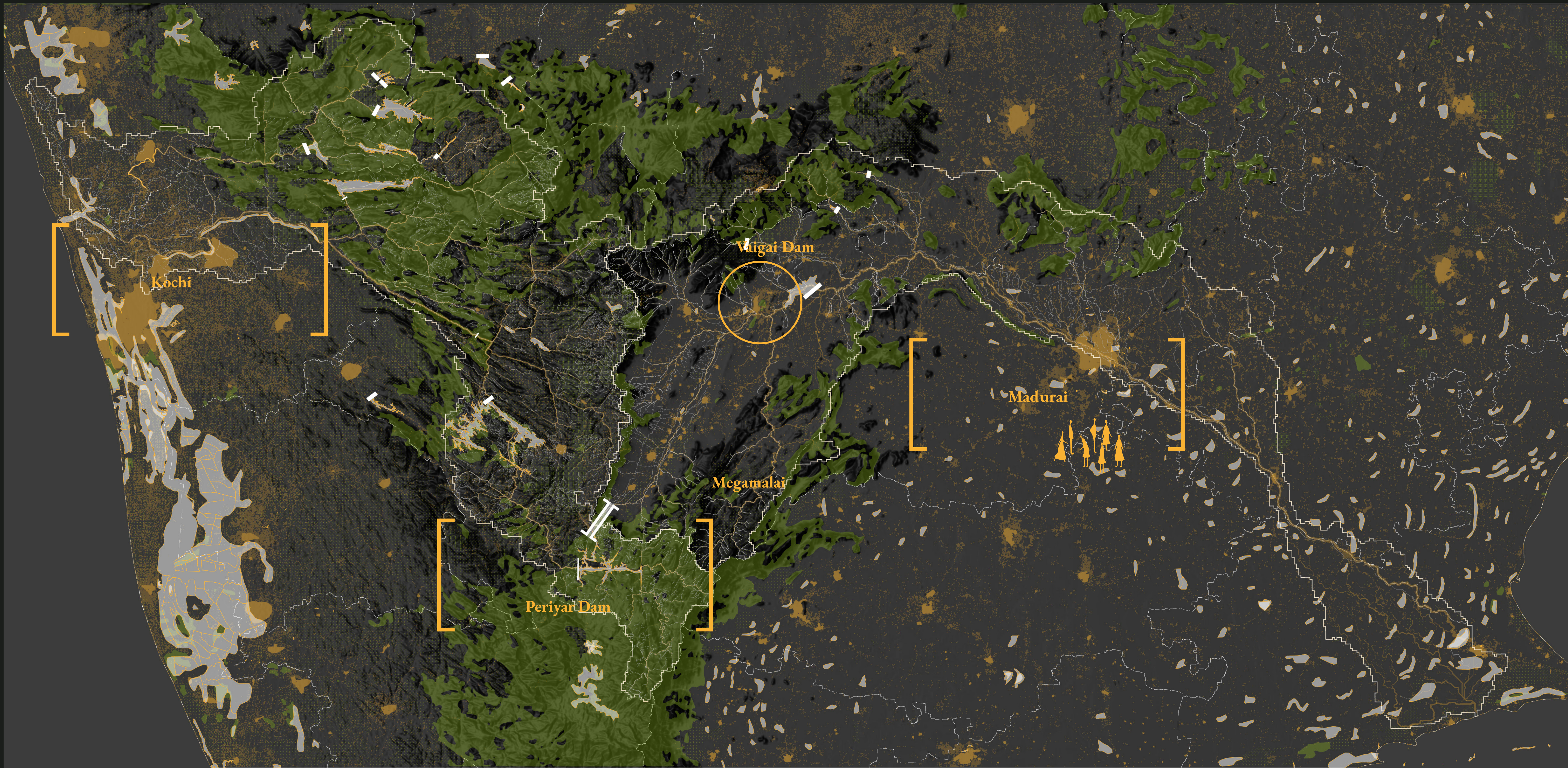
Monsoonal Landscapes

Territorial Adaptation through
Co-habitation in Critical Geographies

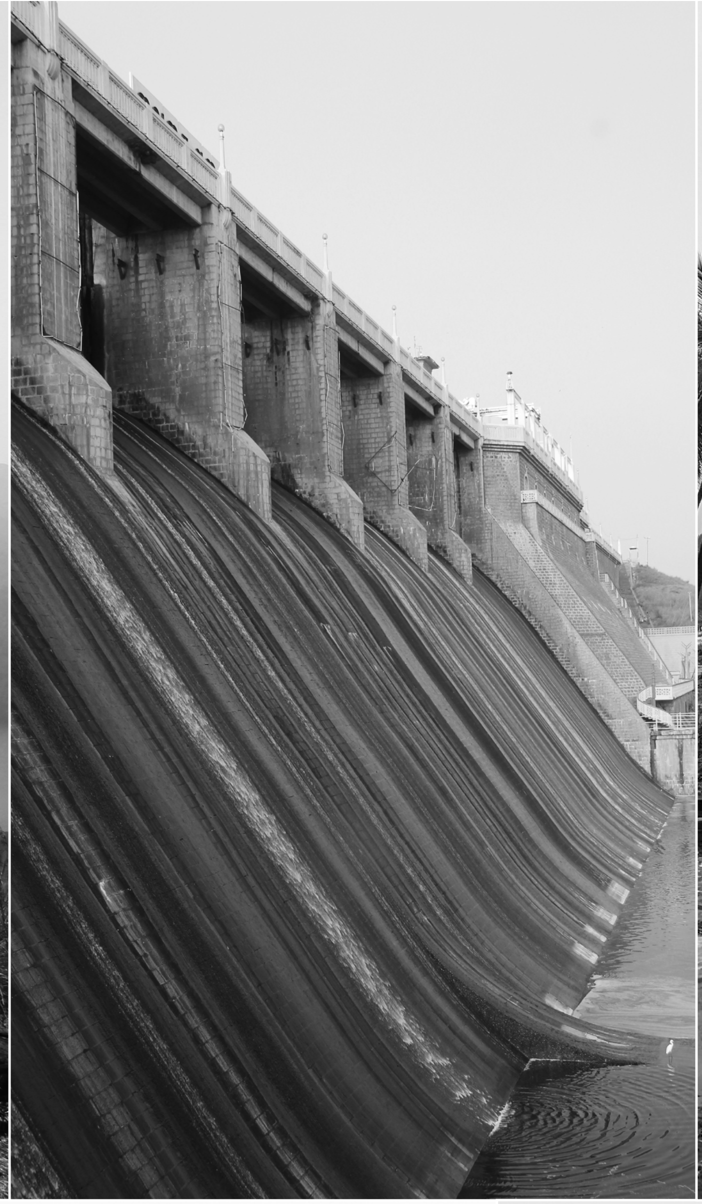

!dea


KOMATSU

Preposition

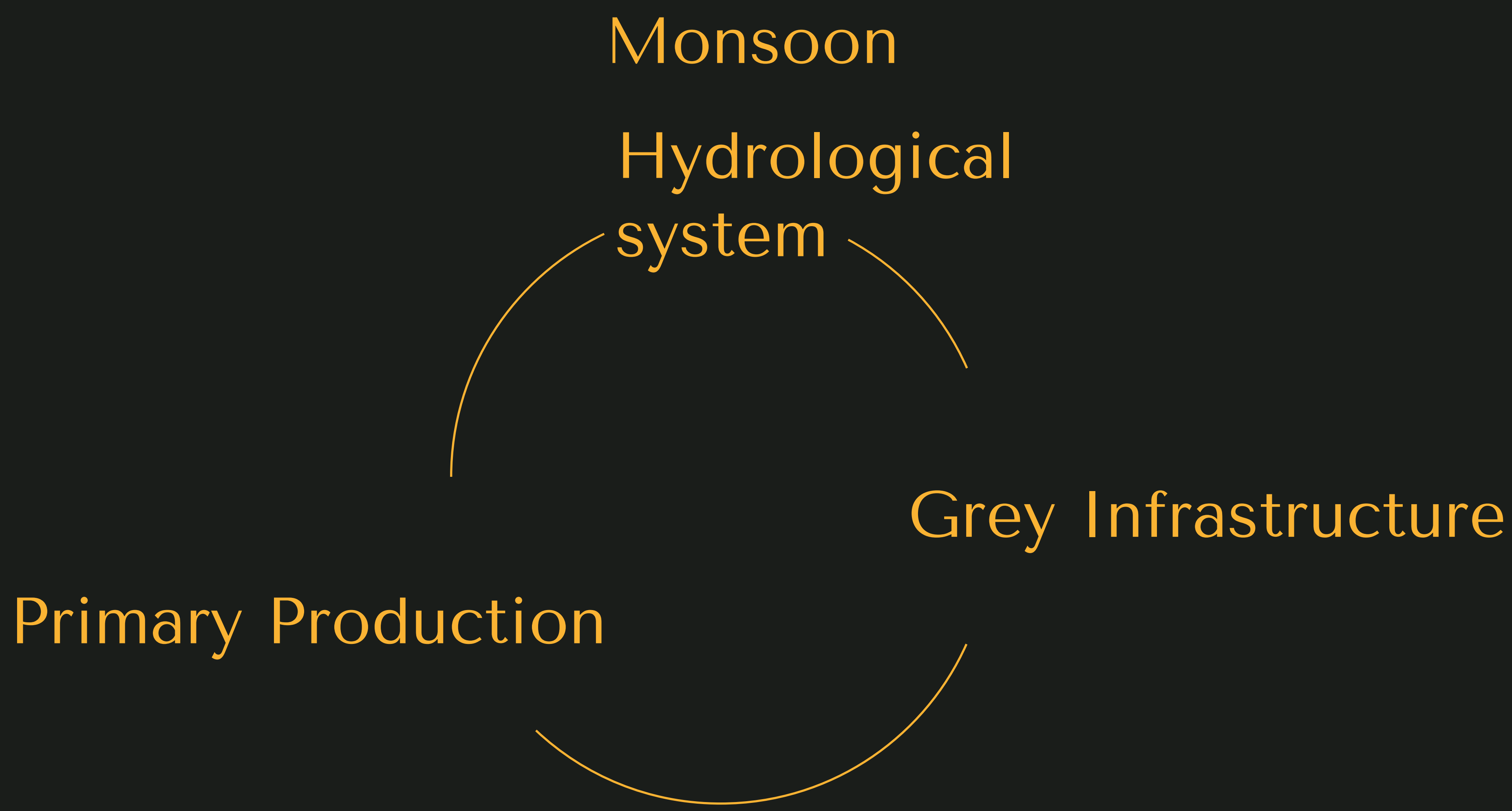


District: Idukki	Mountain: Periyar/Megamalai	City: Madurai
Flooding/ Landslides	Flooding & Landslides + Dams(externalities)	Drought
Population growth	16,842,150 people	Population growth
Urbanisation Agriculture	Deforestation/Habitat loss Agriculture Soil erosion	Urbanisation Agriculture

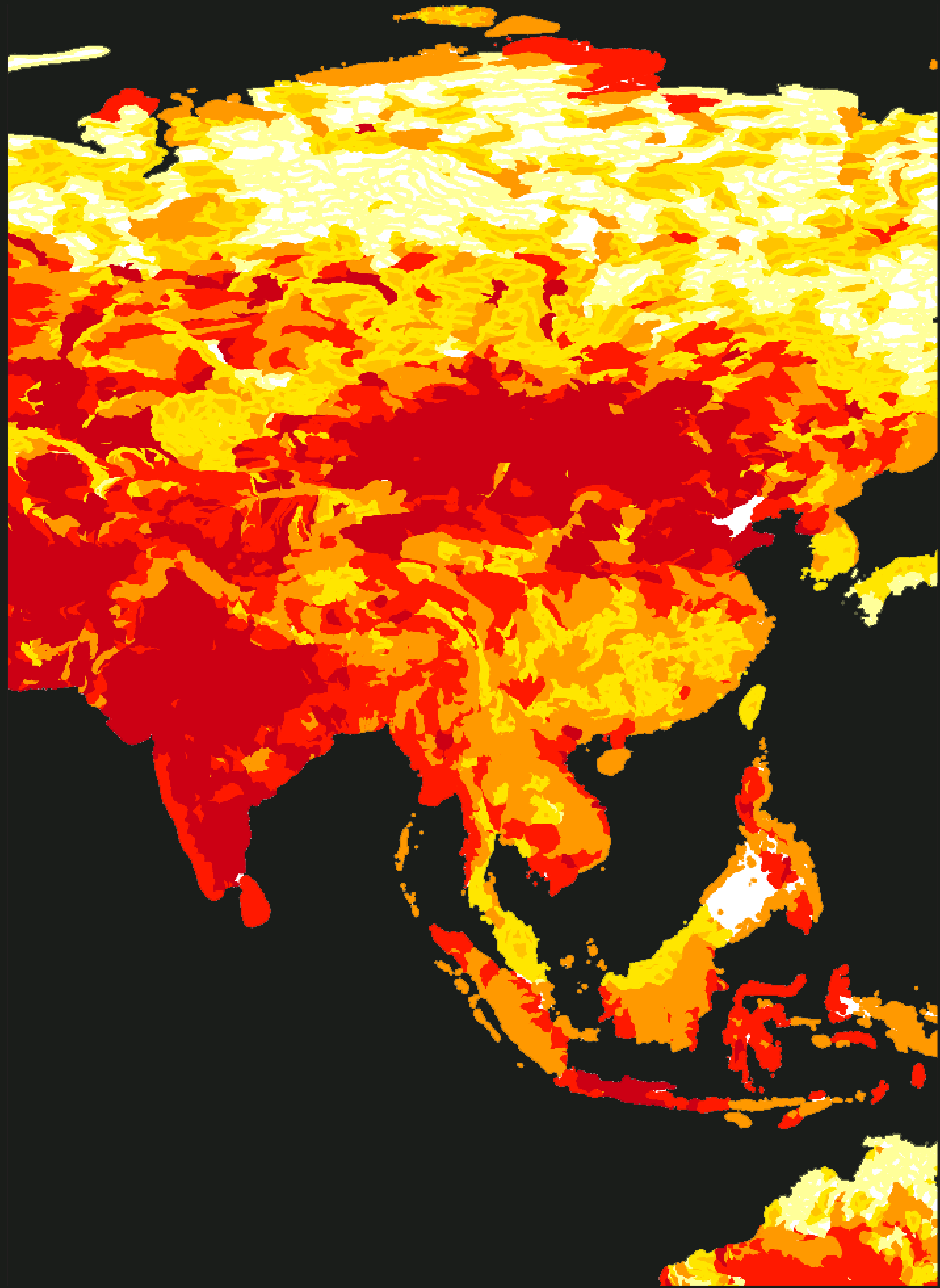





Risk: 3 Key systems



Water stress

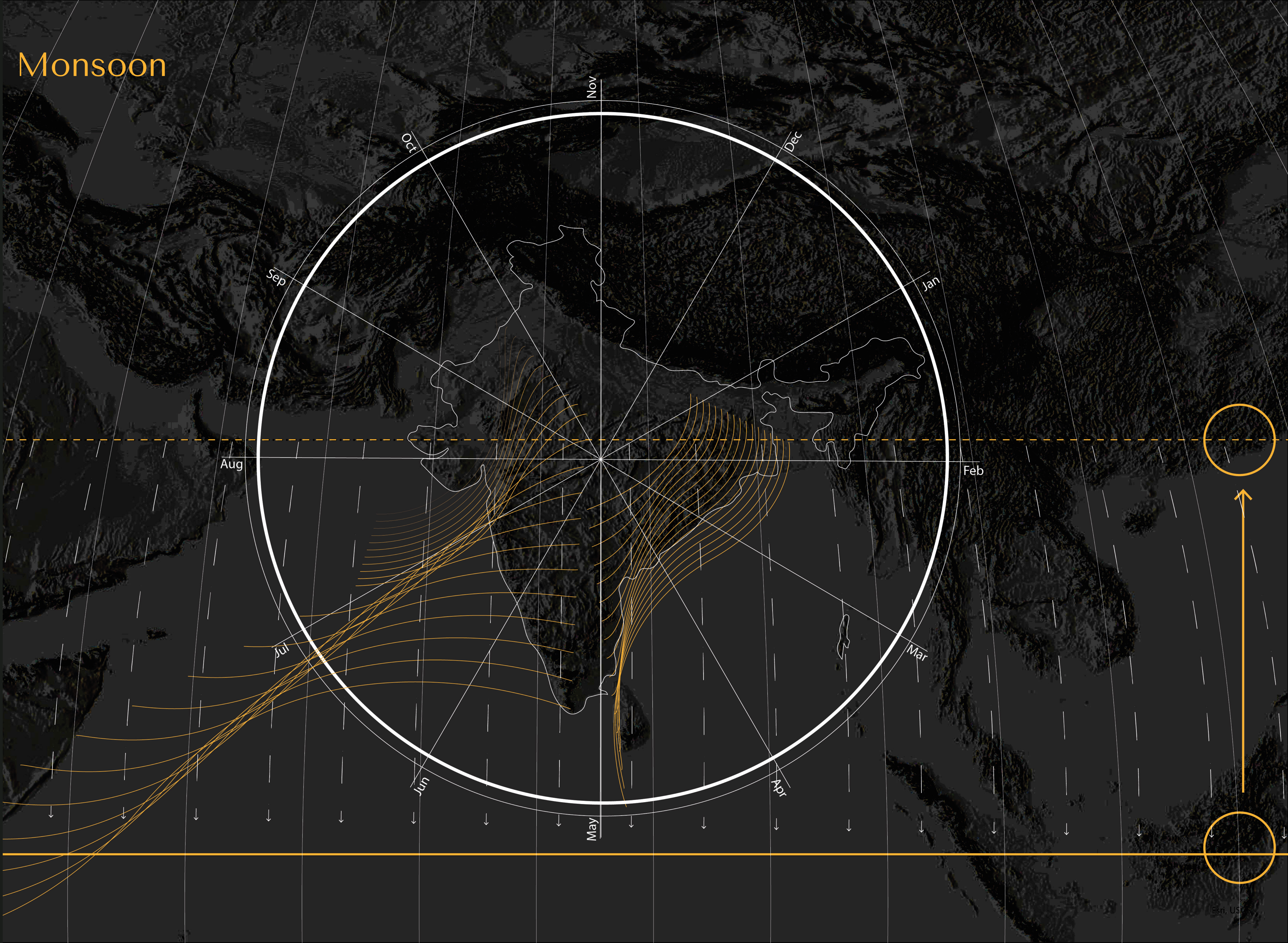


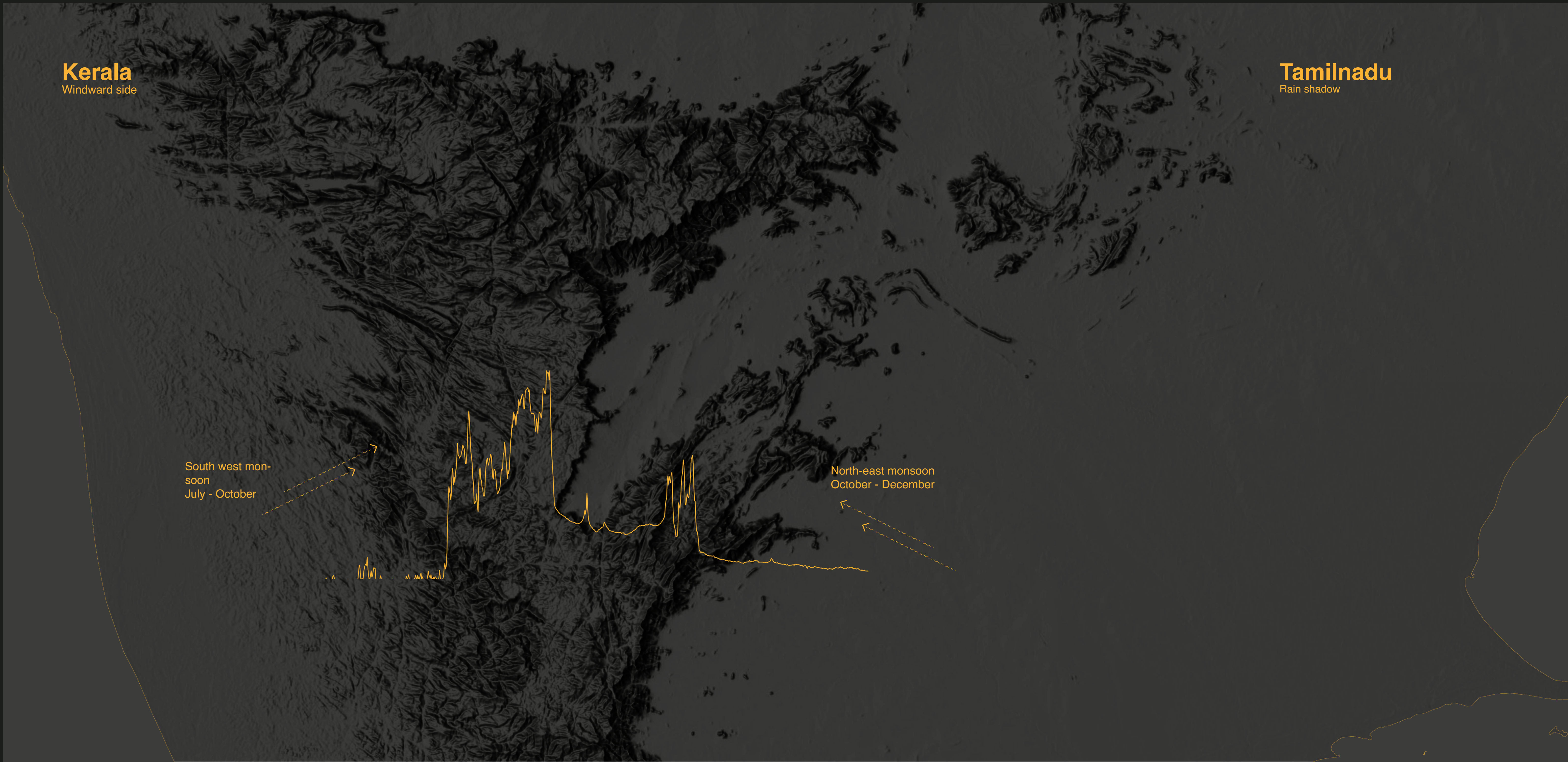
Overall water risk

default

- Low (0-1)
- Low - Medium (1-2)
- Medium - High (2-3)
- High (3-4)
- Extremely High (4-5)
- Not enough valid data

Monsoon

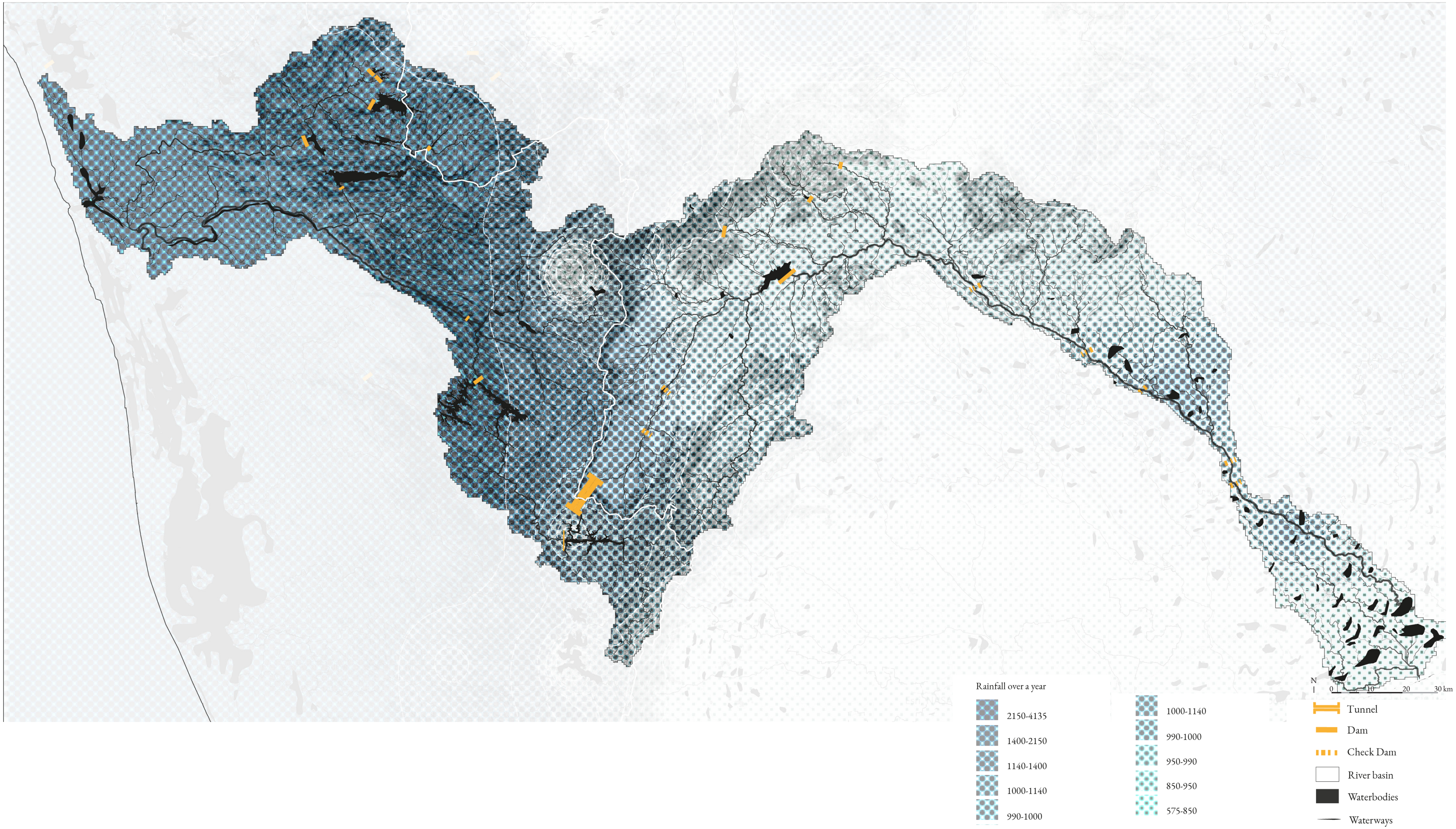



Kerala
Windward side
Tamilnadu
Rain shadow
South west mon-
soon
July - October
North-east monsoon
October - December

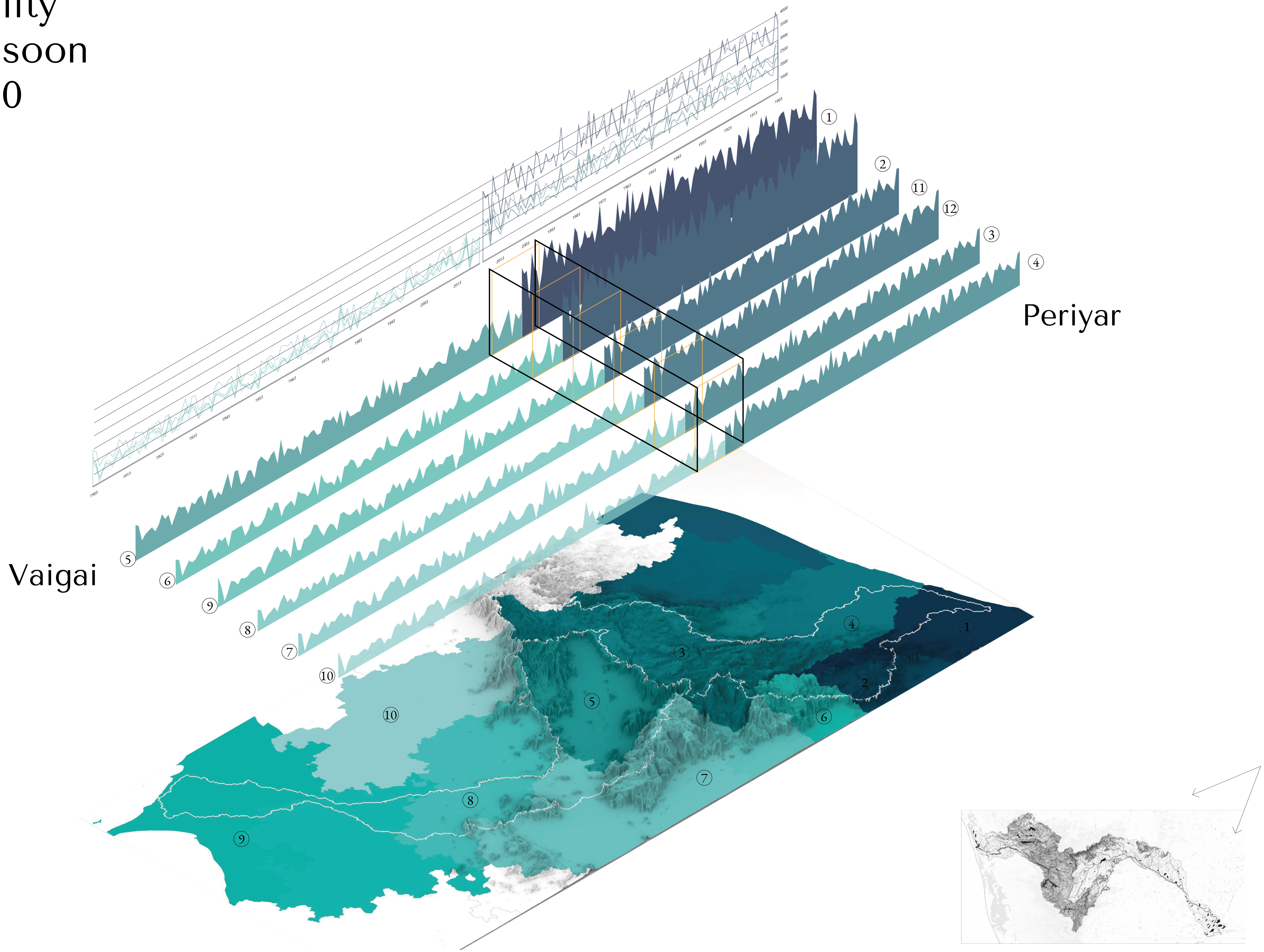
Variability of the monsoon 2019

Periyar River Basin

Vaigai River Basin



Variability of monsoon over 100 years



0 10 20 30 km

Cumulative rainfall mapped for 100years 1903 - 2013

1. Thrissur
2. Pallakad
3. Idukki
4. Kottayam
5. Theni
6. Coimbatore
7. Tiruppur
8. Madurai
9. Ramanadhapuram
10. Virudunagar
11. Allapuzha
12. Kakkanad

Grey Infrastructure

Global impact on local systems

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.

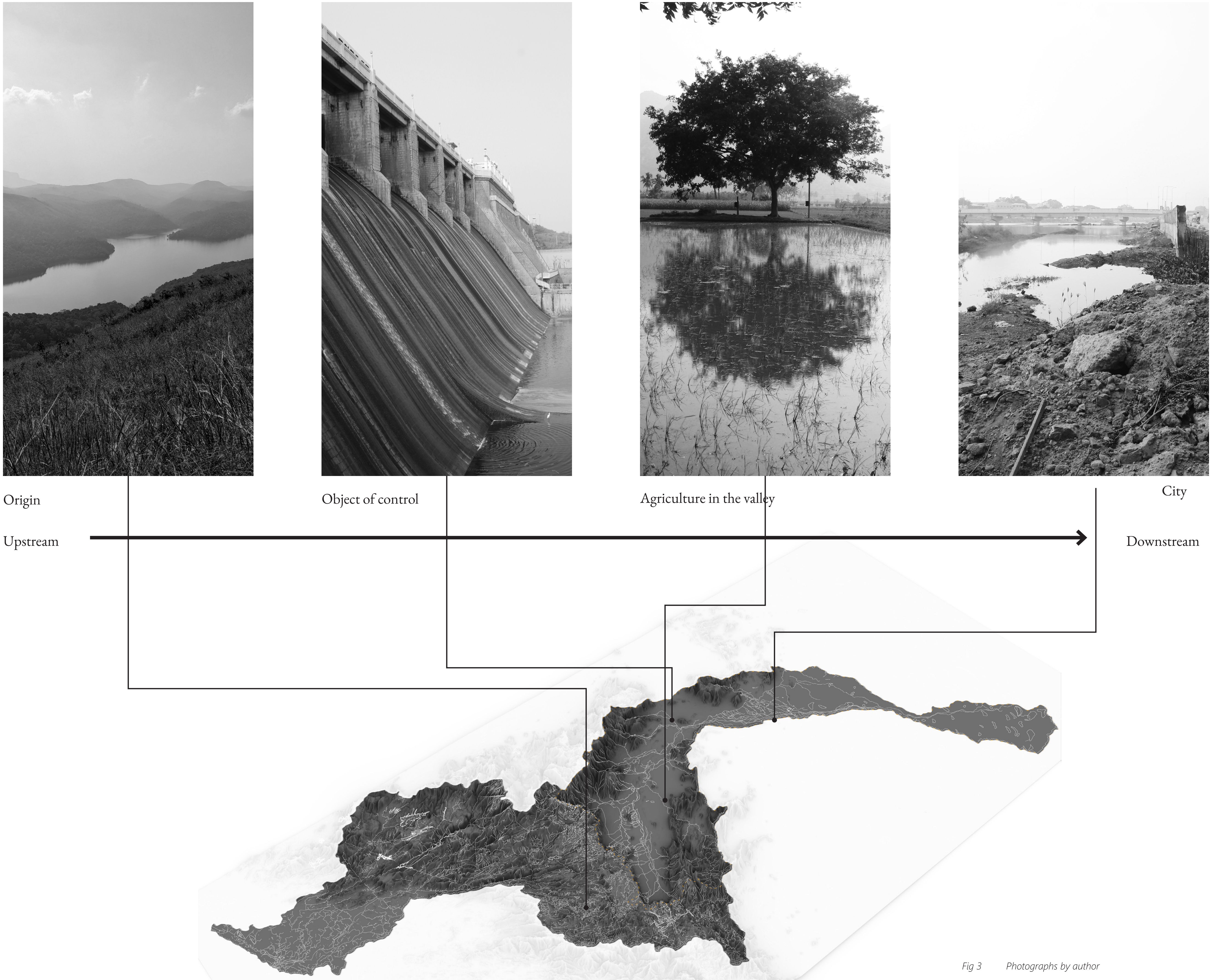
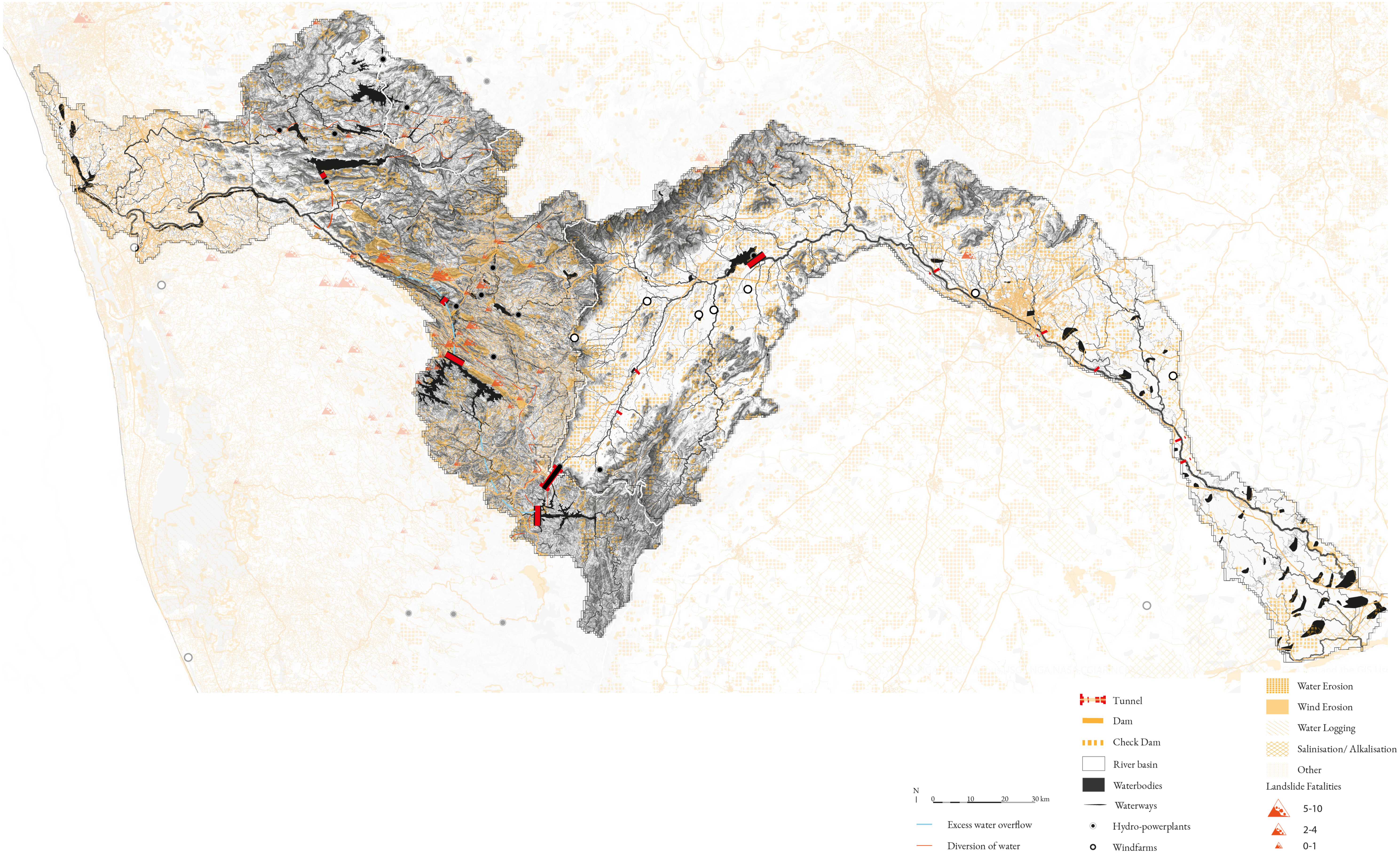


