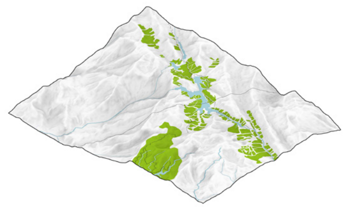
Idukki

Megamalai

The major vision for the river as discussed before is the rejuvenation of the river which is achieved through Reforestation and sustainable agriculture.
Large scale tea plantations adorn the side of the river which are proposed to be converted into Agro-forestry.
Shading trees which are found in-between tea-plantations are taken as starting points to transform the intensive mono-cultures.
Tea plantation in southern India have 2 pruning stages at which the distance between the shading trees are increased until the plants reach their maturity. This is used as an advantage here and agro-forestry is introduces to rejuvenate the forest thereby bringing back the rainfall to the region.
Five stages of transformations are envisioned derived from the pruning periods of the tea cycles. Theses stages propose a cyclic cultivation pattern incorporating rest periods: corresponding to full grown forests until intensive tea cultivations.

To supplement the loss of productivity, woodland camping and hiking routes are introduce opposed to resorts and bungalow to minimise the human impact in these wild areas.

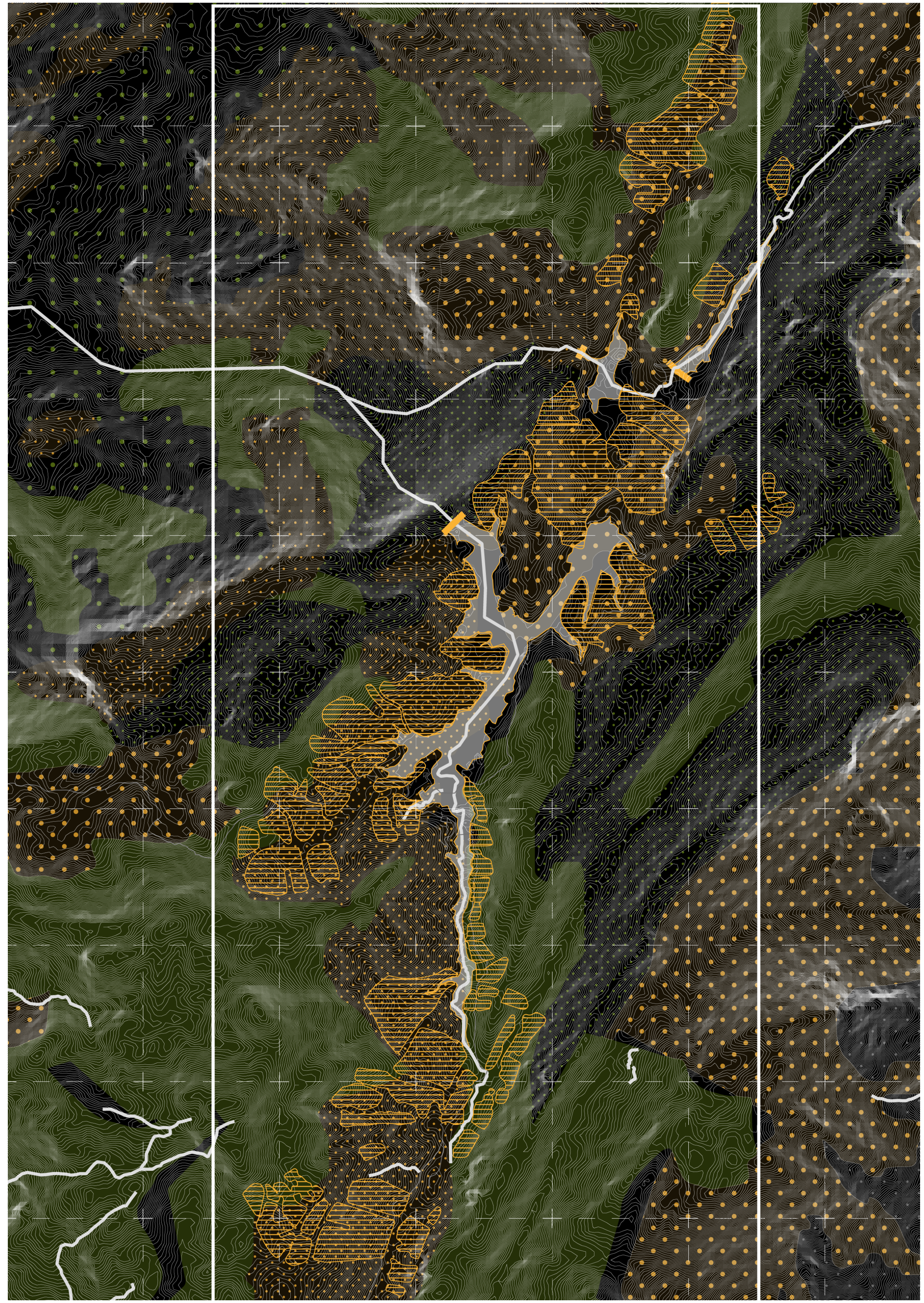
Earth image



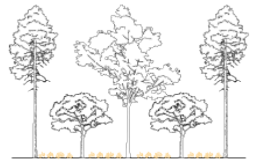
Plantations

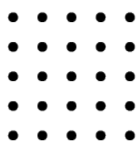
Slope

Fig 80 Right: Megamalai Map by Author
Fig 81 Below: Production cycle

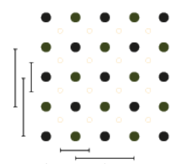


Patterns of Production + Forestry

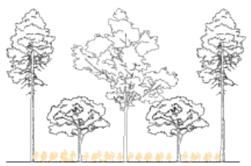




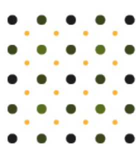
1. Forest



2. Forest+fruit trees
Tea Nursery
Year 1

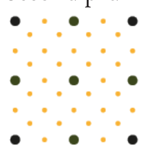


First pruning stage

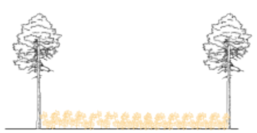


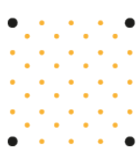
3. Forest + Fruit trees +Tea plants
Year : 3

Second pruning stage



4. Perimeter forest + Mature tea plants
+ Tea
Year : 10





5. Tea plantations
Year : 30

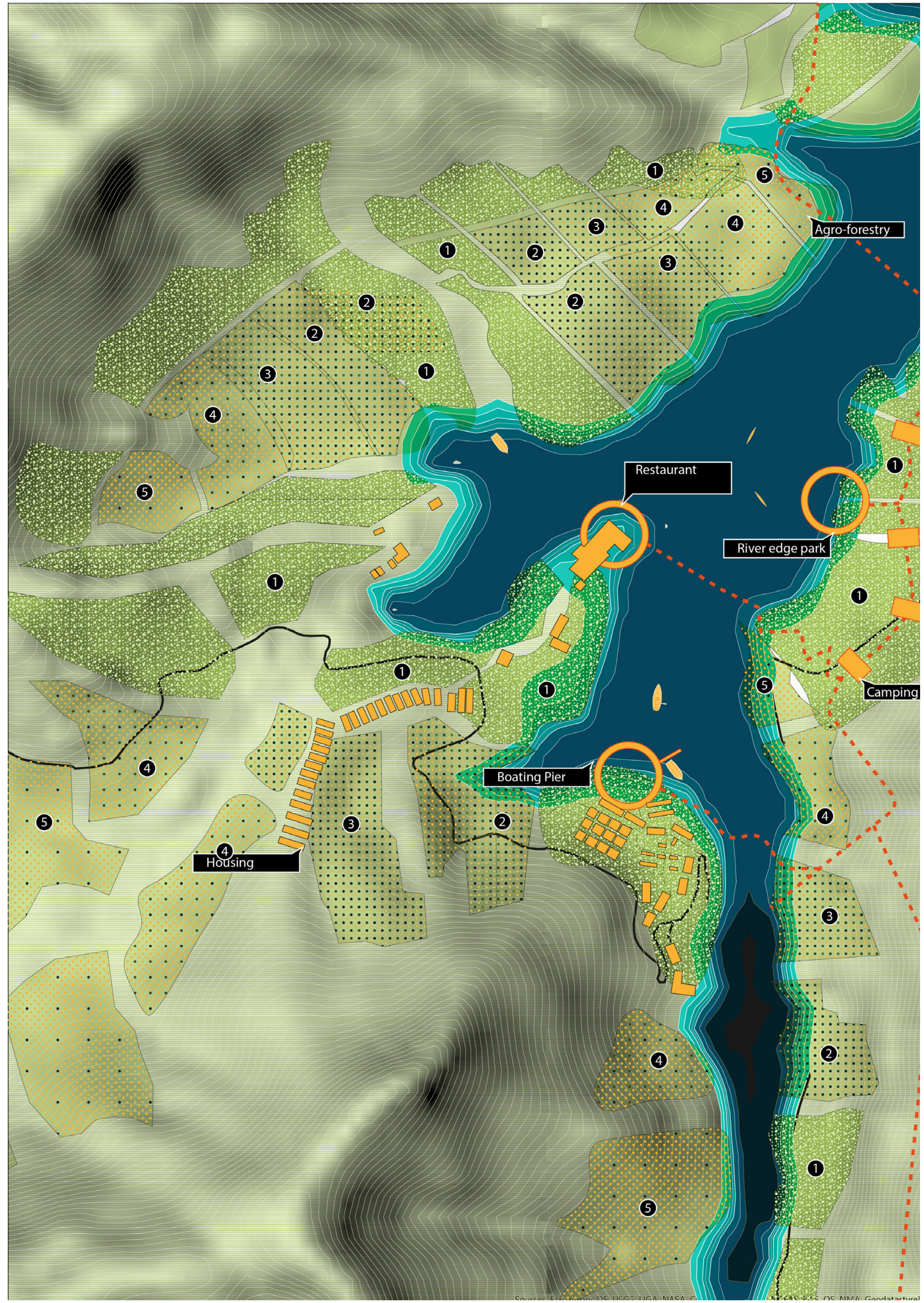
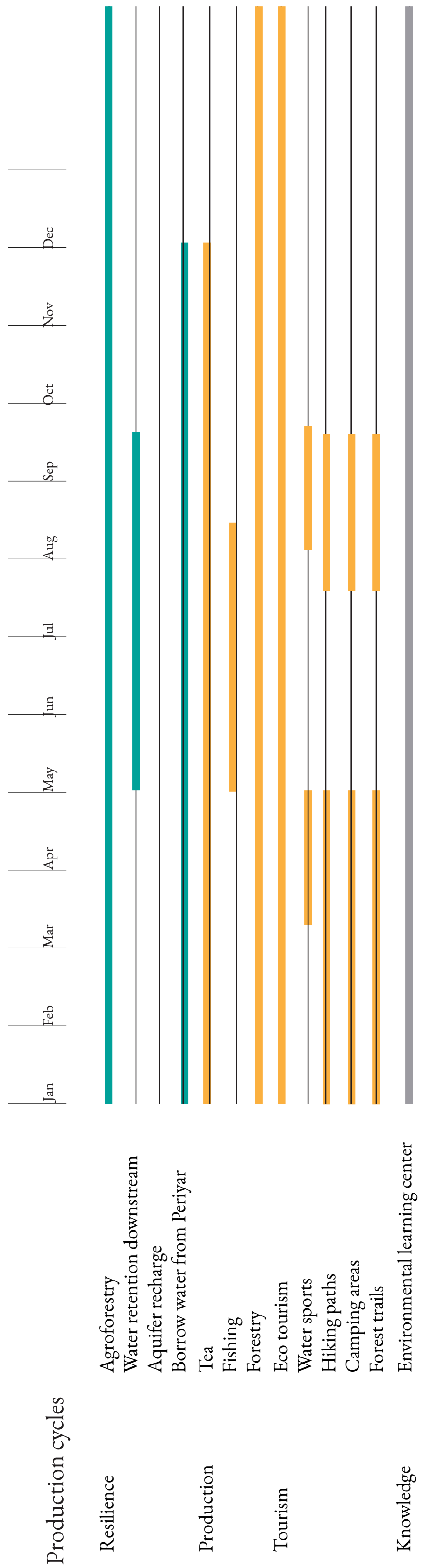
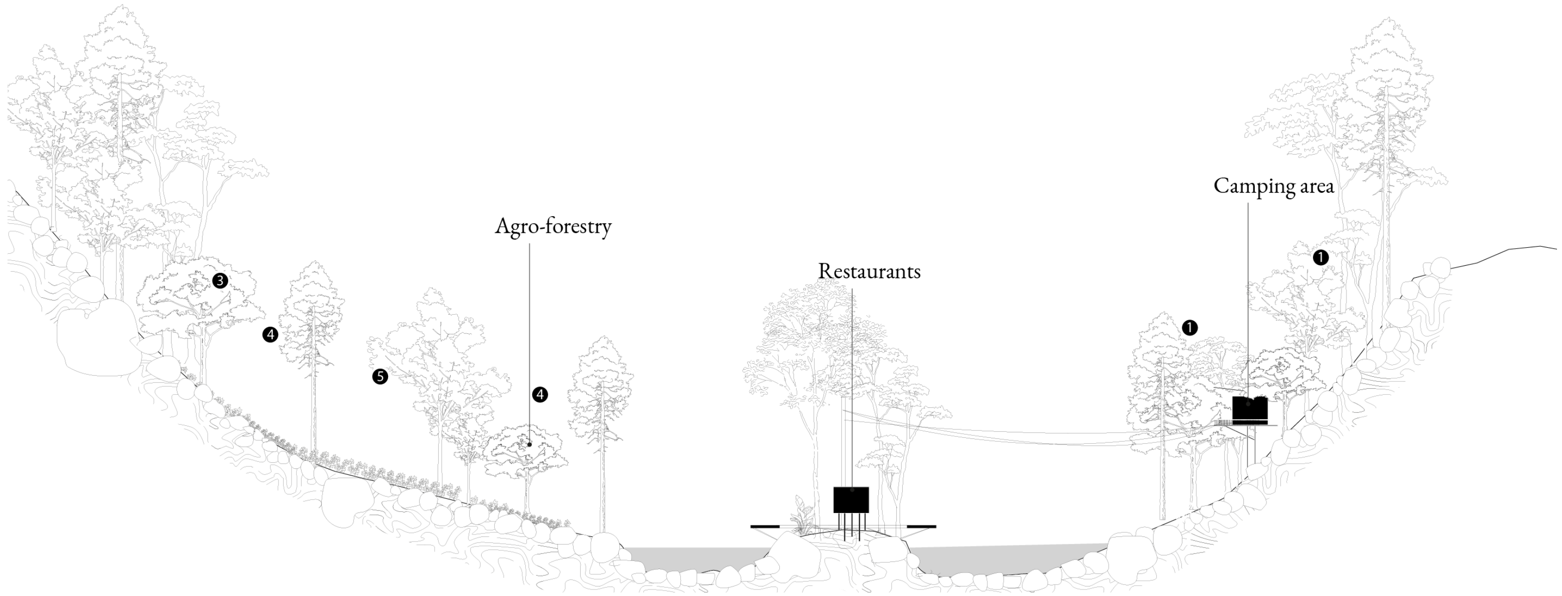
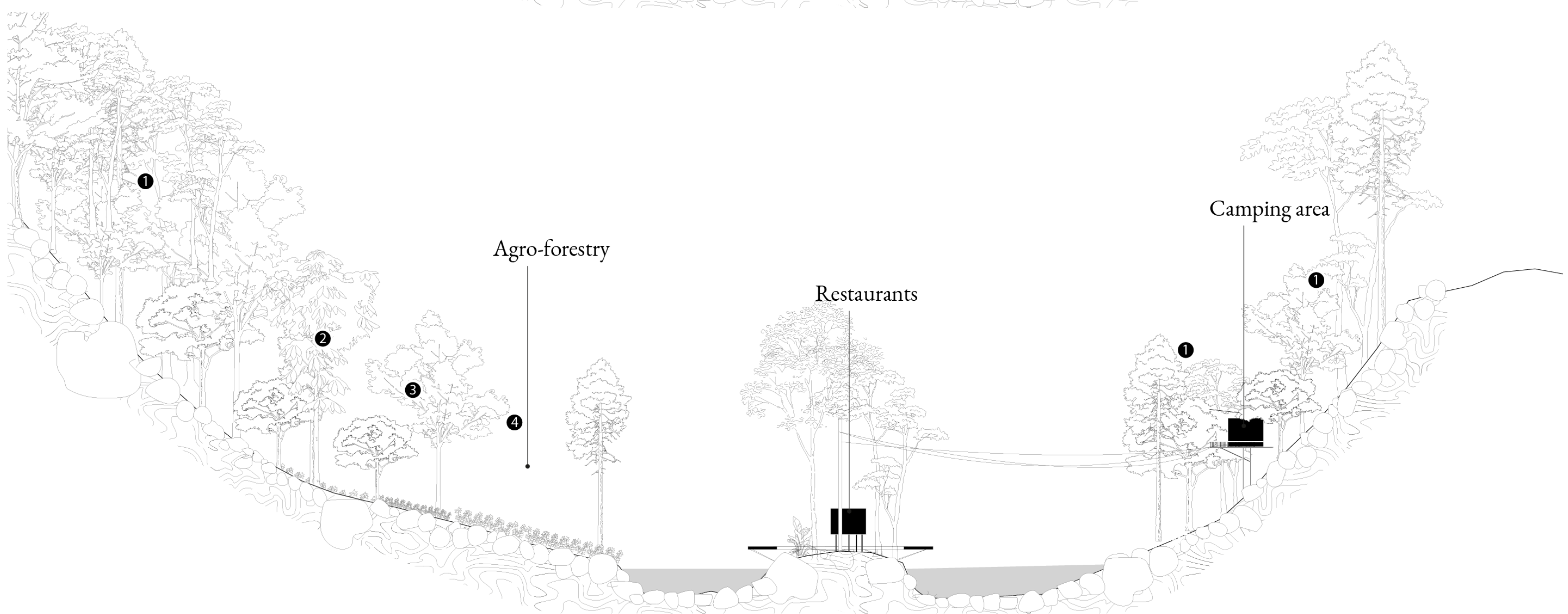