Fig 3 Photographs by author

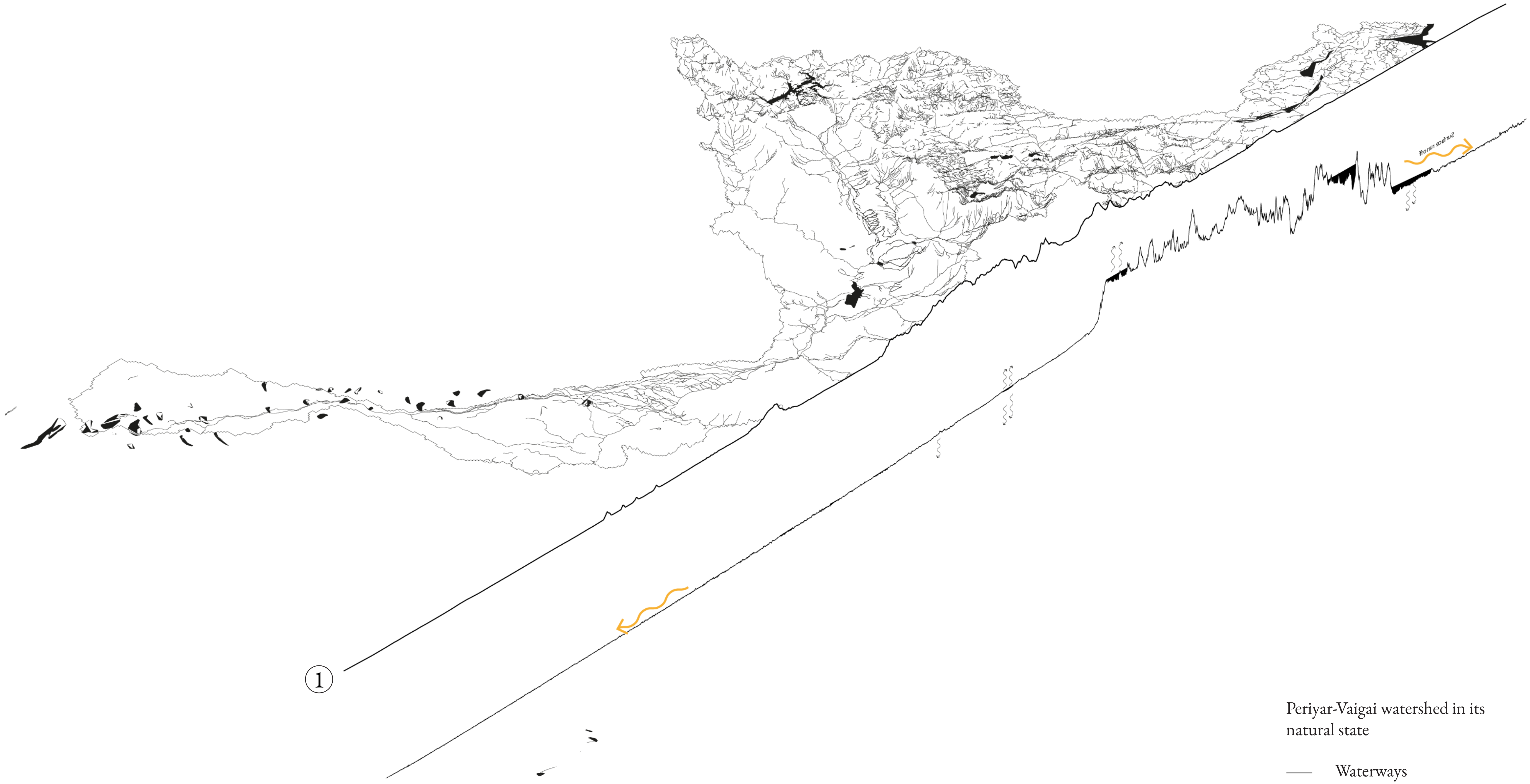
Composition of grey infrastructure

Periyar River Basin

Vaigai River Basin



Temporal change in control of water



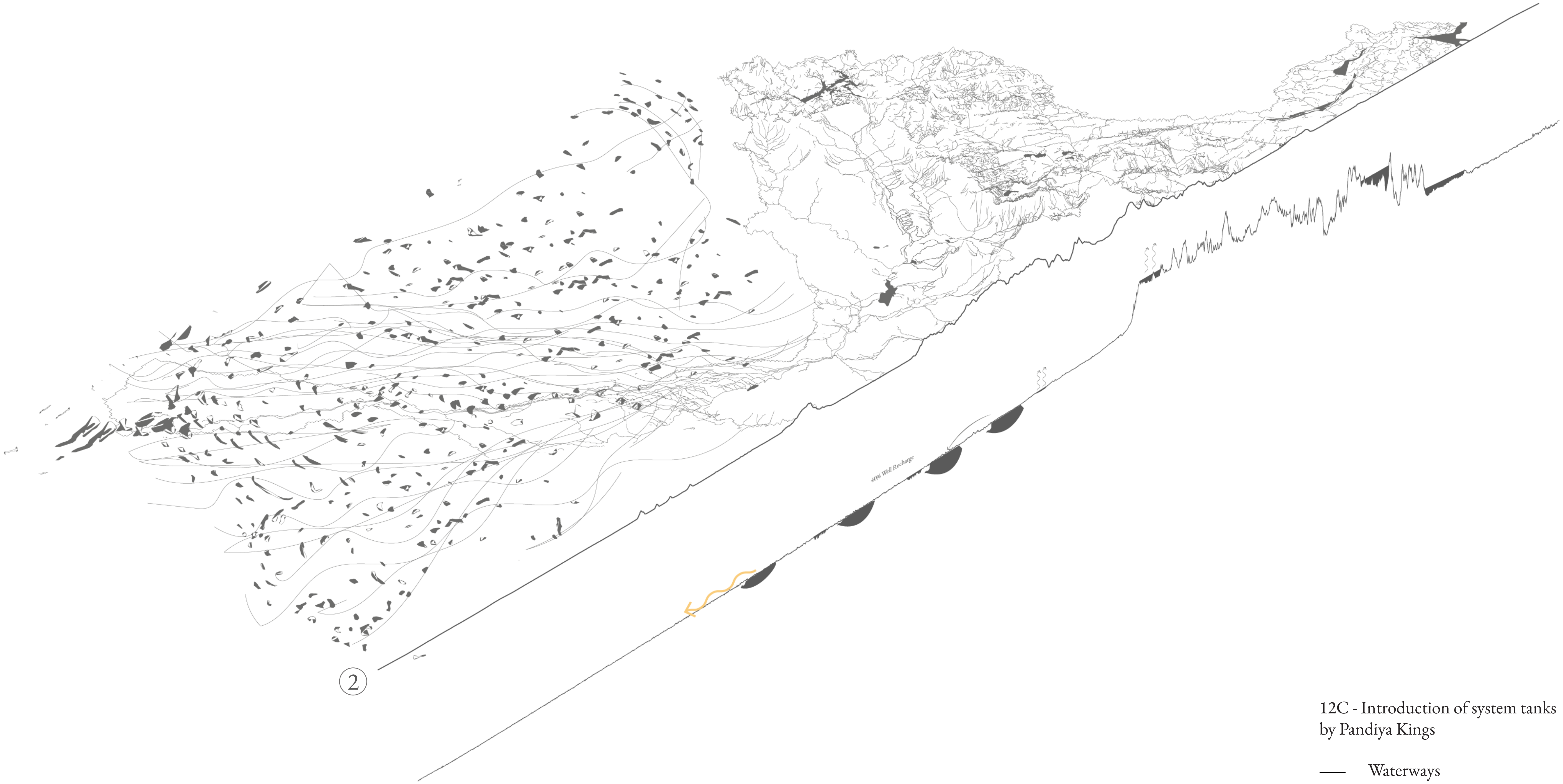
Periyar-Vaigai watershed in its natural state

Waterways

Waterbodies

Dam infrastructure

Temporal change in control of water 12C



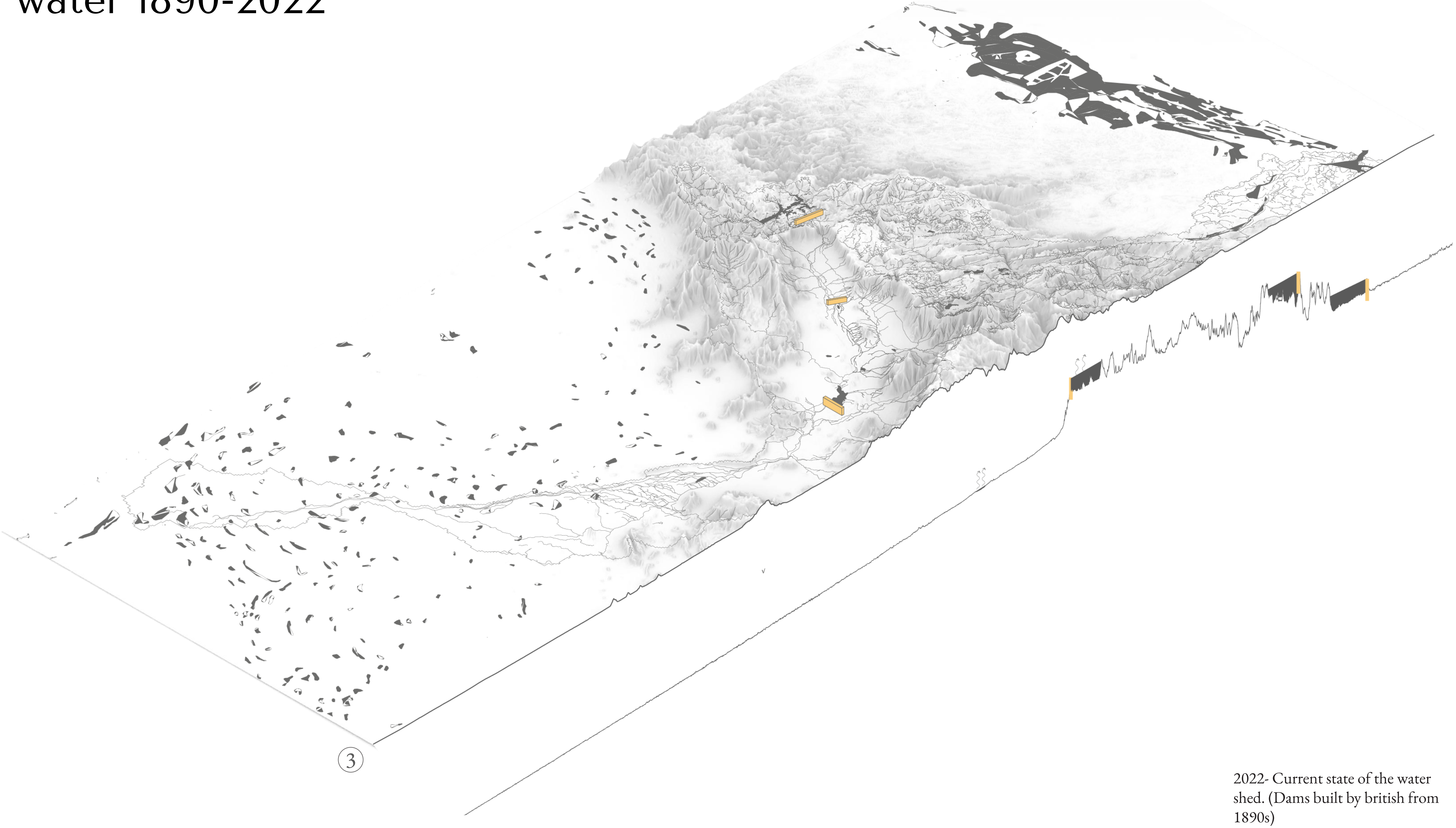
12C - Introduction of system tanks by Pandiya Kings

Waterways

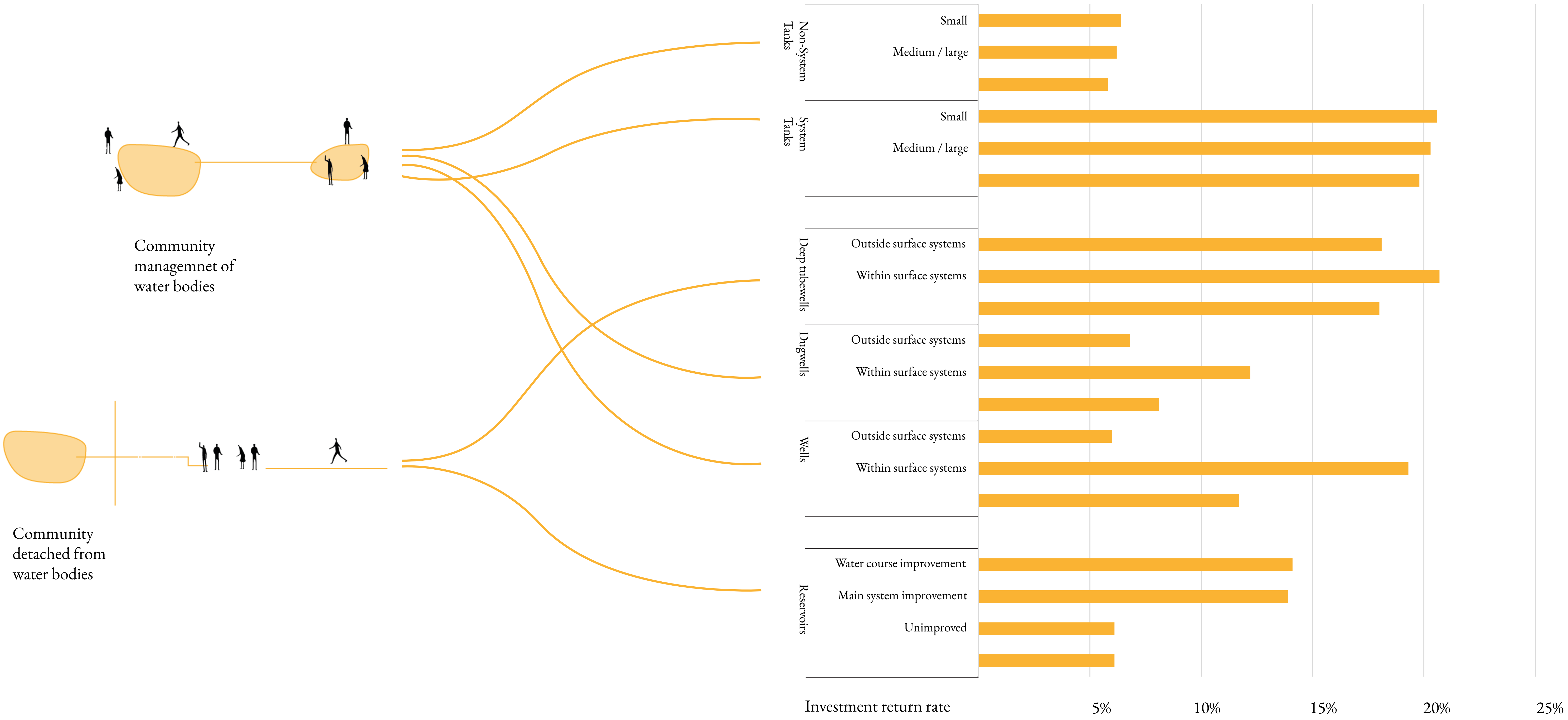
Waterbodies

Dam infrastructure

Temporal change in control of water 1890-2022



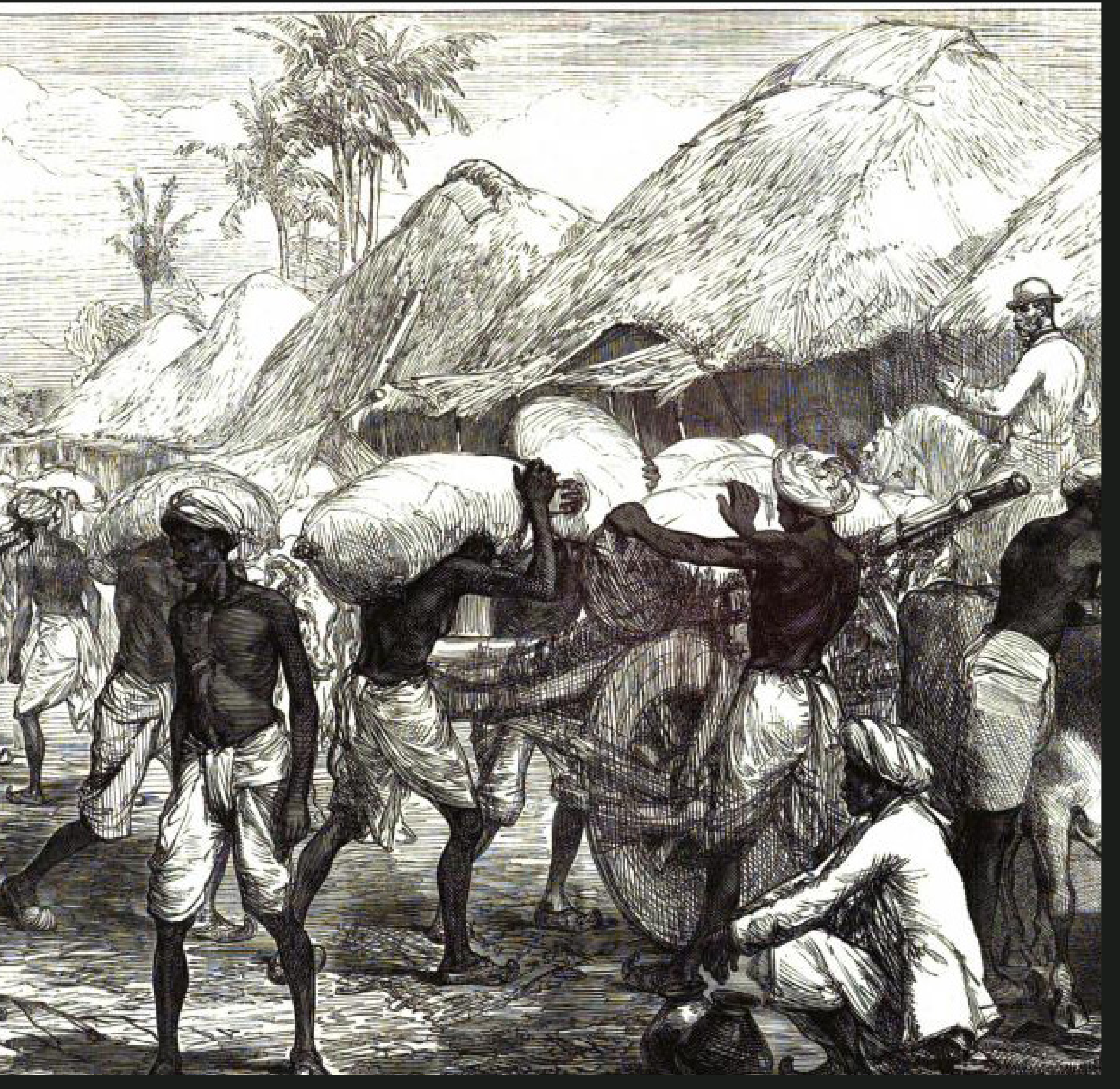
Nature of infrastructural projects



Primary Production

Global impact on local systems

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.



Global impact on local systems

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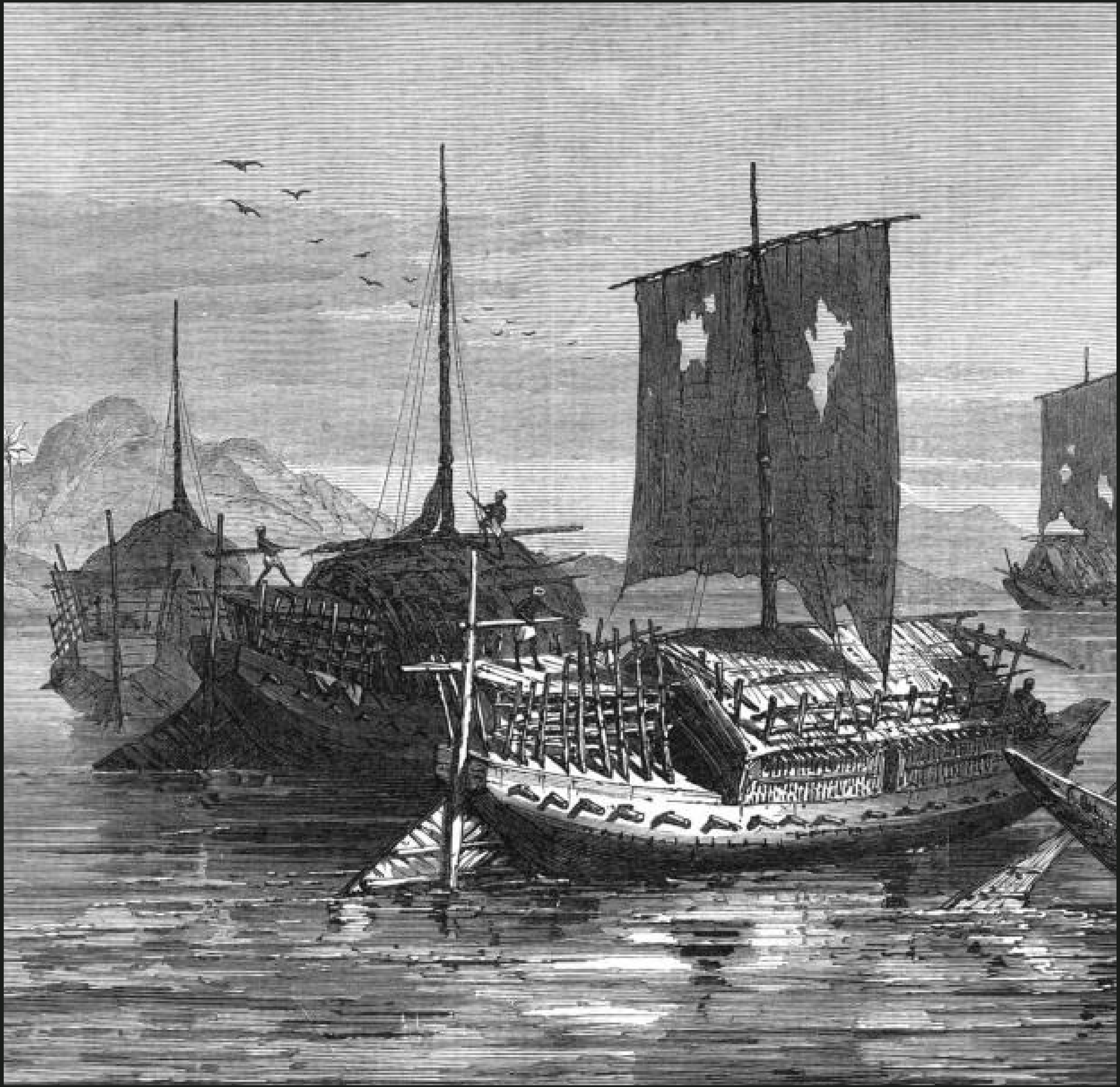


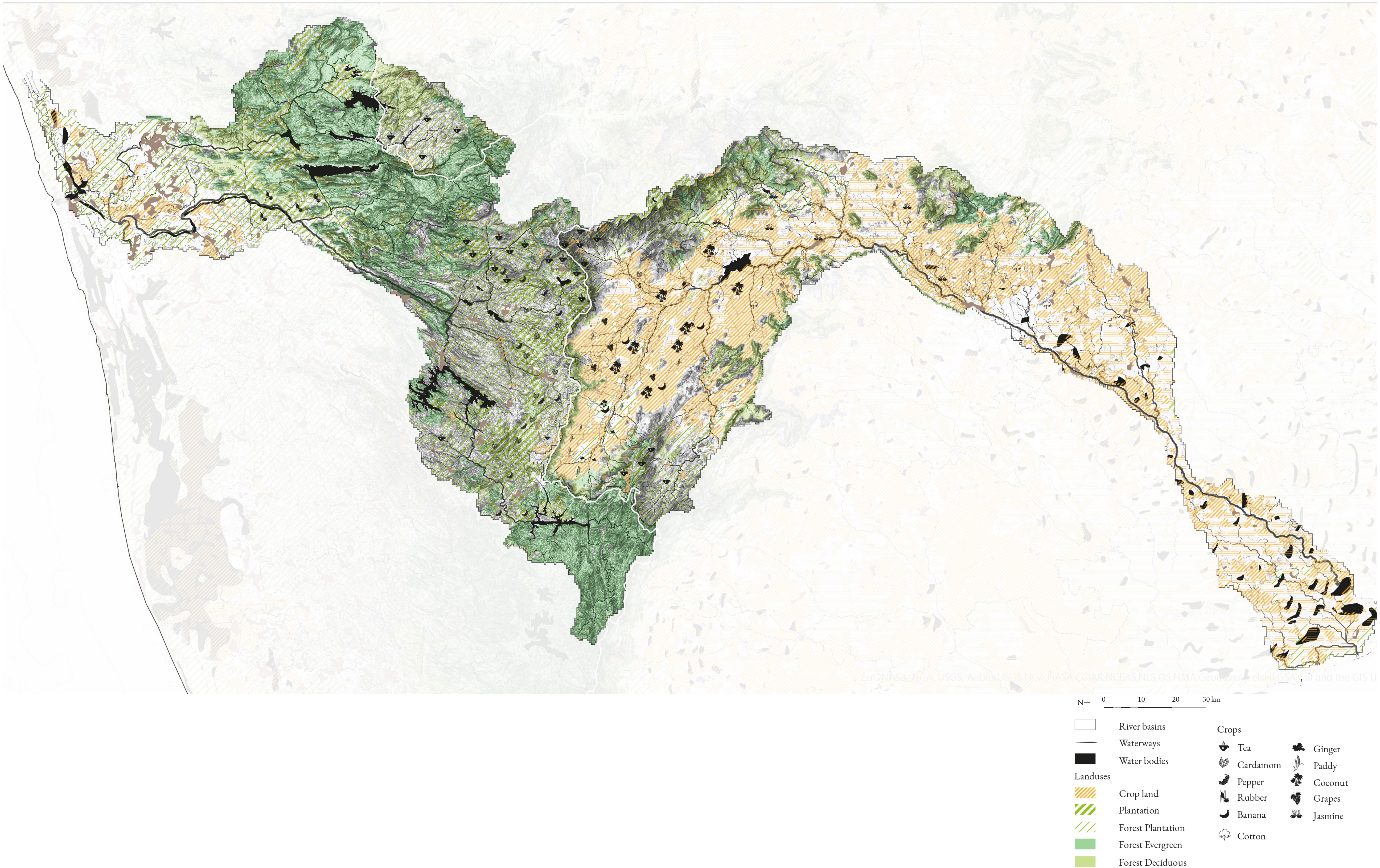
Global impact on local systems

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.

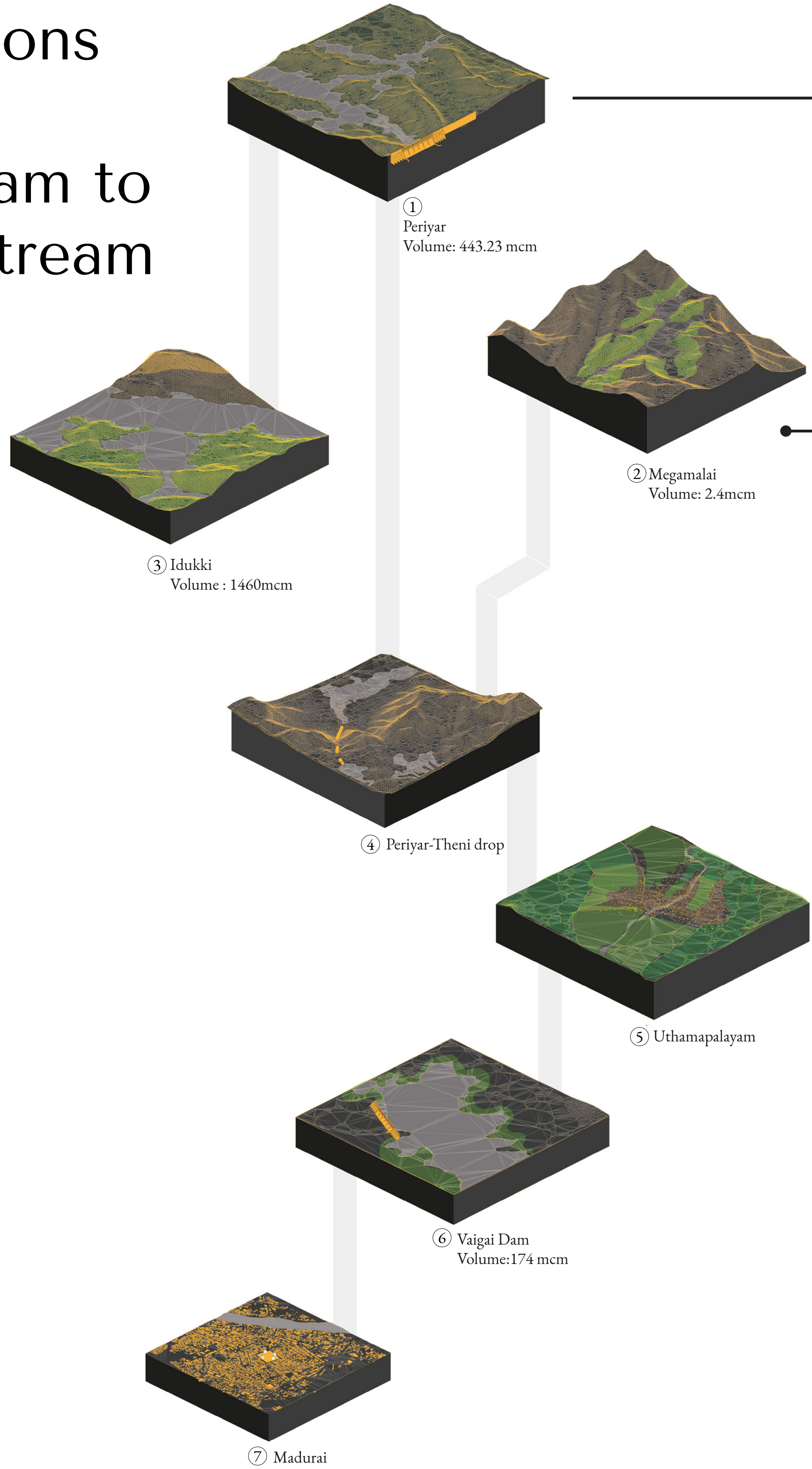
Fragmented Habitats

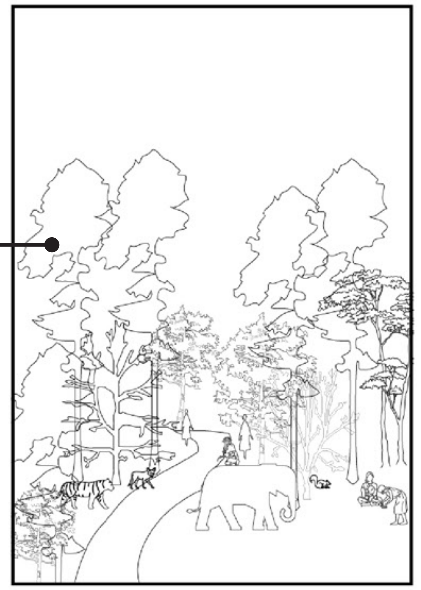
Periyar River Basin

Vaigai River Basin



Local conditions from Upstream to Downstream





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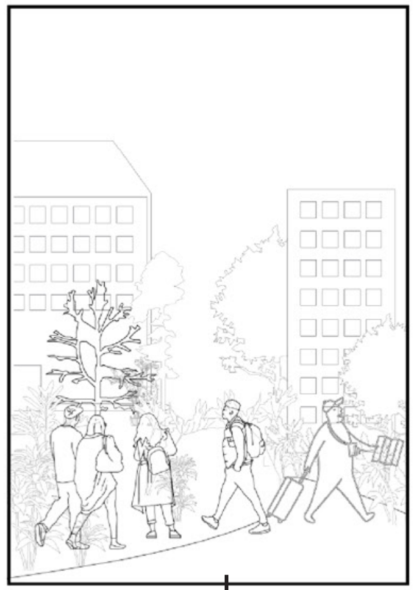
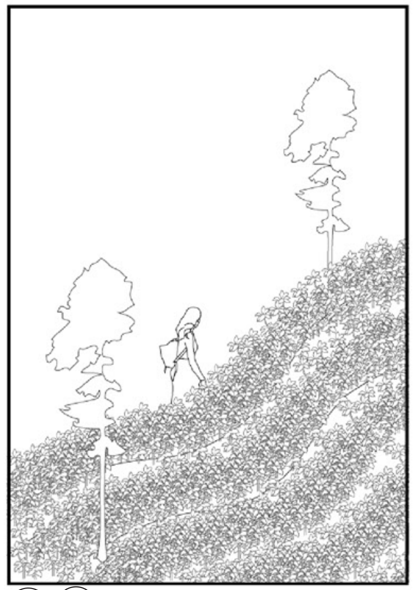
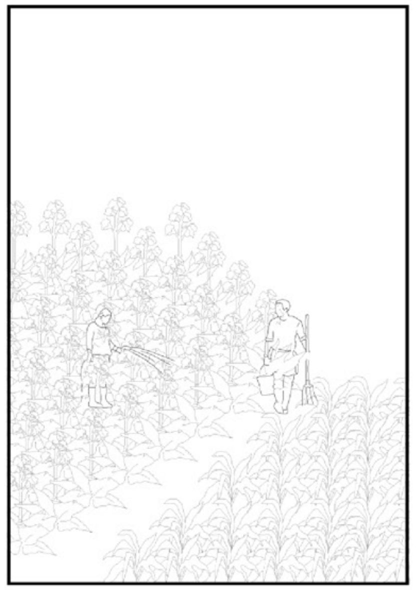