Fig 82 Right: Megamalai 2 Map by Author
Fig 83 Above: Sections megamalai







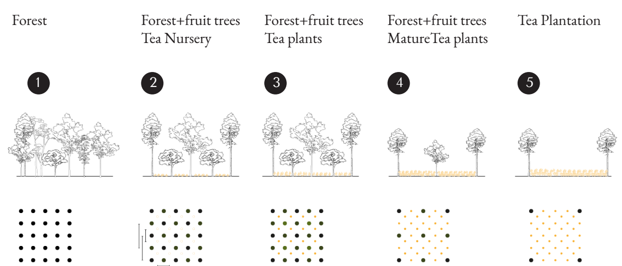
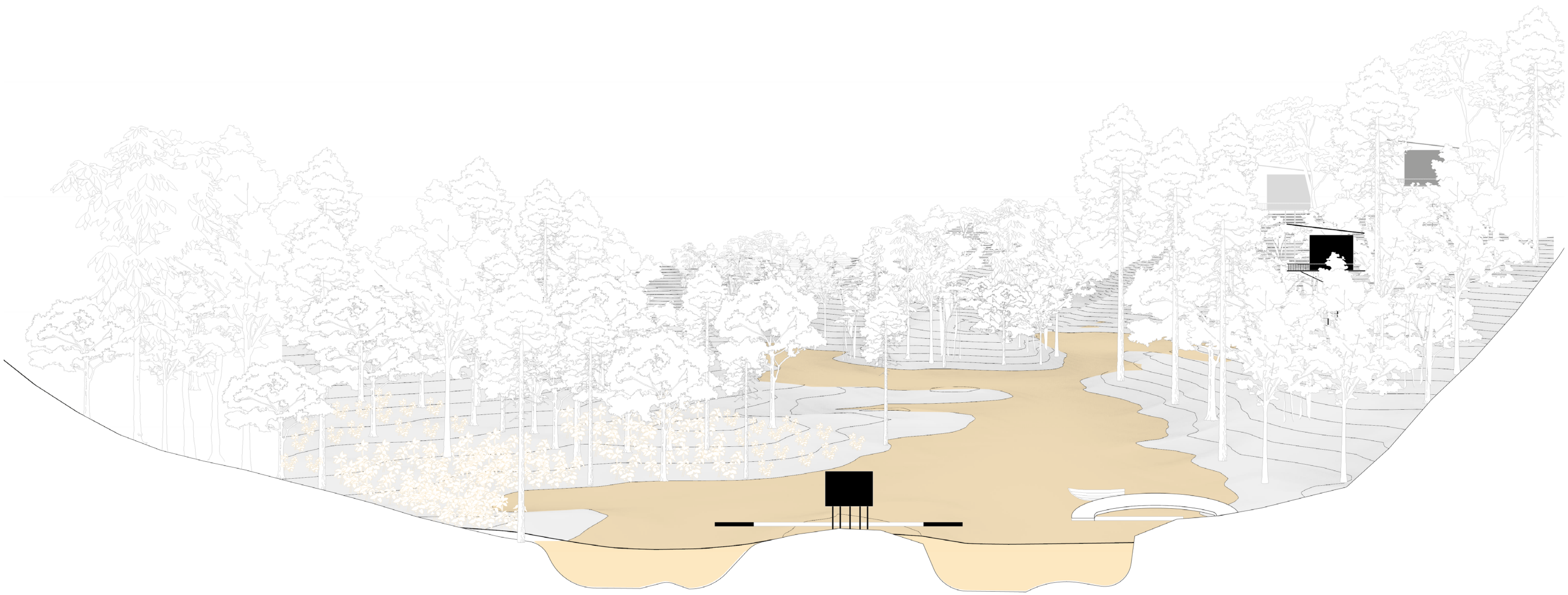


Fig 84 Above a cycle in regenerative agricuture Megamalai 1
Fig 85 Above a cycle in regenerative agricuture Megamalai 2
Fig 86 Left structural production cycles Megamalai made by author

Megamalai



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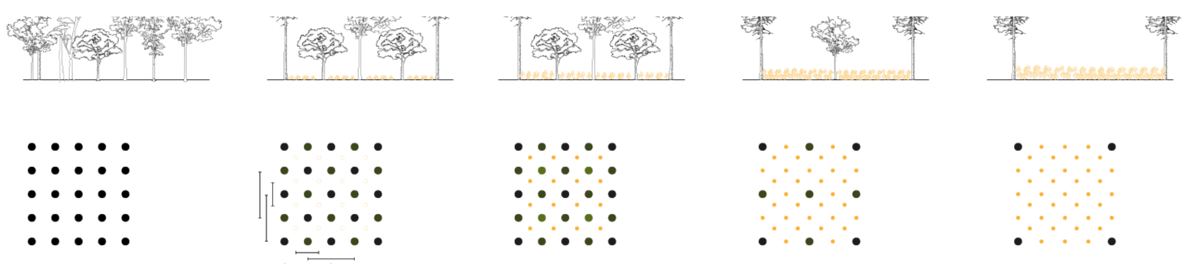


Madurai

The vision for the city of Madurai is to restore the traditional systems tanks capacity and to envision a riverine water storage system which would act as a recreational riparian edge.
Due to large scale dumping of debris and garbage in the river, initial steps to clean the river are necessary.

A solid waste management unit has been established which cleans the river and recycles waste. Water retention tanks along the edge of the river filter ans store water for summer, in case of dry seasons treated water could be used for minimum ecological flow in the river.
The river channel is designed to hold water in its lower point and introduces recreational zones, grazing areas which bring people to the edge of the river and encourage them to maintain it.

Strategic road in the city of Madurai could be doubled up as surface run-off water storage systems which help in storing as much waster from the monsoon as possible. Thus forming a system tank like structural water retention for the city. The city could use this rivers edge to show the amount of water left for summer indicating the preciousness of the available resource.

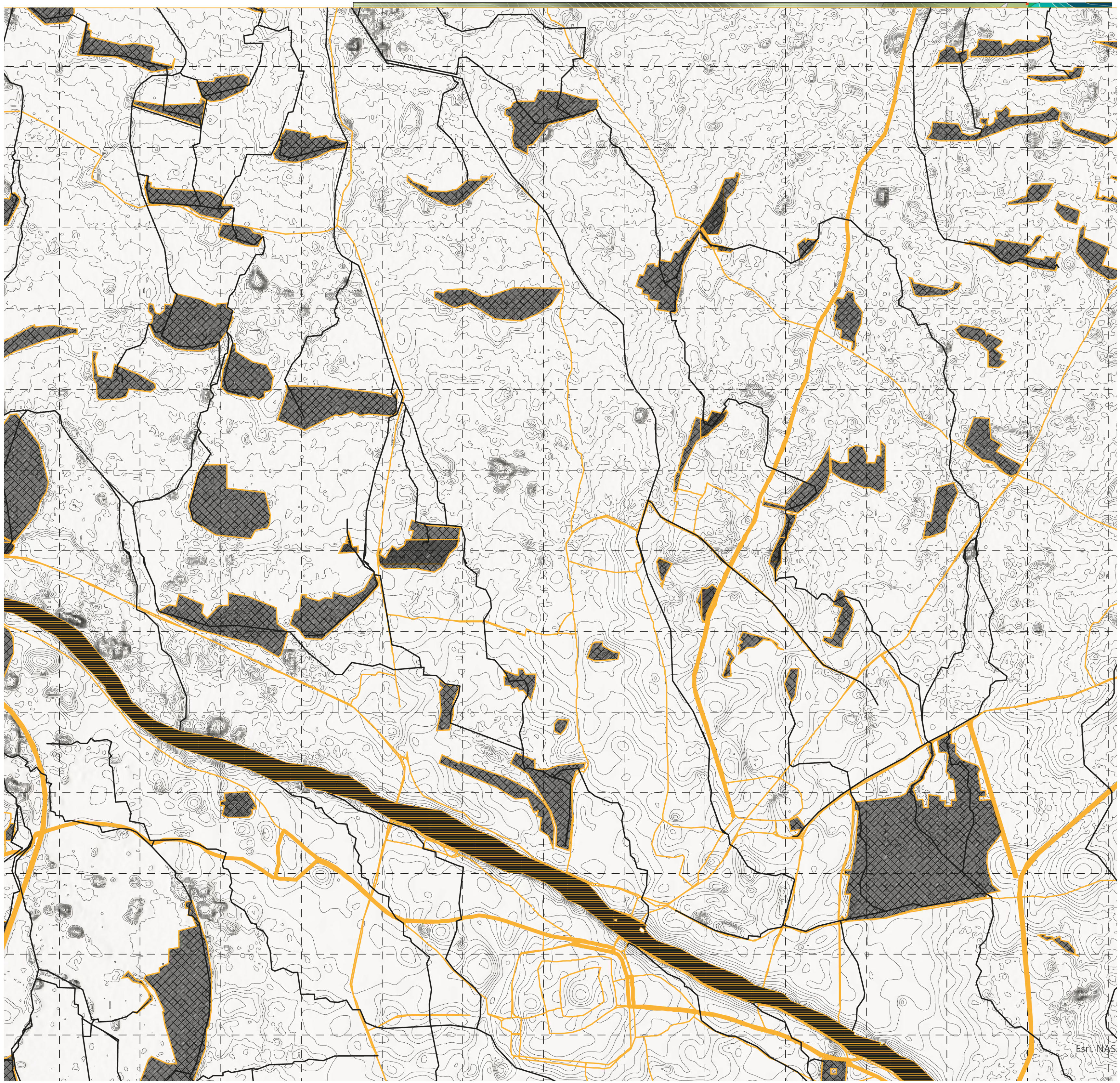
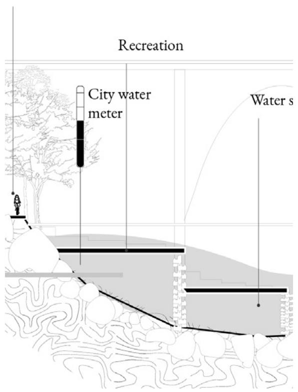
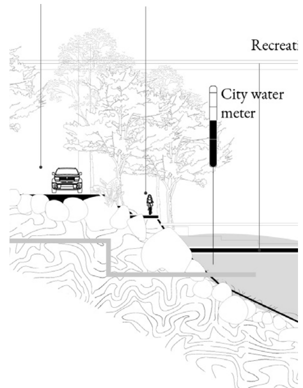