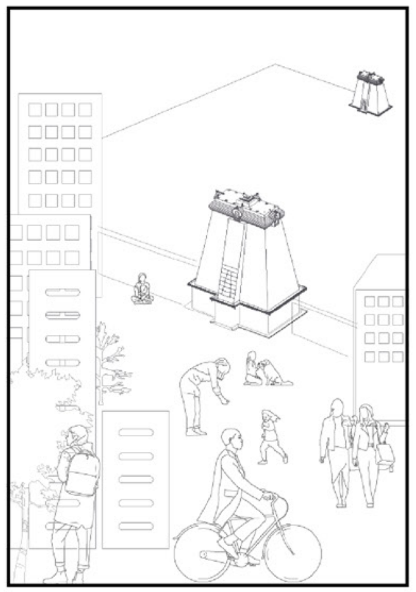
1 2 3



2 3



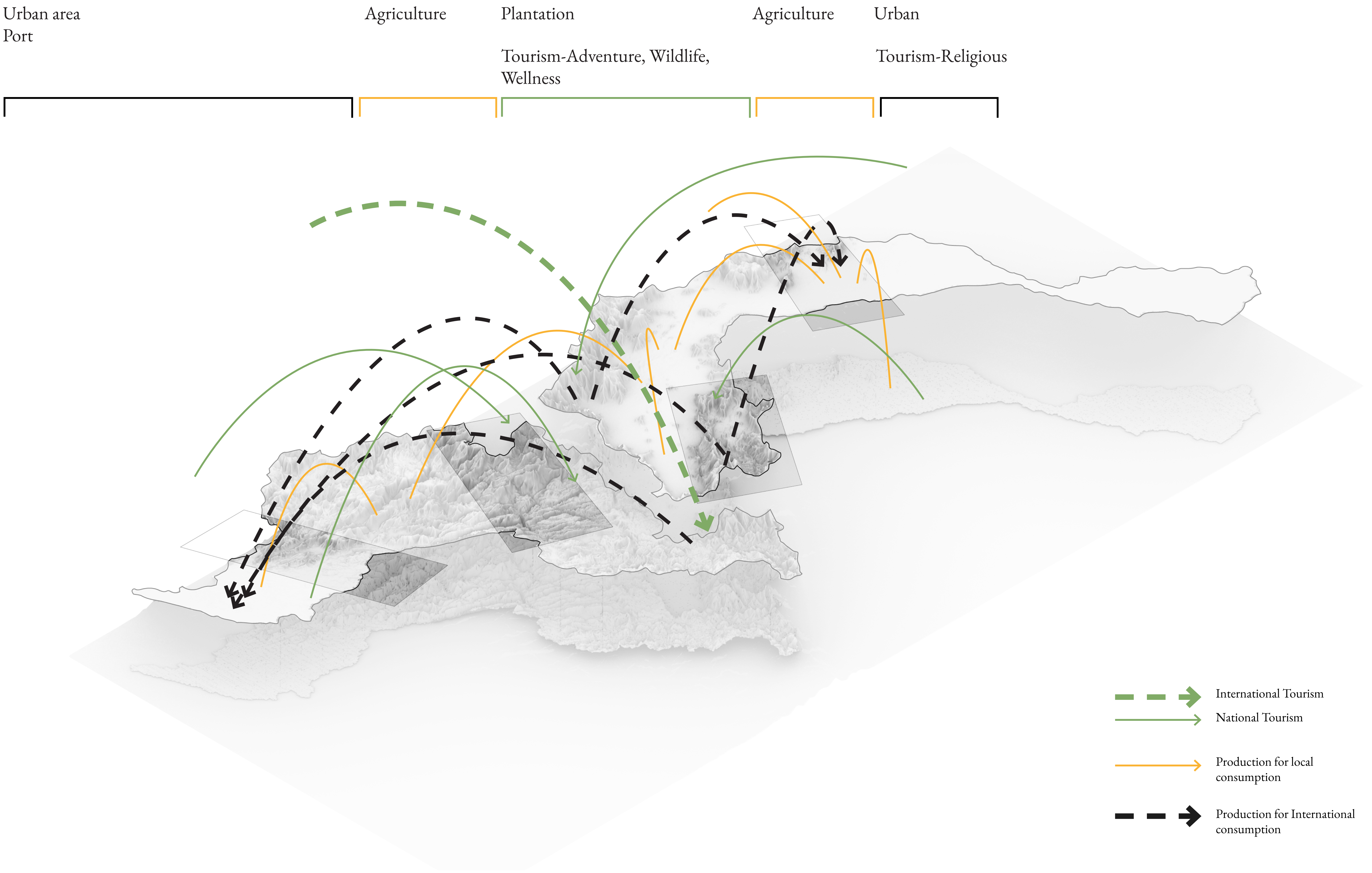
5 6



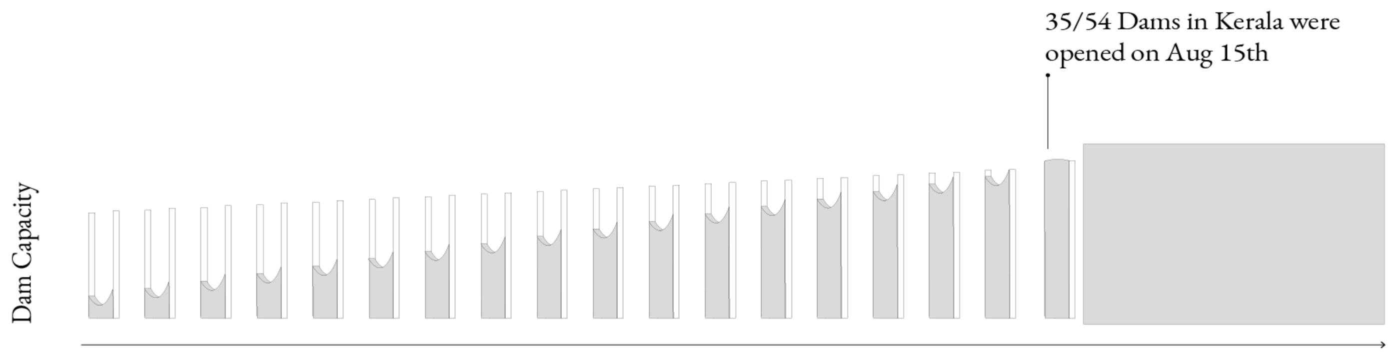
7

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

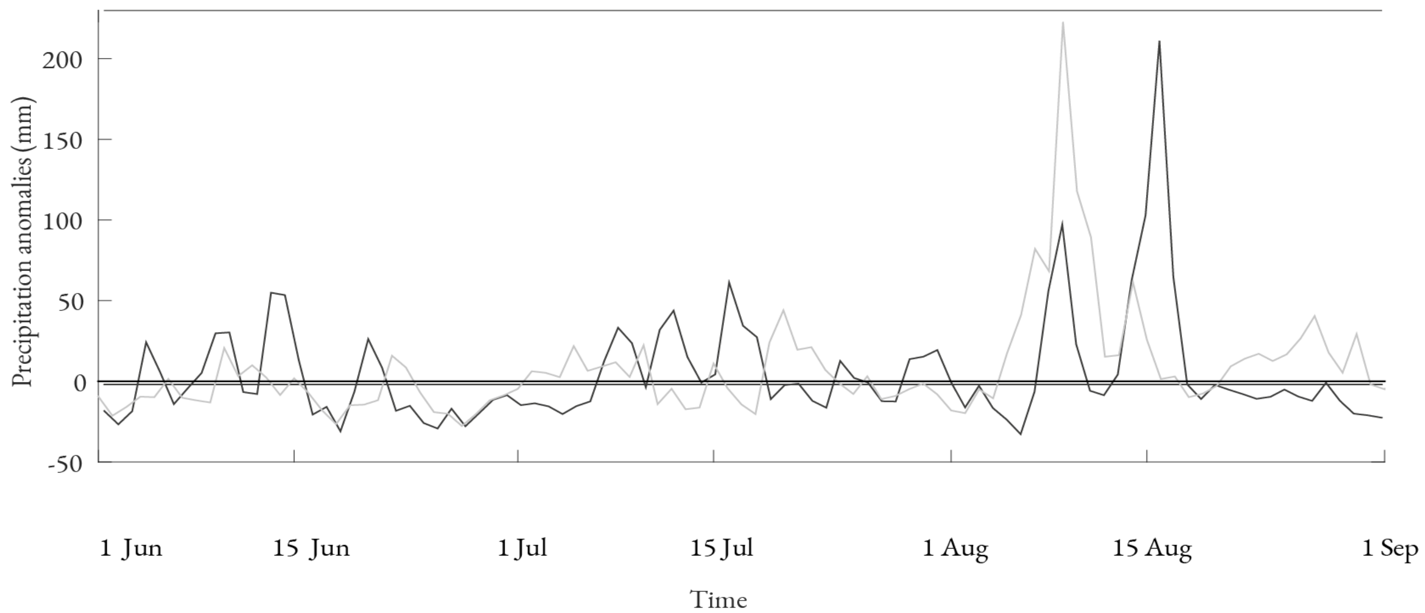
Economic Composition



Extreme weather event



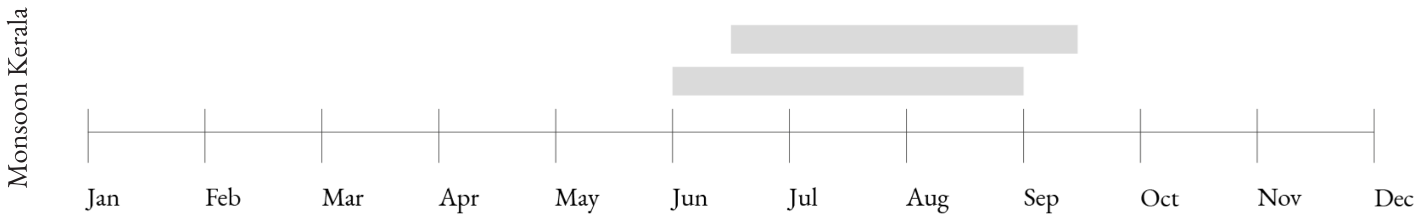
Dams



Rainfall anomalies of X = X- 7 years mean daily rainfall

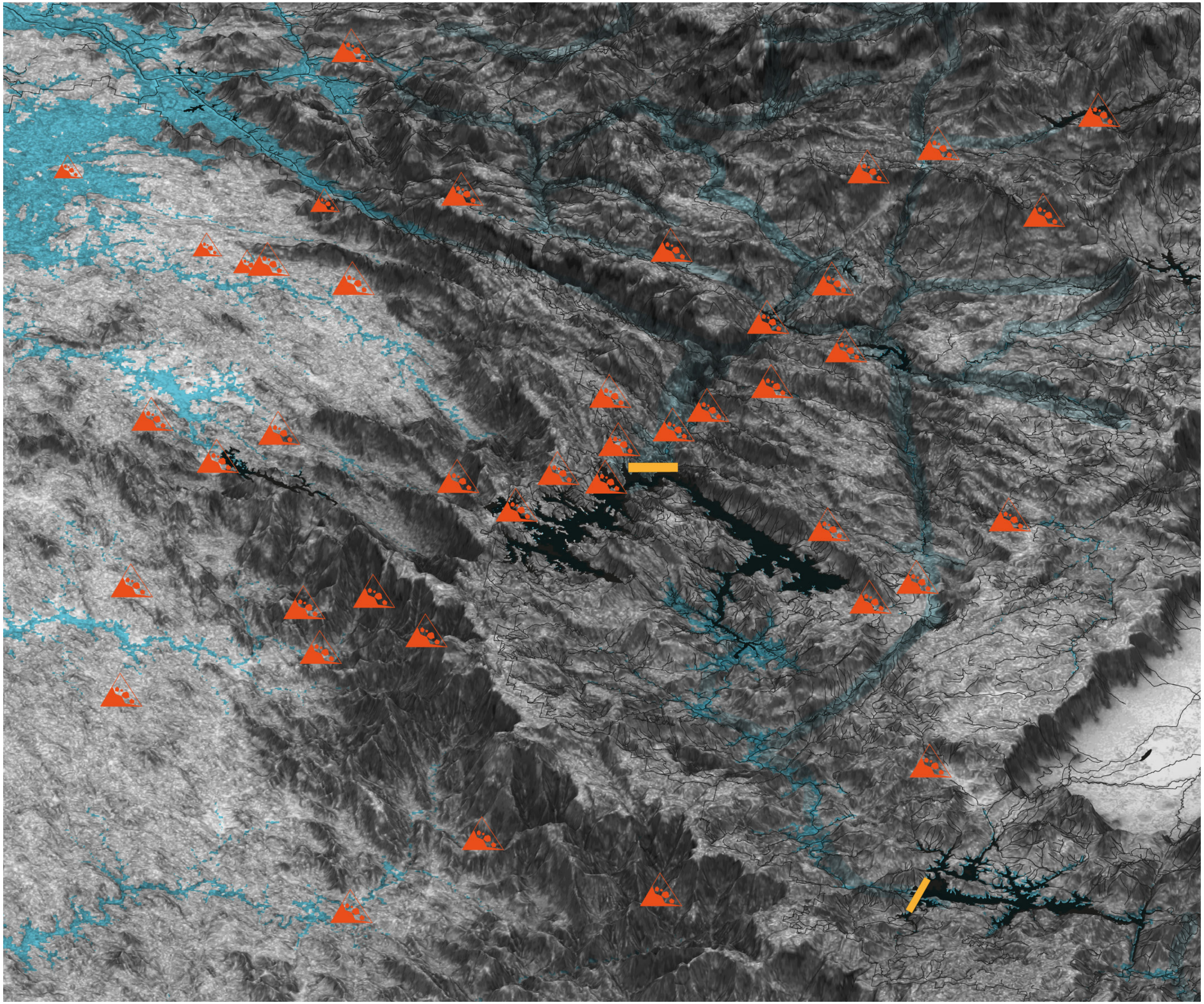
2018

2019



Monsoons

2018 Flooding in Kerala



Slope

<78

<33

<15

Waterways

Waterbodies

Dam (map)

Rainfall

Landslides

N

0 2 4 8km

How do we design for uncertainity?

Monsoon

Fluctuations

Hydrological system

Grey Infrastructure ?

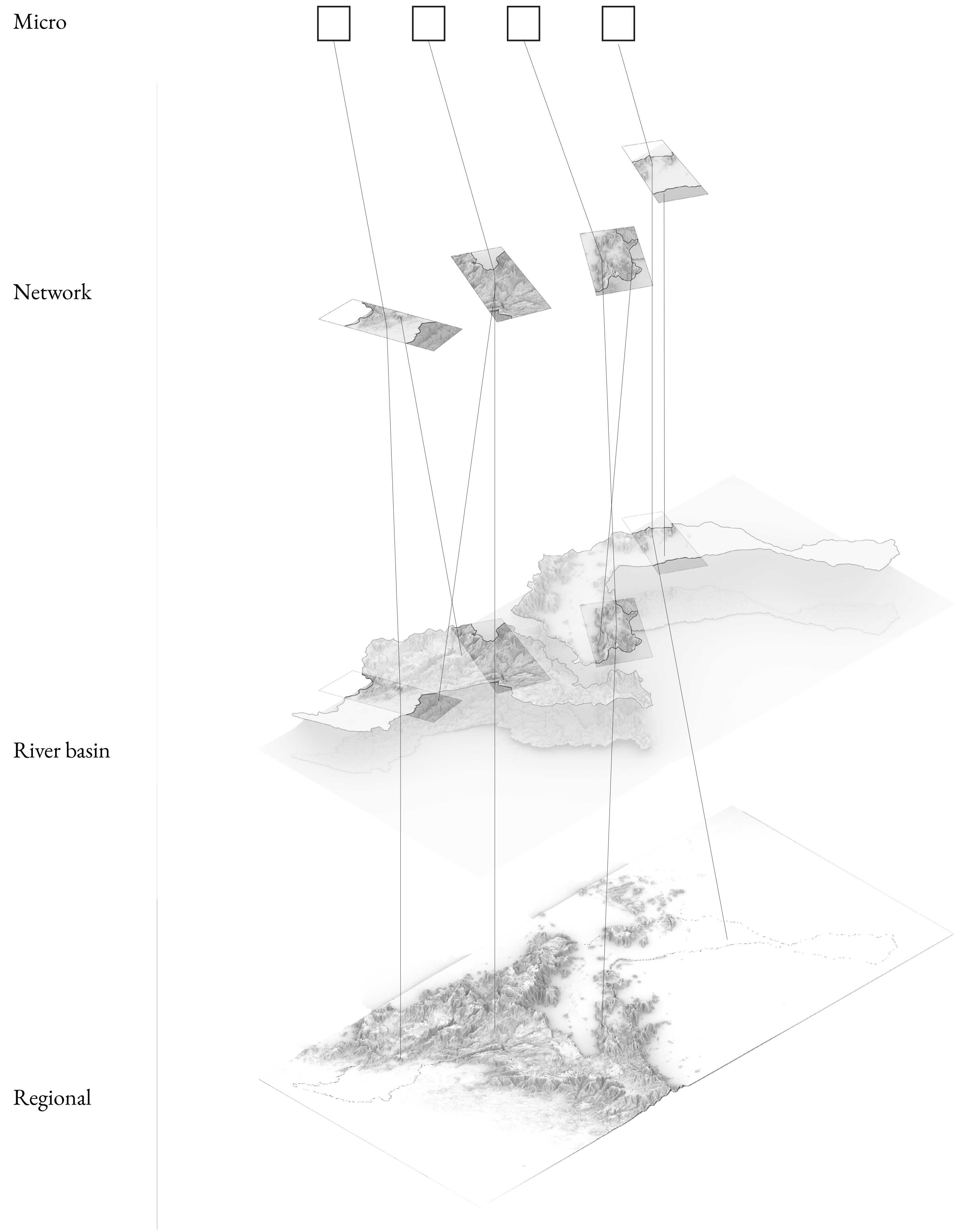
Landscape as infrastructure

? Primary Production

Diversifying production to respond to the climate

Research Question

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



Design framework

Uncertainities in Monsoon

Seasons

Summer

Monsoon/Rainy season

Winter

Resource

Availability of water

Extreme precipitation event

High

Average

Low

Extreme scarcity

Risk

Flooding

Landslides

Drought

Design framework

Adaptation

Structure

Seasons

Summer

Monsoon/Rainy season

Winter

Resource

Availability of water

Extreme precipitation event

High

Average

Low

Extreme scarcity

Risk

Flooding

Landslides

Drought

Territorial

Riverbasin

Network

Micro

From a centralised to a decentralised system using landscape as infrastructure

Resilient landscapes

Essential infrastructure

Production infrastructure

Design framework

Adaptation

Structure — Agency

Seasons

Summer

Monsoon/Rainy season

Winter

Resource

Availability of water

Extreme precipitation event

High

Average

Low

Extreme scarcity

Risk

Flooding

Landslides

Drought

Territorial

Riverbasin

Network

Micro

Program

Ecosystem restoration

Primary Production

Habitation

Recreation

Practices

Aligning to phenology

Aligning to the indigenous culture

Aligning daily life to phenology

Design framework

Adaptation

Structure — Agency — Protocols of care

Seasons

Summer

Monsoon/Rainy season

Winter

Resource

Availability of water

Extreme precipitation event

High

Average

Low

Extreme scarcity

Risk

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Landslides

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Ecosystem restoration

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Practices

Aligning to phenology

Aligning to the indigenous culture

Aligning daily life to phenology

Ecosystem based economy

Placing care on nature.

Design framework

Adaptation

Resource

Seasons
- Summer
- Monsoon/Rainy season
- Winter

Availability of water
- Extreme precipitation event
- High
- Average
- Low
- Extreme scarcity

Risk
- Flooding
- Landslides
- Drought

Structure
- Territorial
- Riverbasin
- Network
- Micro
- Resilient landscapes
- Essential infrastructure
- Production infrastructure

Agency

High

Low

Program
- Ecosystem restora-tion
- Primary Production
- Habitation
- Recreation

Practices
- Aligning to phenology
- Aligning to the indigenous culture
- Aligning daily life to phenology

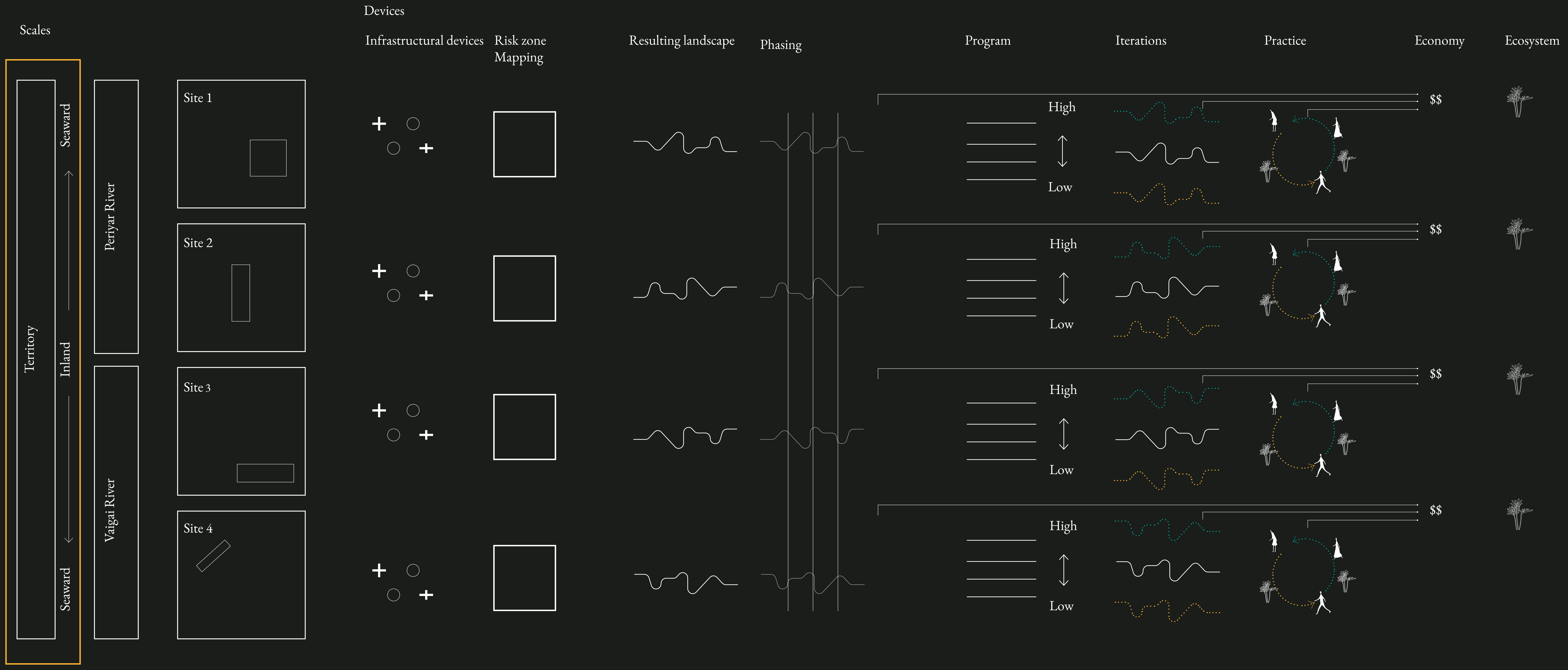
Protocols of care
- Ecosystem based economy
- Placing care on nature.

Structure

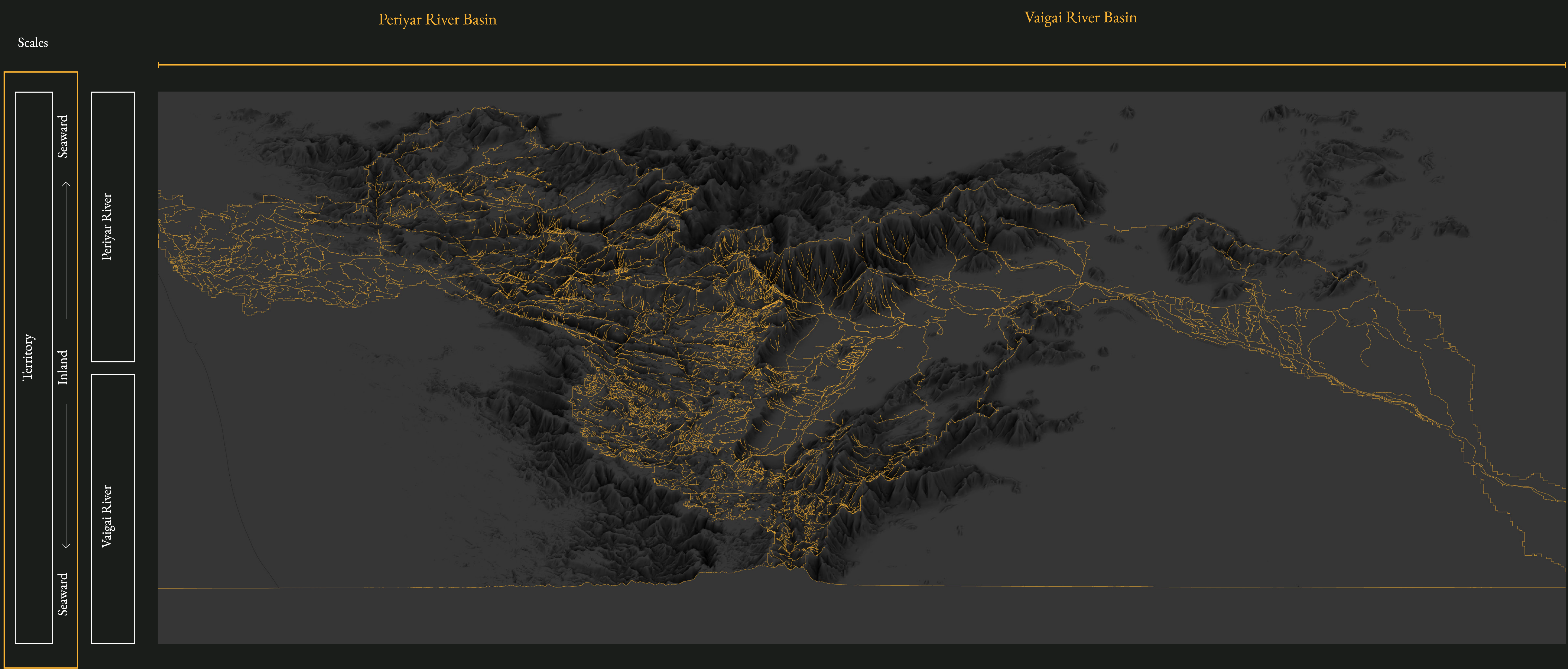
Resilient Landscapes

Agency

Protocol of Care



Structure : Territory



Goals : From a Centralised to de-centralised system

1. Water Balance

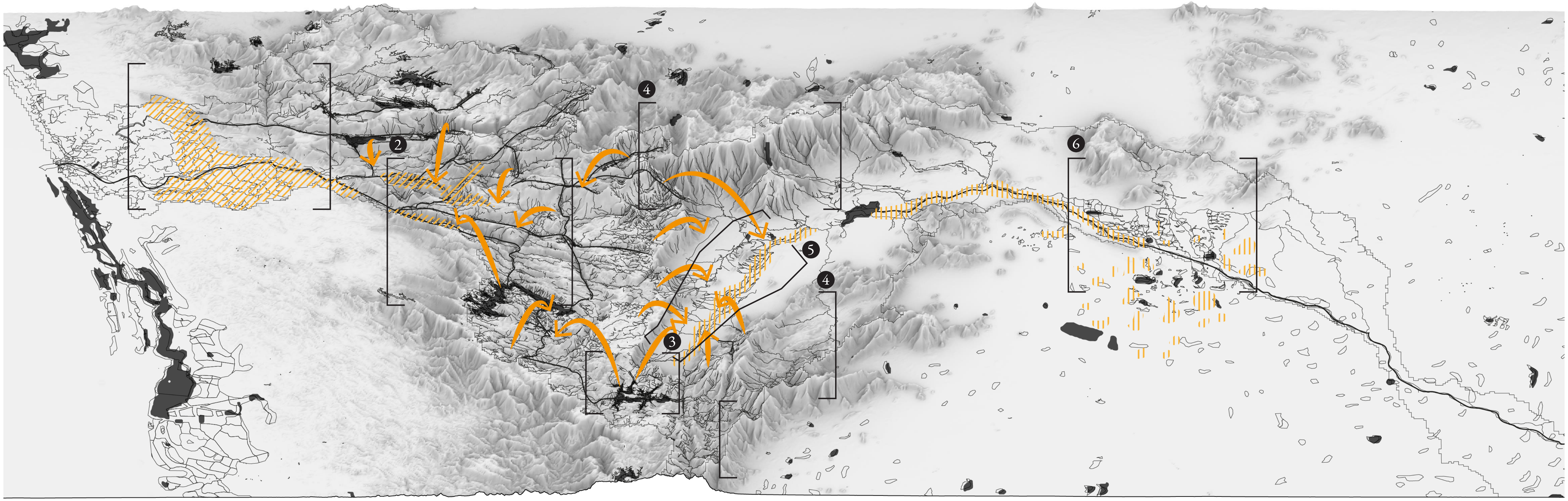
2a. Re-naturalisation : Transitioning intensive monocultures to dynamic production land-scapes aligned to natural cycles

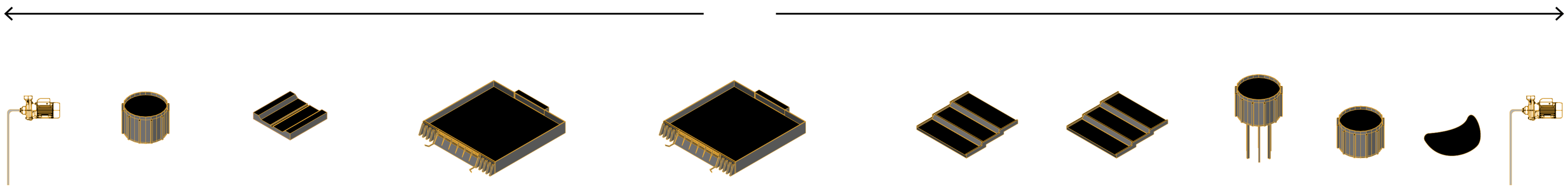
2b. Re-introducing nature in cities.