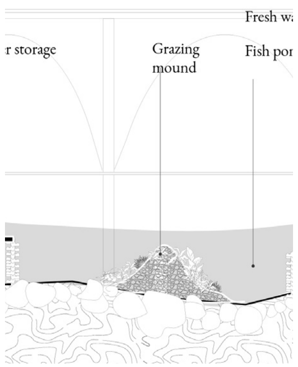
Fig 87 Right: Madurai Map by Author



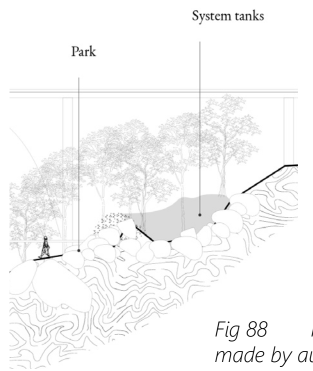
Recreational area



Cycling path

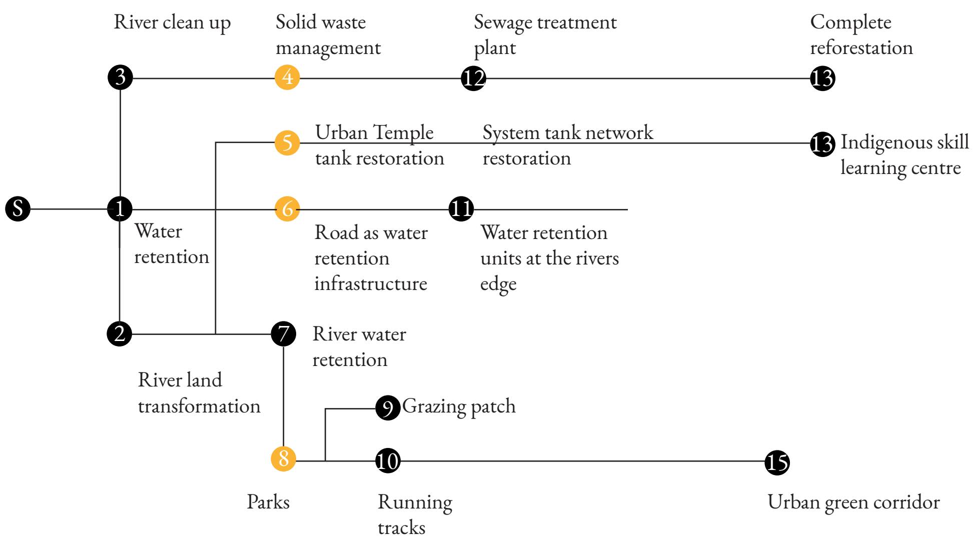


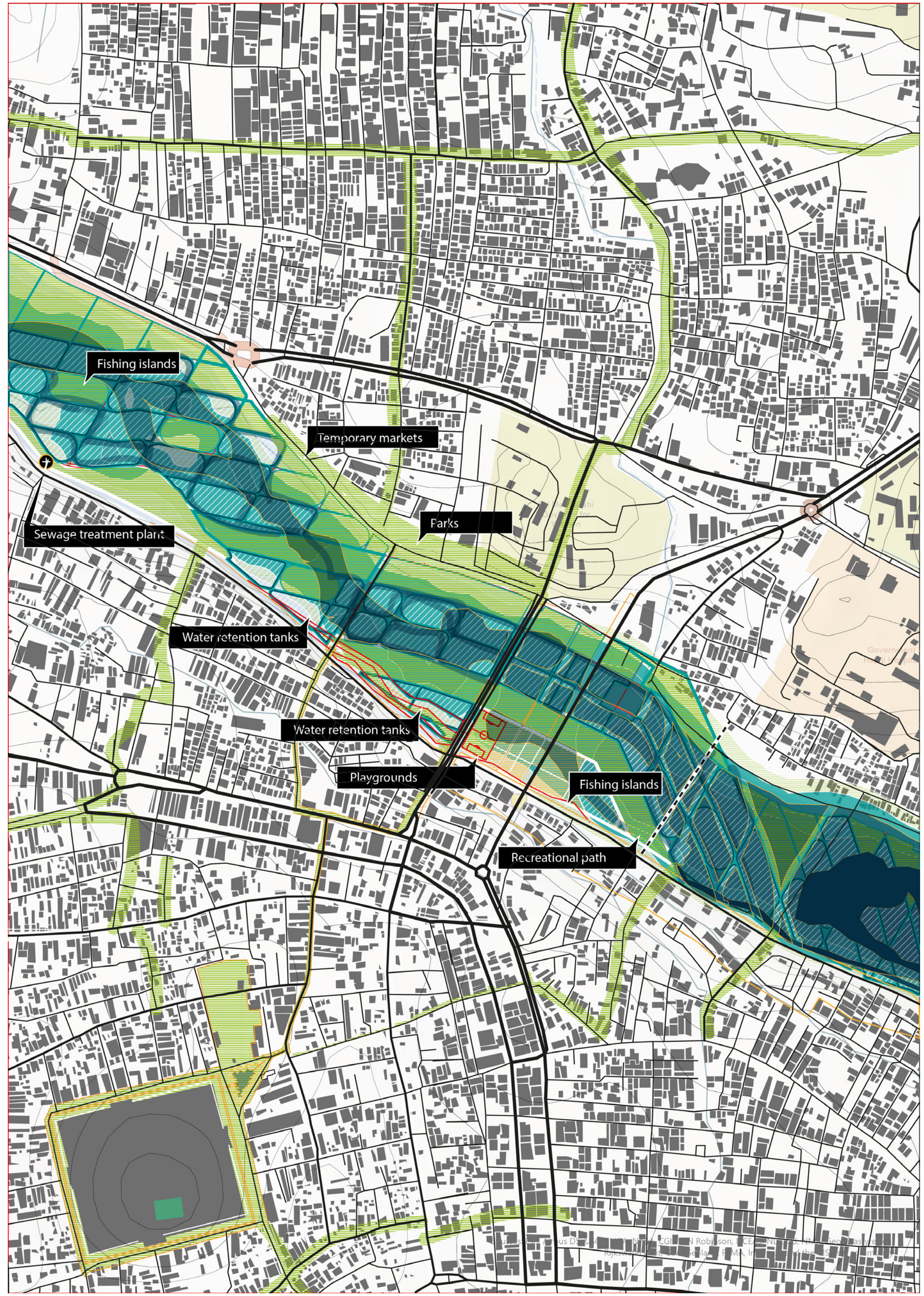
Grazing patch

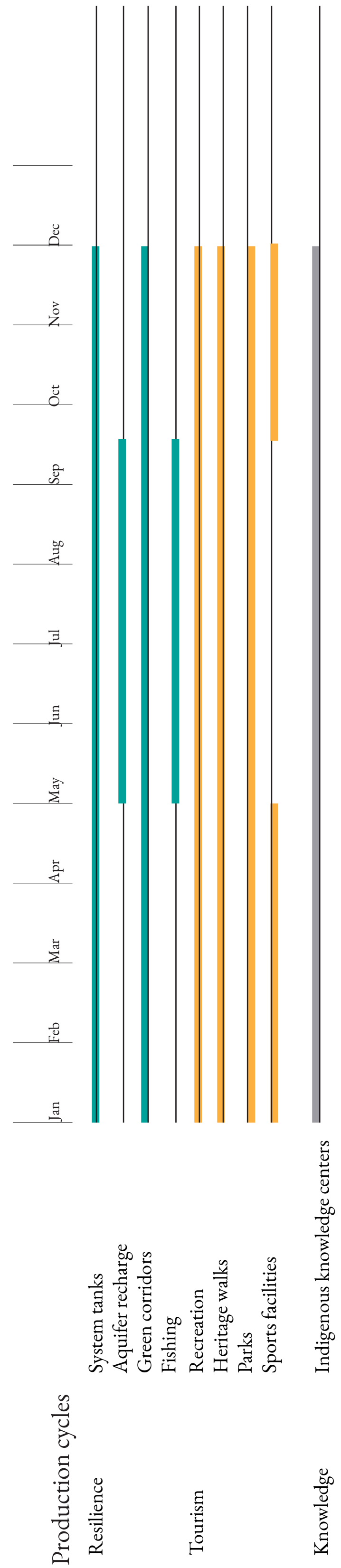


System tank

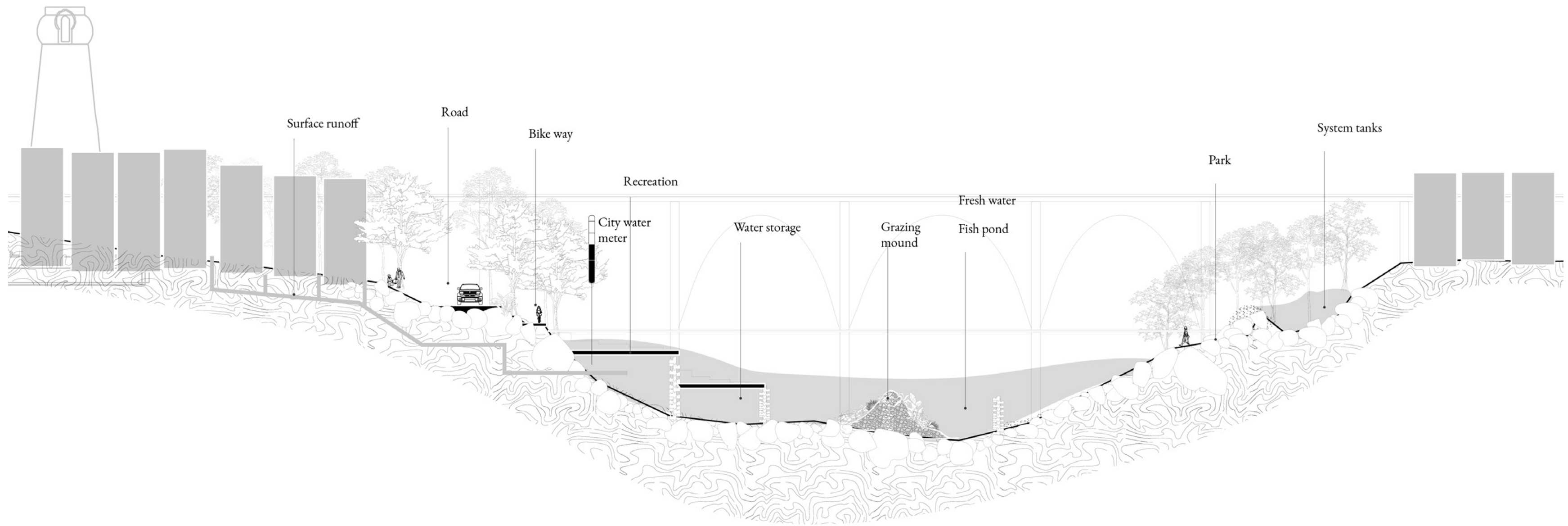
Fig 88 Right: Plan of Madurai made by author
Fig 89 Left : Details of interventions made by author
Fig 90 Below structural timeline of Madurai



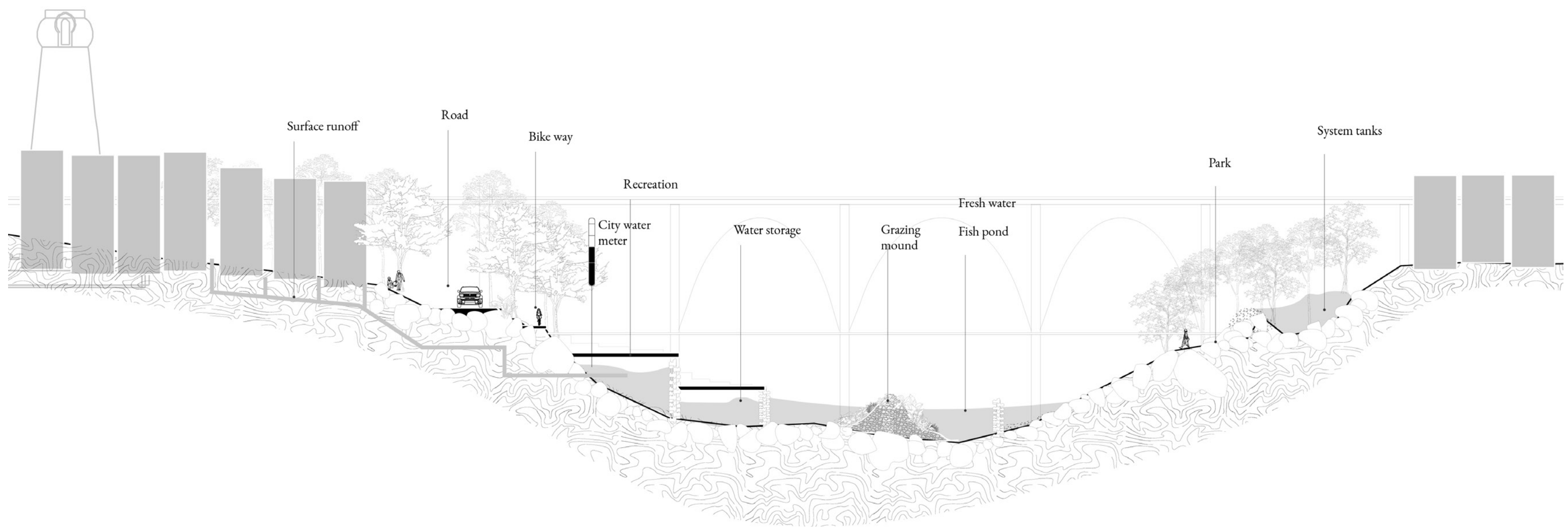




Production cycles
Resilience
System tanks
Aquifer recharge
Green corridors
Fishing
Tourism
Recreation
Heritage walks
Parks
Sports facilities
Knowledge
Indigenous knowledge centers
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Surface runoff
Road
Bike way
Recreation
City water meter
Water storage
Grazing mound
Fresh water
Fish pond
Park
System tanks



Surface runoff
Road
Bike way
Recreation
City water meter
Water storage
Grazing mound
Fresh water
Fish pond
Park
System tanks

Systemic Interrelations

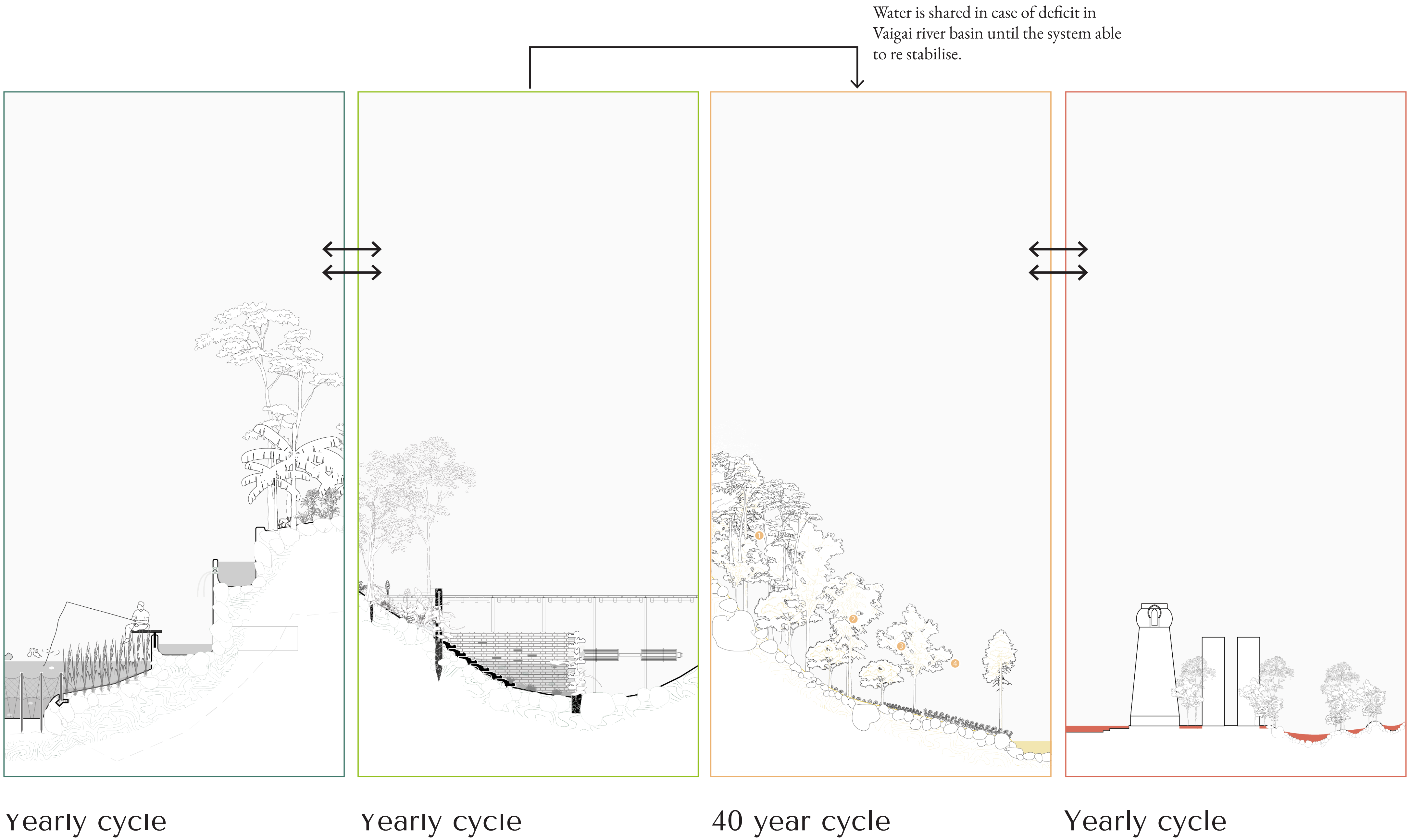
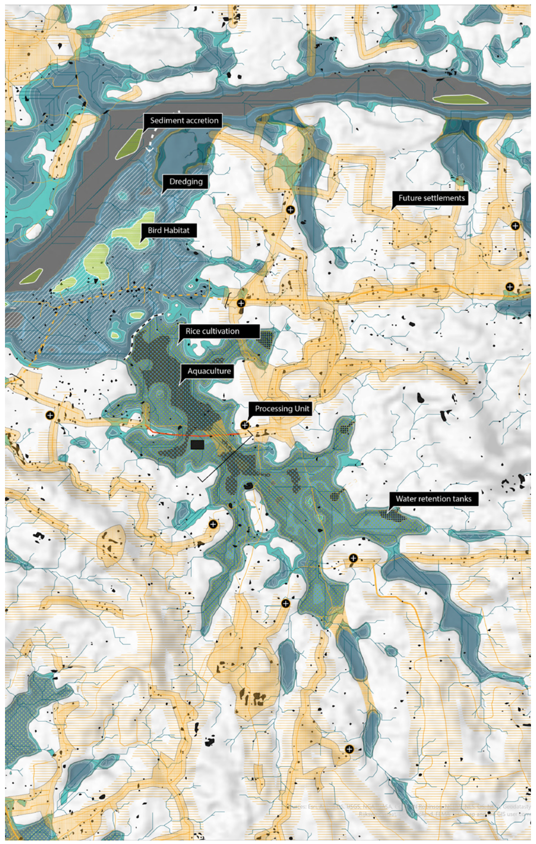