Water Balance

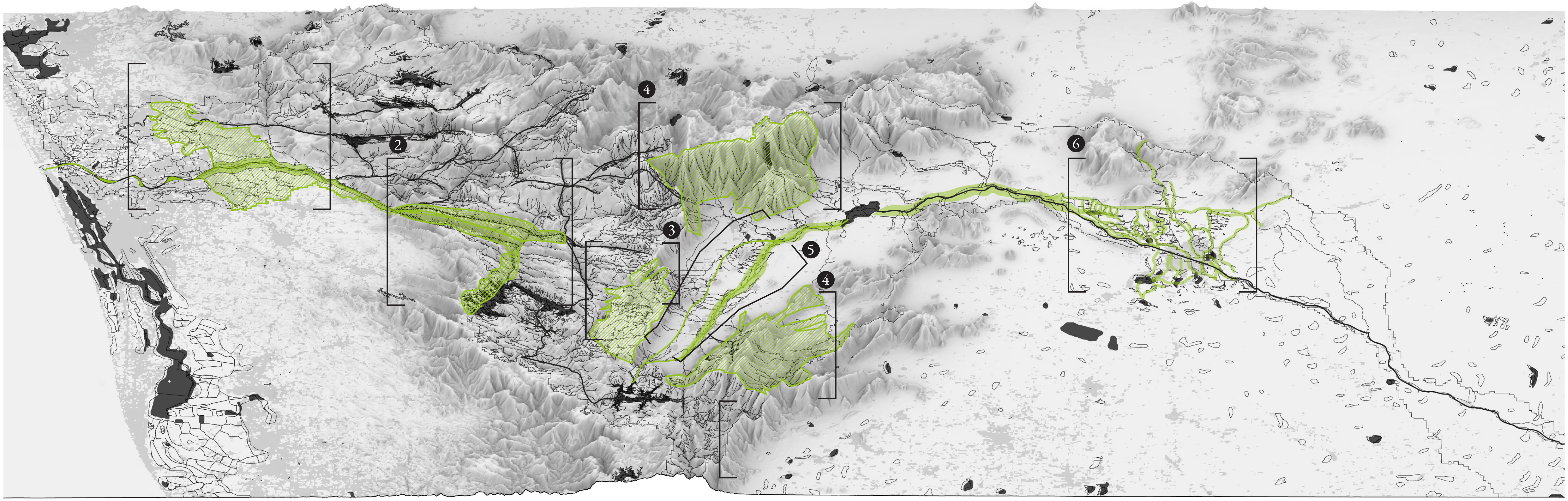
Re-distribute
water storage

1 Storage/Passage 2 Passage 3 Release 4 Interceptors 5 Storage/Passage 6 Storage/ Passage

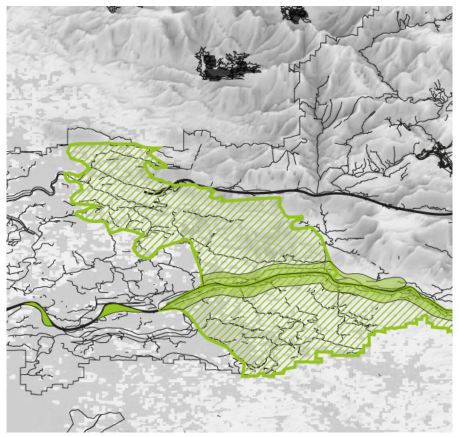




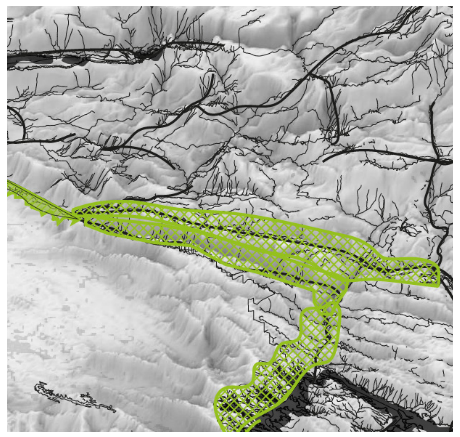
Re-naturalisation



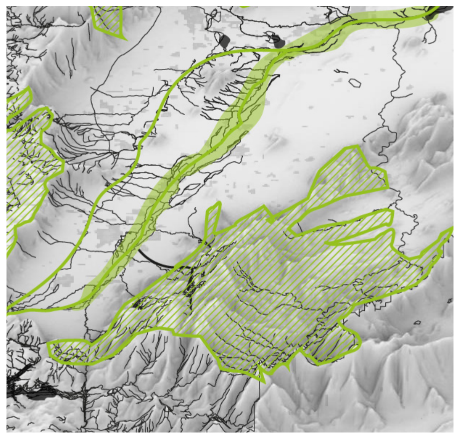
Kodanad



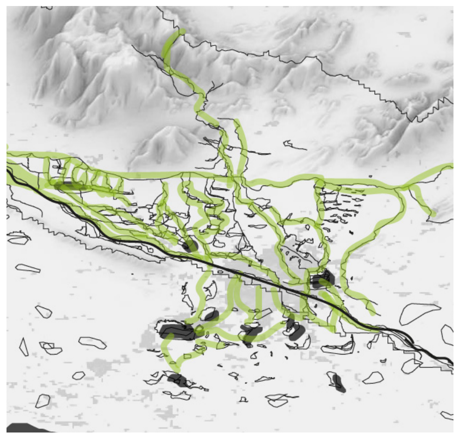
Idukki



Megamalai

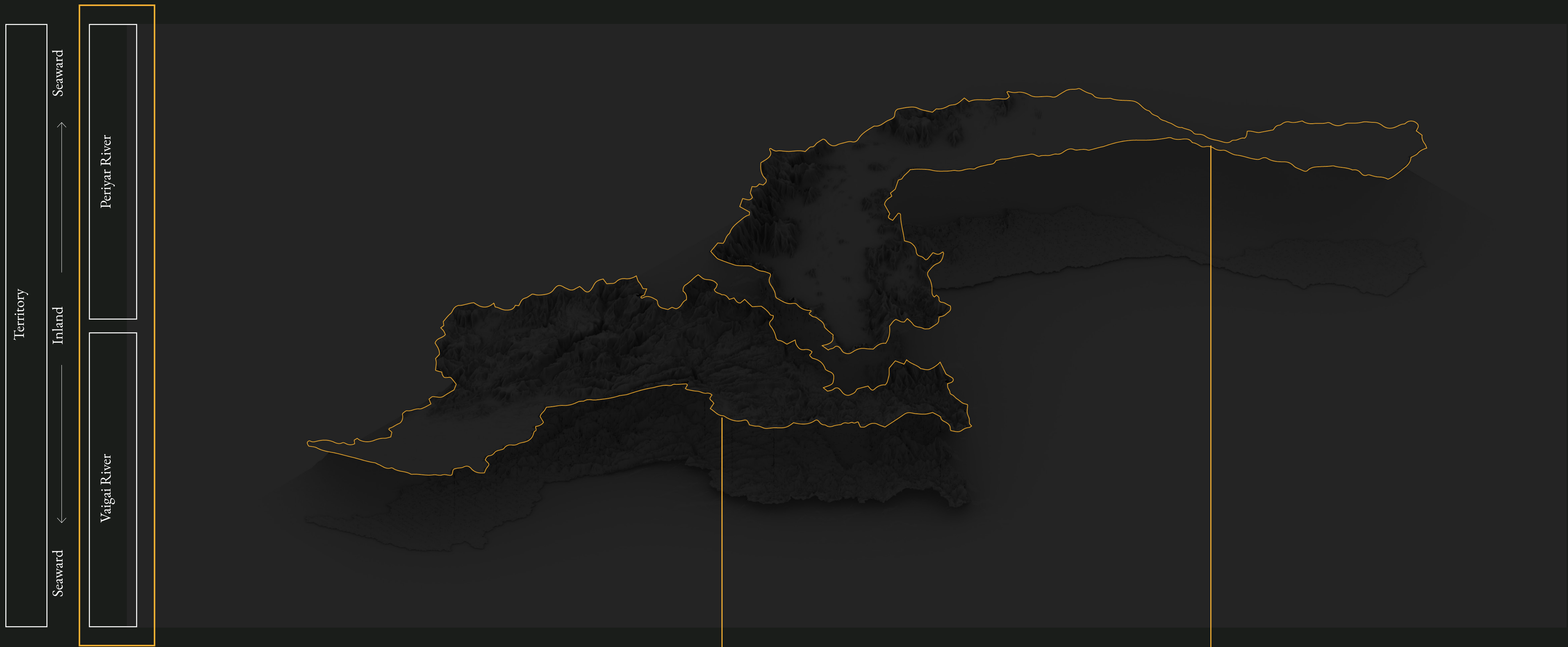


Madurai



Structure : River basin

Scales



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

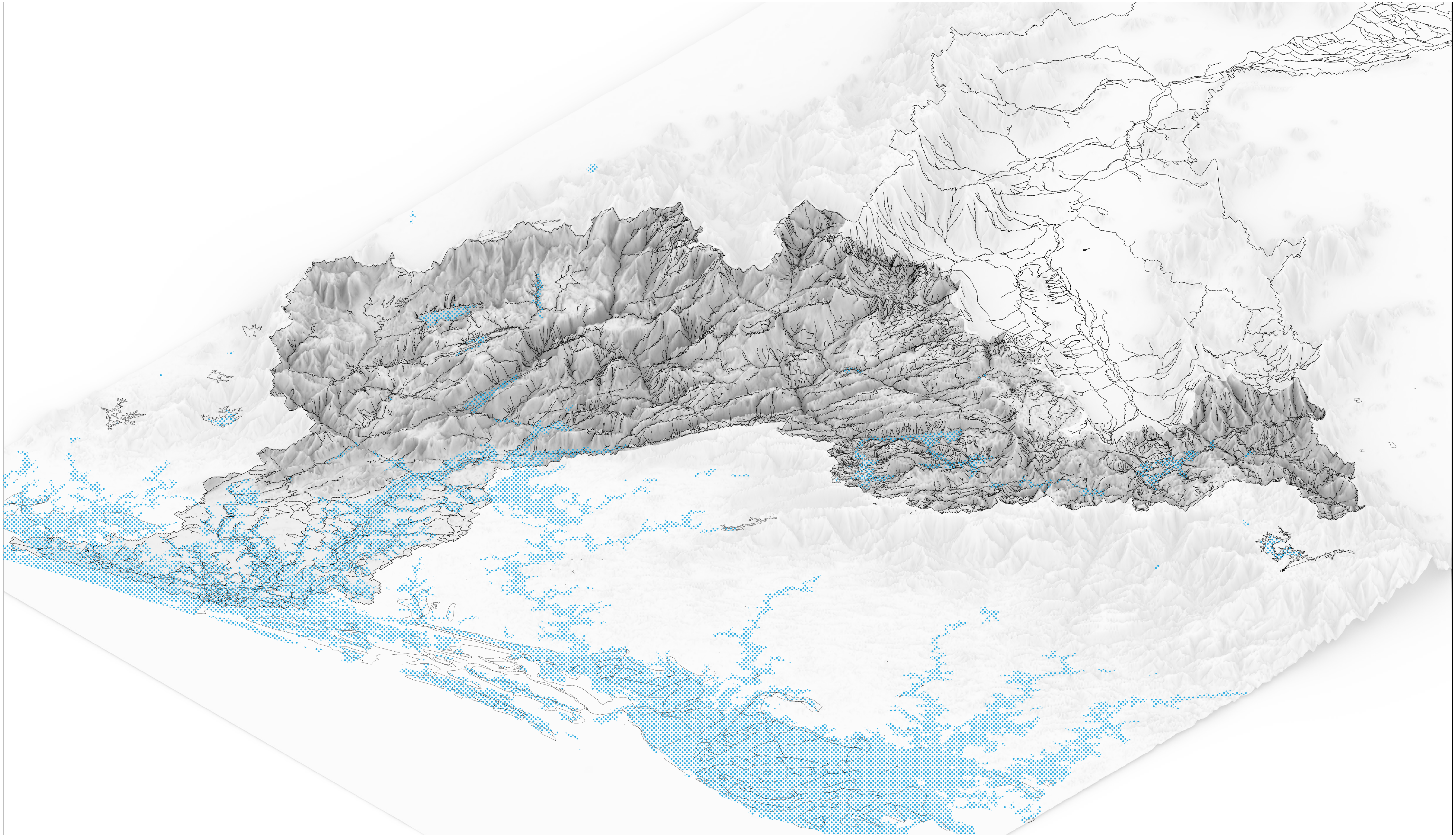
Goals : Vaigai

1. Resilience for drought.

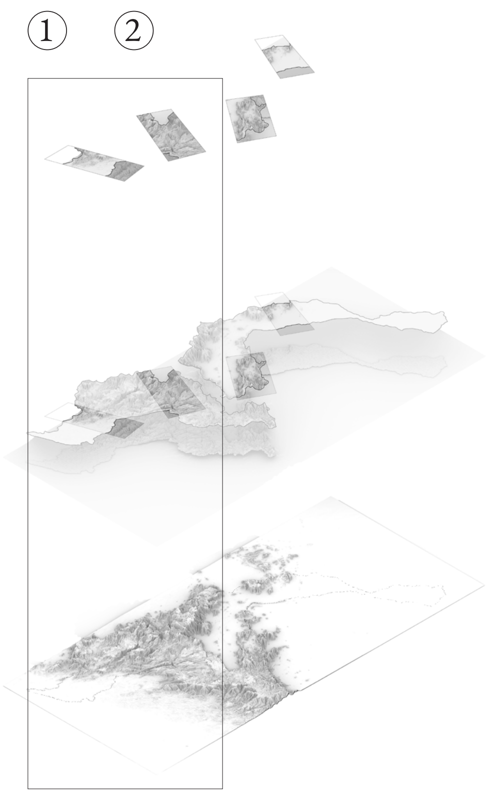
2. Rejuvenate the river.

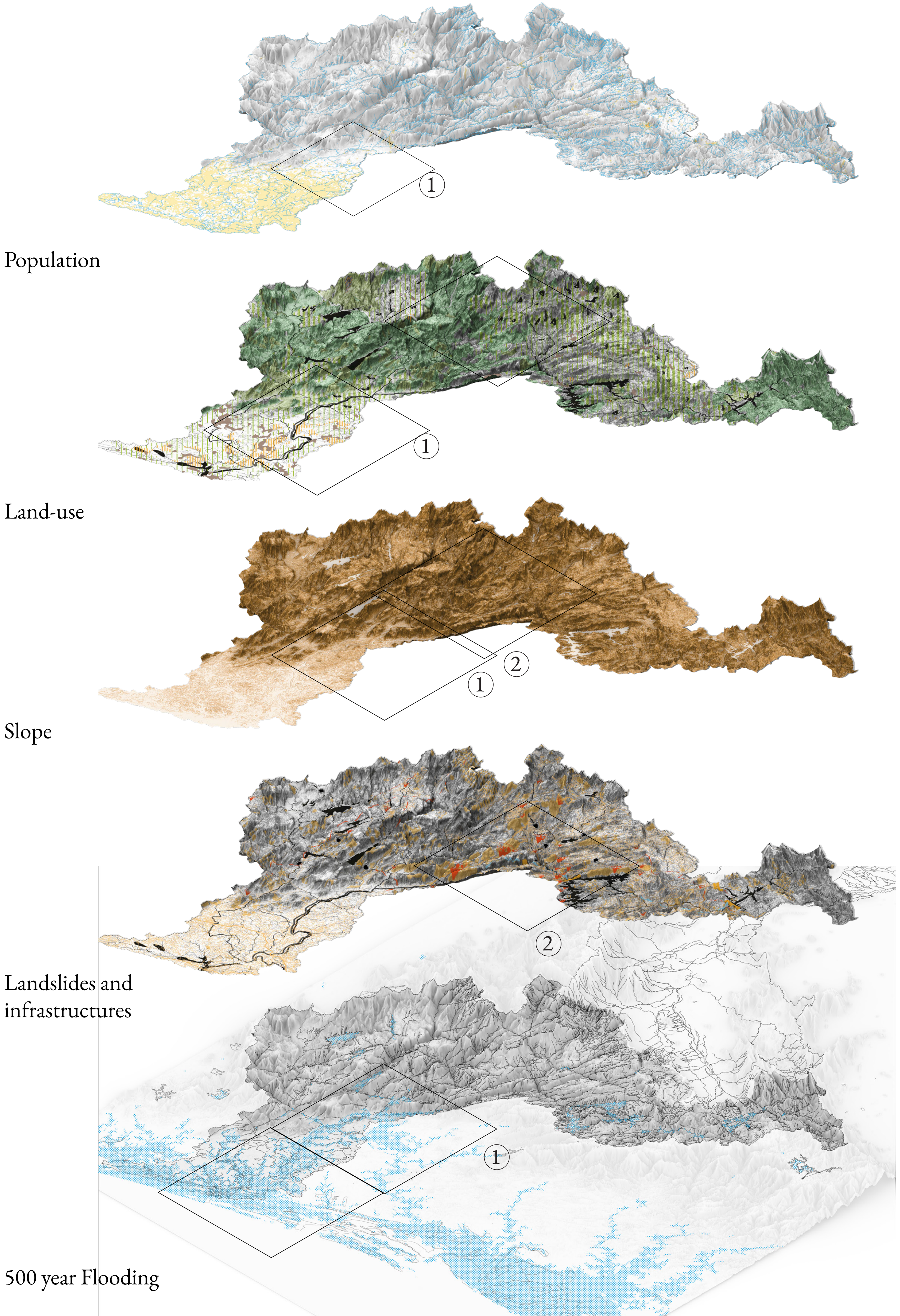
3. Sustainable production and consumption.

Structure :
Periyar River basin

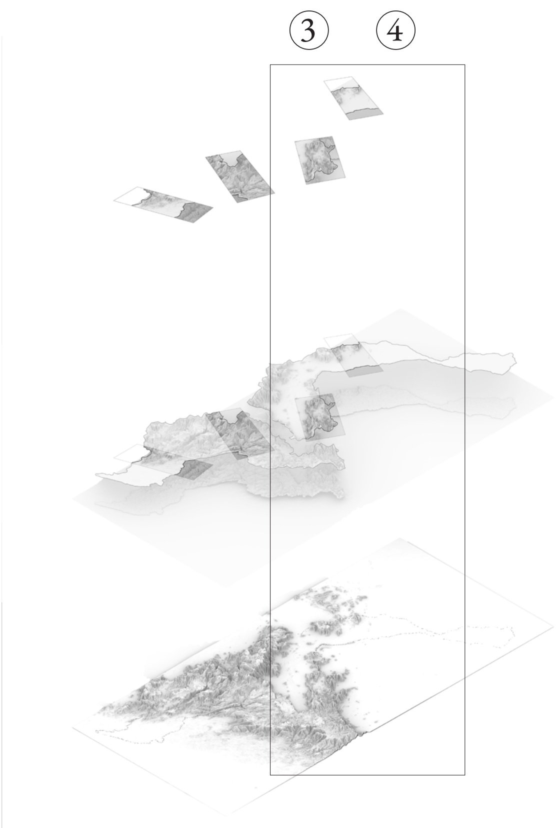


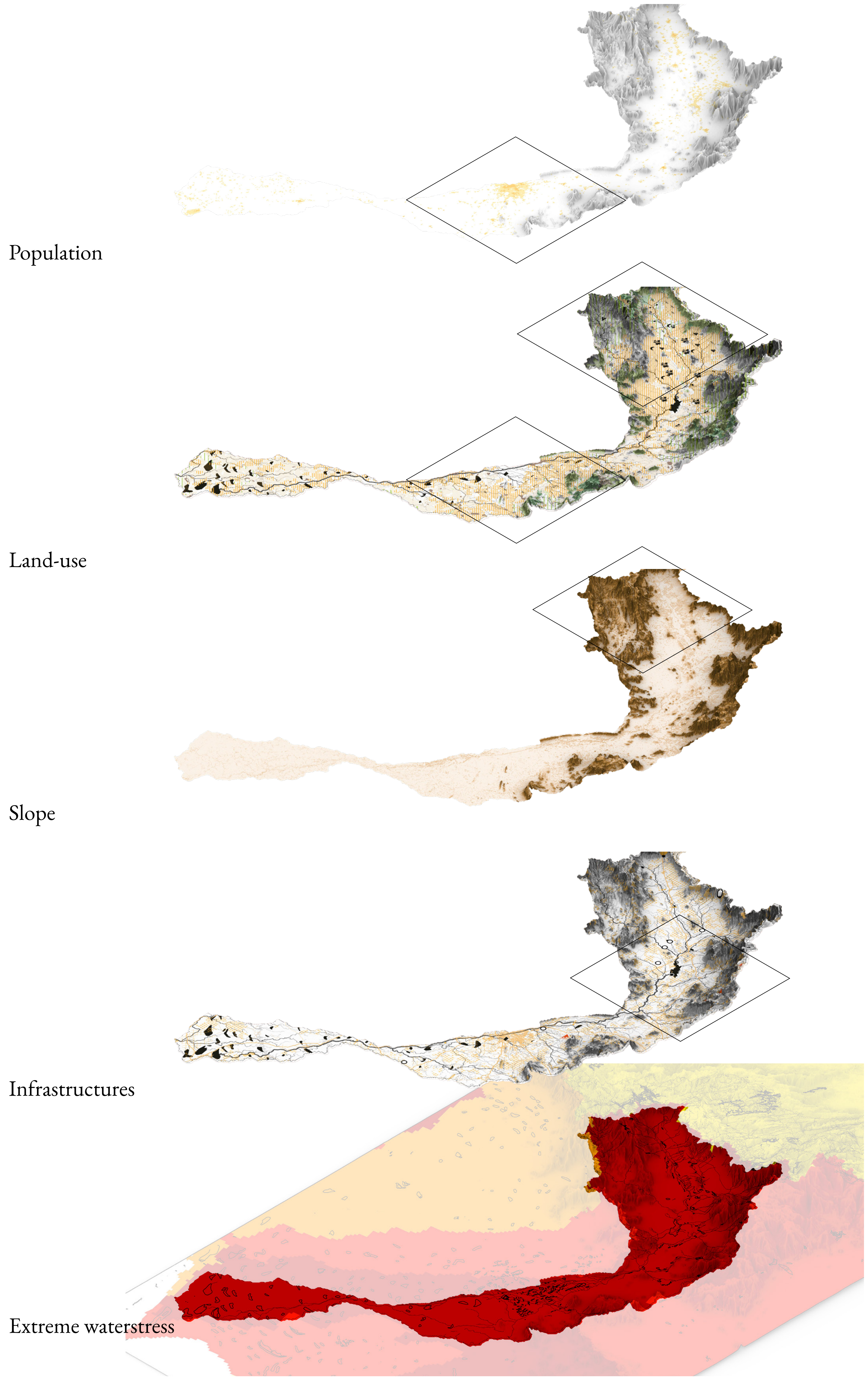
Structure : Periyar River basin



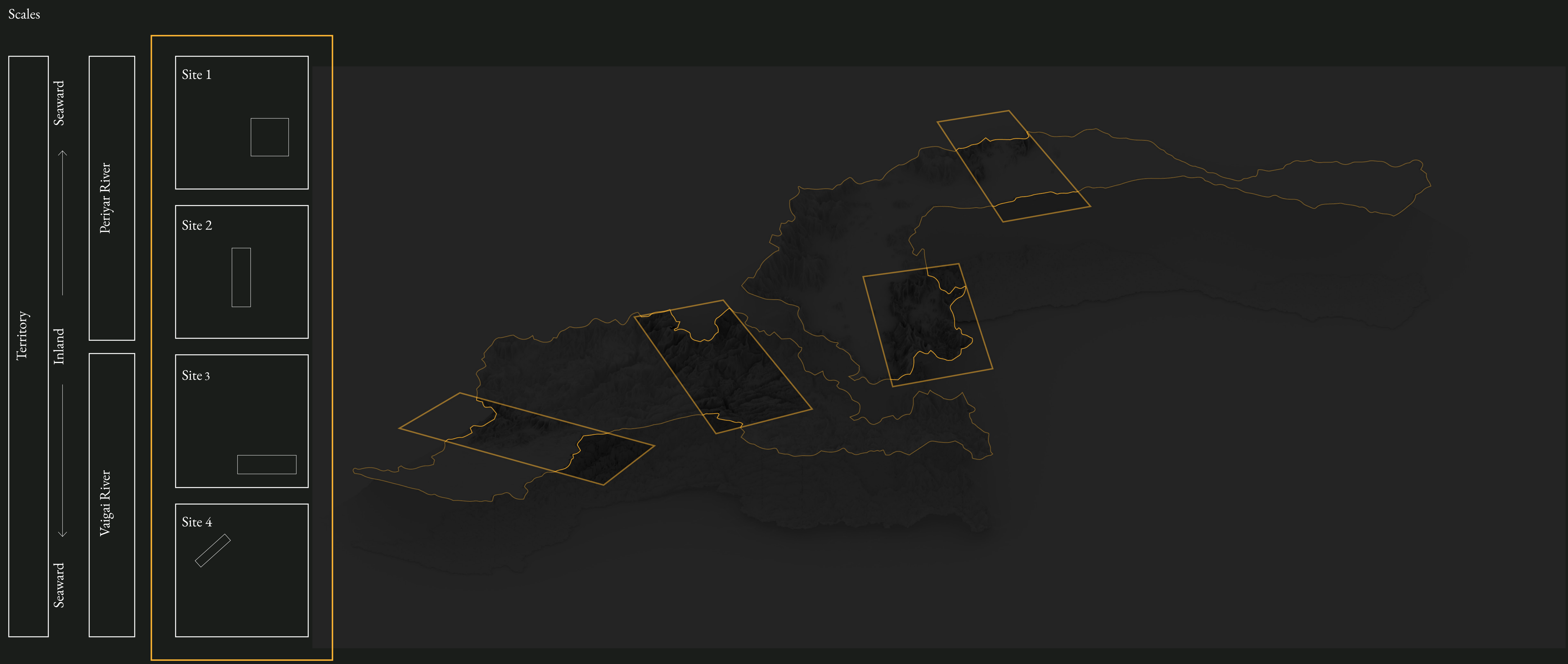


Structure : Vaigai River basin





Structure : Network scale



Goals : Sponge

1. Water retention
2.Regenerative agriculture.

Goals : Passage

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

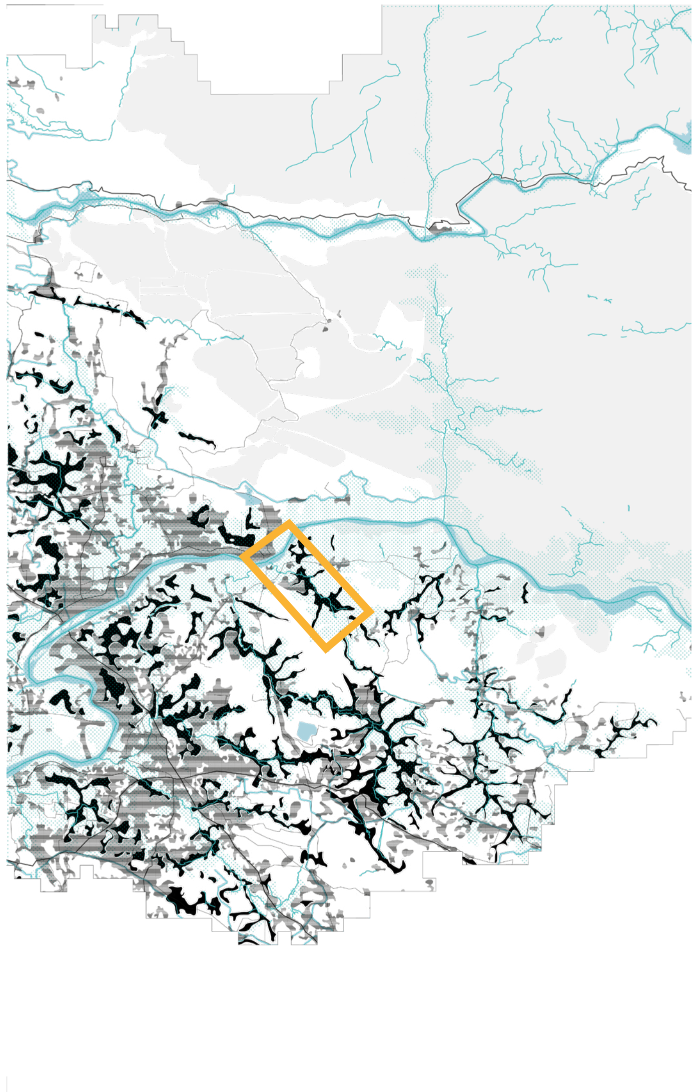
Goals : Interception

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

Goals : Mediator

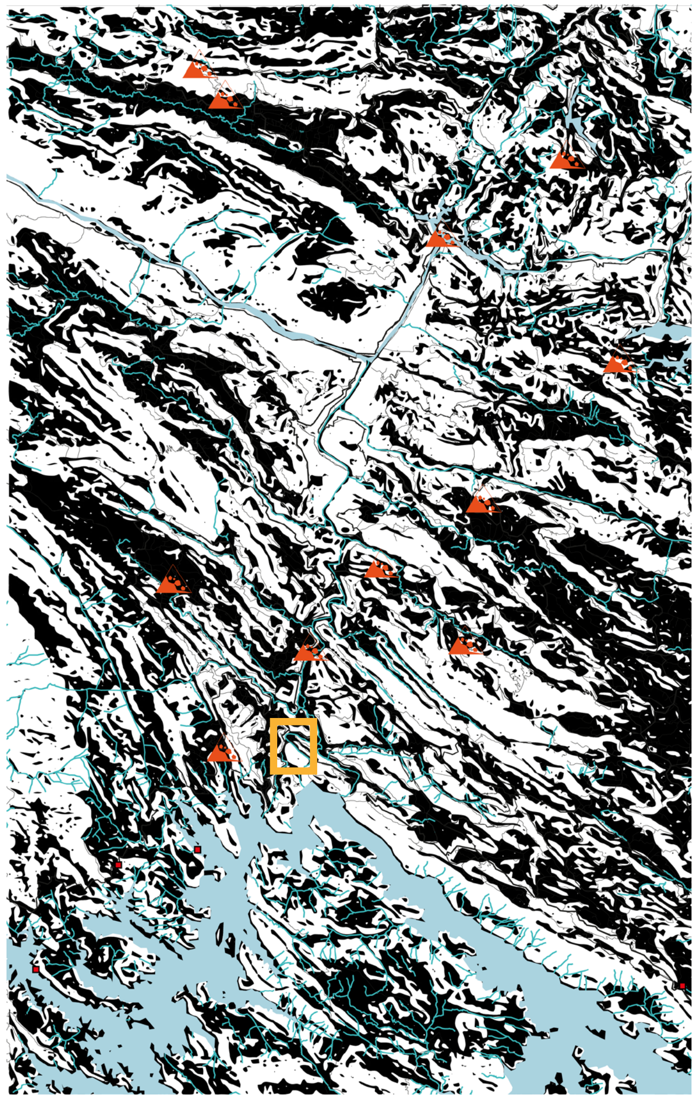
1. Riparian restoration
2. From consumer to producer

Structure :
Network scale



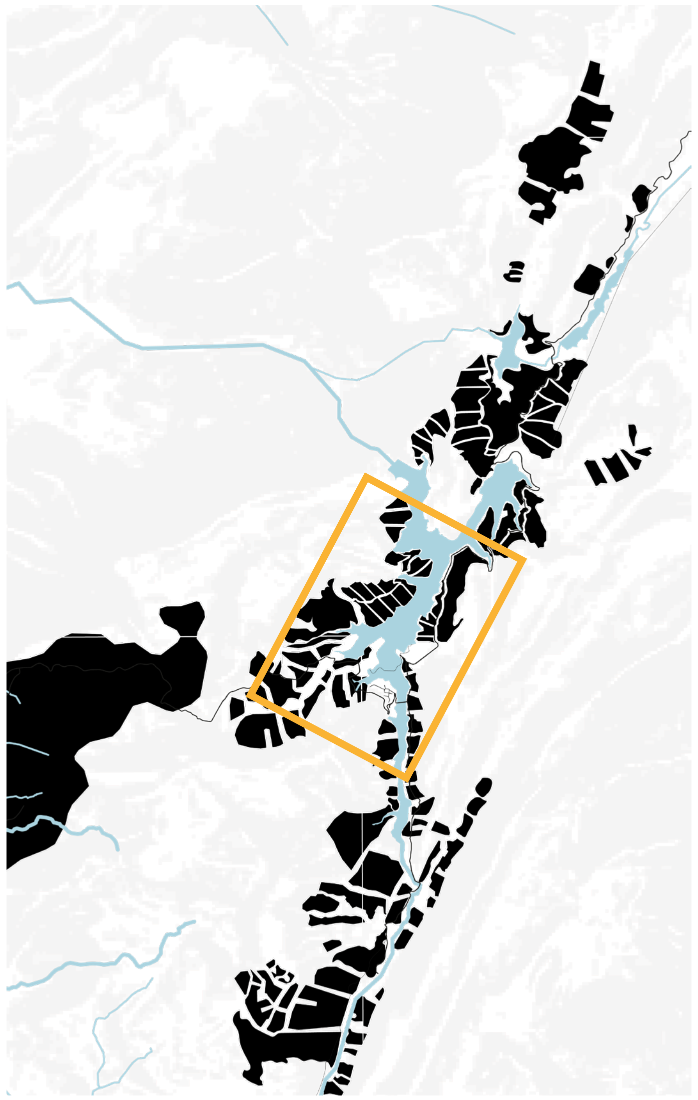
Site 1: Kodanad

Population : 15,953
Occupation : Agriculture



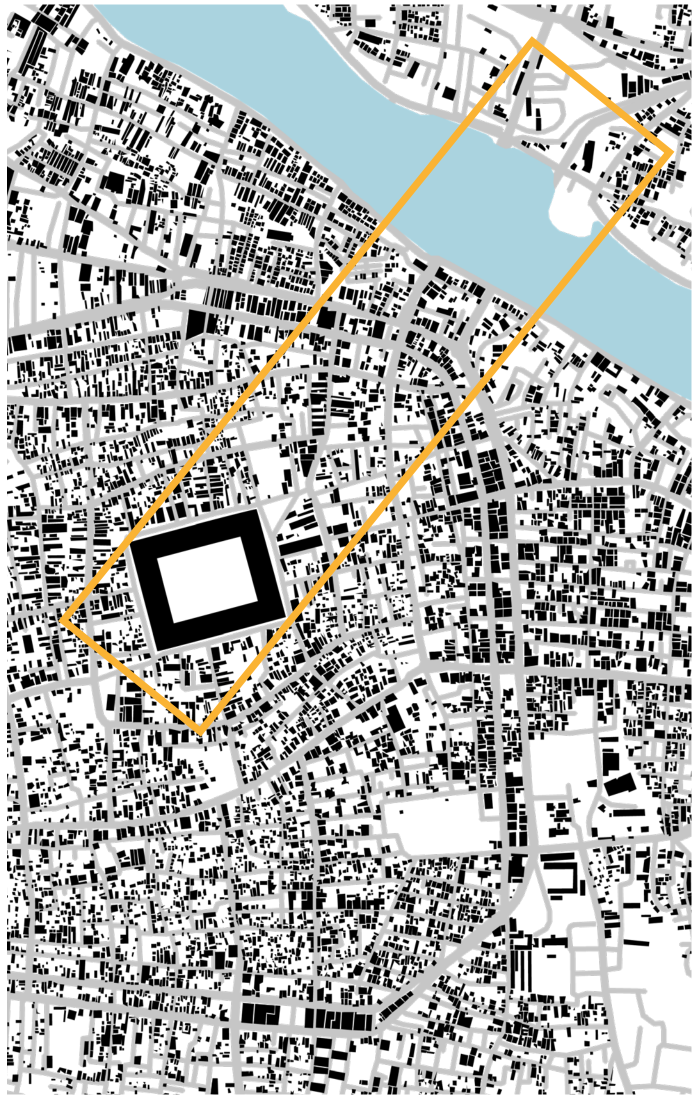
Site 2: Idukki dam

Population : 26,250 Occupation :
Tourism, plantations



Site 3: Megamalai

Population : 8,348
Occupation : Tourism, plantations

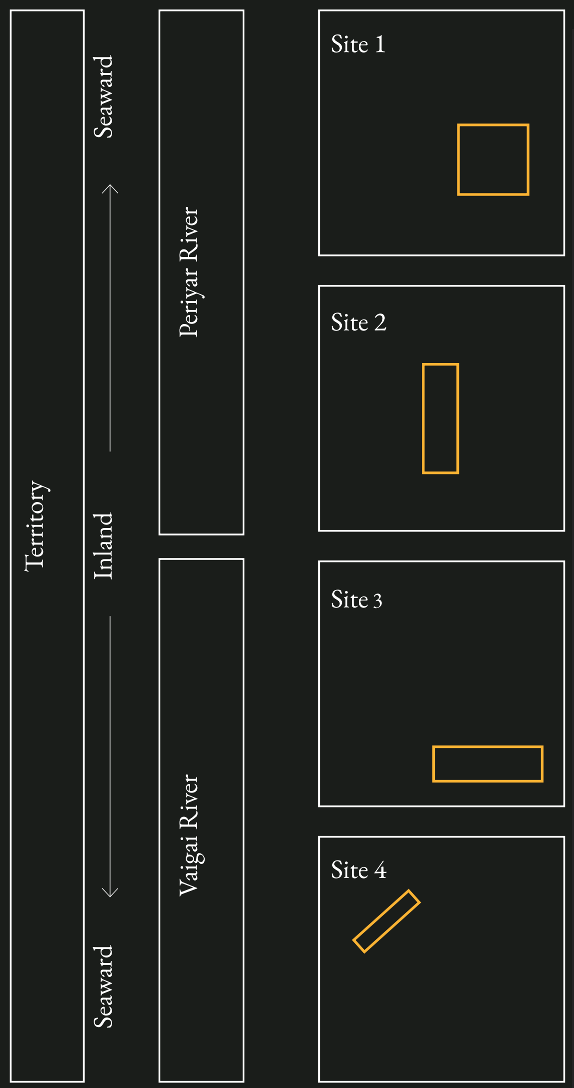


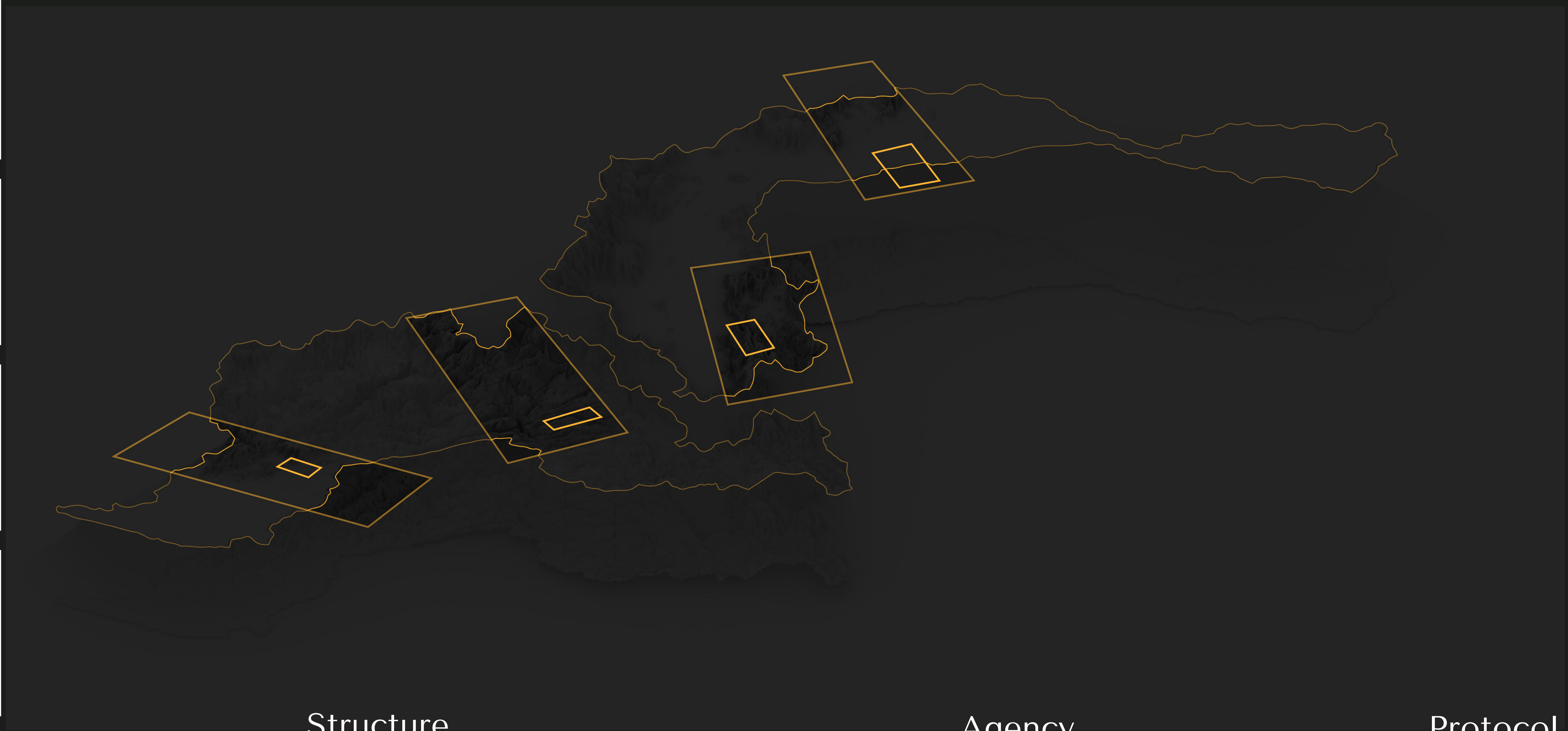
Site 4: Madurai

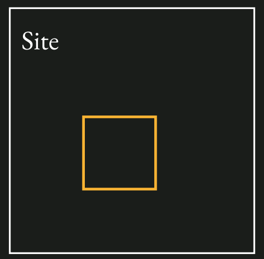
Population : 1,766,000
Occupation : Tourism, Urban

Structure :
Local scale

Scales







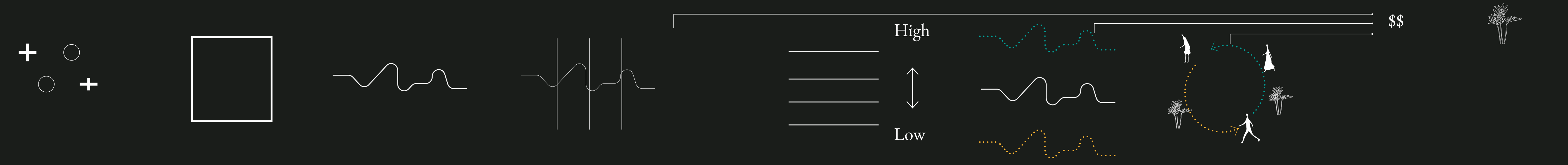
Structure

Agency

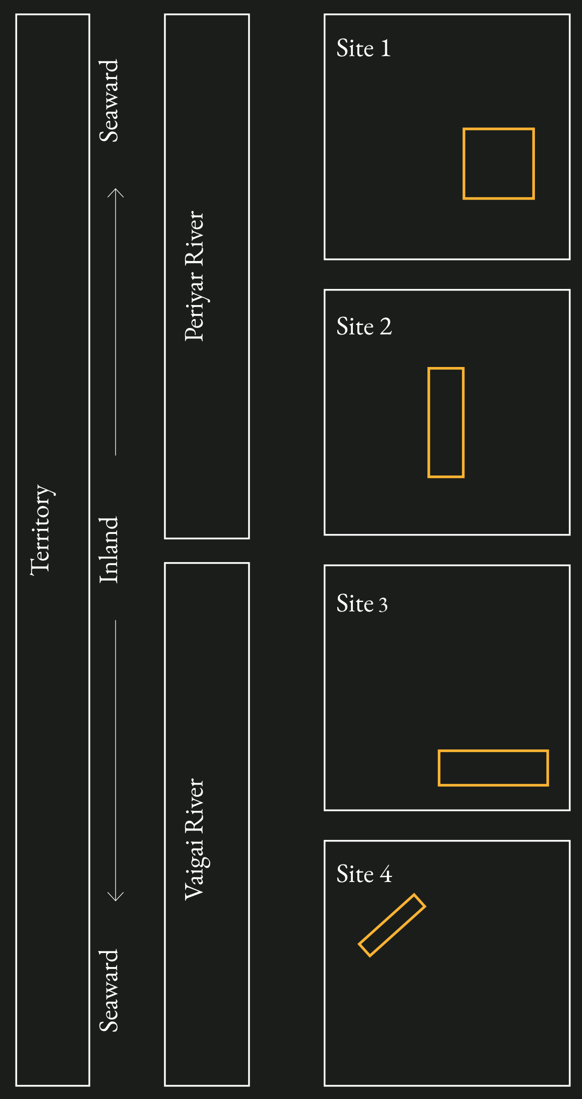
Protocol of Care

Devices

Infrastructural devices | Risk zone Mapping | Resulting landscape | Phasing | Program | Iterations | Practice | Economy — Ecosystem



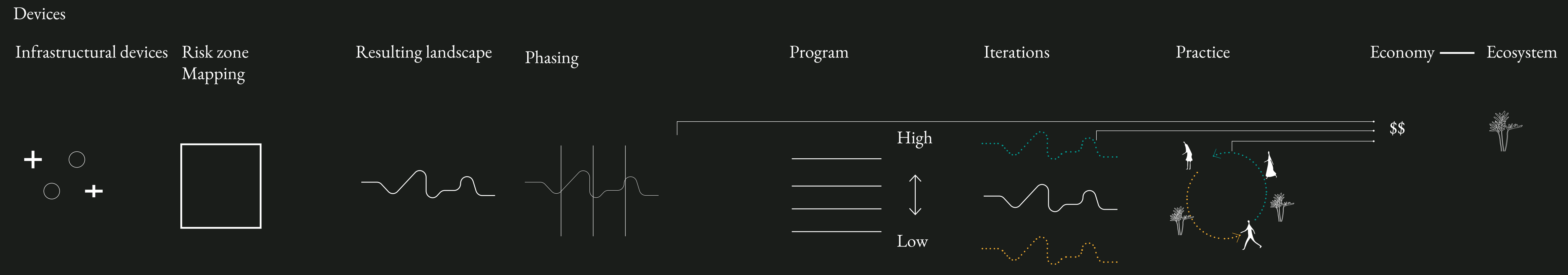
Scales



Structure

Agency

Protocol of Care



Devices

01.Sediment Accretion

02.Terraced Cultivation

Agency

Program

Resilient infrastructure

Water Retention

Floodable landscape

Terraced water tanks

Production

Aquaculture

Fishing

Sewage treatment

Built environment

Settlement pattern

Road networks

Production units

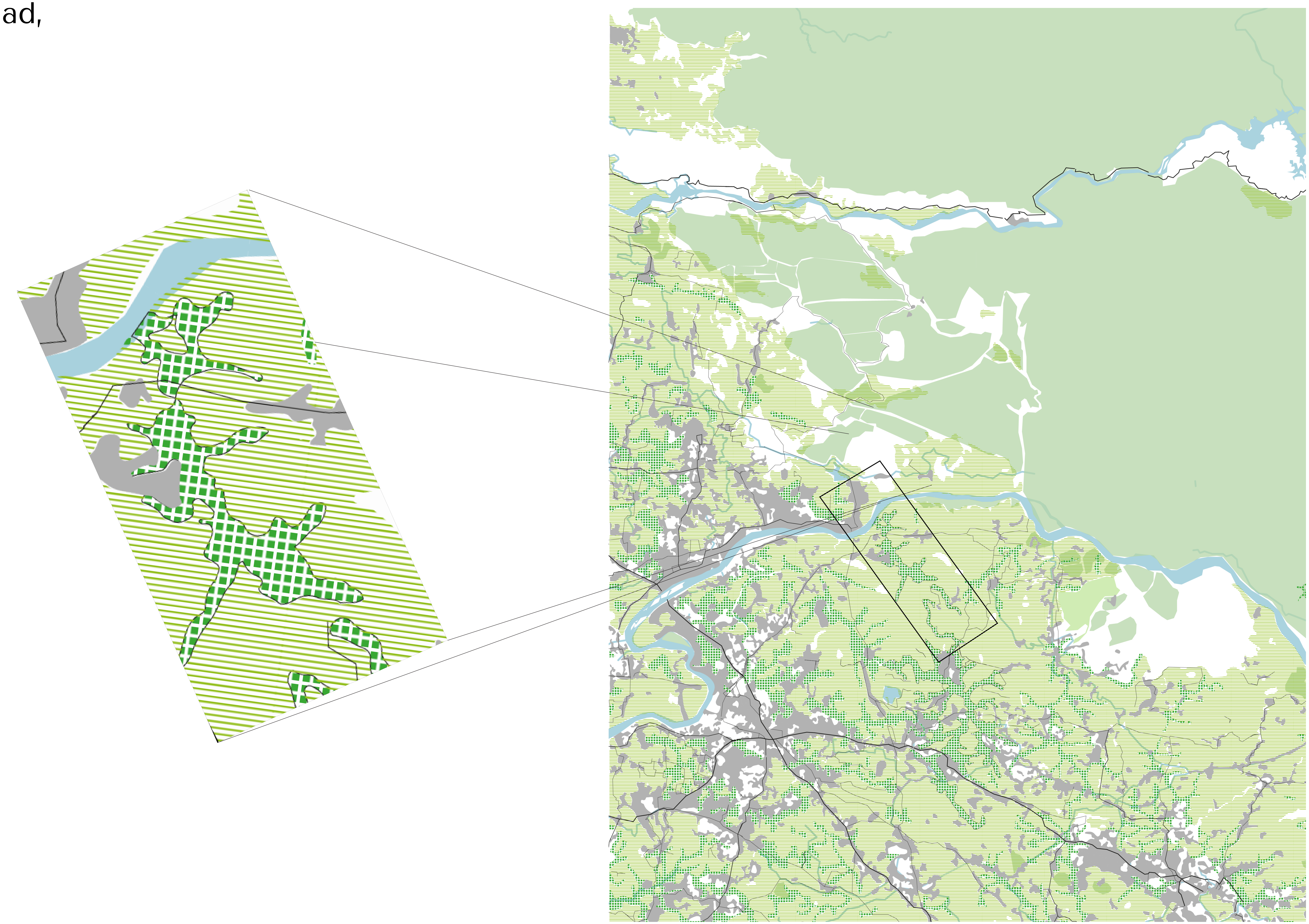
Practice

Economy

Monitising regenerative period of these productive landscapes by giving subsidies to landowners who practice these cycles.

Site 1: Kodanad, Kerala

Site 1: Kodanad, Kerala



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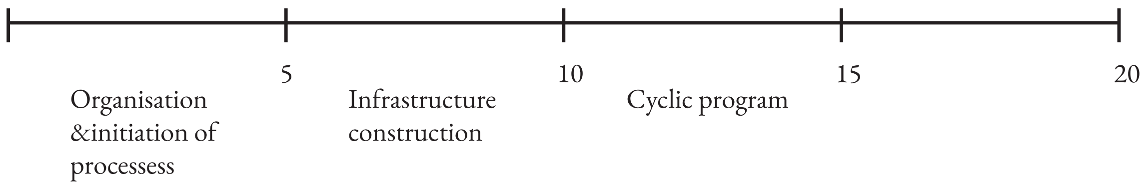
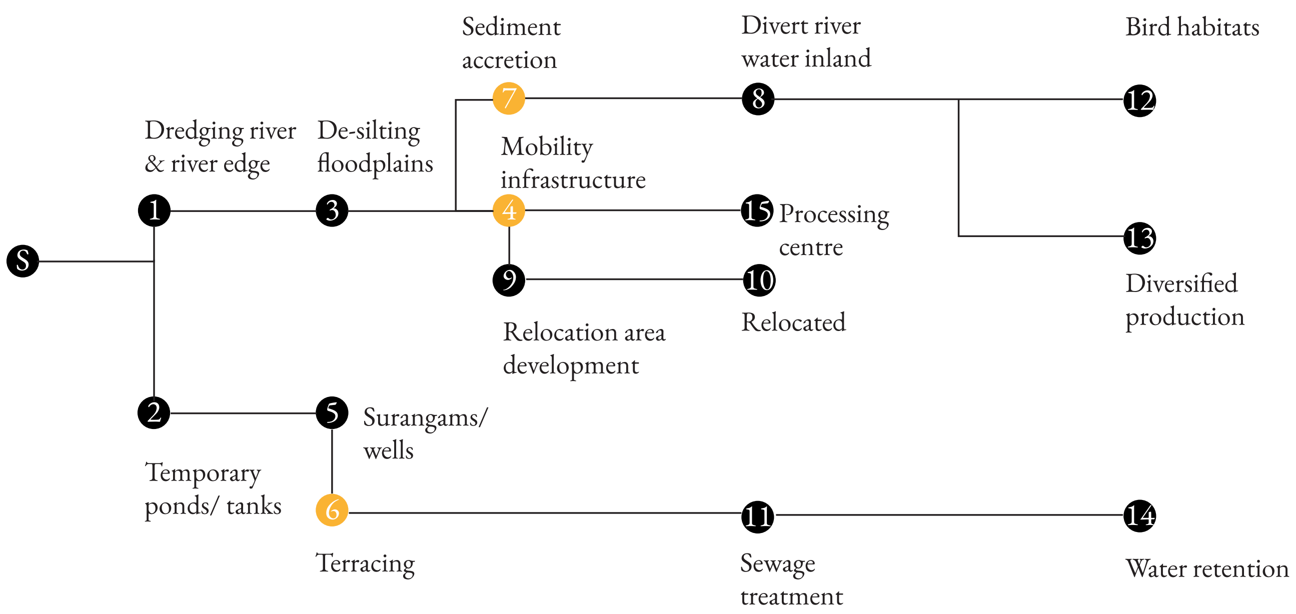
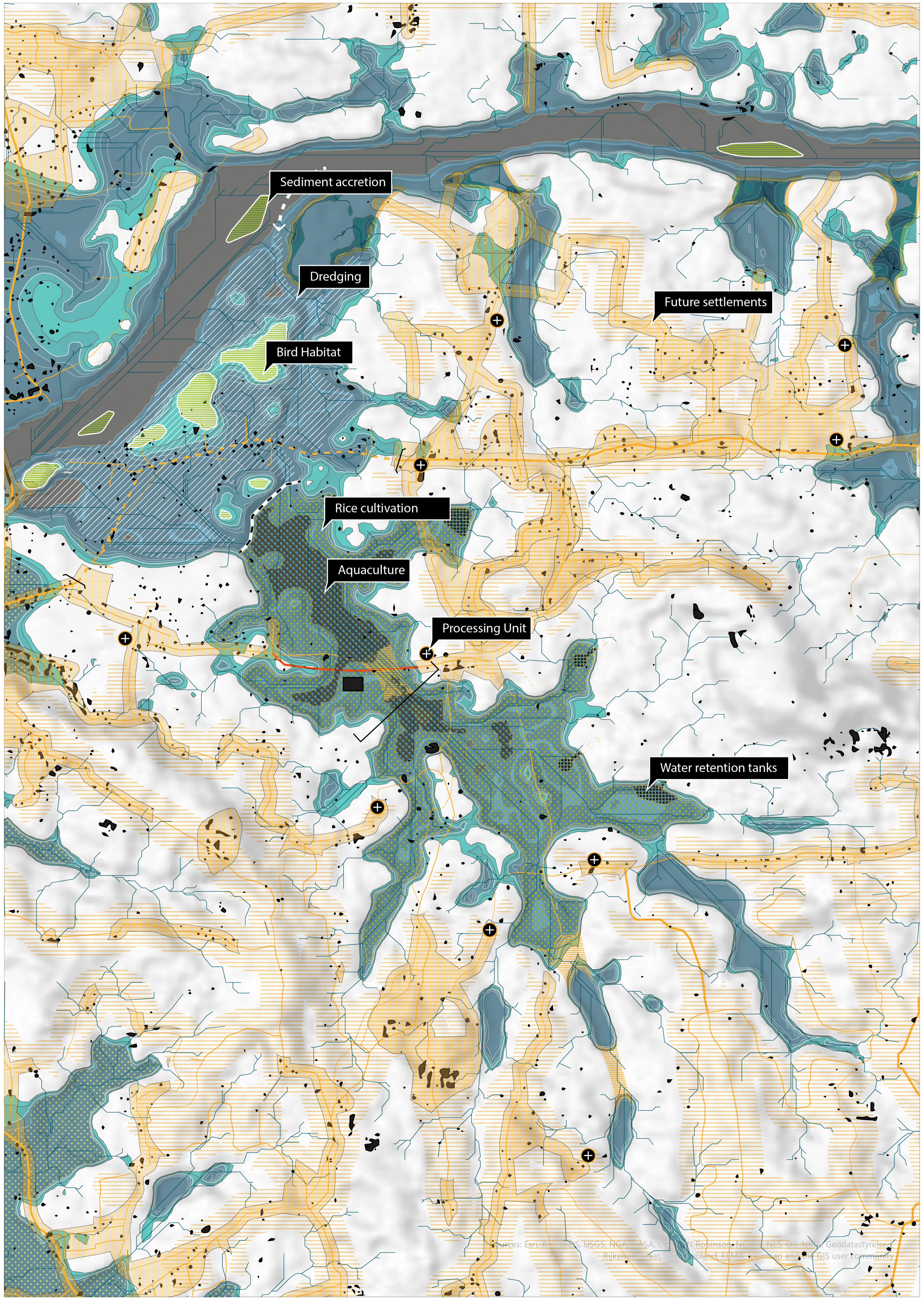


Site 1





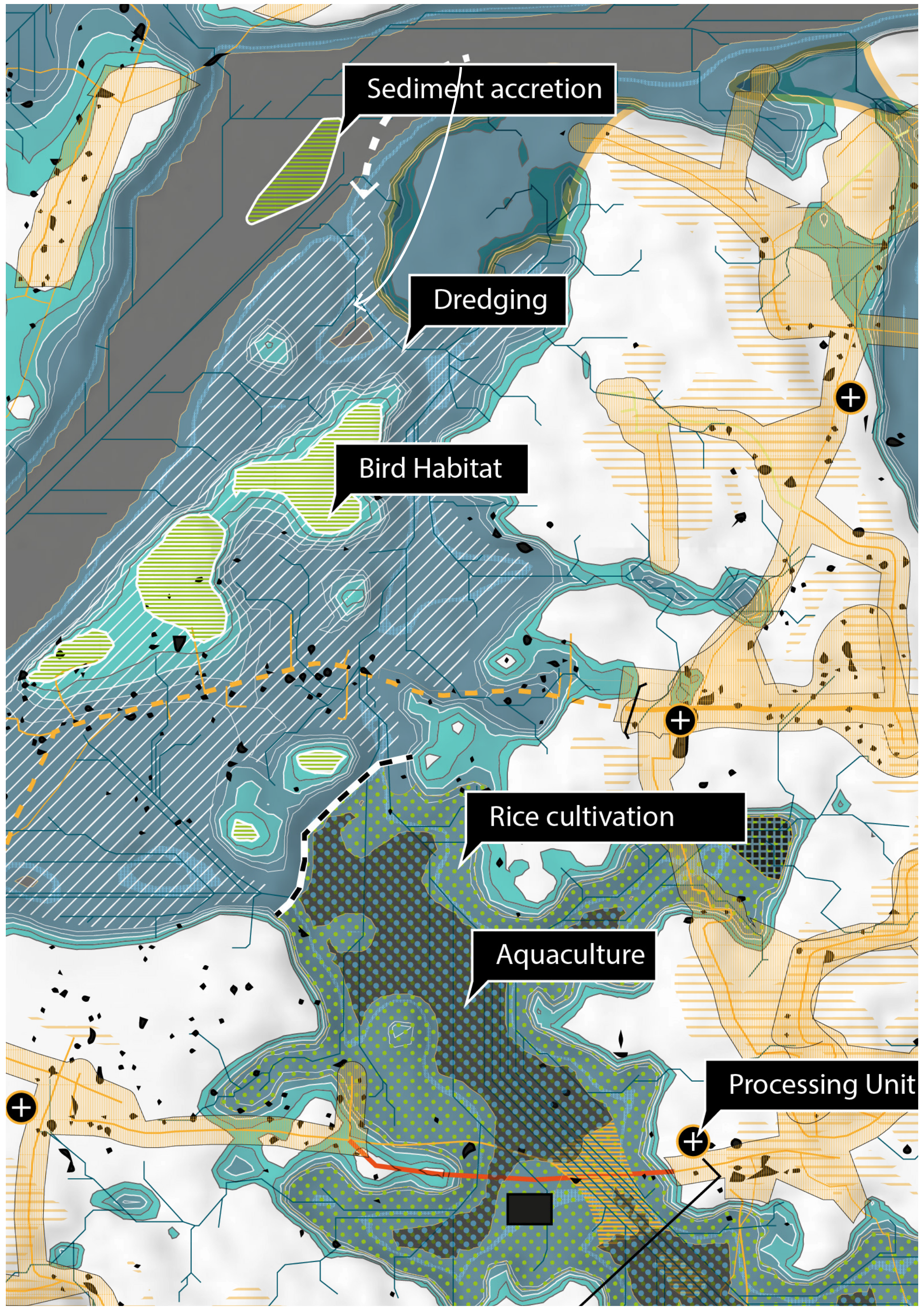
Site 1: Kodanad, Kerala

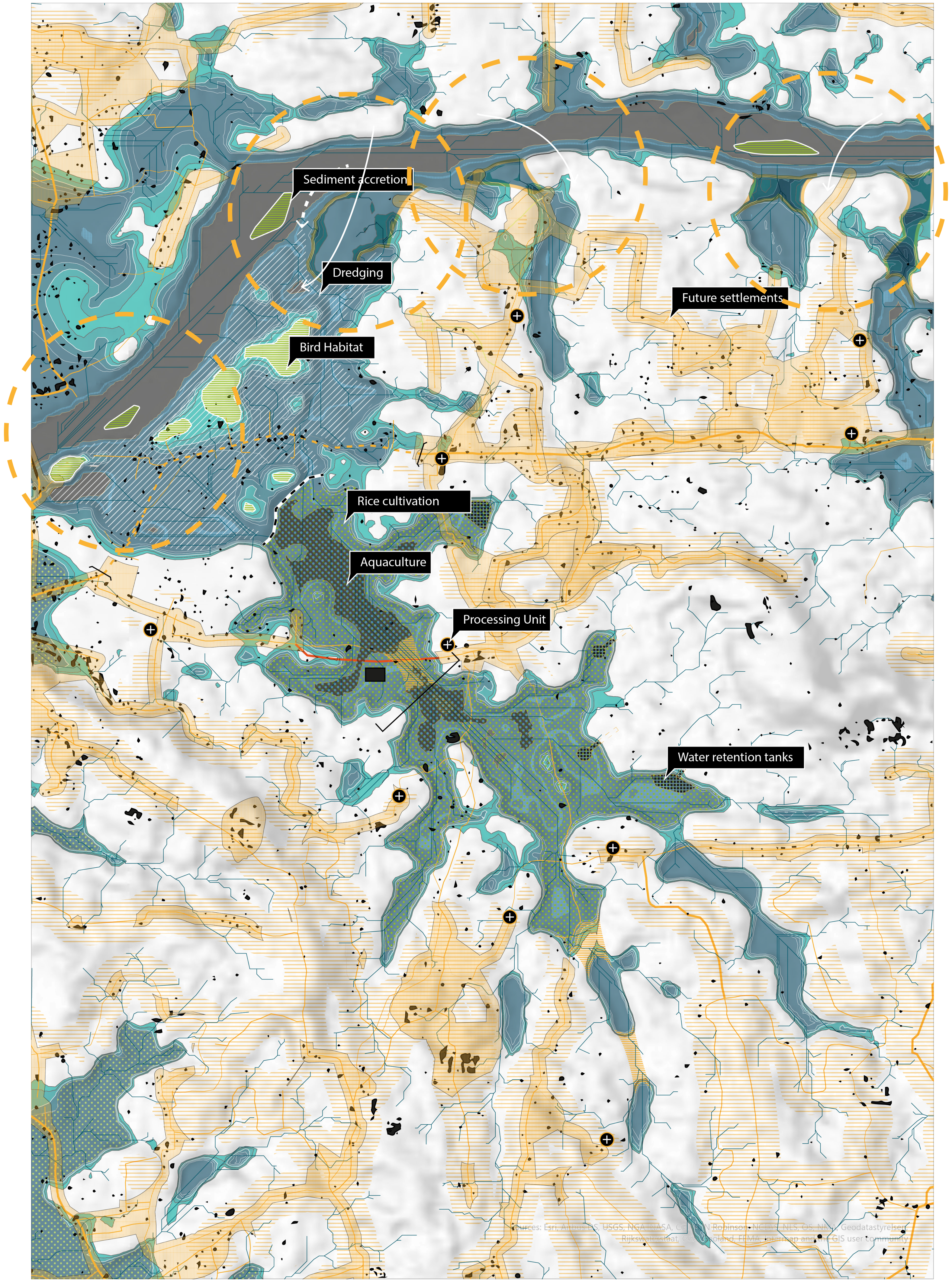
1 Devices

Infrastructural devices

01.Sediment Accretion

02.Terraced Cultivation





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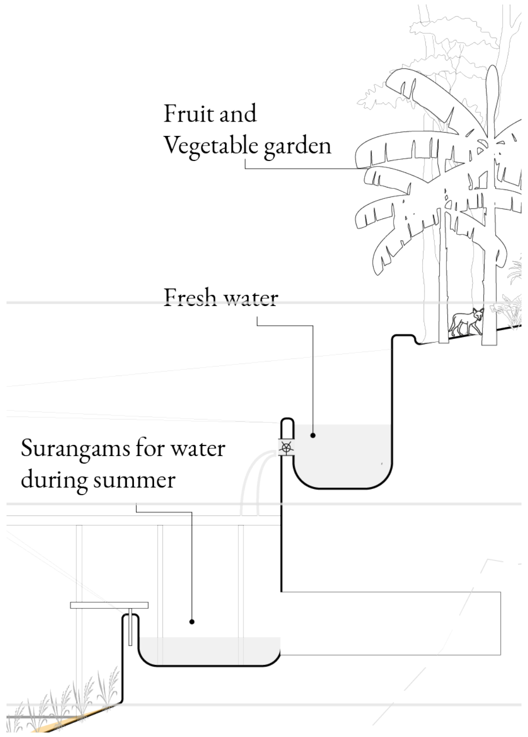
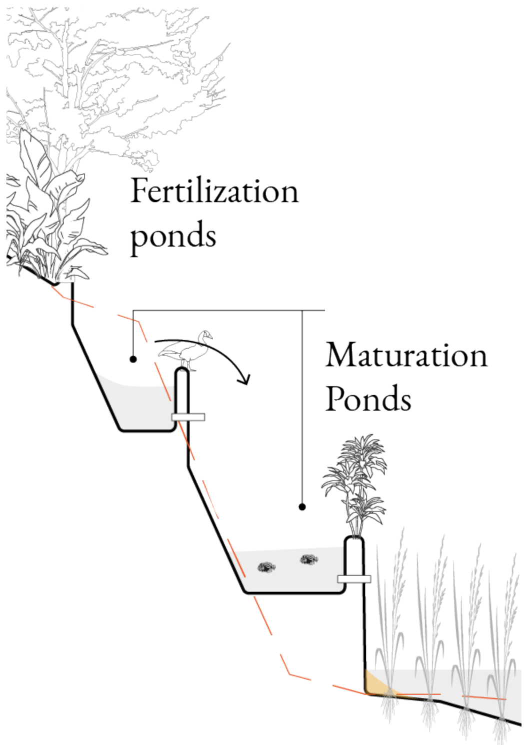
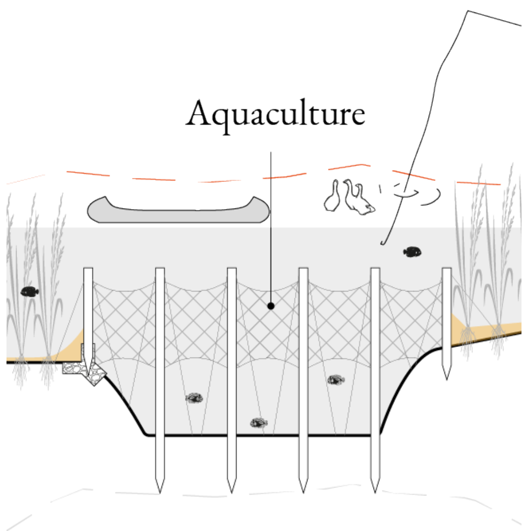


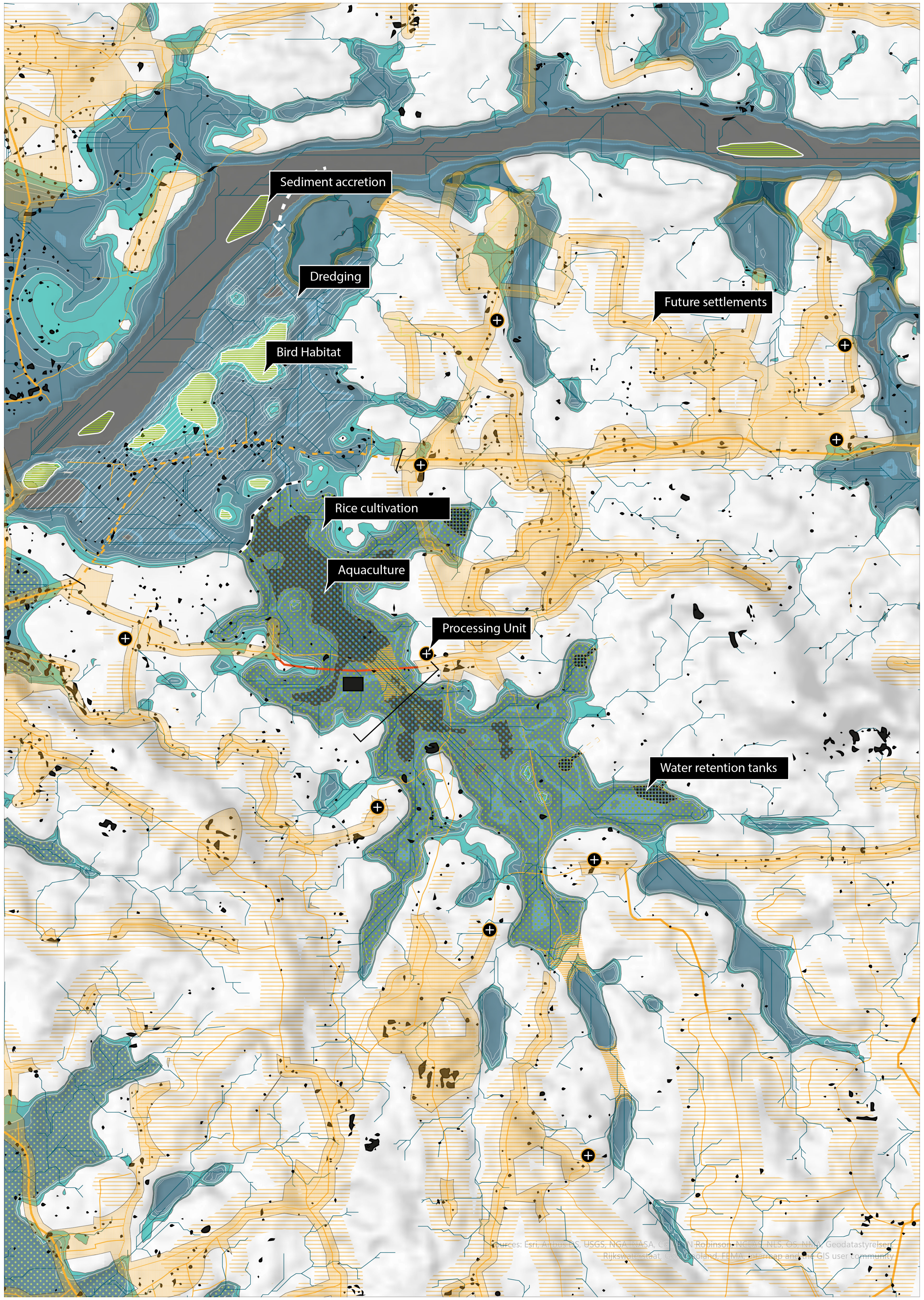
Water storage



Sewage treatment



Aquaculture



Site 1: Kodanad, Kerala

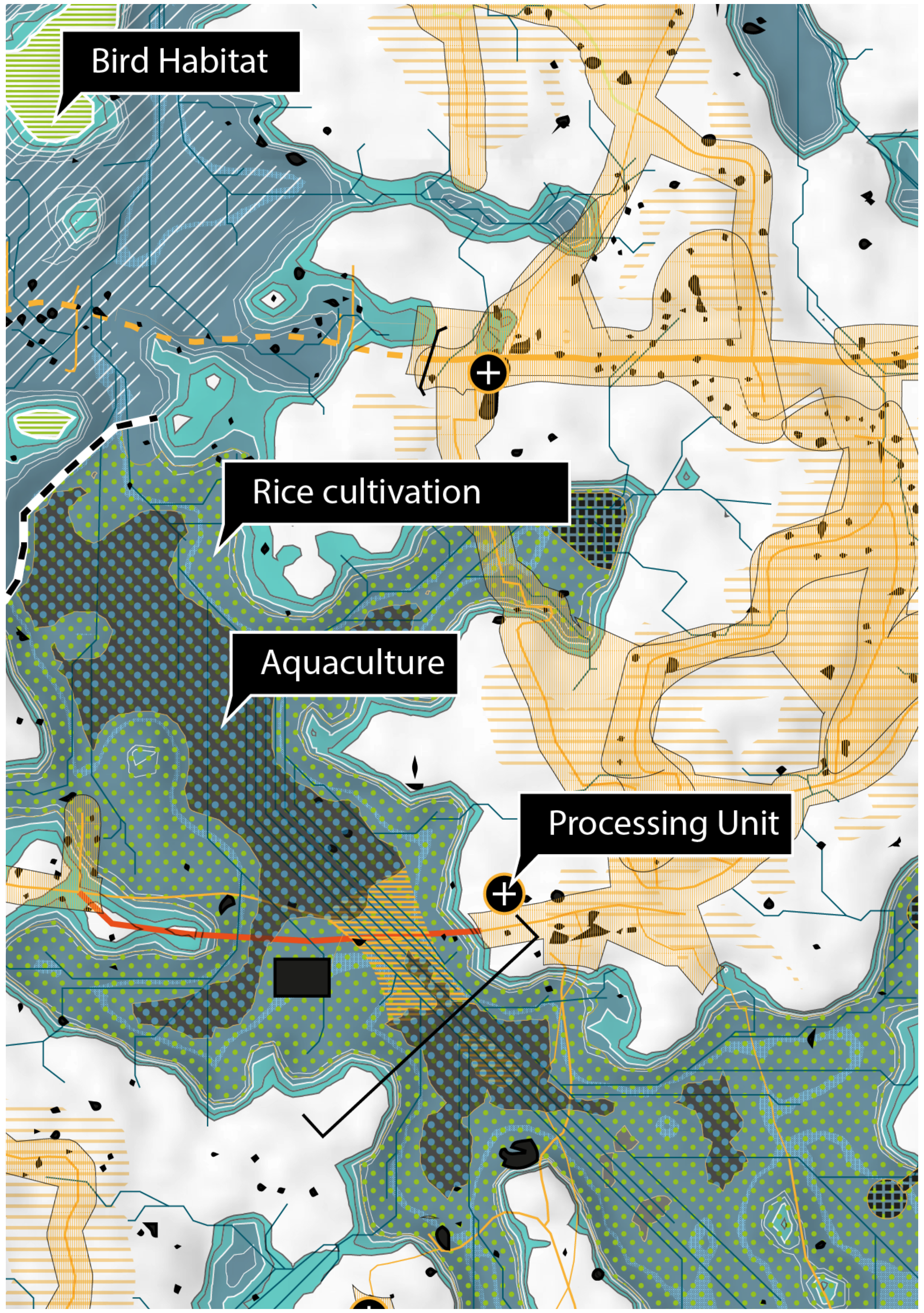
2 Devices

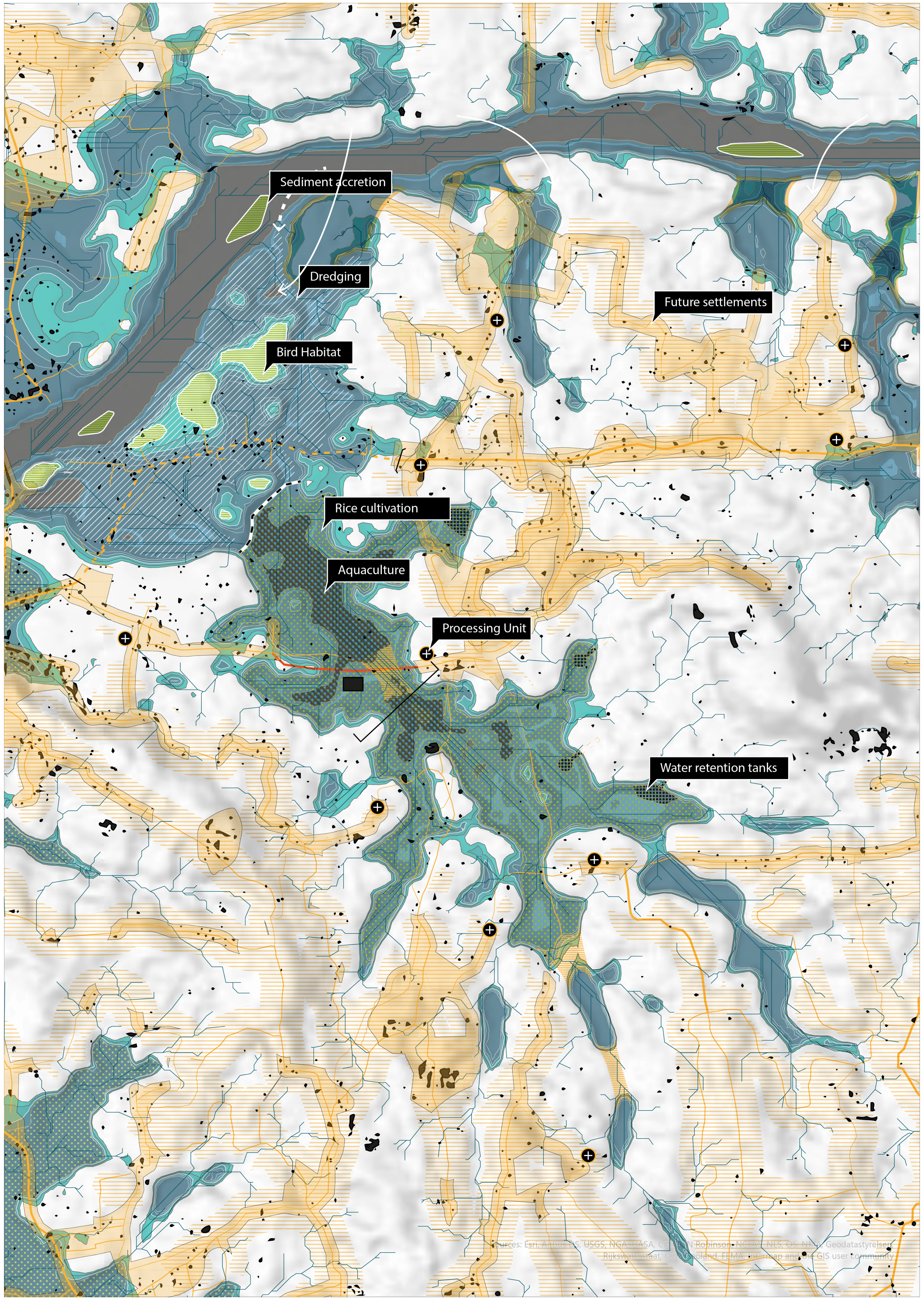
Risk zone Mapping

2 Program

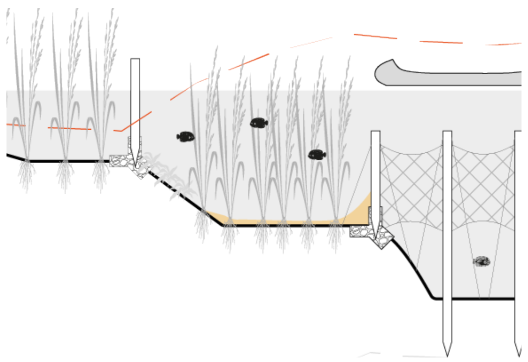
Safe zones for habitation.