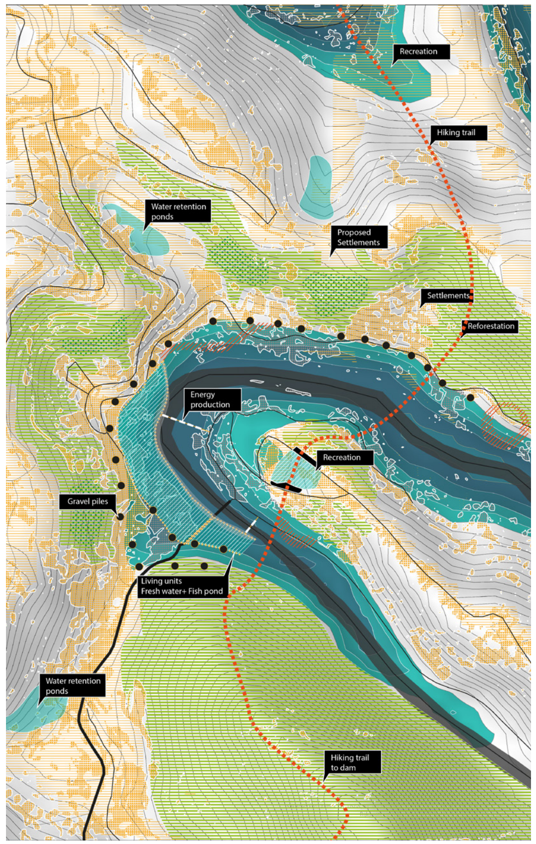
Fig 94 Systemic Interrelations

Systemic Interrelations

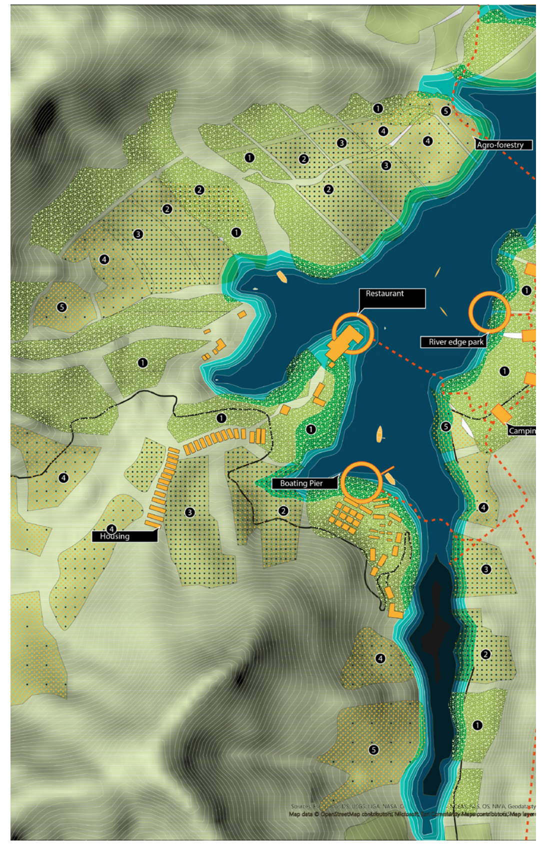
Kodanad



Idukki



Megamalai



Madurai

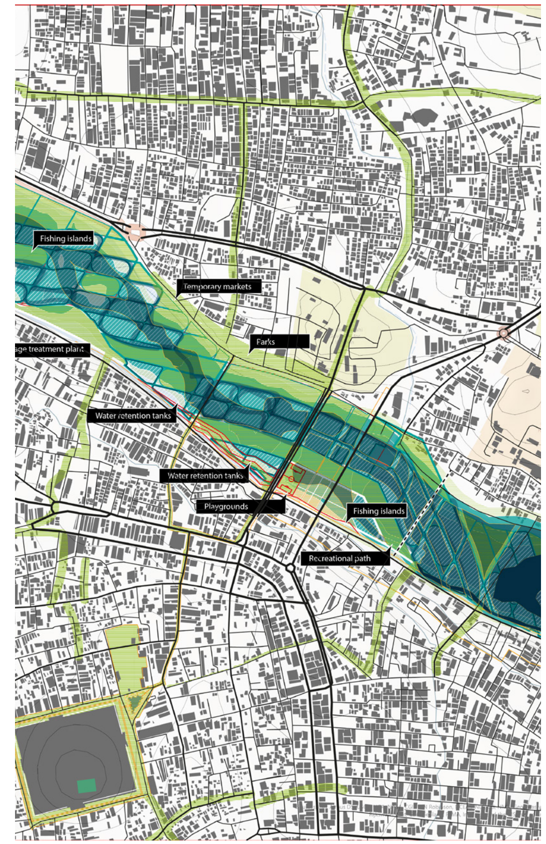
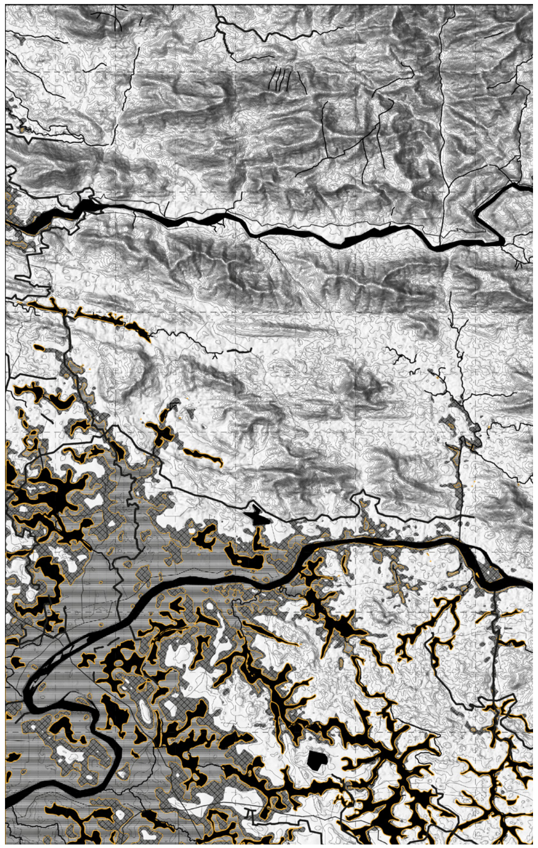


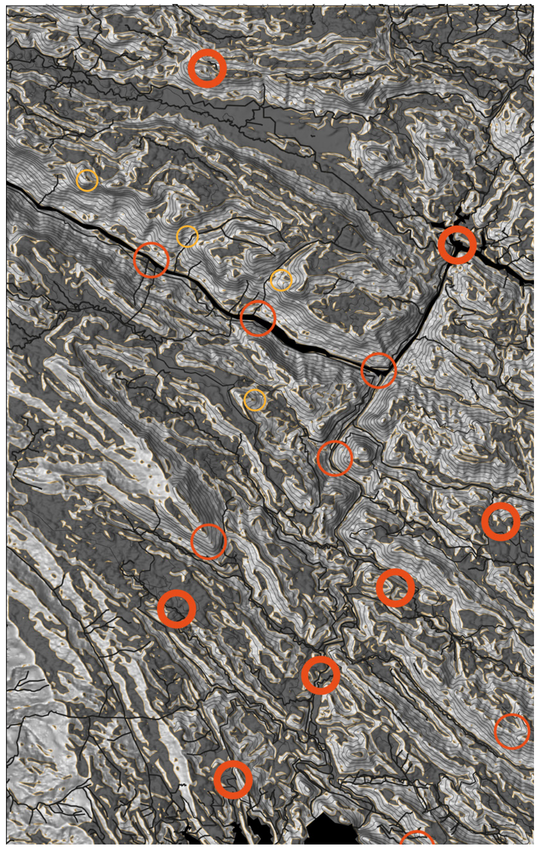
Fig 95 Systemic Interrelations Local scale

Patterns of territorialisation

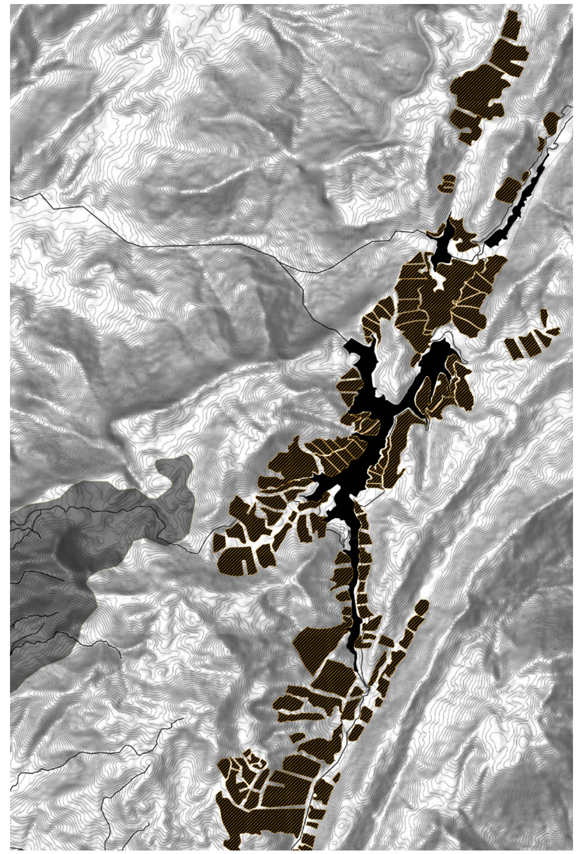
Branced



Islands



Fingers



Network [River+Road]

Fig 96 Systemic Interrelations Network scale

Chapter 06

Humans of Monsoonal Landscapes

Sequencing action

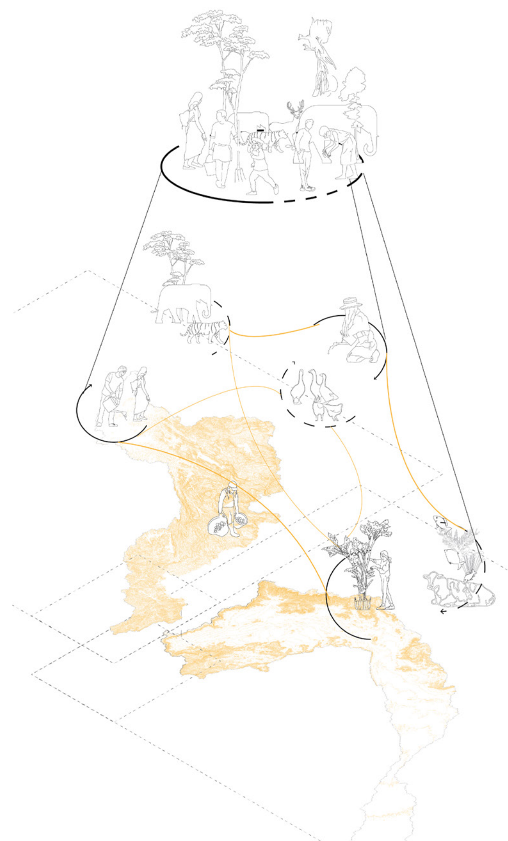
01. Recognition & Social activation

The socio-ecological approach to resilience as defined by the ecological resilience establishes the importance of considering society and culture as interdependent systems. The initiation of the transition calls for a recognition of the all the actors involved and vulnerable groups to recognise the ecosystem services, a resilient ecological system provides and imparts the importance of transitioning social systems from primarily extraction to aligning them to the ecosystem.

The project identified 4 strategic location for the initiation of the transformation to restore the systemic functions of the monsoonal system, along with the programmatic changes. This additionally requires the transition in the society to organise, regulate and maintain anthropocentric which works with the ecosystem and not against it.
The said alignment requires the congregation of multiple actors right from vulnerable communities to farmers, private agencies, states, national government and also international multilateral actors.
It is important to mobilise actors to participate and recognise the power of nature based solutions as much as incorporate regenerative processes of production and manage these processes over a longer period of time. Thus the societal activation is not just a phase but is active in all the stages of the project.
Initially all the different actors are evaluated to figure out where the power resides and through the design it is embeded in the community through their indigenous practices, process of regulating production and management of the landscapes.

Stakeholders

Community stewards



States act as supporting bodies

Fig 97 Sequencing actions diagrams, clearance geopolitics made by author

02. Procedural phase

In the procedural phase the actors already recognise the values and set principles that direct the project . Involving actors from local informal to organised government bodies. At this stage once the goals are set the organising communities test out small pilot projects which are instrumental to encourage actors to participate in the process of transition. The roadmap from encouraging local actors to implementing potential next steps and involvement until international actors can be set.

03. Structural phase

Once the roadmap for implementation of set, then the time line for structural work is done by developer led by communities and state. As this project involves multiple interventions simultaneously there are 4 structural timelines developed for each site and then built up to the network scale and then the regional scale.

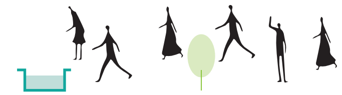
04. Programmatic phase

With the construction of essential infrastructures such as mobility networks, terraces, water retaining living units the project is at a stage where the regenerative practices need to be introduced and maintained. Here it is essential to organise workshops, give subsidies to people to start incorporating such practices over profitable ones.

04. Ecological-economic stage

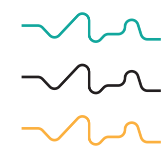
The key to making this project truly meaningful lies in the fact that services provided by the ecosystem have to be values and cared for. Hence the economy has to recognise the gains of managing such regenerative cycles as ecological profit which in hindsight provides ecological resilience. For this to happen a shift from a capitalistic economy is necessary.

Stakeholder roadmaps



Structural Timeline

Adaptive pathways



Economic+Ecological

$$ $$ $$

Stakeholders

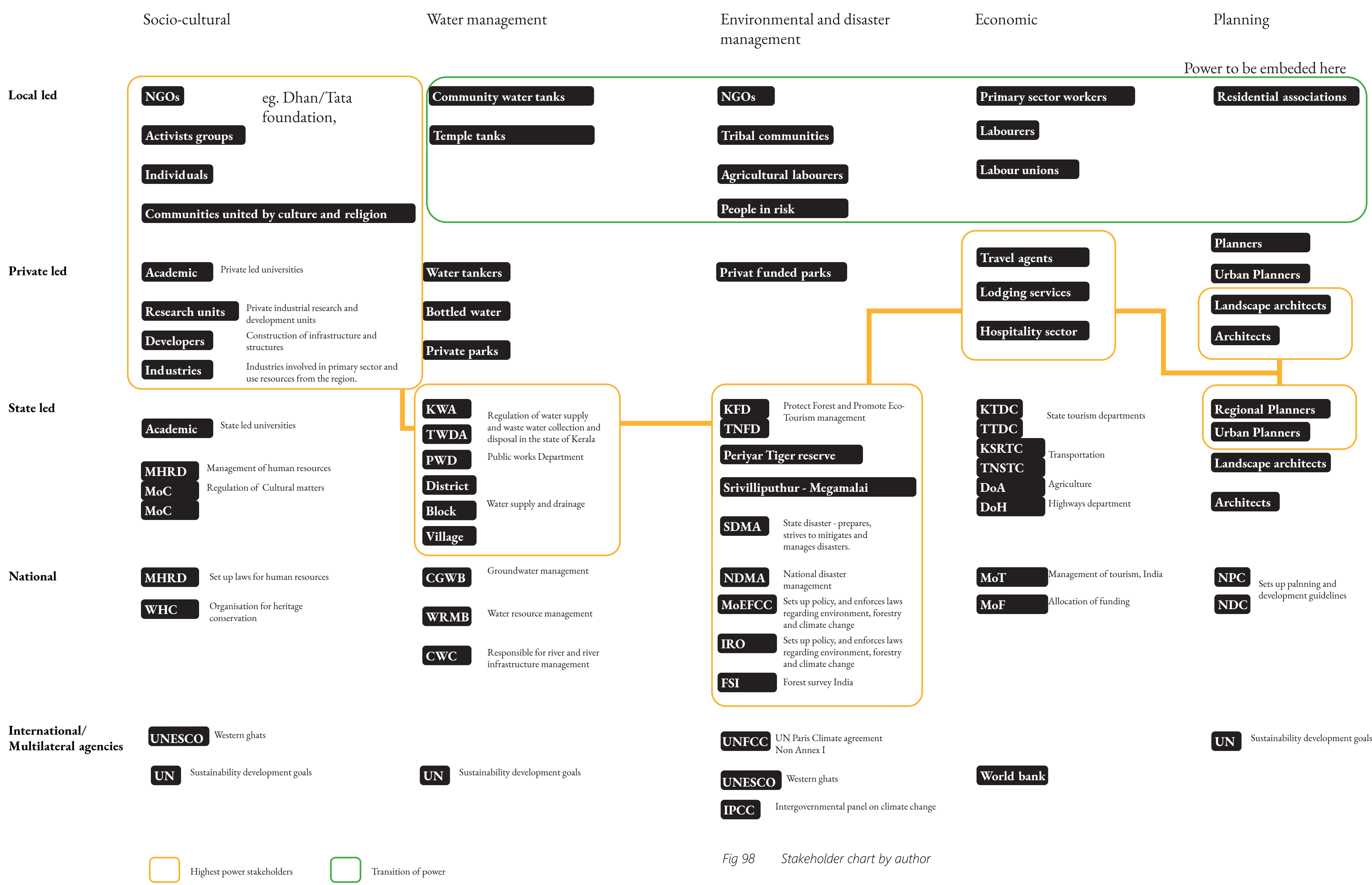


Fig 98 Stakeholder chart by author

Stakeholder roadmap

Current situation

Stage 1 | Stage 2 | Stage 3 | Stage 4

Local led

Local

Stage 1: **Citizens organise** local vulnerable communities with the help of NGOs, along with the state to set up **workshops** for **immediate temporary resilient measures** with the municipality aiding their efforts by providing space and infrastructures.

Gather **indigenous knowledge** for propagating learning local understanding of ecological management and skill building. By **employing skilled locals** from the region.

Network + Interstate: **Organise cross-community interrelations** for careful co-ordination of each others interest.

Stage 2: The local groups choose **experimental pilot projects** to test the interventions along the river, to bring the interest of the larger actors involved.

Local groups start to take **administrative command of the municipal facilities** to engage with locals and coordinate participatory workshops to agree on project time lines and relocation strategies.

Stage 3: In this phase the local committees have a **strong knowledge on the working of the small interventions** and the project impact on resilience of the area. Thus encouraging local farmers, workers to follow **regenerative agriculture or maintain water local tank** as a community in return for **subsidies** from the local government. For example regenerative agriculture doubles up as flood storage which save considerable cost of flood damage for the state, which could be utilised for the reduced productivity.

Stage 4: A possible pathway here could be that the state with NGOs organises the pilot projects to test and also encourage the locals to understand the impact of nature based solutions.

Private led

Stage 1: In the first phase the private entities are informed by the state (through a process of tender) for the need to **build urgent infrastructure** such as mobility networks in areas out of risk.

As the strategies proposed require a **change in the business models of the actors**, the involved businesses formulate to switch to the new proposed model in collaboration with other businesses and the state. Citizens organisations involve private actors to assess the timeline and feasibility of the project.

Stage 2: The tender taken from the government to **build urgent mobility networks is started**, development in the safe regions start which can be used for the relocation of the critical zones soon.

Simultaneously **Landscape work** starts in the 4 sites for the preparation of the site to handle the next monsoon season. For example terracing, water retention units, reforestation and restoring or building system tanks in the region.
In-case of lack of funding from the state or the municipality private organisations can potentially invest in public works forming a **public-private partnership.**

Stage 3: In this stage the private actors **complete the construction of the mobility infrastructure and the landscape works**, which sets the stage for local actors to start the regenerative production program throughout the river basins.
After this stage the private actors just act as service agents appointed by the local-state committees and eventually let go of ownership of the said infrastructure.

State led

Local

Stage 1: Recognise immediate risks and set up committee to overlook redevelopment of the site and network scale. **Float tender** for building urgent infrastructures and urgent operations.
Such as mobility networks, dredging in riverbeds, building water retention units,

Interstate: Additionally set up a larger committee to foster a **non-biased opinion** of matters related to the interlinked river and in the context of water management.

Stage 2: The tenders floated for the urgent infrastructure construction are given to appropriate agencies while the state and **local communities follow the process of construction on a regular basis.**
The state redevelop zoning planning regulations based on the risk zones and resilience at the forefront of planning.
The need for multilateral agencies and local participation in planning processes is taking into account.
Interstate committee appoints professionals from various fields to manage and regulate water in the two river-basins.

Stage 3: The state at this point after mobilising actors for the construction of resilient infrastructure the **state gives managing responsibility to the communities**, yet overlooking certain administration.

A potential adaptive pathway here is that the state could act as a mediator between the community and the private actor providing service.
The state here could try to recoup ownership of private built infrastructure with the gains of such infrastructure.

International/ Multilateral agencies

Stage 1: International commissions help national organisation in **setting up goals** for the future and in certain cases financially aid for sustainable transitions with developed world.

Stage 2: An adaptive pathway here could be international organisations could fund for testing such nature based projects in the region.

5 | 10 | 15 | 20 | 25 | 30 years

Fig 99 Stakeholder roadmap chart by author

Timeline

After testing the pilot project by the local actors, the project is initiated by setting up the local units to receive the water from the release of large scale infrastructures.

These 4 pilot projects establishes in this report are to be coupled with multiple other projects to achieve the envisioned goal.
Starting from the lowest intervention, areas of similar interventions are to be identified and there by form the network at the Network scale.

At the time the local interventions are developing the large scale infrastructures can initiate the process of releasing control towards a point in the future where their dependence becomes obsolete.

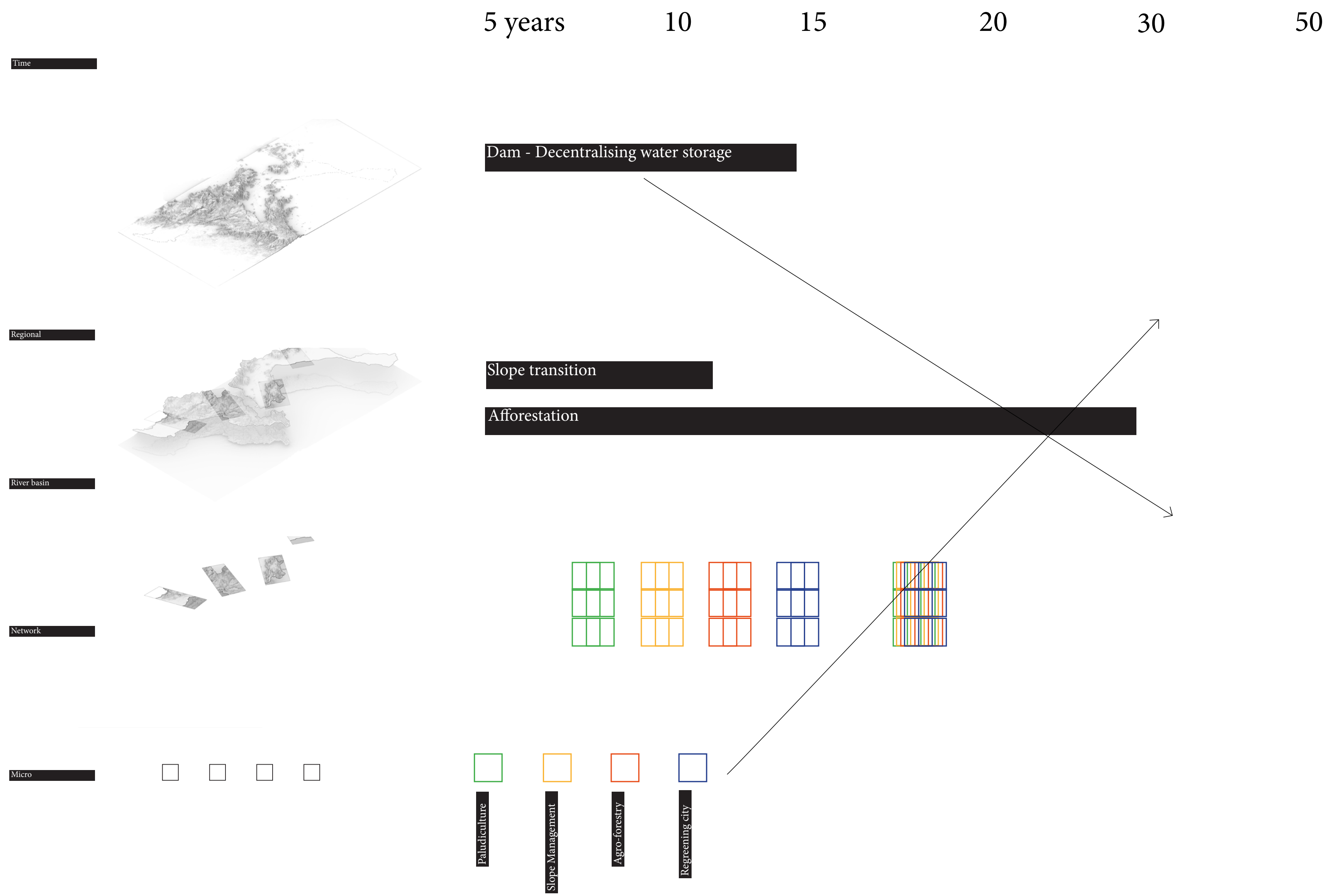
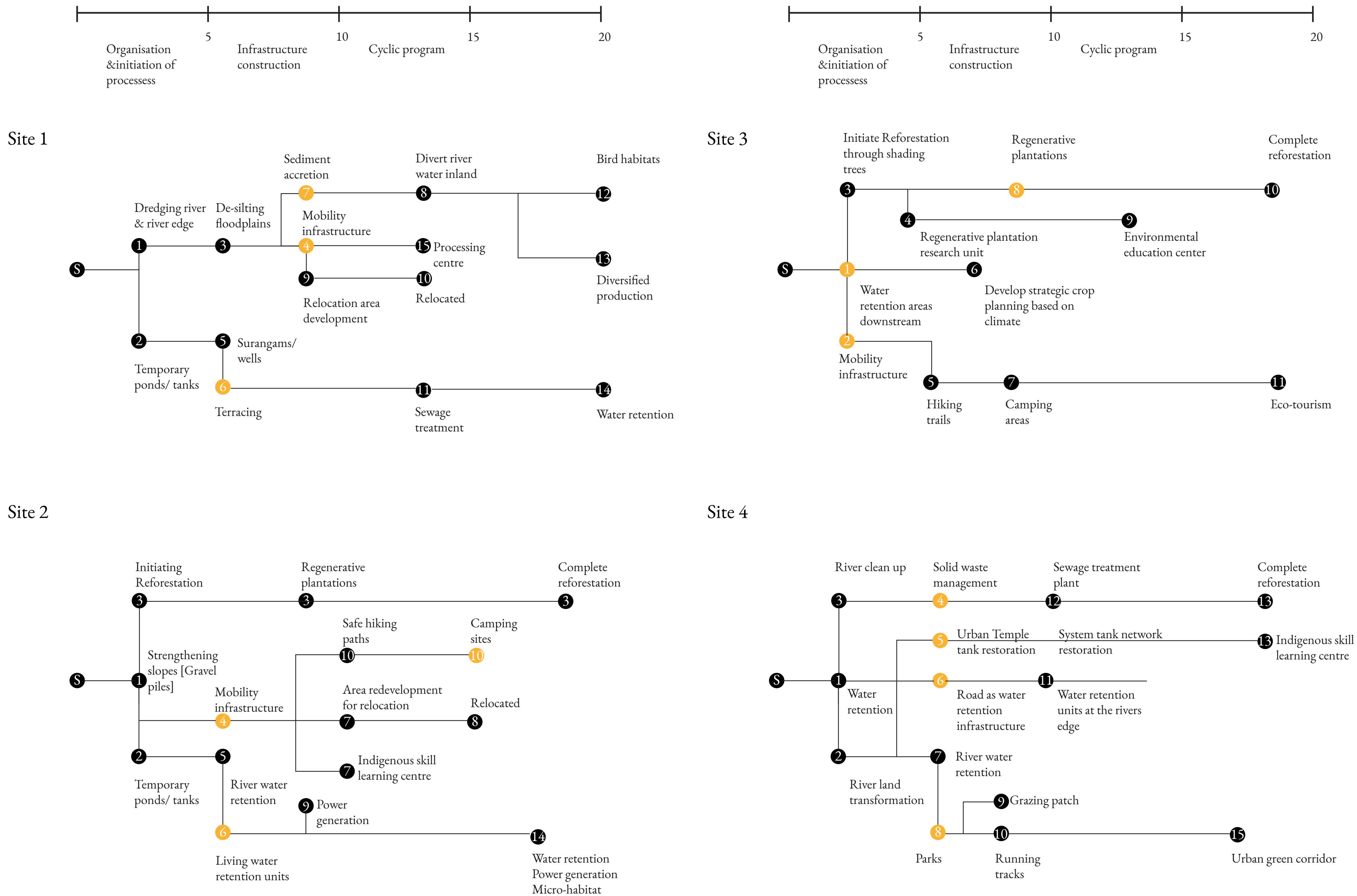


Fig 100 Phasing by author

Structural Time-line



S Social activation

S Milestones

Fig 101 Structural timeline by author

5 years

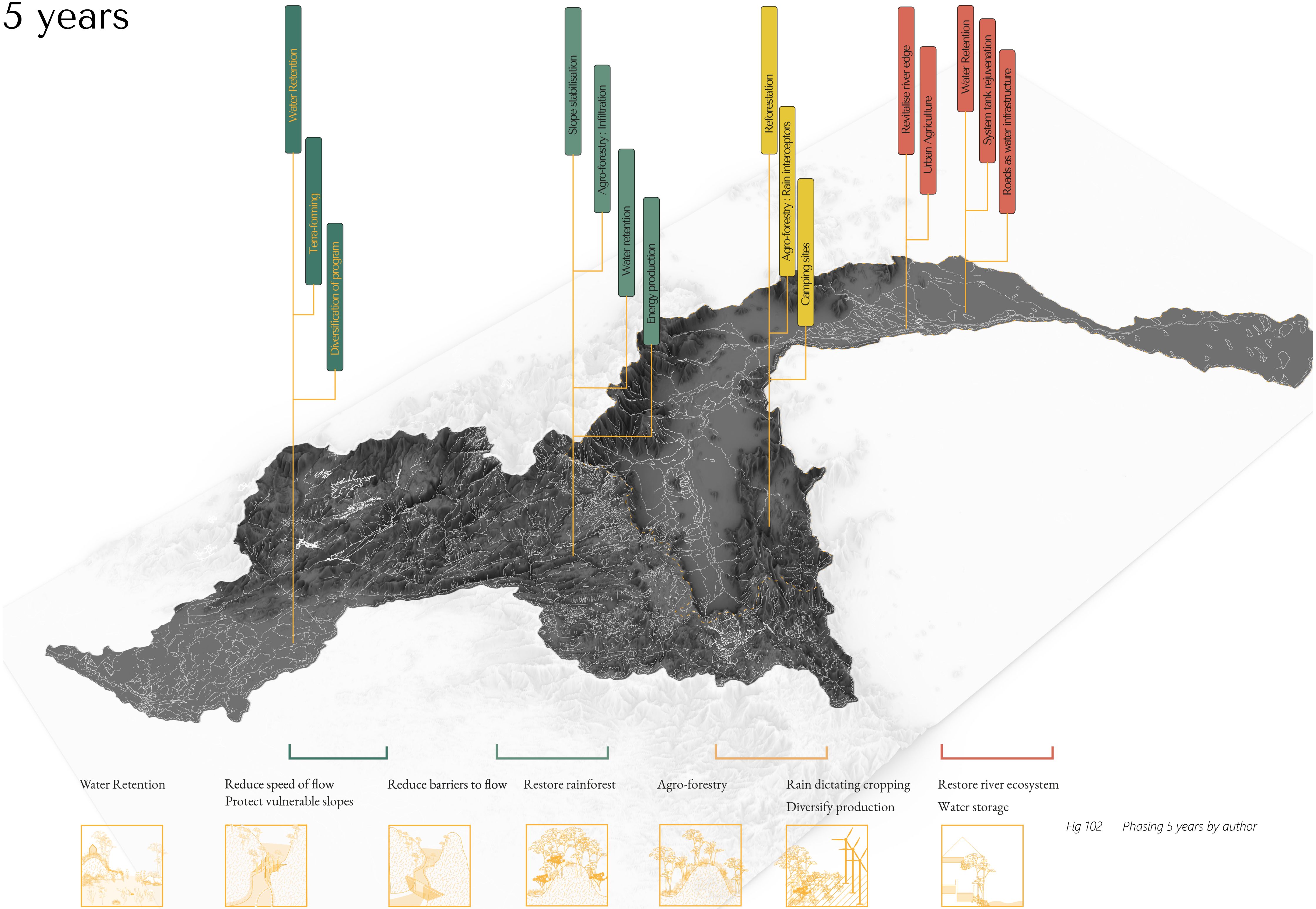
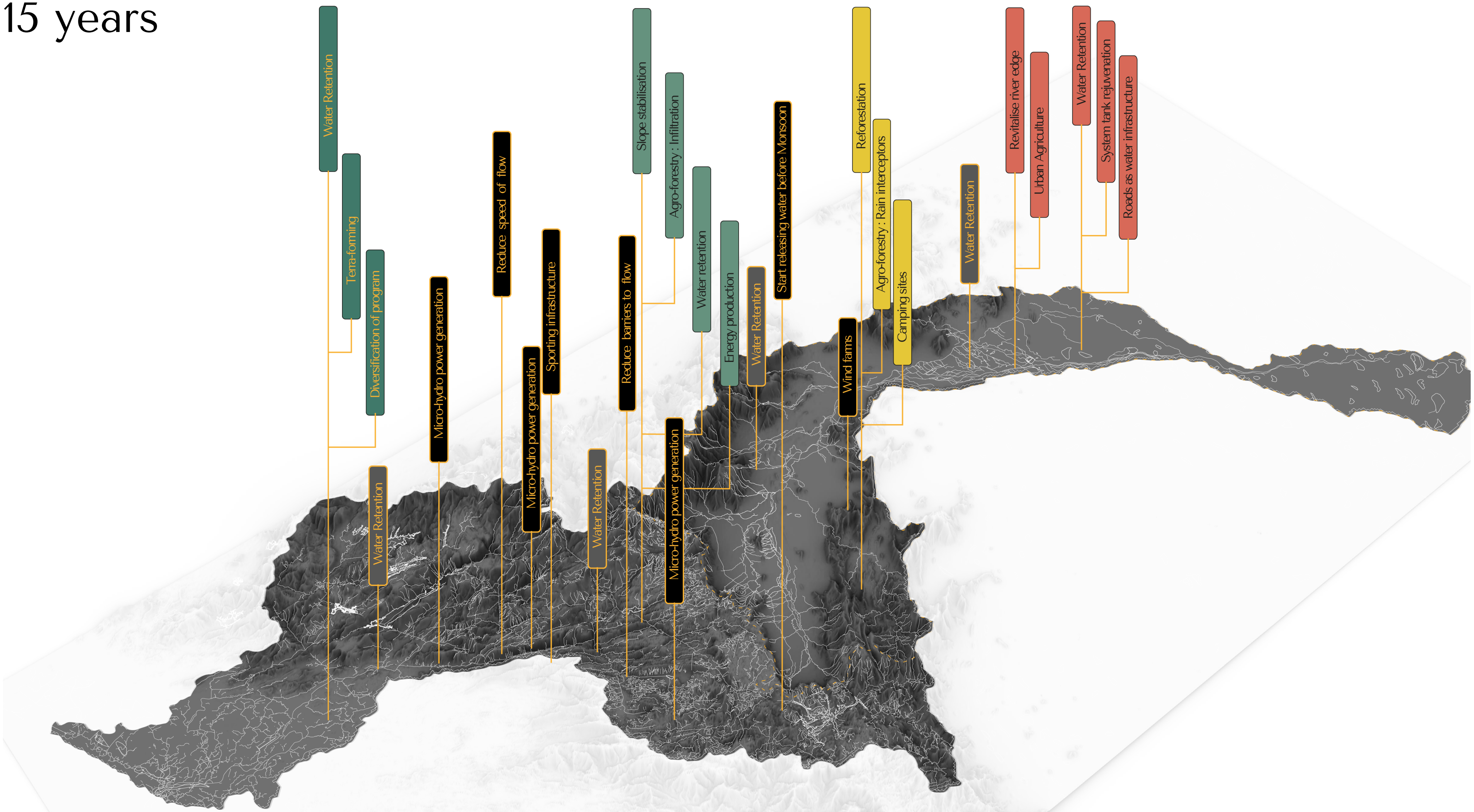