Diversifying production

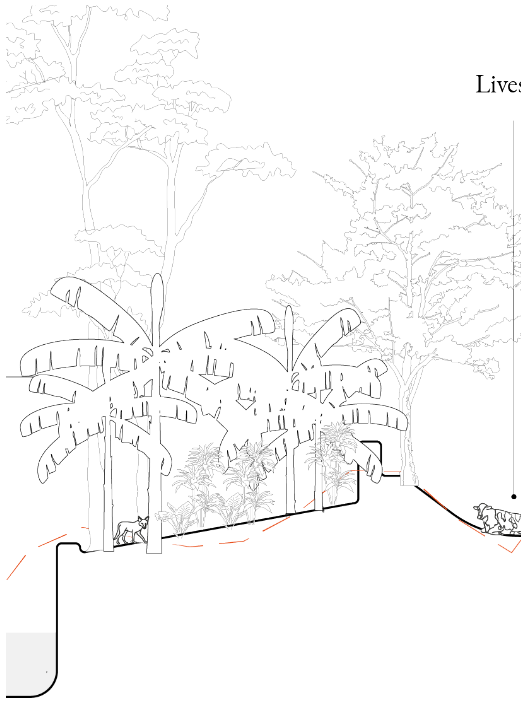




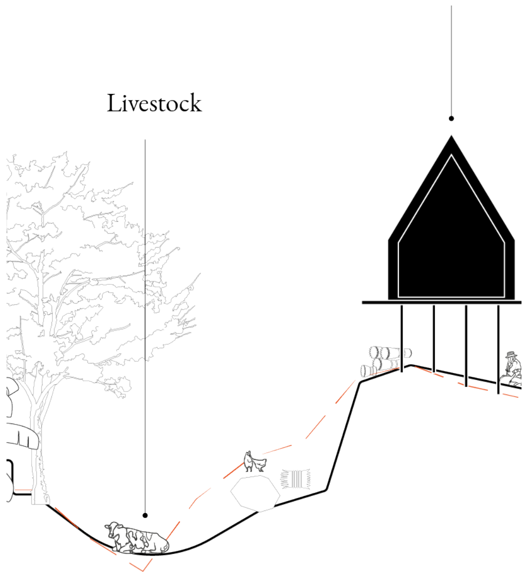
Site 1: Kodanad, Kerala



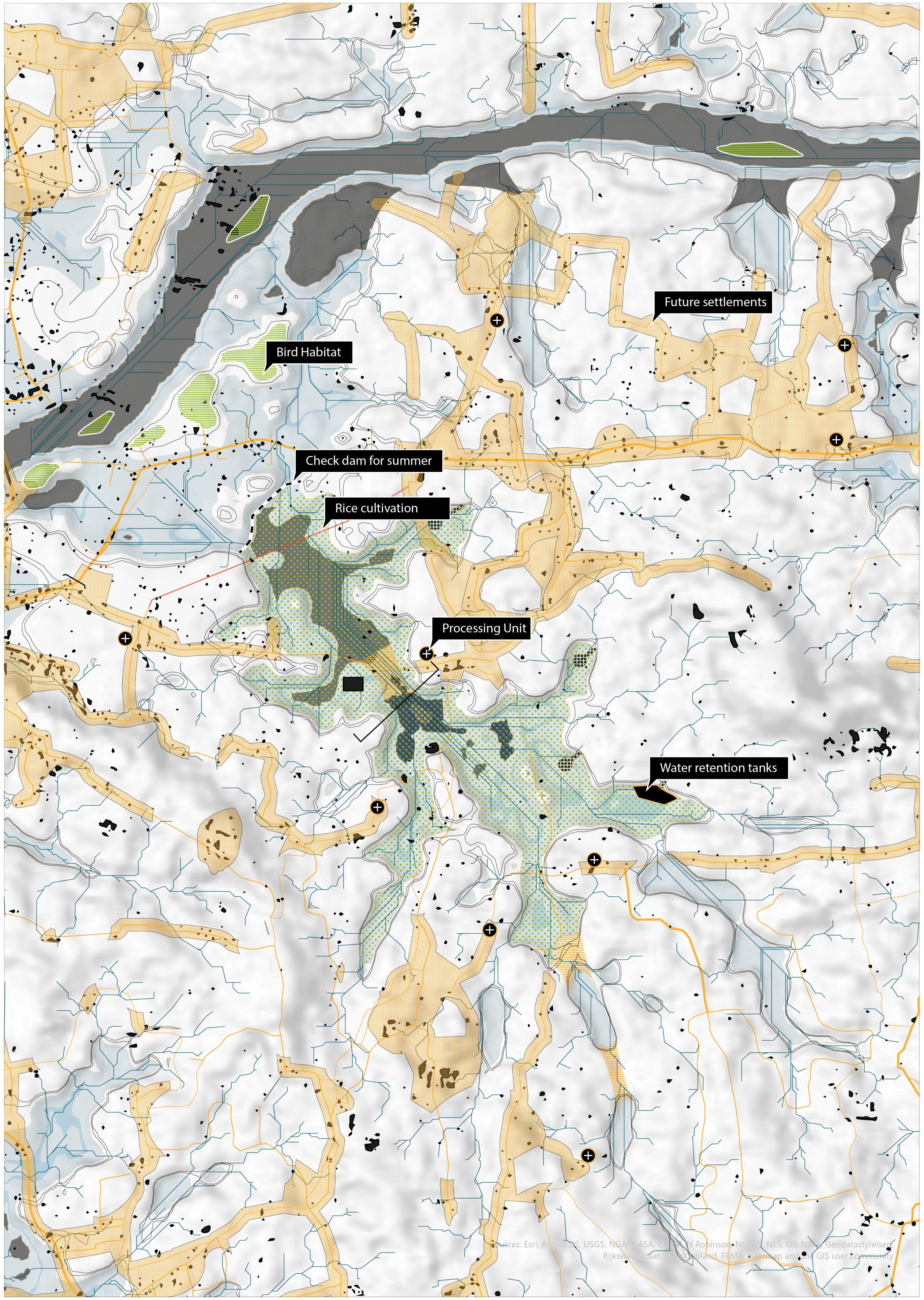
Rice cultivation



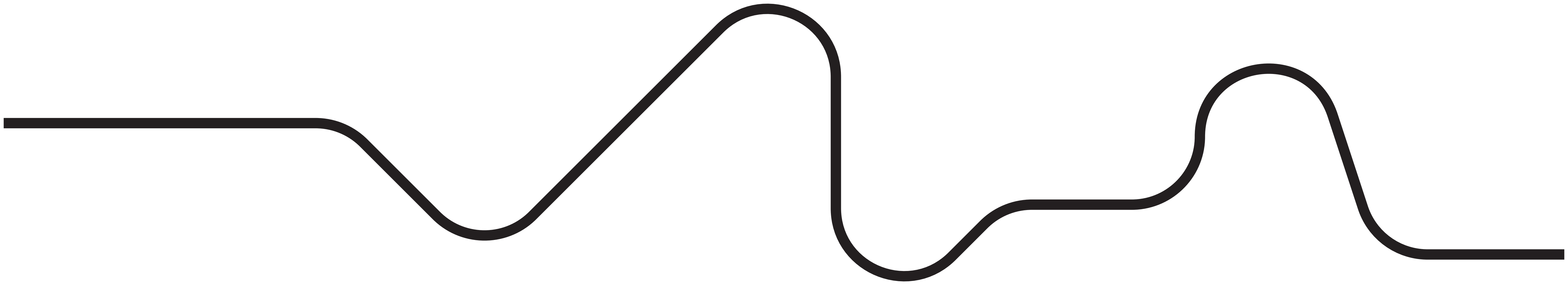
Fruit and Vegetable garden



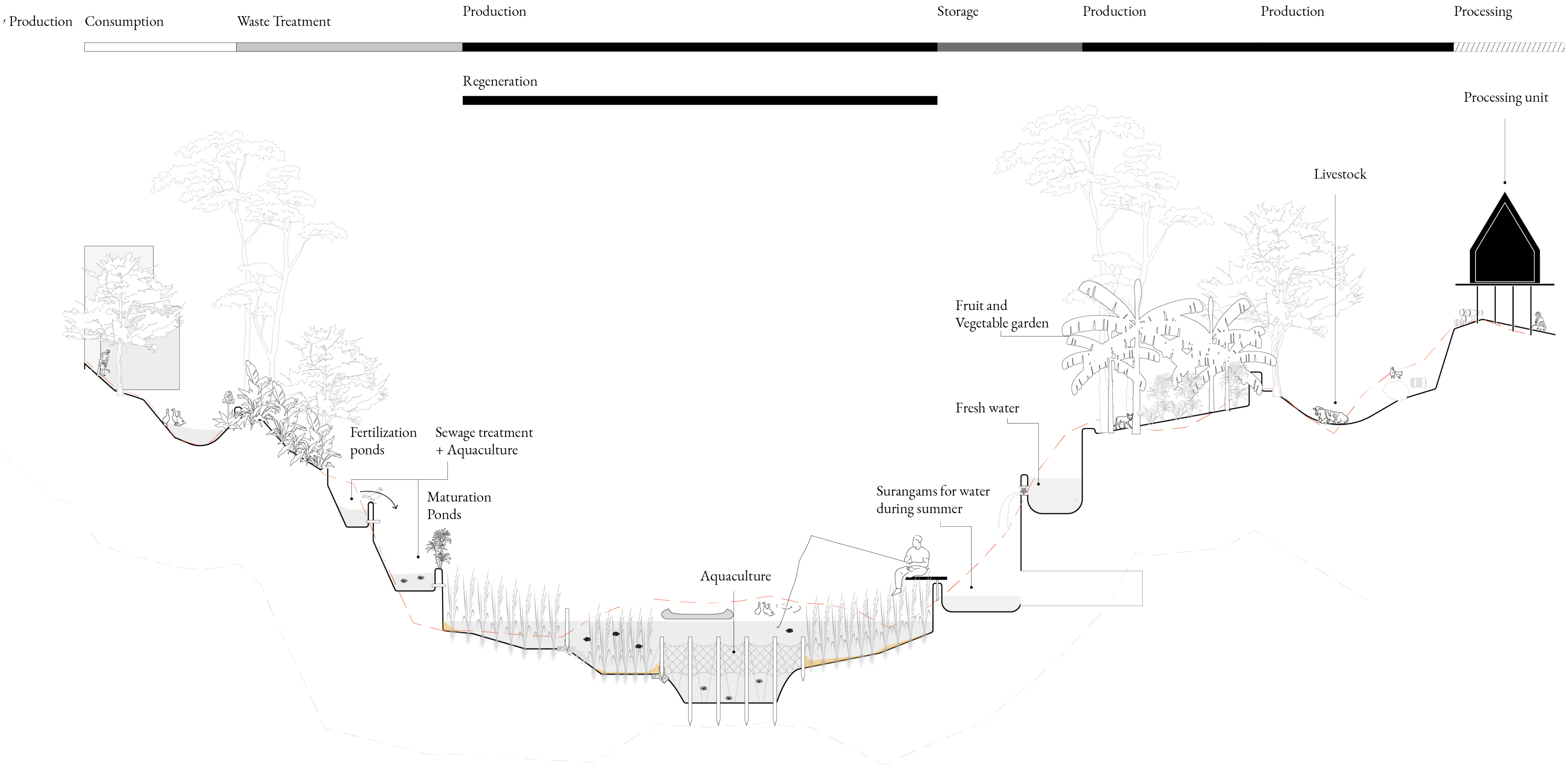
Processing Unit



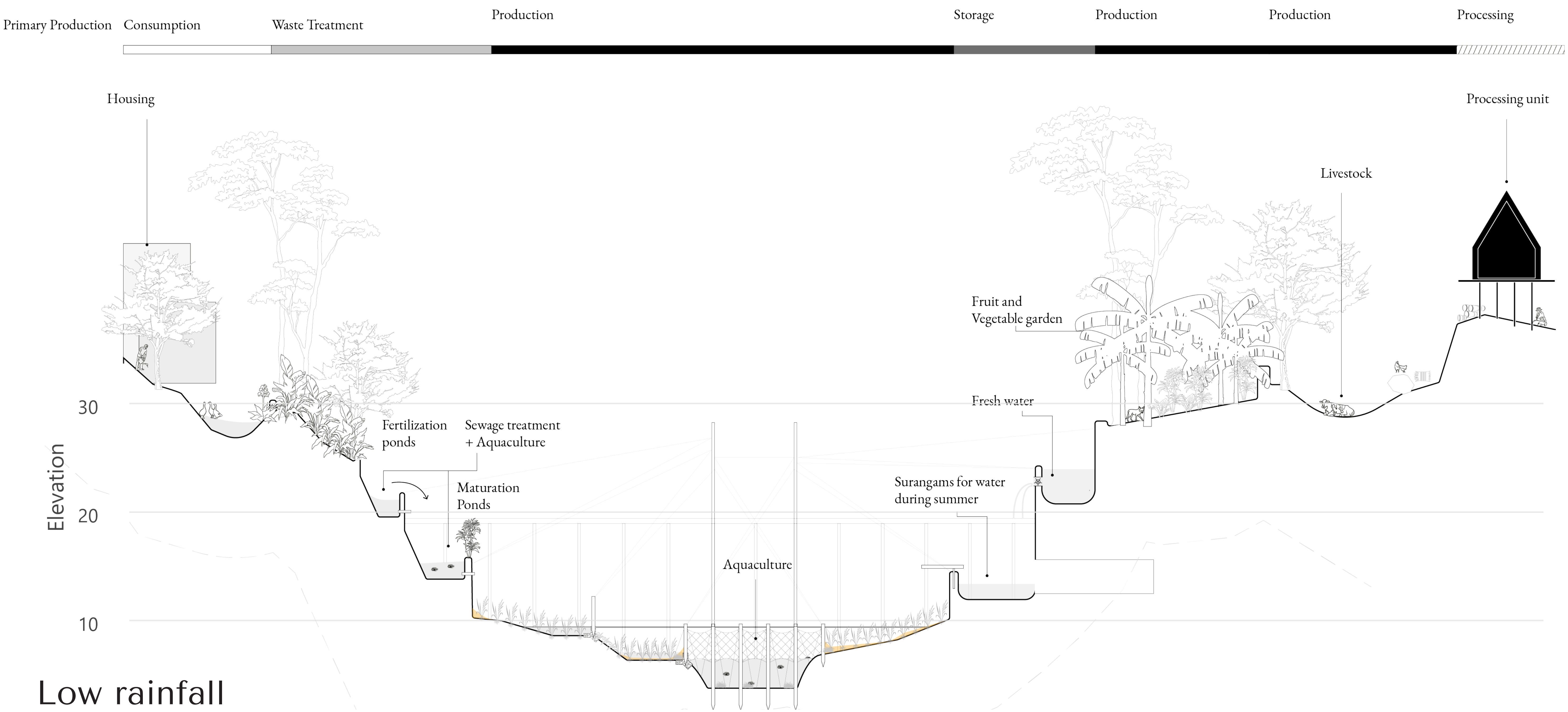
What is the section which exist between these extremes?



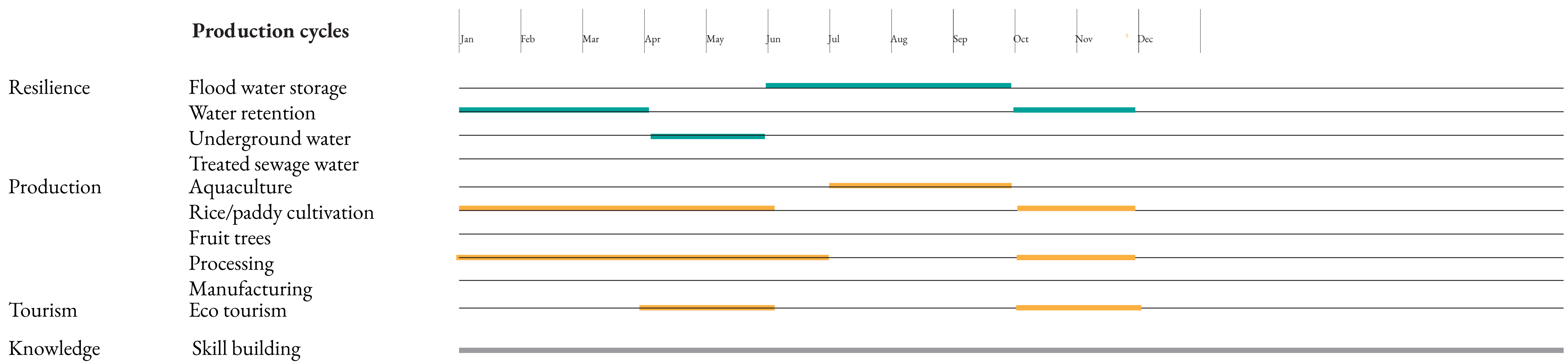
Site 1: Kodanad, Kerala



Site 1: Kodanad, Kerala



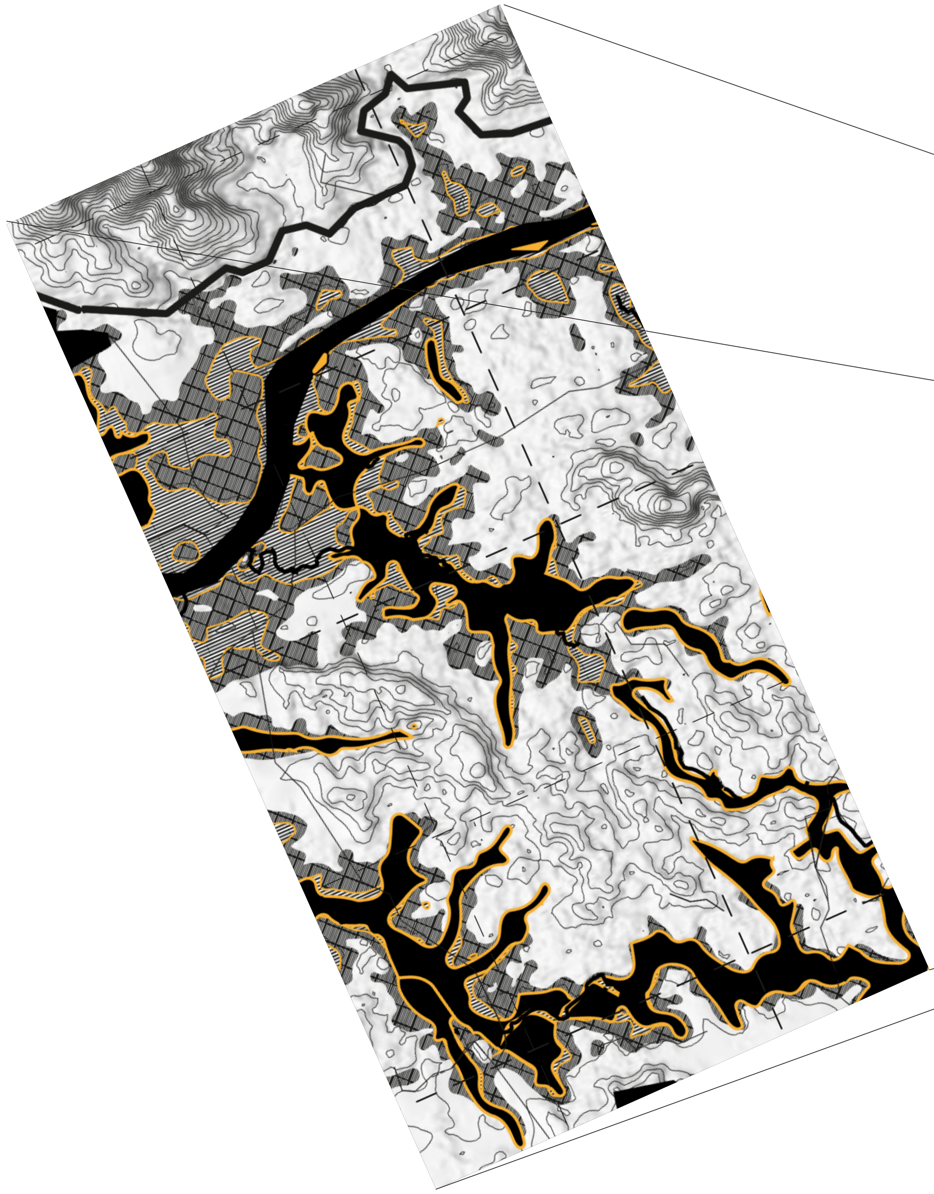
Low rainfall

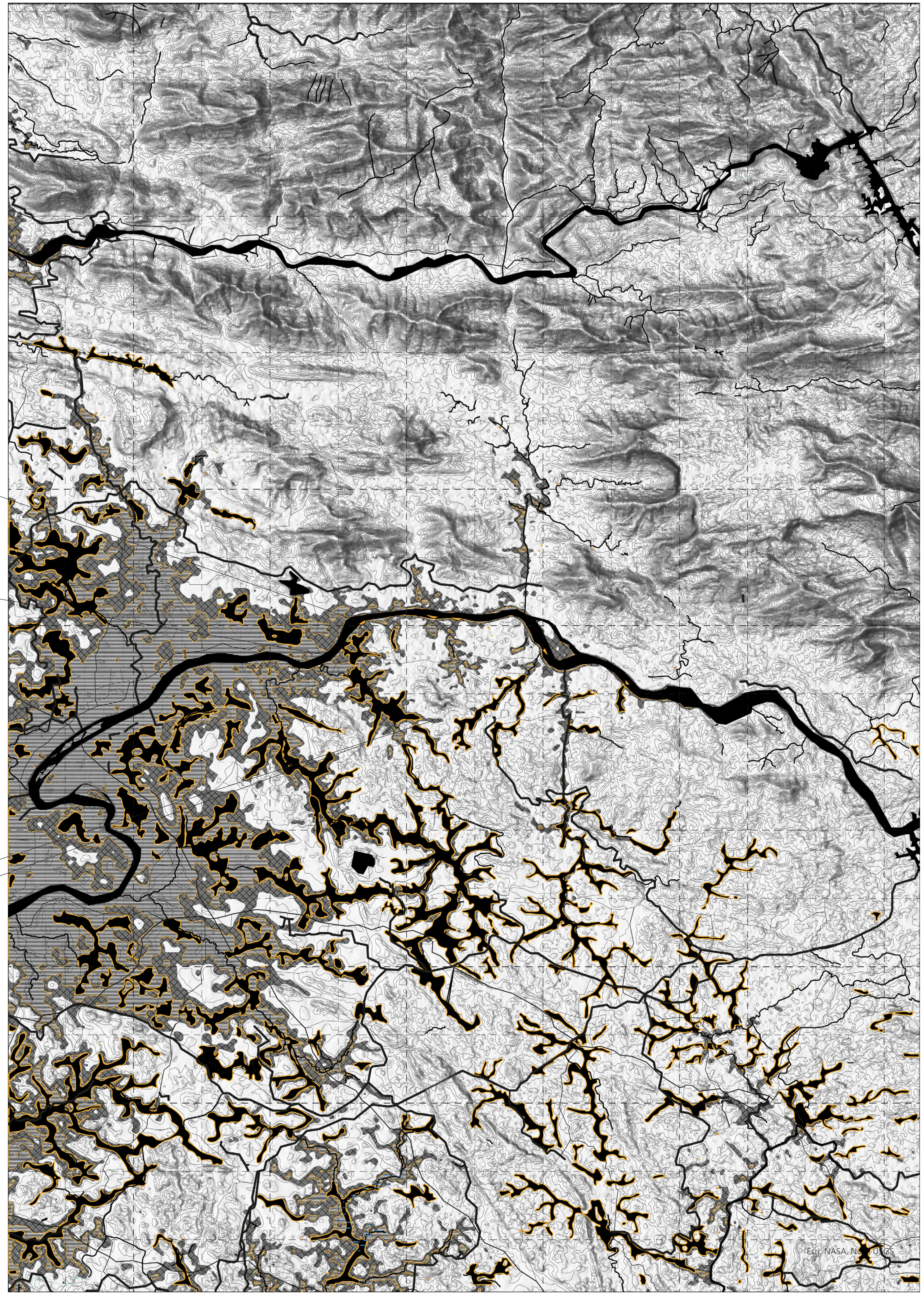



High rainfall


Low rainfall

Site 1:
Kodanad, Kerala





Site 2 :
Idukki dam

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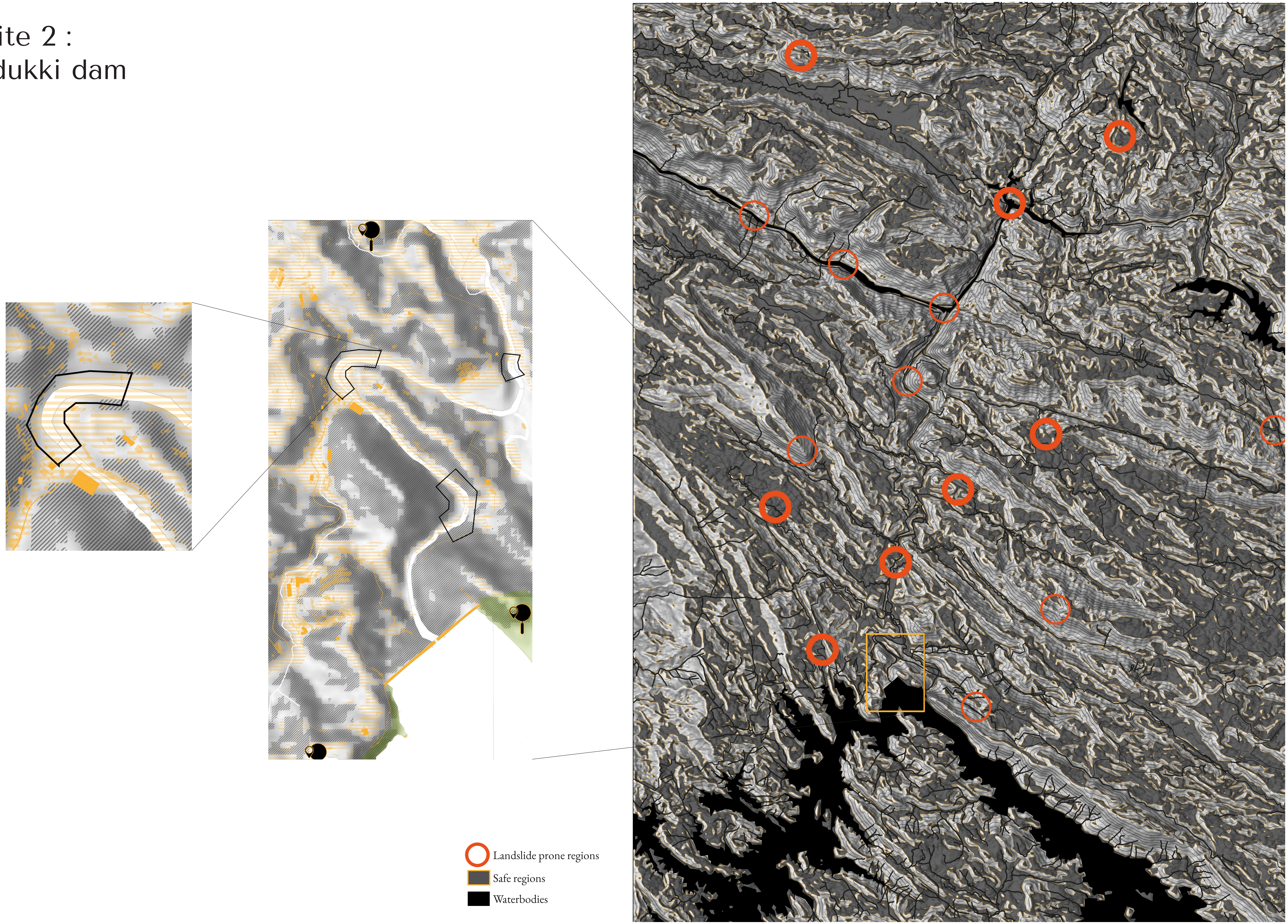
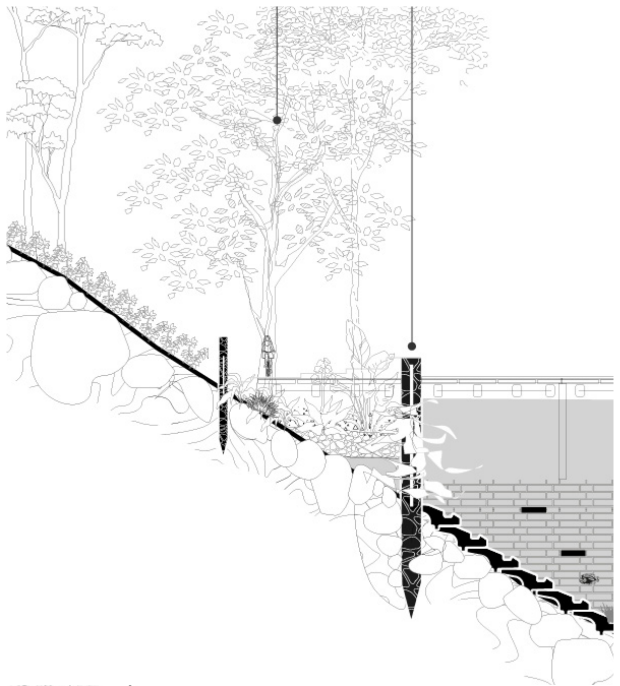
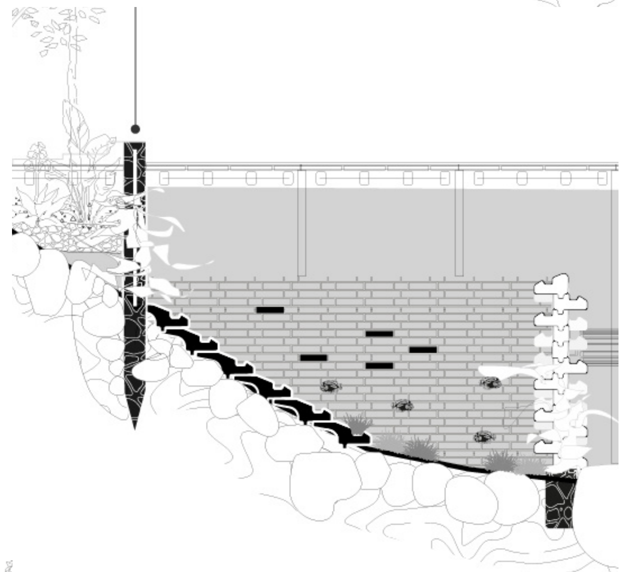
Idukki dam