Fig 102 Phasing 5 years by author

15 years



Water Retention

Reduce speed of flow
Protect vulnerable slopes

Reduce barriers to flow

Restore rainforest

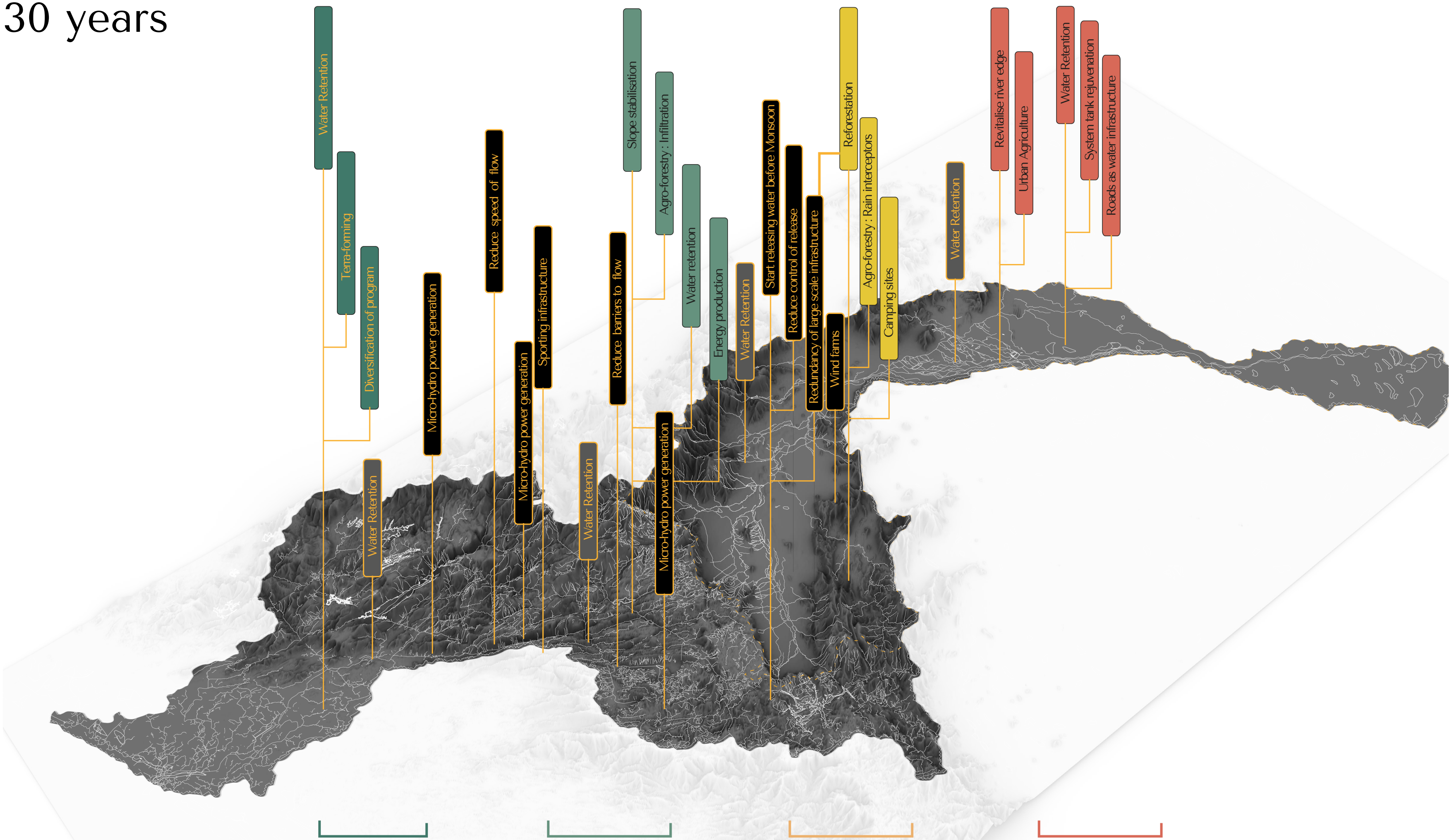
Agro-forestry

Rain dictating cropping
Diversify production

Restore river ecosystem
Water storage

Fig 103 Phasing 15 years by author

30 years



Water Retention

Reduce speed of flow
Protect vulnerable slopes

Reduce barriers to flow

Restore rainforest

Agro-forestry

Rain dictating cropping
Diversify production

Restore river ecosystem
Water storage

Fig 104 Phasing 30 years by author

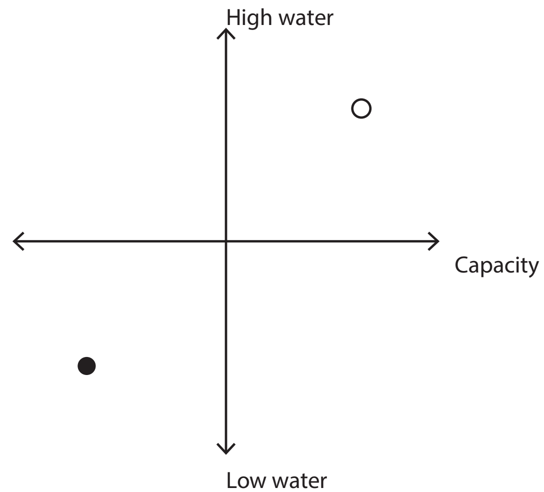
Programmatic Phase

Along with construction of essential infrastructure at the 4 site, programmatic change is needed, meaning change in the way we take part in anthropogenic activities such as agriculture, housing, tourism etc.

For the critical sections to exist between the extremes (high or low precipitation), the program with respect to the scenario and time are highly important. Thus the project considers scenarios between High and low additionally a average rainfall year.

For each year after the monsoon season from June to August in Periyar and from September to December in Vaigai the available water is determined and the plan for production is laid. Thus the cycles of production, regeneration and resilience are set, this in fact correlates with the traditional festivals found in the respective states. The harvest season is in August after the monsoon for Periyar river basin while it is in April for Vaigai.

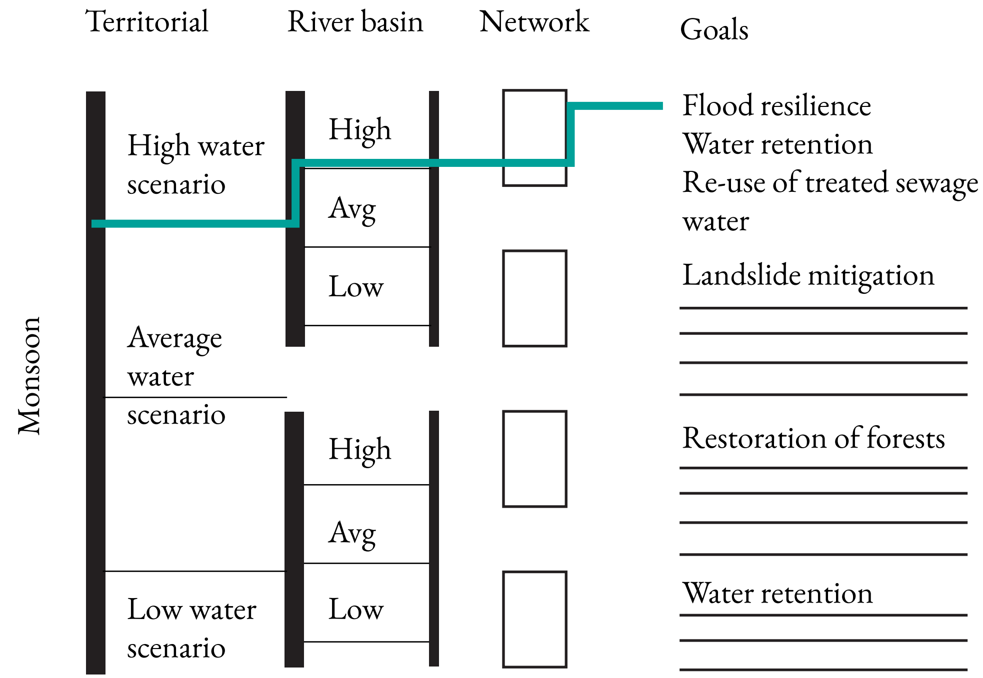
The adaptive pathways are determined for every year with consideration of past few years to determine the state of the system.
The monsoon here acts as an activator to start the process, the cumulative rainfall in both the river basins determine the state of the system, in case of high rainfall in Periyar and low in Vaigai the system exists in an average state. Since the two river systems are linked to each other, until Vaigai river is restored to its original state of rainfall the systems will still be interlinked to ensure water security for the people downstream.



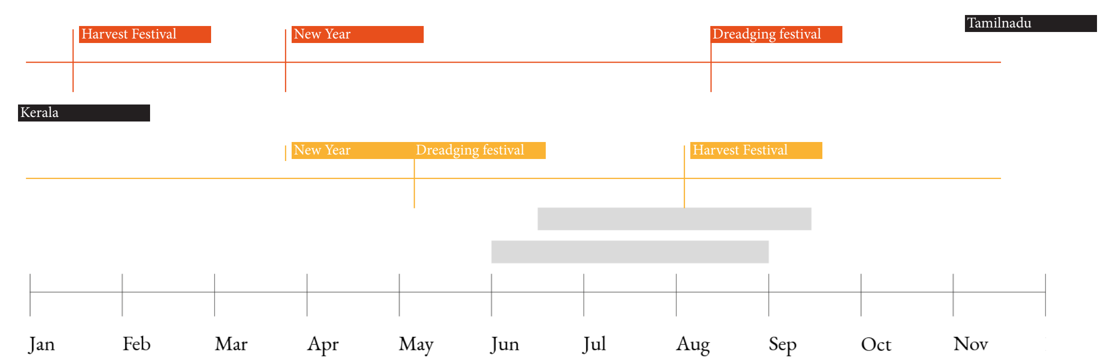
The state of the system determines the composition of resilient, productive and skill building program for each of these 4 smallest sections which build up to the network scale and then the river basin as well.

Each of these smaller sites are interrelated to the other in its own river basin as well as the whole system. For example the Resilience of Madurai (site 4) depends up the production in Megamalai(site 2). The inter-dependencies are not just in the same category but are across resilience and production.

Fig 105 Festivals timeline by author
Fig 106 Adaptive pathways diagram by author



Festivals timeline



Adaptive pathways

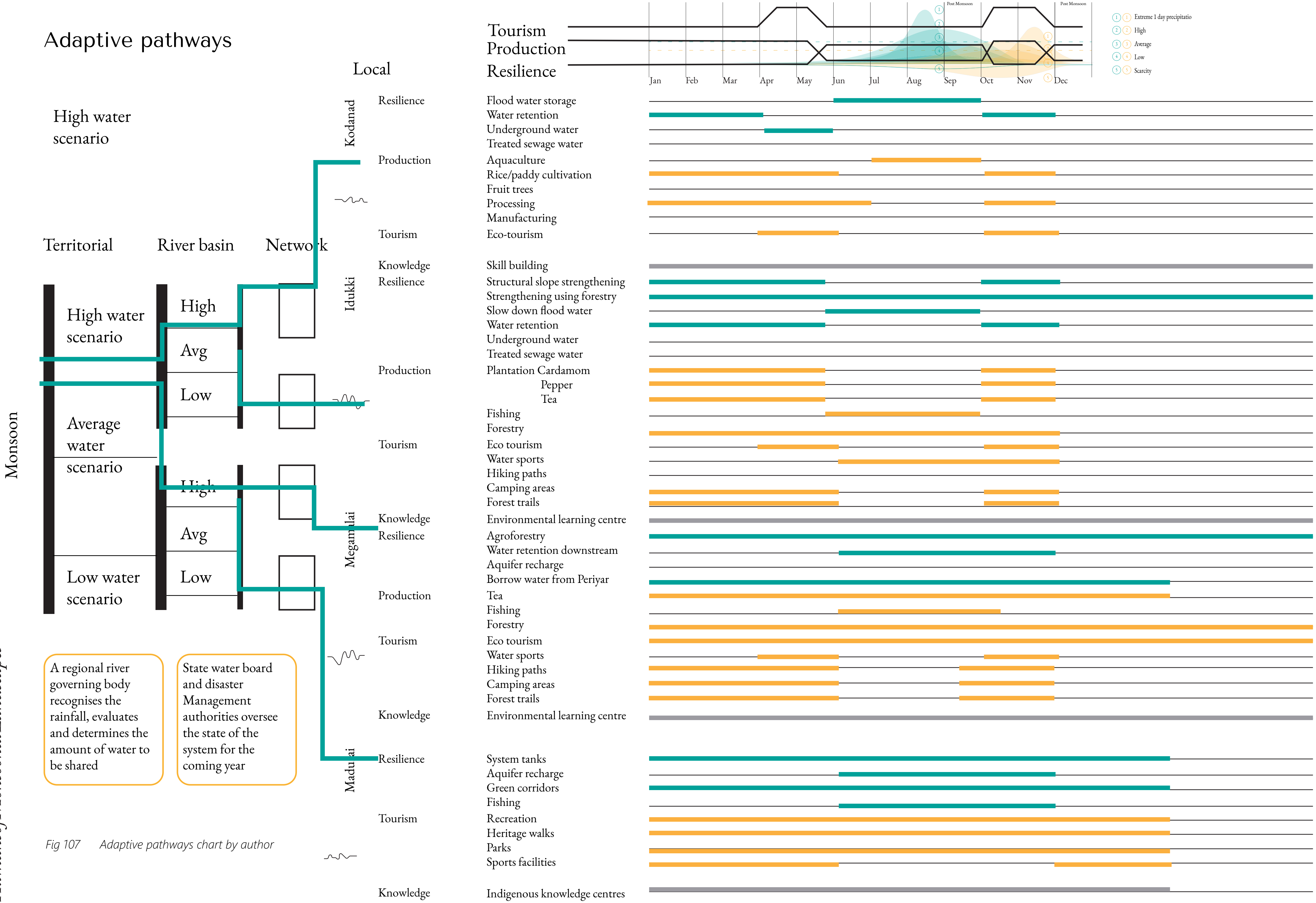


Fig 107 Adaptive pathways chart by author

Fig 108 Photographs by author
Fig 109 Adaptive pathways chart by author Periyar

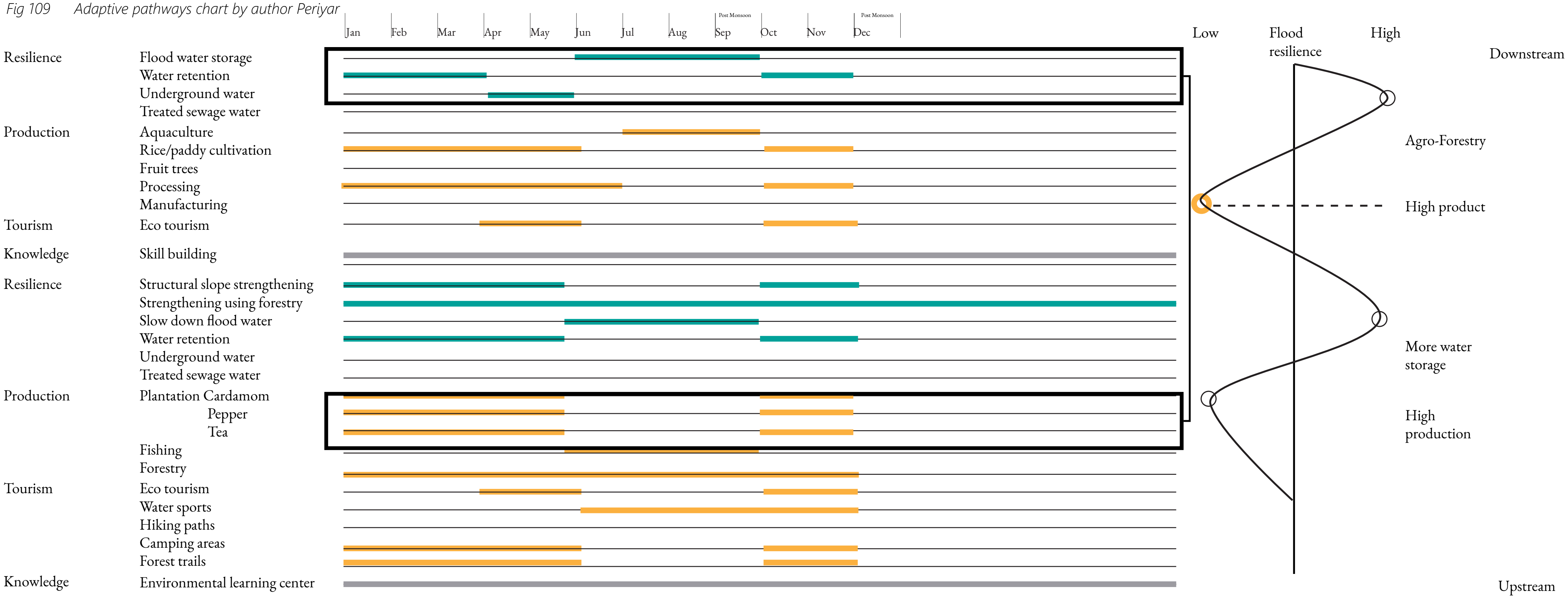
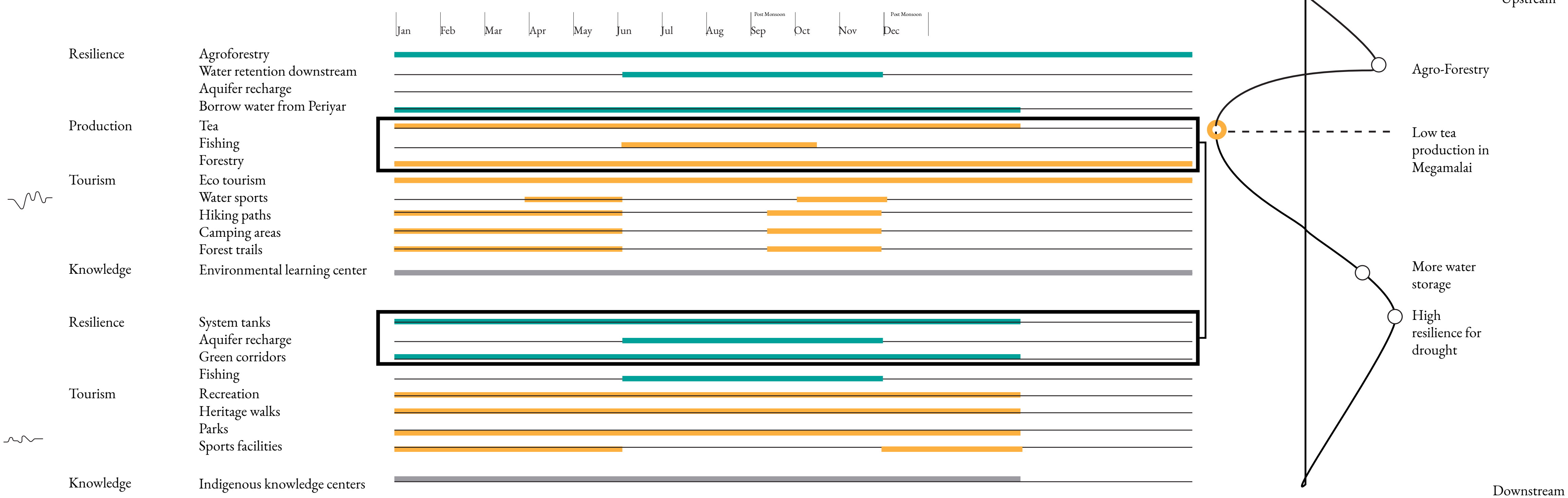


Fig 110 *Photographs by author*
Fig 111 *Adaptive pathways chart by author Vaigai*

The resilience of the city of Madurai against drought depends on the forests and change in plantation crops in Theni district



Evolutionary adaptaion

By implementing the design proposals at the smallest scale and building it up to the river basin the design envisions a territorial adaptation but although function of the smallest level of intervention and the network might be the same, they exhibit different characteristics. For example, at the smallest level it might be just water retention pond, but when multiplied over the network the system exhibits the character of floodplain and at the scale of the river basin the system is restored its resilience capacity, this also gives rise to multiple ecosystem services at each state.

These ecosystem services evolving through ecological succession at each stage of the process helps in restoring the systems stability and achieve evolutionary resilience. Beyond a certain point in time anthropogenic systems acts in sync with the climatic systems.

A key for this vision coming to play is the way we care for services the ecosystem provides. Here the concern is if we start monetising ecosystem services, where do we stop?
How can care for ecological systems from the local to the territorial scale be valued? The answer to this question is beyond the scope of the project, but I believe caring for the ecosystem and its services outweighs the short lived profit gained out of profit oriented development.

Could ecosystem services be monetised? Could environmental stewards be compensated with so called capital? Could the ecosystems western ghats mountain range be compensated for ensuring water safety? Could an upstream region which restores and safe keeps its ecosystem for the benefit of downstream consumers gain profit for the resources they provide? Could restoring and maintaining the systemic function of each local level in agreement for the larger good be an solution?

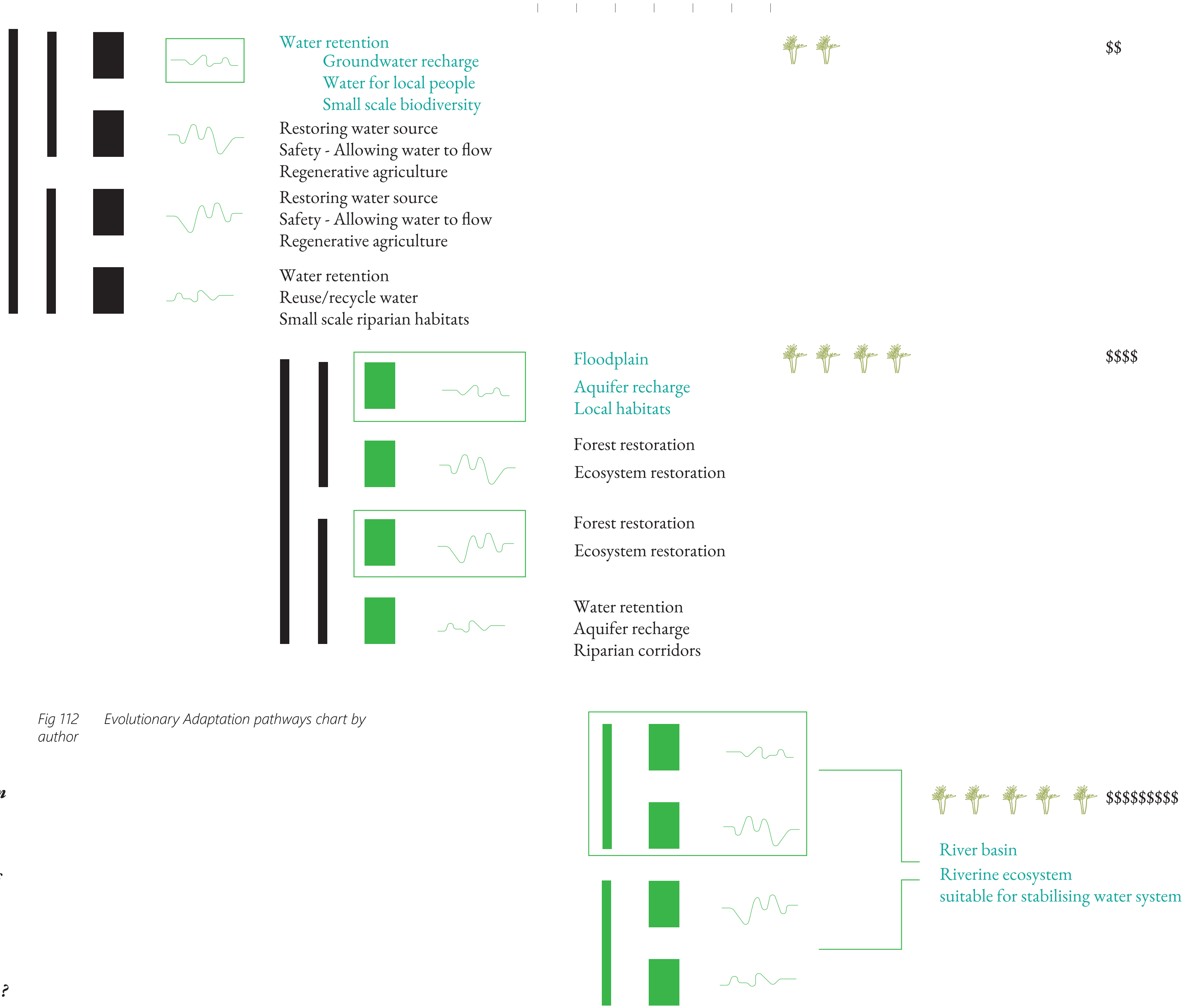


Fig 112 Evolutionary Adaptation pathways chart by author

Chapter 07

Evaluation

Evaluation

An initial critique of the way the two river basins was that they have been still managed as it was during the colonial times using redundant infrastructures and subsequent highly productive primary production zones lacking flexibility to adapt to changing climate. Thus crumbling to cope with extreme weather events as seen in the past two decades. A way to evaluate the feasibility of the project would be to see if we have restored the buffering capacity of the system to absorb change and exist in the domain of stability while evolving into new system states.
As the project focuses on the monsoon as a activator, the system can exist in states corresponding to the amount of precipitation received yearly in relation to previous years for example high water or low water scenarios. Here lets consider business as usual and for the proposed design.

Without any changes in the composition, structure and control of the hydrological systems, the changing climate pressures pushes the system to its limits causing frequent drought and flood. The system is unable to regenerate or reorganise itself to attain a state of equilibrium within the domain of stability and hence with every extreme climate event it is pushed further and eventually collapse.
While the anthropogenic systems fail cope with fluctuating climate and collapse, ecosystems reorganise and emerge into new forms to gain stability for example in case of lack of water, the vegetation in the area changes and eventually after ecological succession forms a new kind of ecosystems like a desert emerge. While ecosystems adapt, anthropogenic system loose water security and food security leading to famine. Thus there requires a shift in the way we inhabit territories and extract from them.

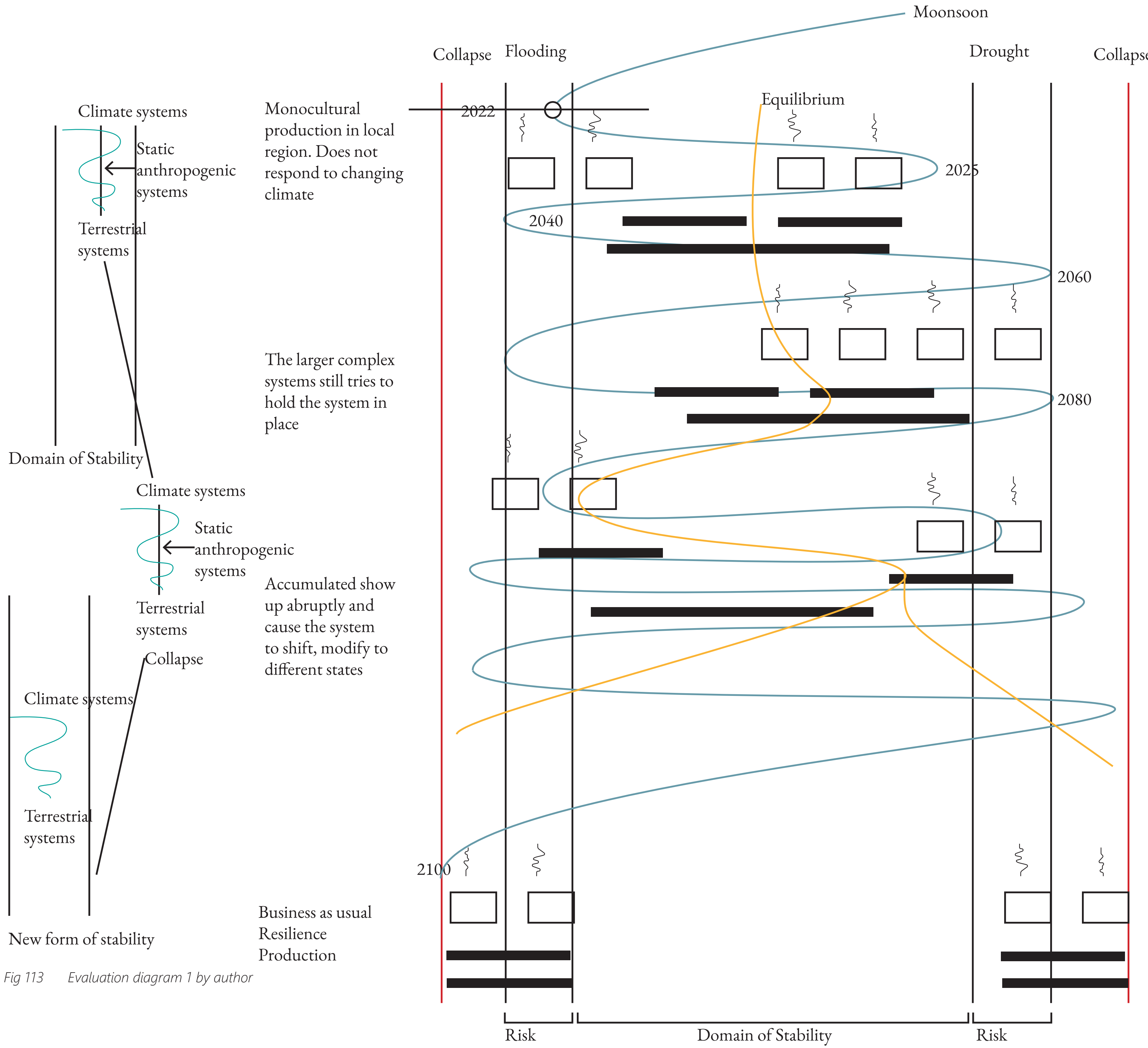


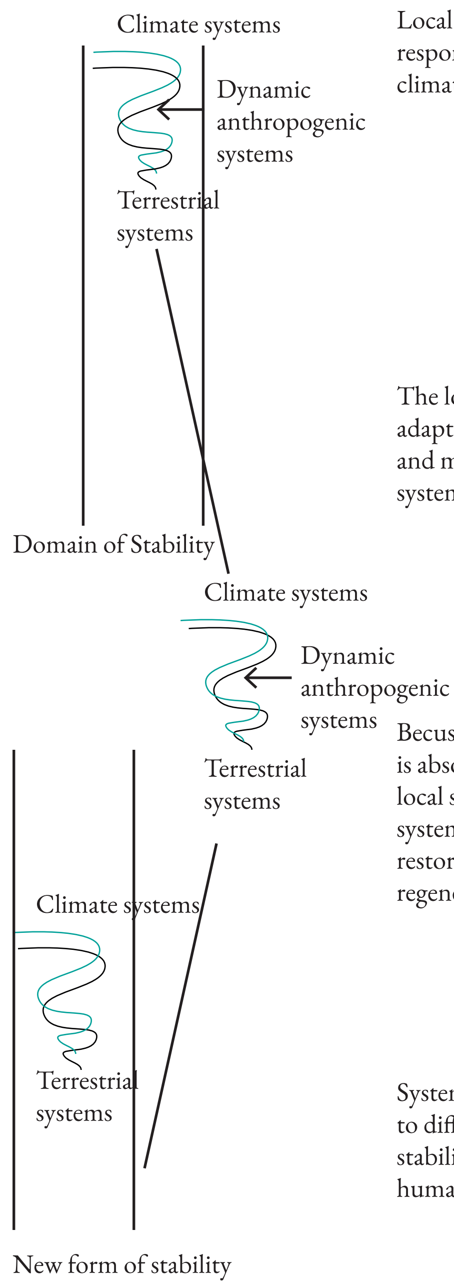
Fig 113 Evaluation diagram 1 by author

Evaluation

The design intervenes in the composition, structure and control of the terrestrial systems at the local scale, the adaptation is in sync with the climate systems. The resilience and production at the local scales respond to extreme weather events positively switching from high water scenario and low water scenario eventually moving along with changing weather events.