Site 2 : Idukki dam

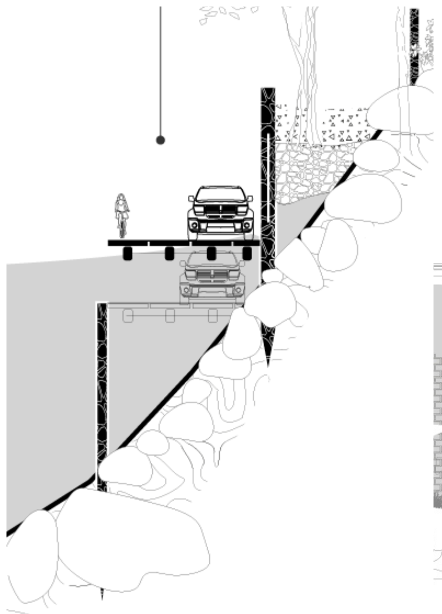


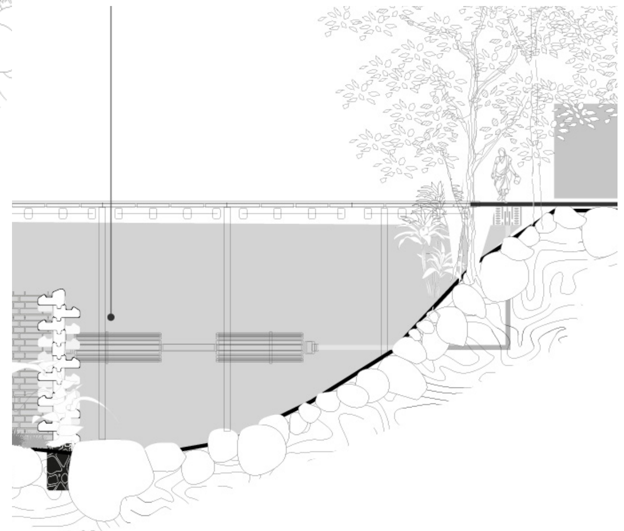
Gravel piles for slope stabilisation



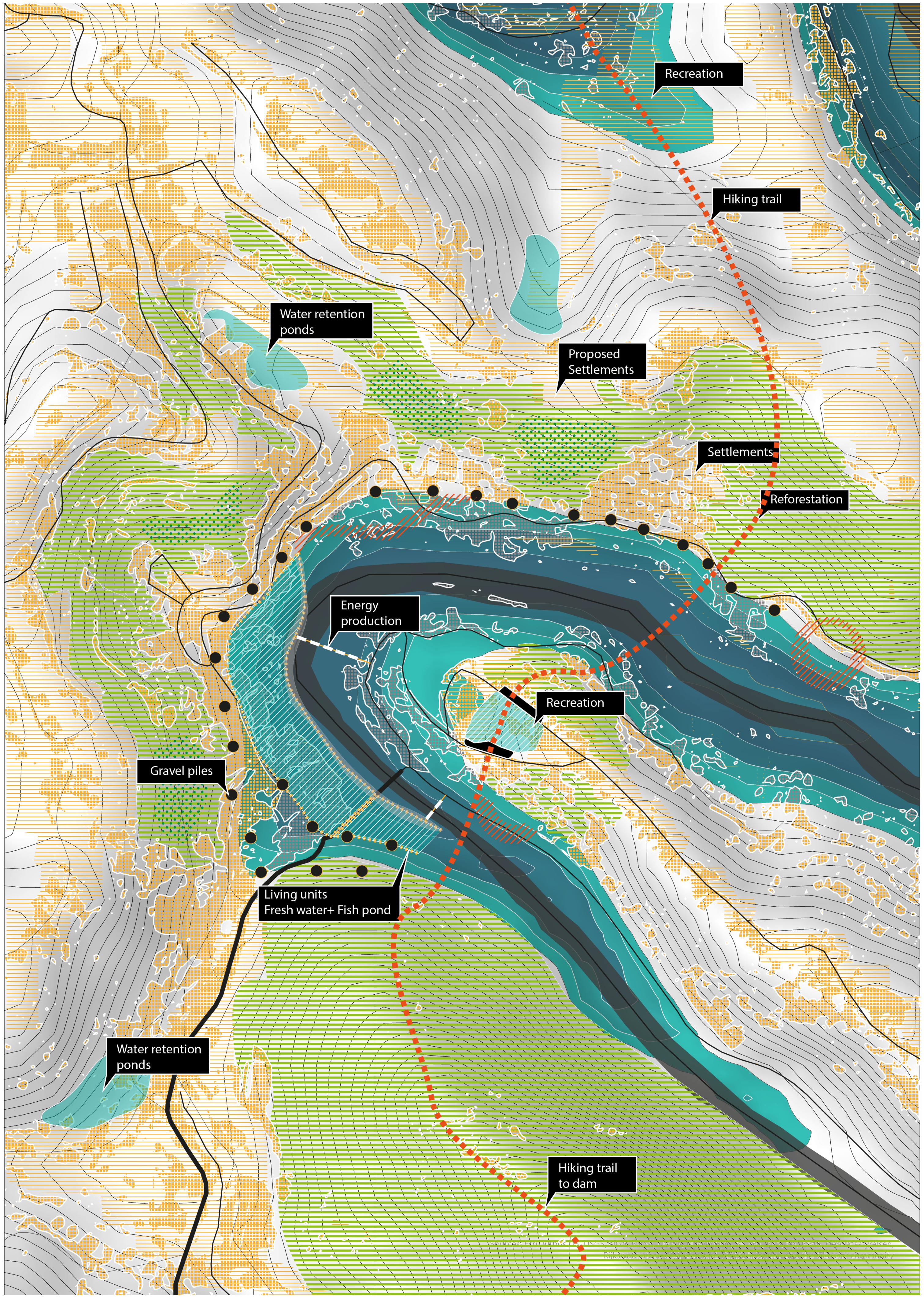
Living units

Floating roads

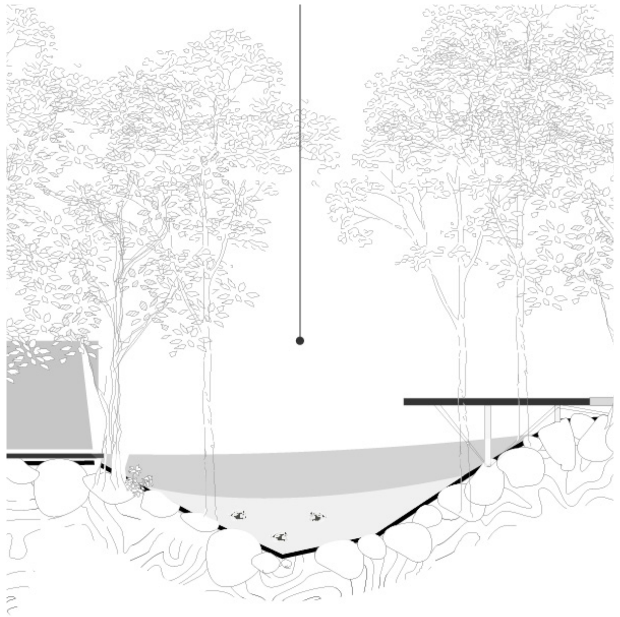




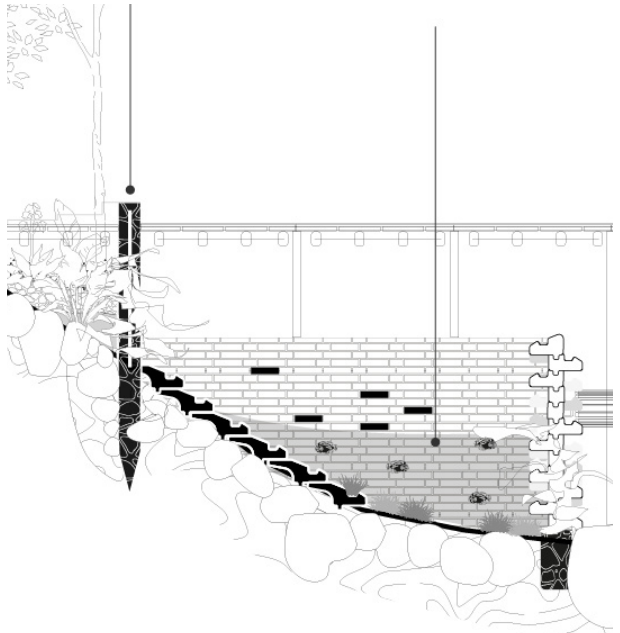
Micro Energy generation



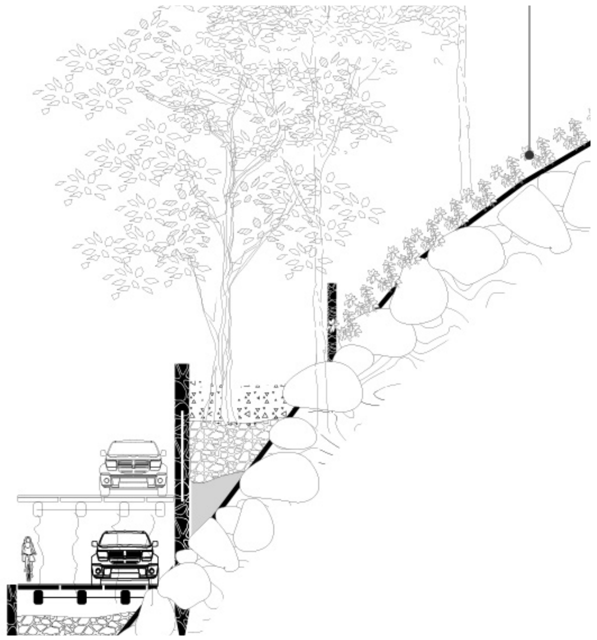
Site 2 : Idukki dam



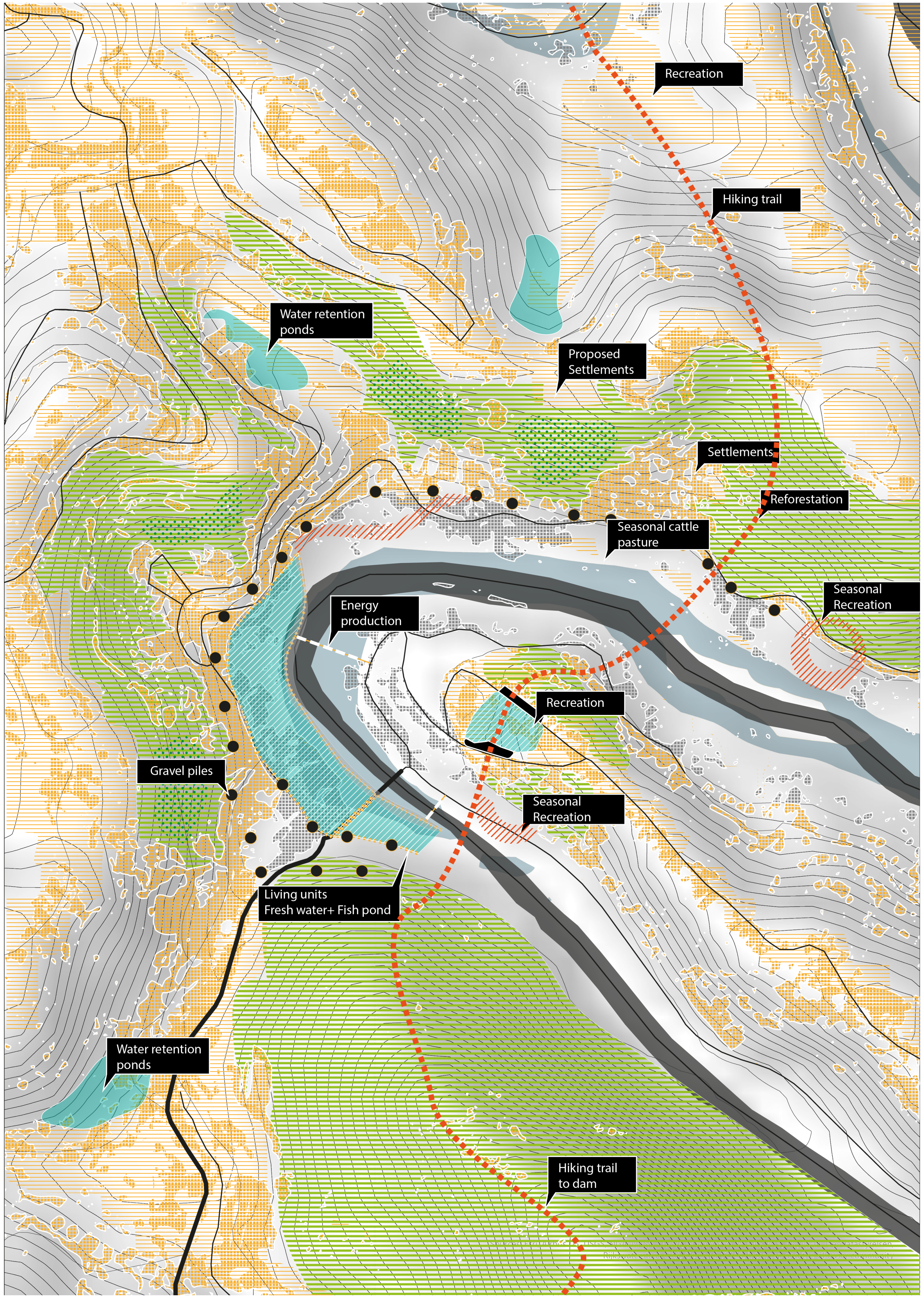
Recreational area



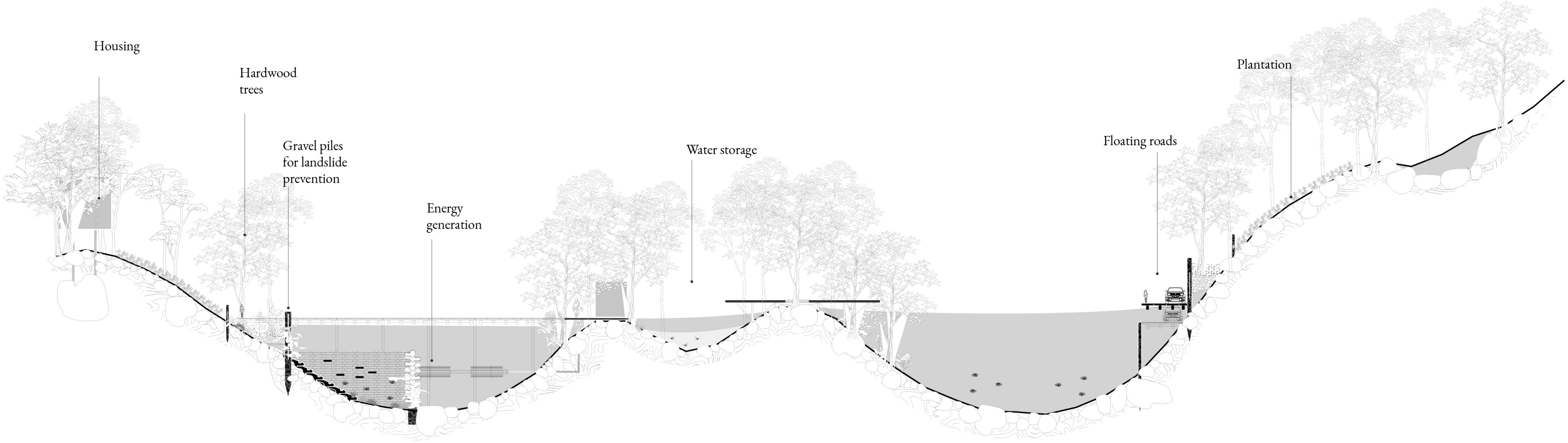
Living units as water retention



Slope stabilisation and agro forestry

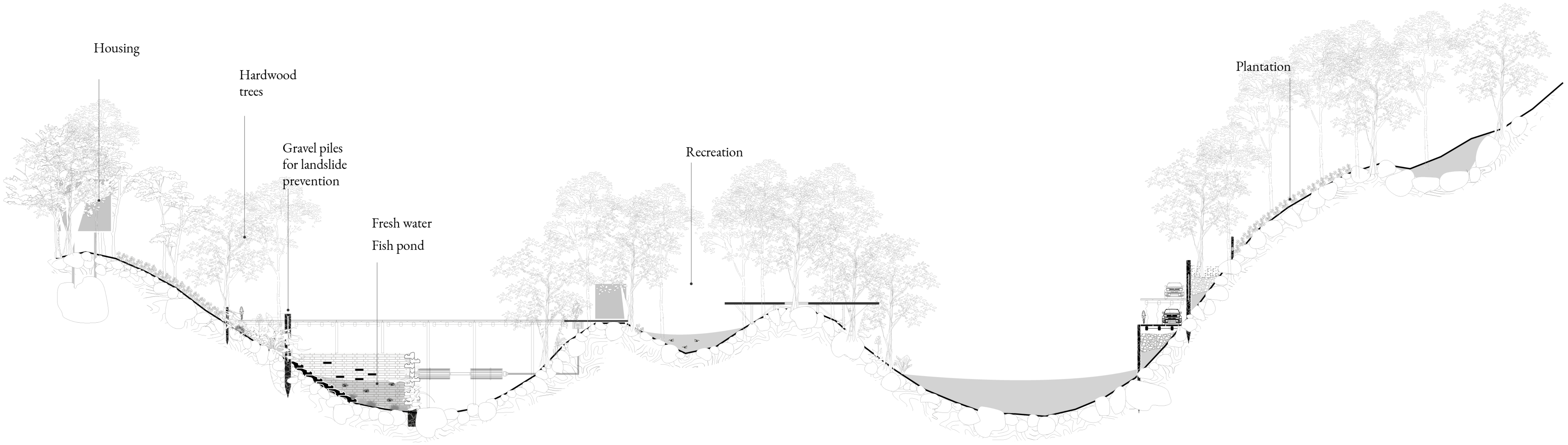


Site 2 :
Idukki dam

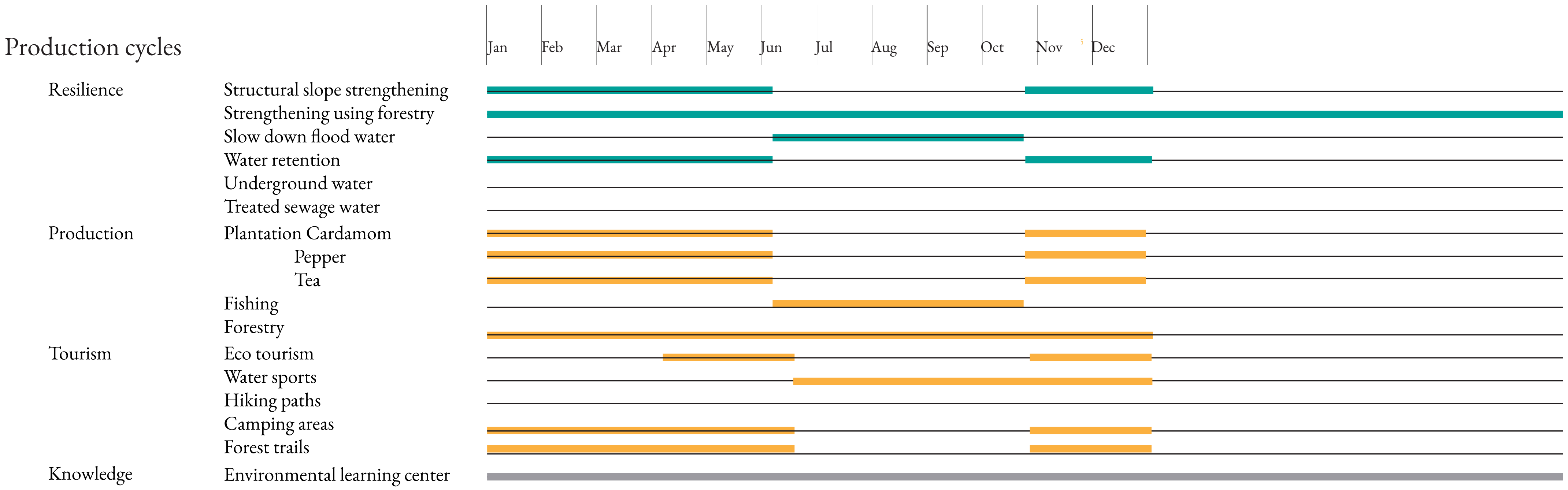


High rainfall

Site 2 : Idukki dam

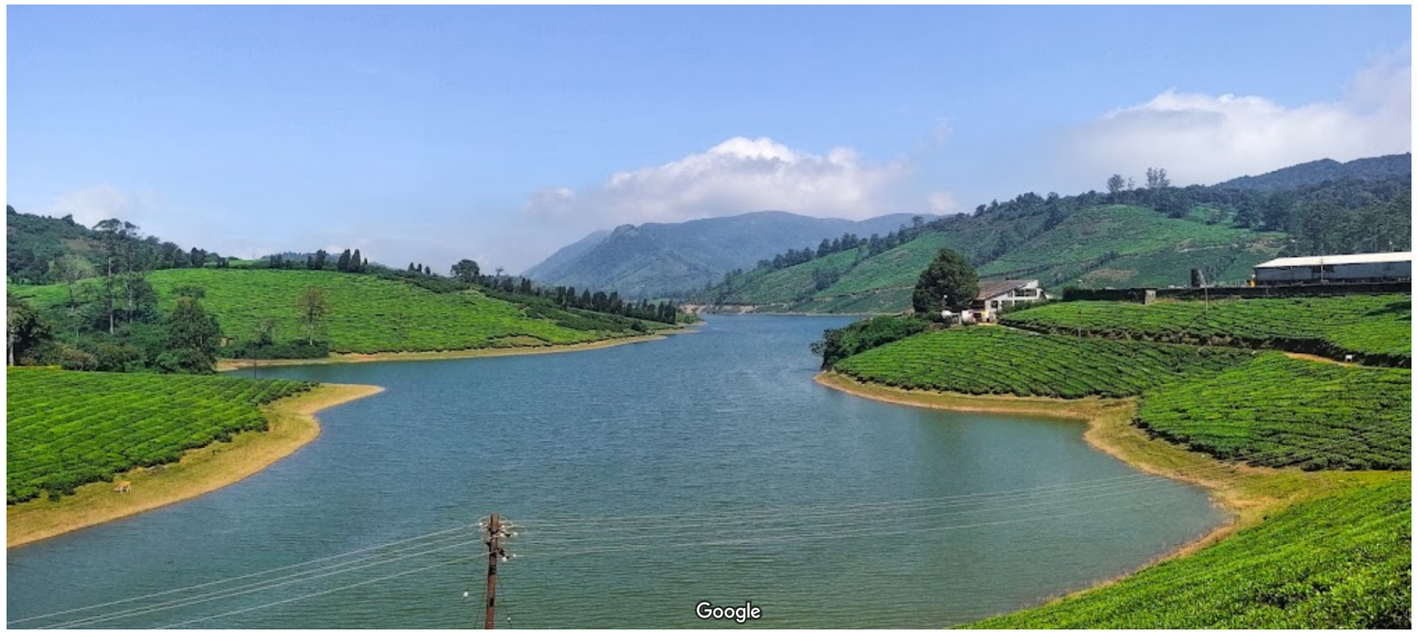


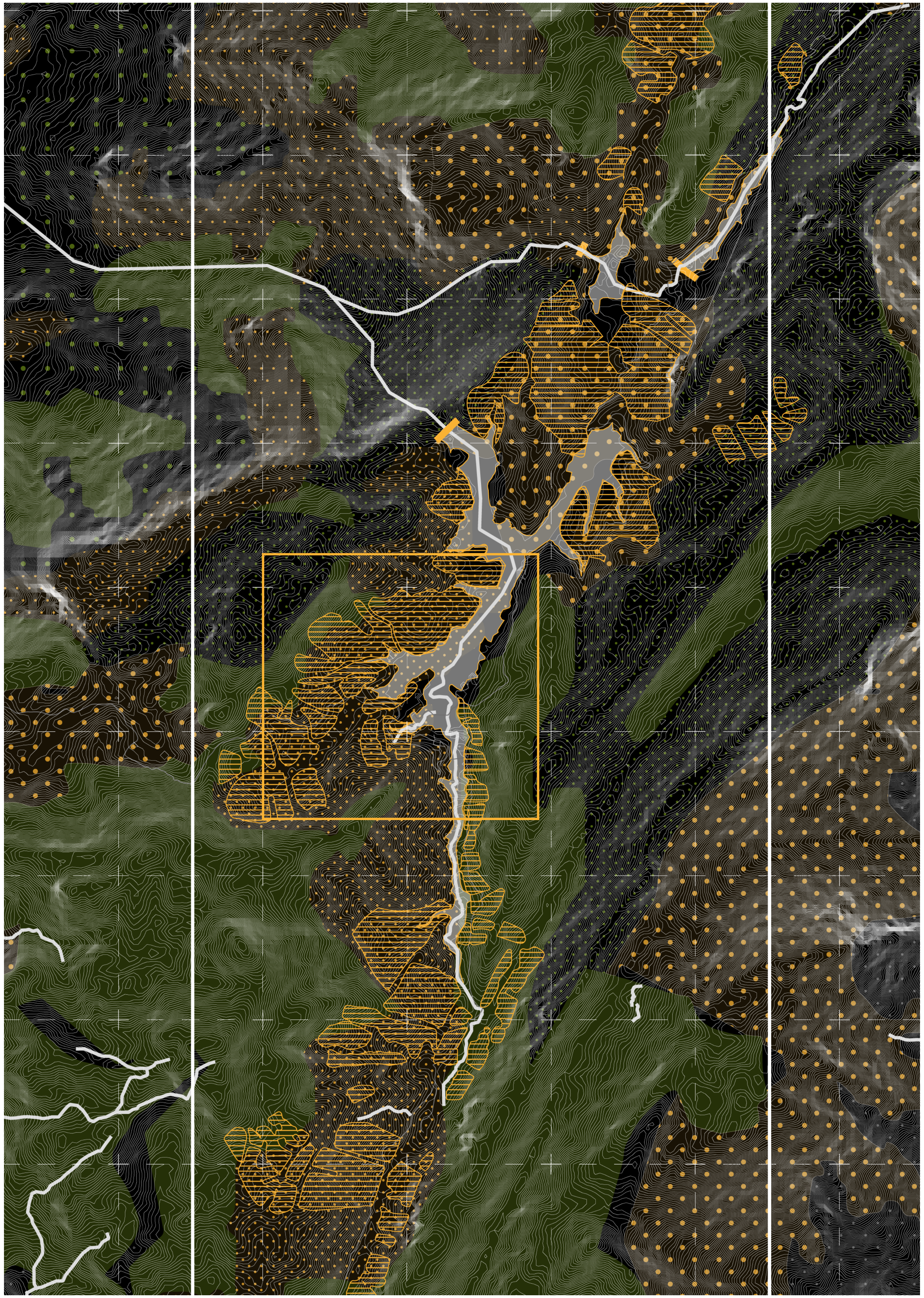
Low rainfall



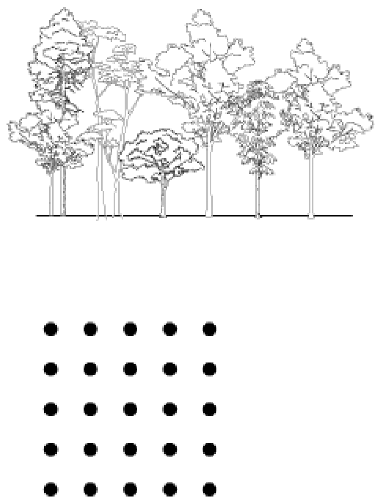
Site 2 :
Idukki dam

Site 3 :
Megamalai

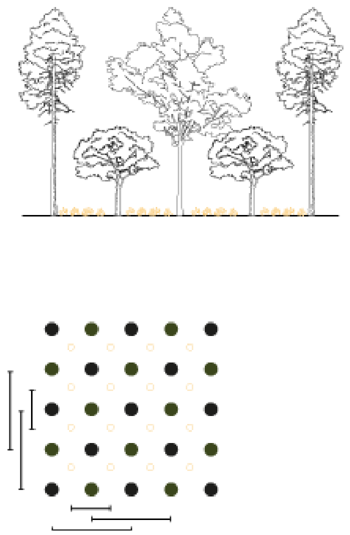




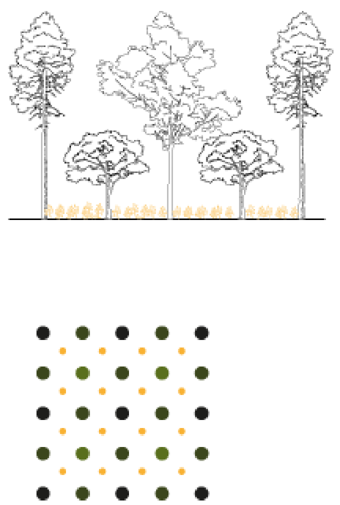
Site 3 : Megamalai



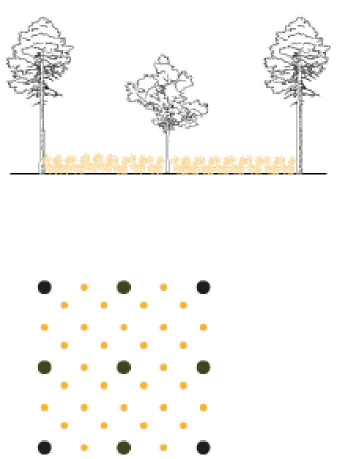
1. Forest



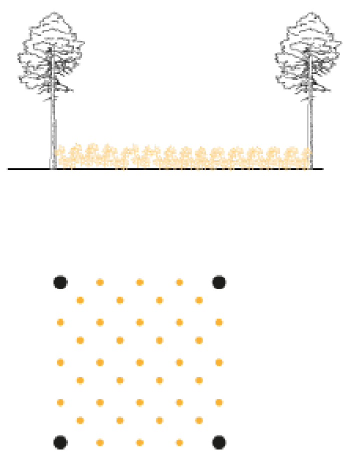
2. Forest+fruit trees
Tea Nursery
Year 1



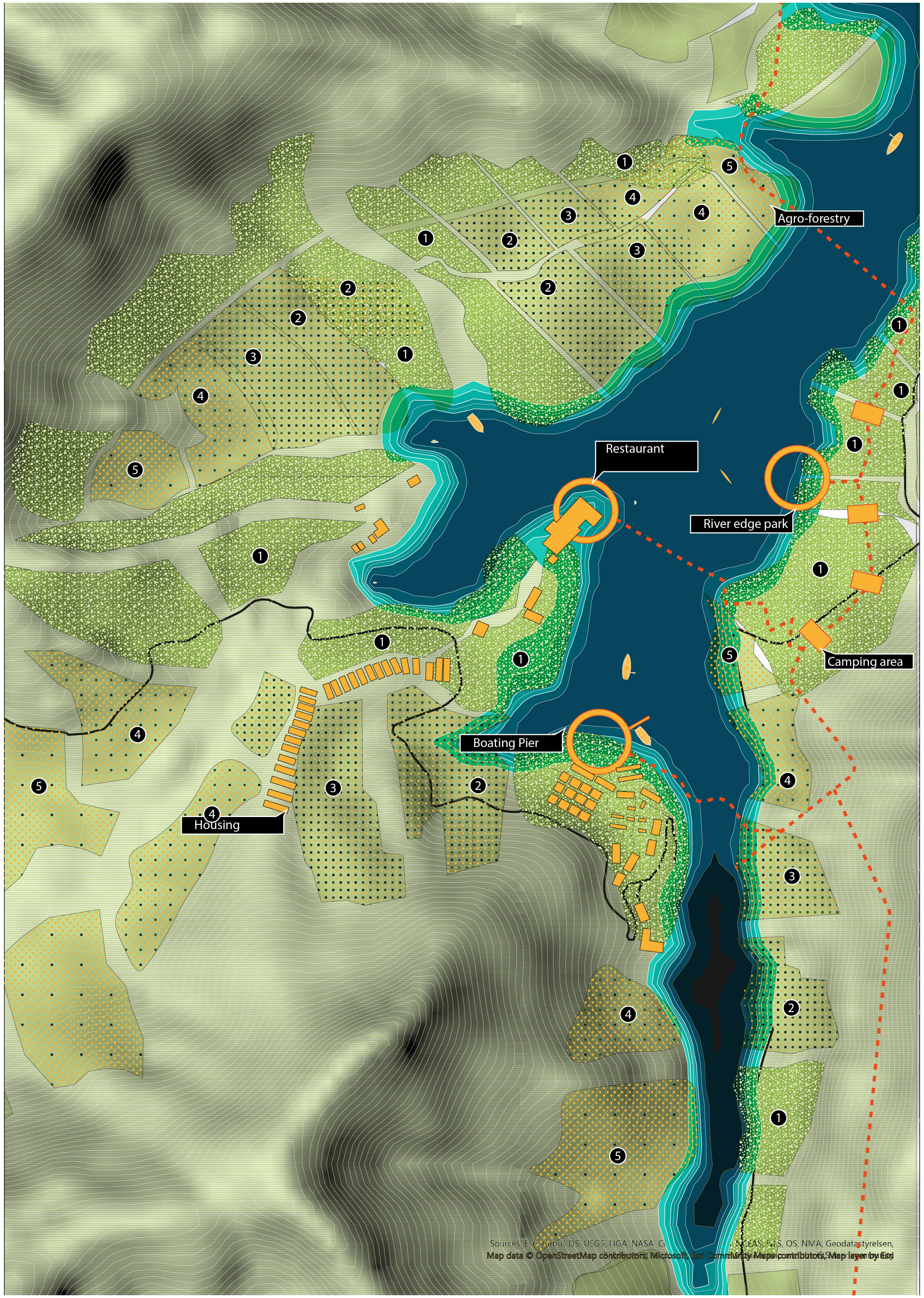
3. Forest + Fruit trees +Tea plants
Year : 3



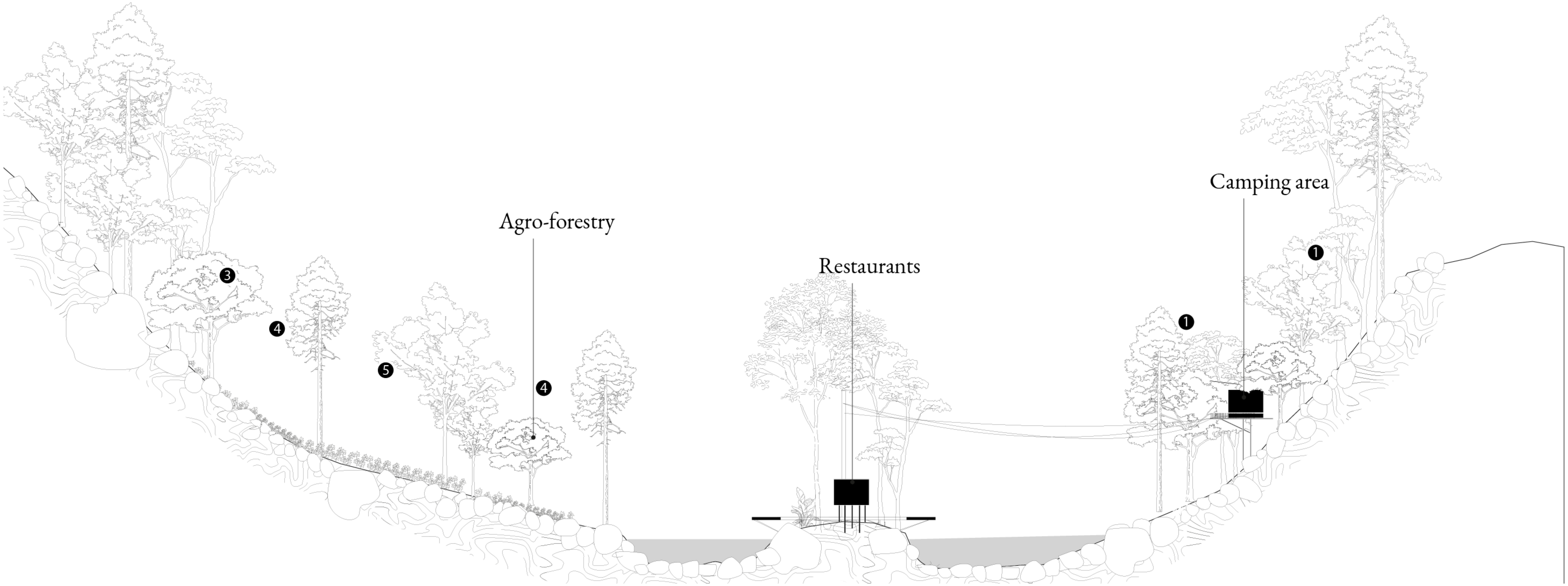
4. Perimeter forest + Mature tea plants
+ Tea
Year : 10