As the system is able to absorb the frequent pressures in the local scale, the larger systems recoup their regenerative state and are maintained in the domain of stability at different states of equilibrium based on the climate. Thus reinstating the balance between the climate system and the terrestrial systems. Further the socio-ecological and climate systems can evolve through ecological succession new forms of dynamic equilibrium states.

The limitations on the other hand for the proposal might be the implementation of all the different proposals, collaboration of stakeholders.



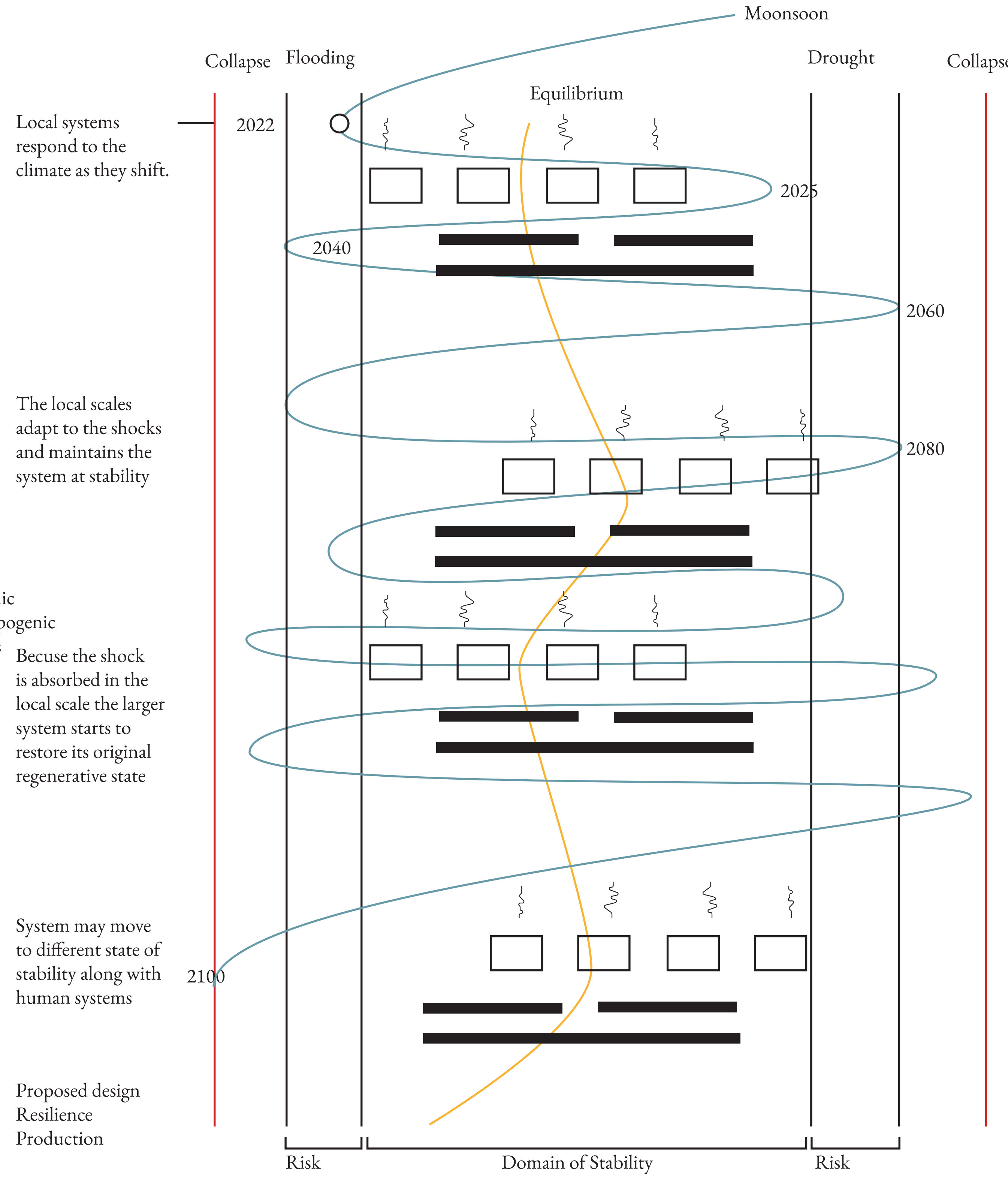


Fig 114 Evaluation diagram 2 by author

Chapter 08

Reflection

Reflection

Process and Alignment

Coming from the city of Chennai in south India, I have experienced flooding and frequently, while I tried to understand in my bachelors in architecture, I wanted to explore it more in a critical region.

I chose transitional territories as I was deeply fascinated by riverine territories and their complex system dynamics. The studio encompassed critical questions about the age of man: accumulating resources, people, pollution and on a quest to finding new realities always keeping in mind the power of ecological systems to realign the current paradigm of development.
The Anthropogenic climate change has exponentially increased the possibility of extreme weather events such as droughts and floods closely related to extremes of water availability. Designing for either will result in a system which is not inherently resilient to any other conditions. Hence, I intended to explore the limits of resilience through designing a system which would respond to uncertainty. Designing for indeterminacy meant a system which respond to a specific amount of resource at a specific time in a specific spatial context influenced by worldly phenomenon such as the monsoon.

Hence the Thesis aims at understanding the systems that are at play in the transect between 2 interdependent river systems, which are at a constant state of conflict due to their shared water and water infrastructure. I always wondered how my summer trips to the mountains of western ghats have changed over the years. The landscapes transforming into more urban environments and suffering from extreme weather event in the recent past.

Studying the entire region gave me insights into how these so called urban, peri-urban, rural, tribal landscapes are inter-related and dynamic which are controlled by static outdated infrastructure, incapable of adapting to change.

Thus the thesis focuses on designing the existing system into an adaptable, flexible and responsive system as a whole instead of a site that needs changing. Using landscapes, programs, settlement patterns that respond to the varying climate the project aims to shift the notion of endless accumulation into a systemic design informed by resource. Thereby constantly aware of our extraction, limits and also diversifying our production to be in sync with the ecological cycle.

How is this an urban project? : I believe the urbanism can no longer be limited to cities and should include the varying territories that are a part of the

Fig 115 Photograph by author

ecological systems. The externalities of urbanisation transcends beyond the boundaries of the city into the hinterlands. The Anthropogenic systems creating our world just for humans is no longer viable or we can no longer ignore the externalities of the perspective that humans are sole proprietors of the world.

There is a need for shifting human habitats more like ecosystems working with atmosphere, surface and sub-surface to sustain life in the possible future.

Methodology

Research approach

At the start of the year, the intensives to explore possible projects and sites gave the freedom to explore and experiment the concepts that aligned to my personal ideologies. This set of exercises was useful in positioning my Thesis scope. The research started off through the frameworks of the studio, understanding different states of accumulation through matter, topos, habitat and geopolitics gave a holistic overview of the regions current state of being. The collective nature of this exercise opened up wider perspectives on what accumulation meant around the world, showing similarities of these anthropogenic systems in for example Mexico, Brazil, Spain and India. Such an understanding expanded my project from a site specific approach to design to a systemic approach. It also helped me identify the unique characteristics of the site such as indigenous knowledge and cultural relevance of landscape management in the Indian context. The introduction to cartography and the synthesis of analysis gave me an opportunity to experiment with climate data and different methods of representation. I had the opportunity to go for field visits, although restricted due to Corona, gave me wider perspective on the communities in critical zones. I visited 2 tribal villages near Periyar tiger reserve to understand their Indigenous ways of living with nature. Traversing the region from Madurai up the mountains enable me to view the transitioning landscapes of the Vagai and Periyar rivers, along with the cultural significance that people have for the river seen in temples and tanks marking the source of water tank systems at every stage.

Design approach

The studio adopted a Research by design methodology which uses design as a tool to explore concepts constantly moving between research and design. In this project I started with understanding the concept in research and site visits, followed by understanding the states of the systems through theory. To transition to a new dynamic, adaptable and flexible system I turned to theory for conceptualising the future. Lastly the design principles, strategies derived out of the theories gave rise to multi scale design interventions. The concept behind the design took a couple of iterations but going back to research helped me readjust my vision from a singular system state to multiple adaptive systemic thinking. Hence, I believe this methodology proved fruitful.

Fig 116 Photograph by author

Significance and Innovation

Scientific relevance

The impact of climate change in developing nations like India is becoming too common and in this territory in particular, monsoon season is now being feared as the season of destruction rather than a source of revival of the landscapes. The flooding of 2018 in Kerala mostly attributed to improper management of large-scale infrastructures, Chennai declaring “day zero” on June 19 2019 as all its reservoirs ran dry are outcomes of extreme anthropogenic manipulation of the natural system for human needs. Hence I believe the criticality of this region requires urgent adaptation, designing for such an uncertain context called for exploration into theories such as adaptive cycles (Gunderson & Holling, 2002), concepts of indeterminacy tested by architects such as OMA and Geuze. The transition towards a resilient future could encompass not just risk resilience, but use it as leverage to formulate a robust and adaptable system that evolves over time. Thus the project test these concepts through bottom-up grounded design interventions taking into consideration the indigenous practices that have existed in the region for centuries and conceive a transition which takes the best of the two.

Ethical considerations and transferability

The project challenges the current paradigm of exploitation and extraction of resources through large scale single purpose infrastructures. Instead, propose to align primary production, human habitation towards ecological cycles, meaning reduced profitability. But by adopting such a framework the ecosystem health is regenerated through the cycles and is capable of functioning in the state of dynamic equilibrium. Hence, the project seeks to reinstate that humans are not sole proprietors of the planet and including the ethics of the planet is the way to move forward.
The concepts from the design framework could be taken and used to adapt a different region, given their respective local context are incorporated in the research and design process.

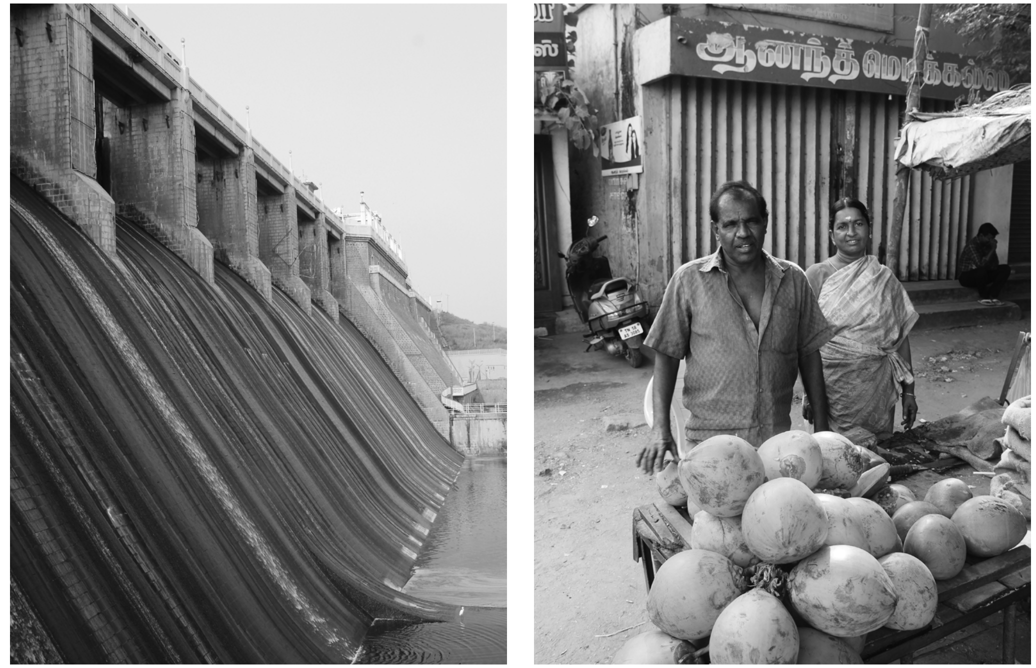
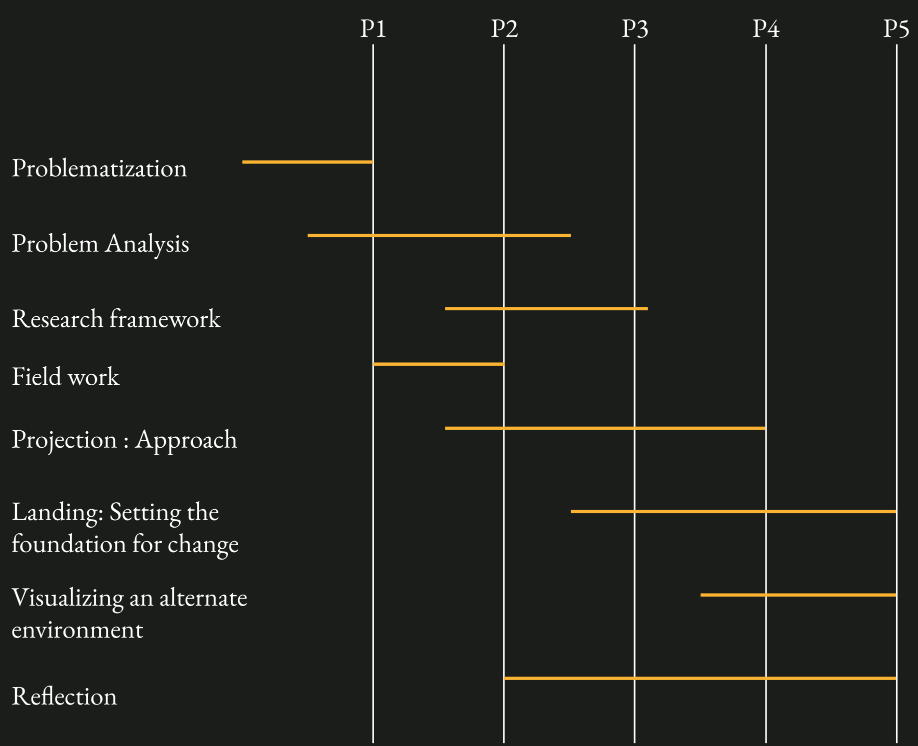


Fig 117 Photographs by author

Limitation and Critique

The context of India entails with it complexities such as availability of data for regions beyond urban areas. Considerable amount of time was spent in gathering, converting and synthesising data. The sophistication of a similar project set in developed nations with larger availability of resources could have much more spatial modelling, socio-economic simulations of newer transition. While discussing a lot on how these large-scale infrastructures are going to be transitioned, little is discussed about their future potential, which could be an accelerant for the transition or an new architectural project. The design envisions a territorial transition, but the systems of politics and difficulty in implementing adaptive planning in the Indian context proves to be a challenge.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