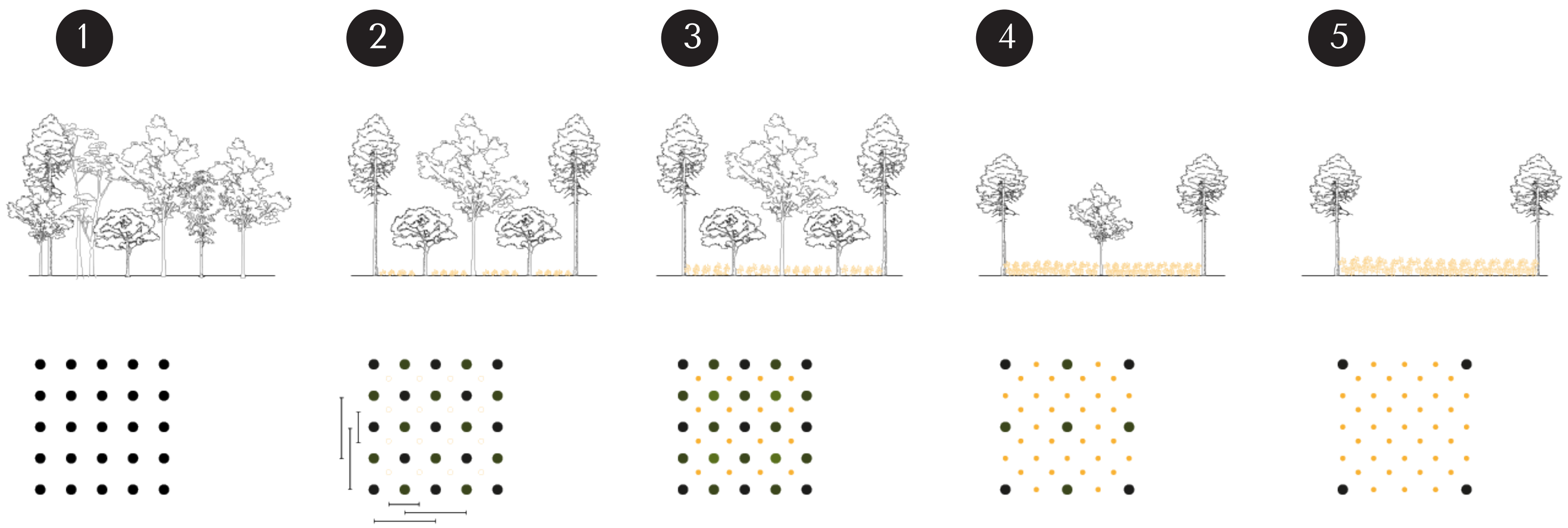
5. Tea plantations
Year : 30



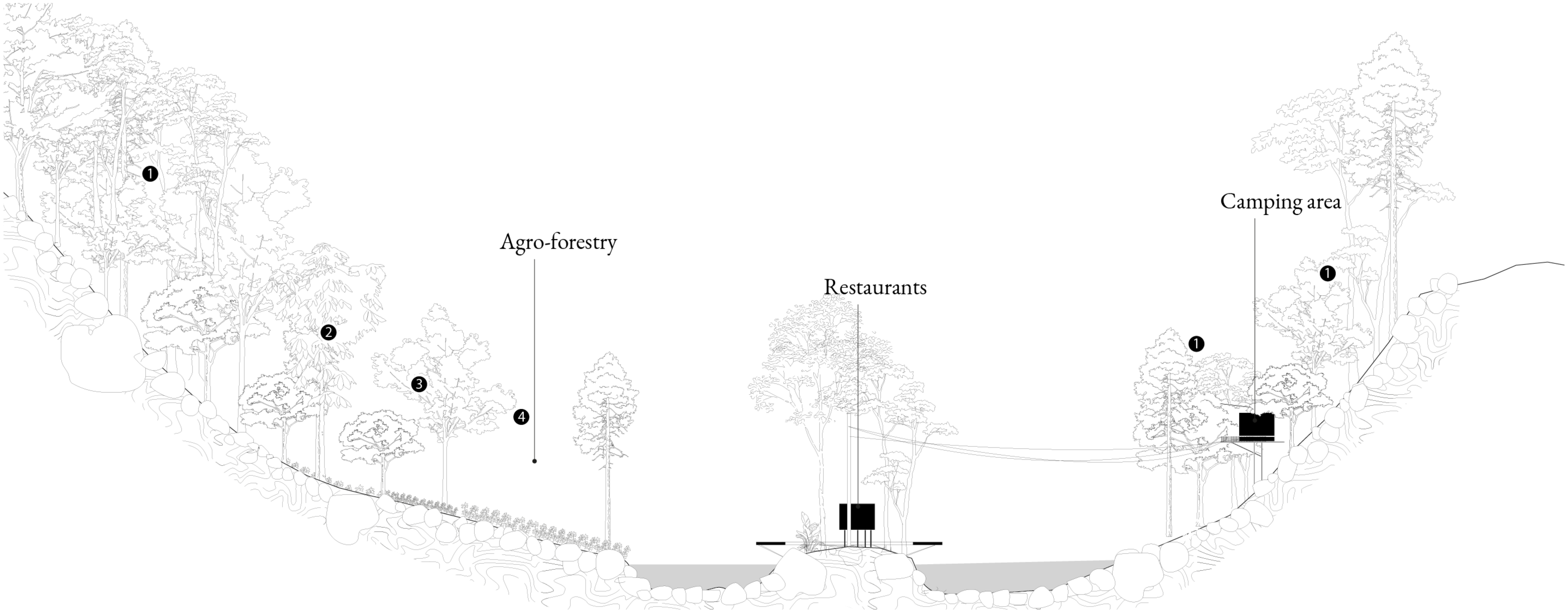
Patterns of Production
+ Forestry : State 1

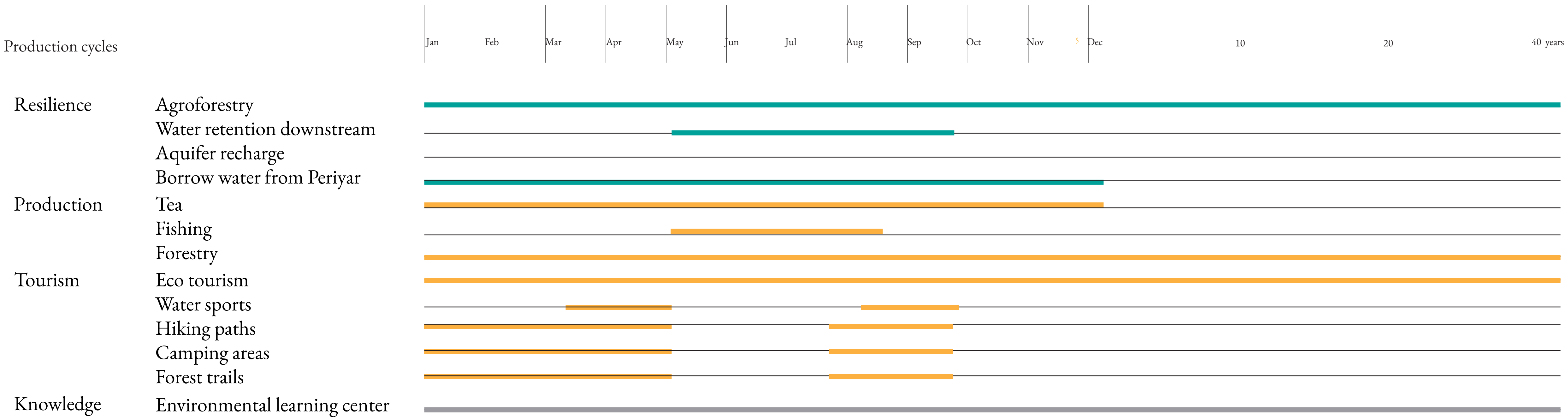


Forest | Forest+fruit trees Tea Nursery | Forest+fruit trees Tea plants | Forest+fruit trees MatureTea plants | Tea Plantation

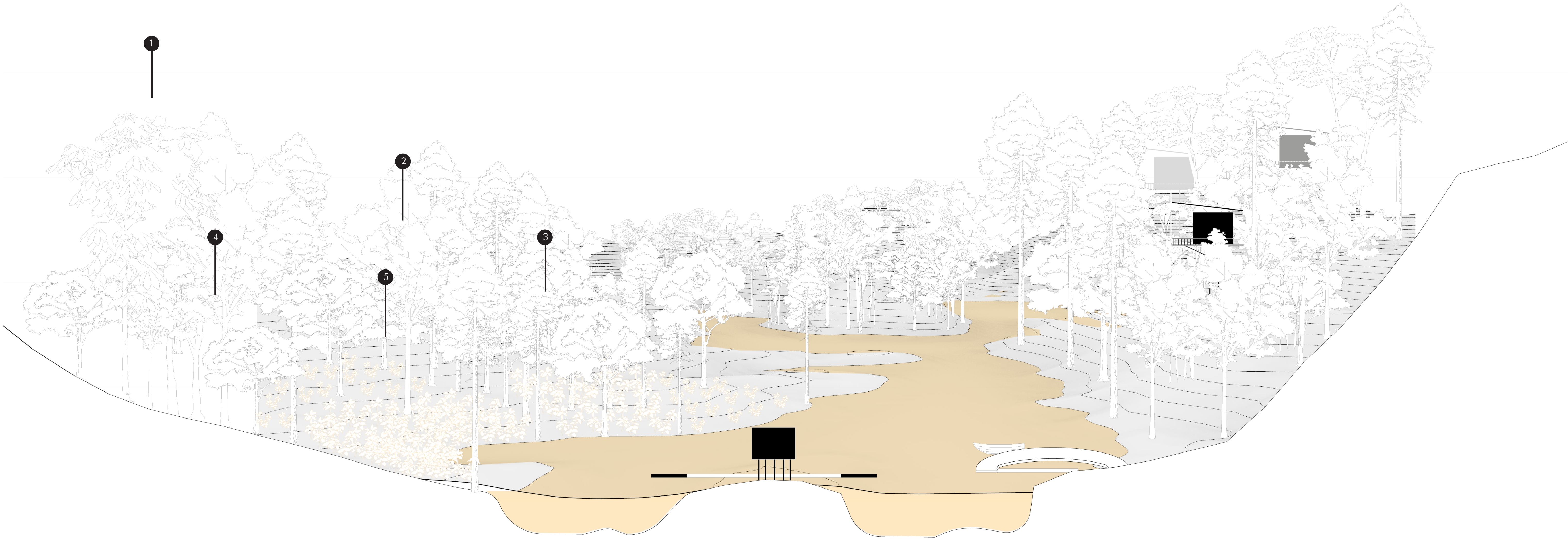


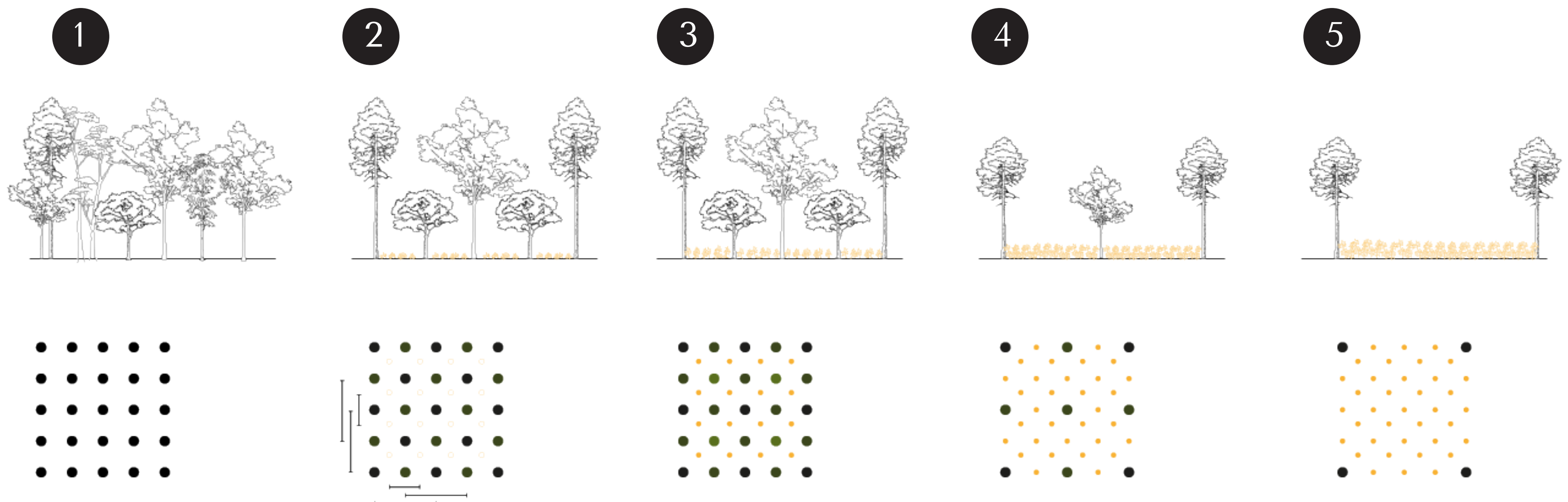
Patterns of Production
+ Forestry : State 2



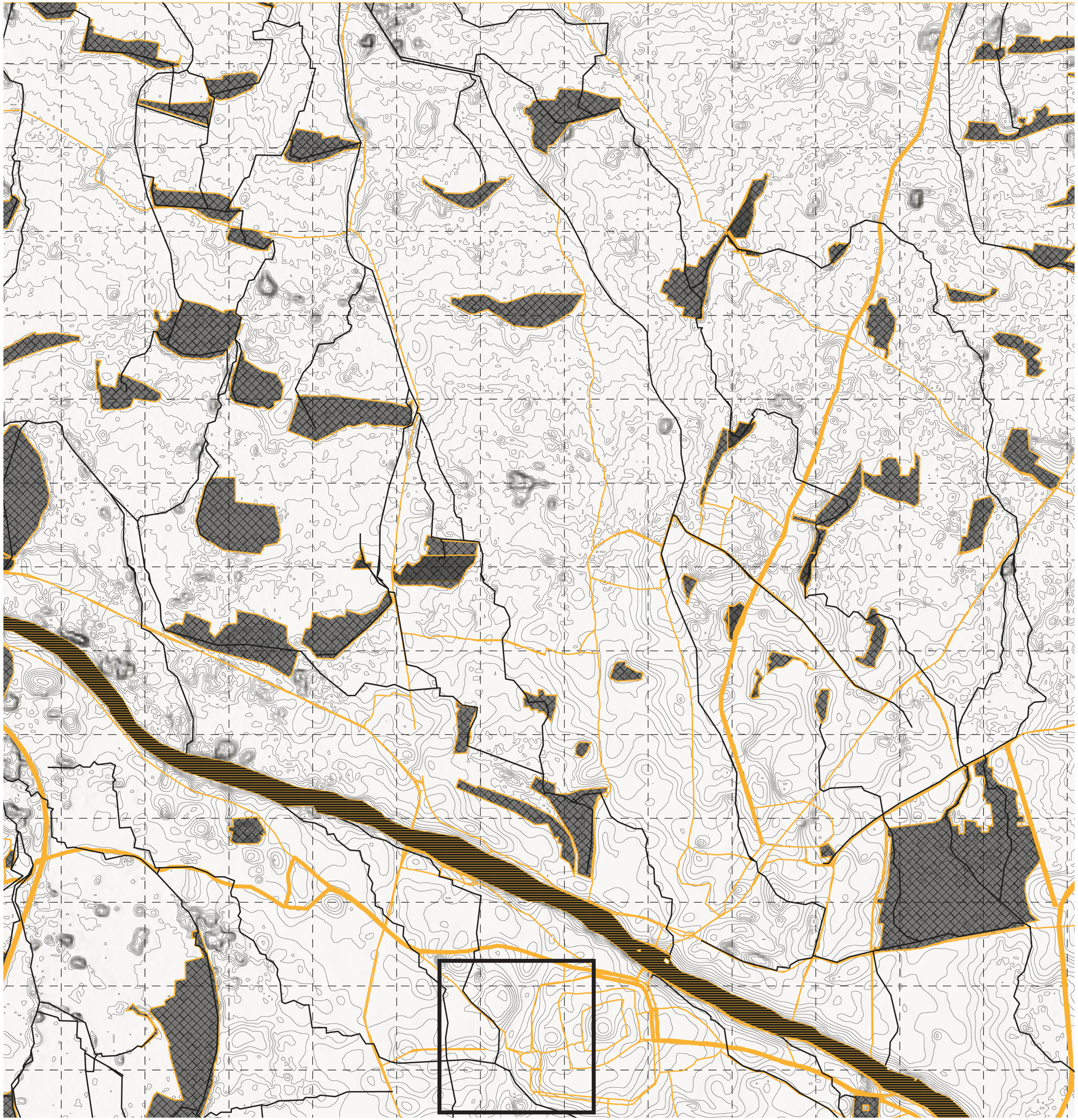


Stage 1 illustration

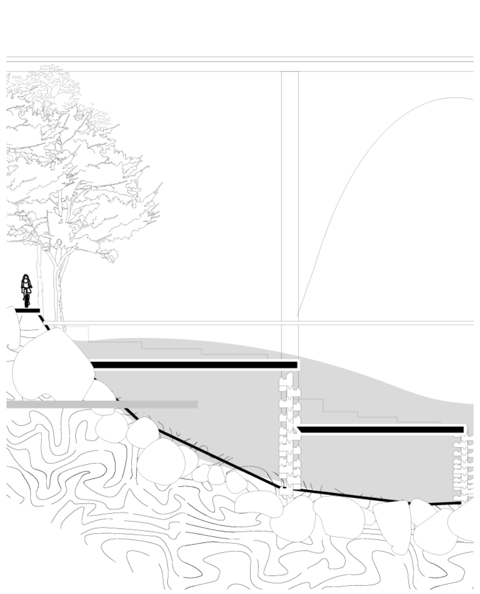




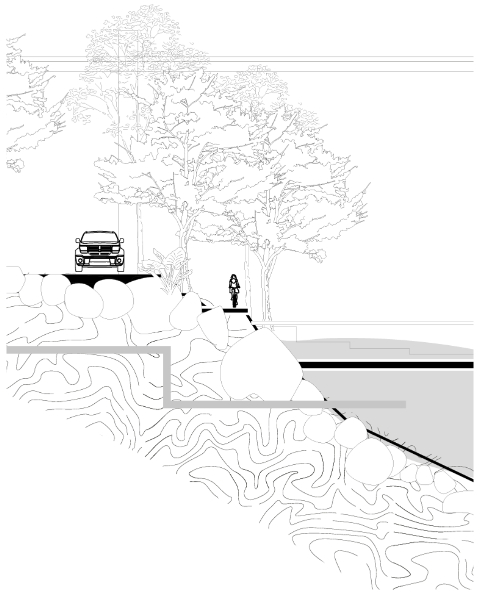
Site 3 : Madurai



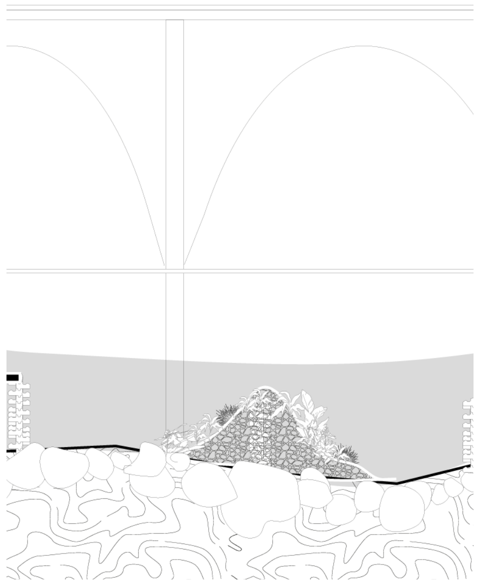
Site 3 : Madurai



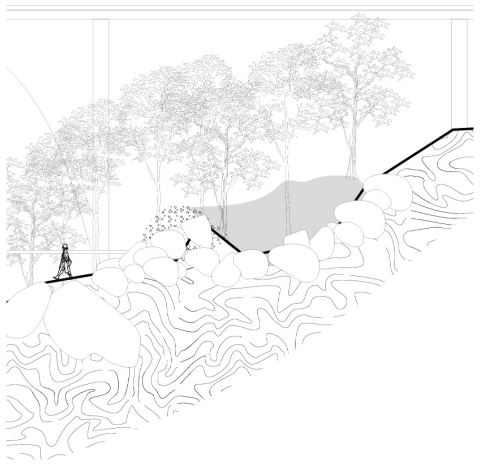
Recreational area



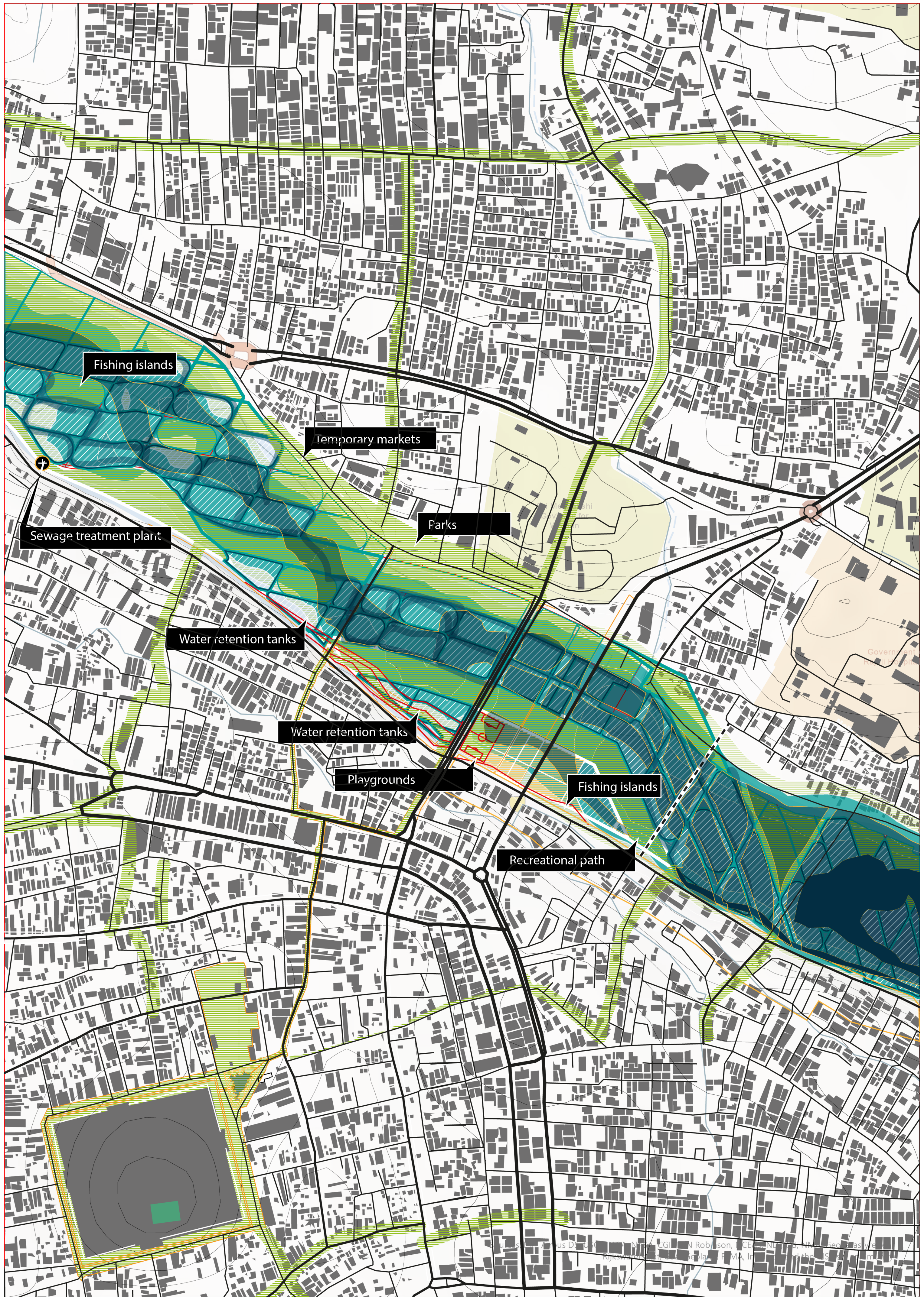
Cycling path



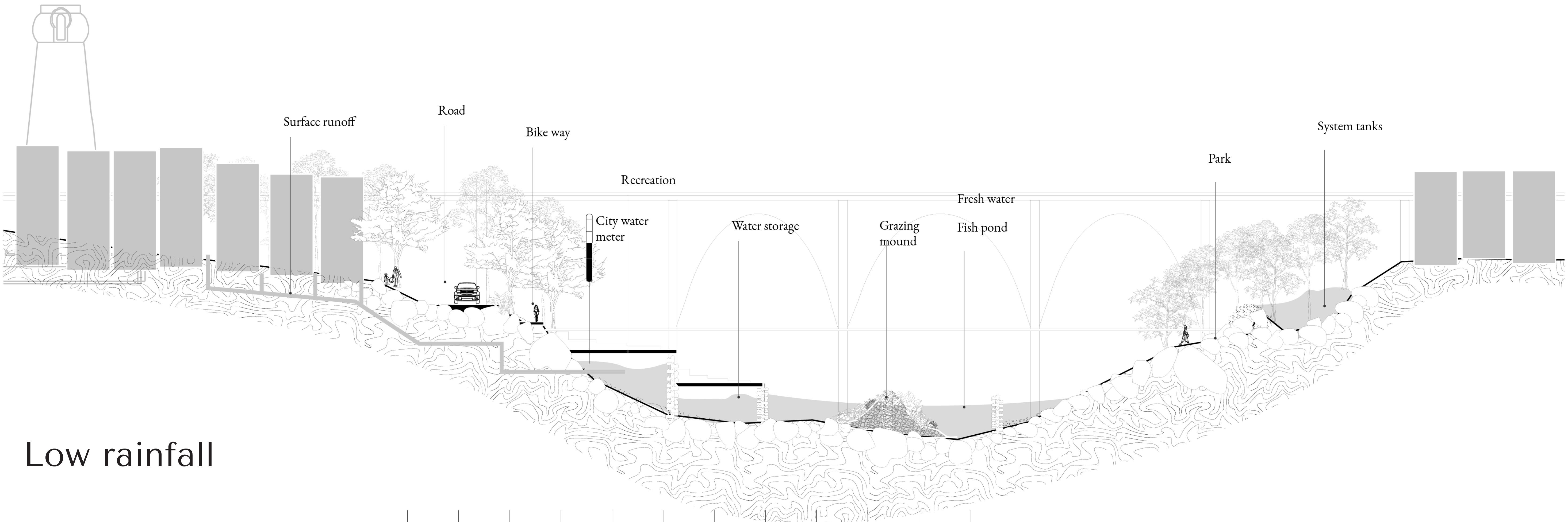
Grazing patch



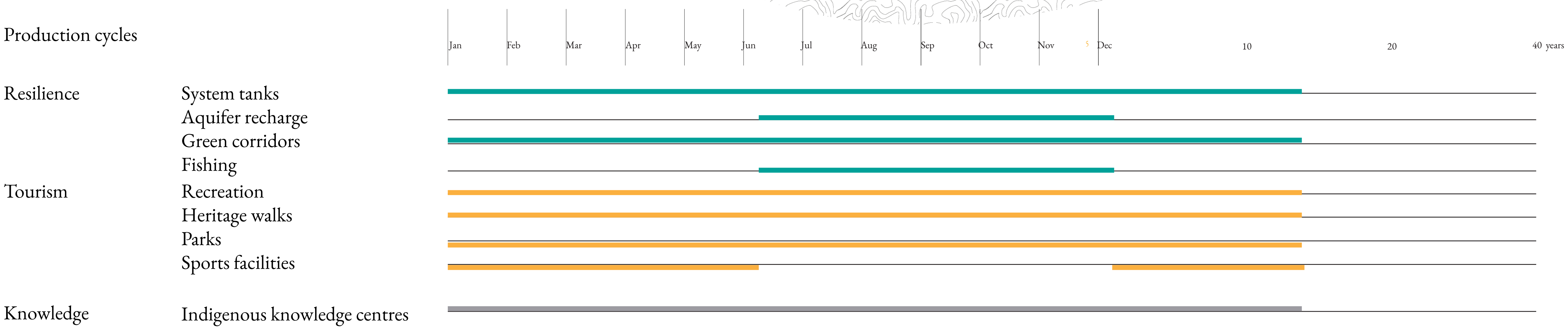
System tank



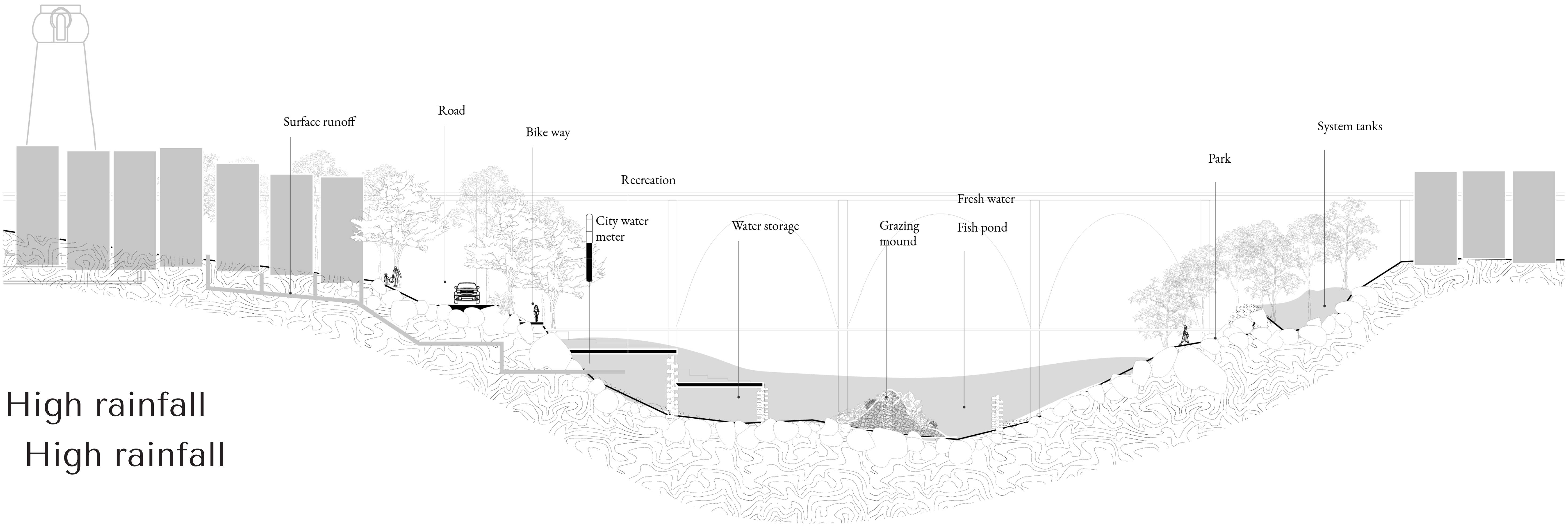
Site 3 : Madurai



Low rainfall



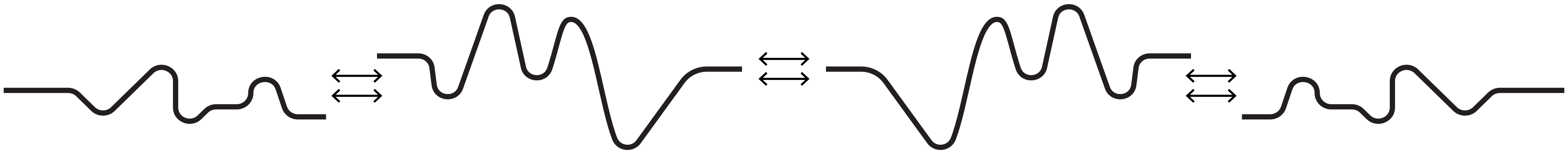
Site 3 : Madurai



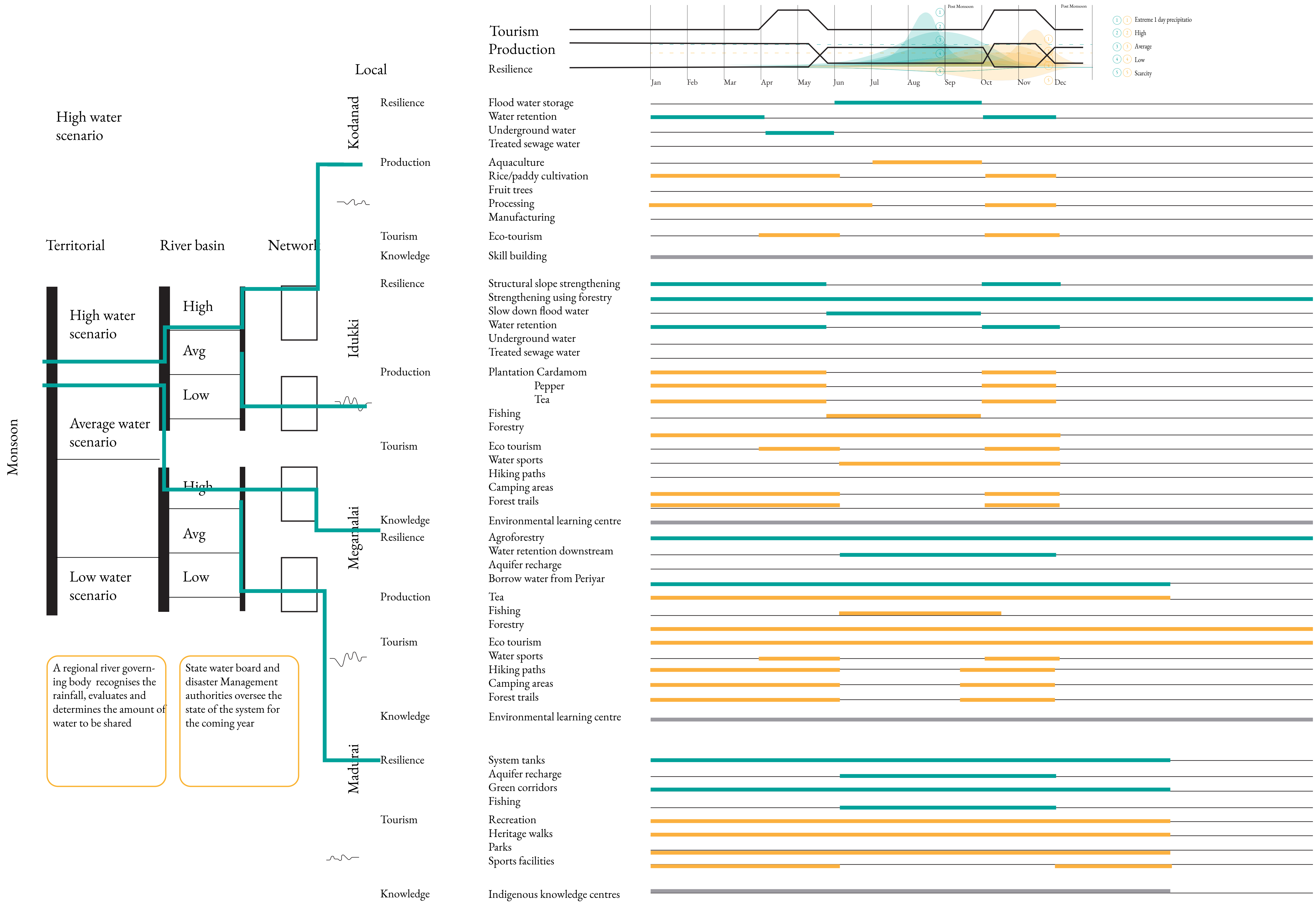
High rainfall

High rainfall

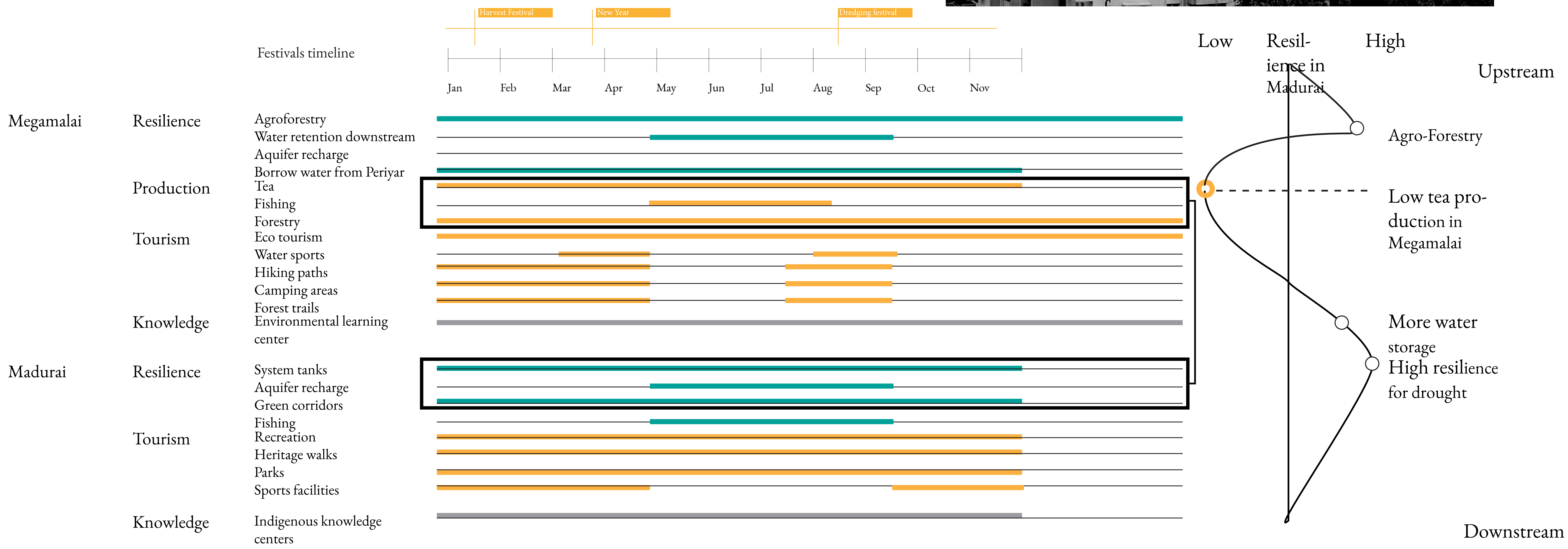
How are these section responding to the other?



Adaptive pathways



Systemic Interrelations

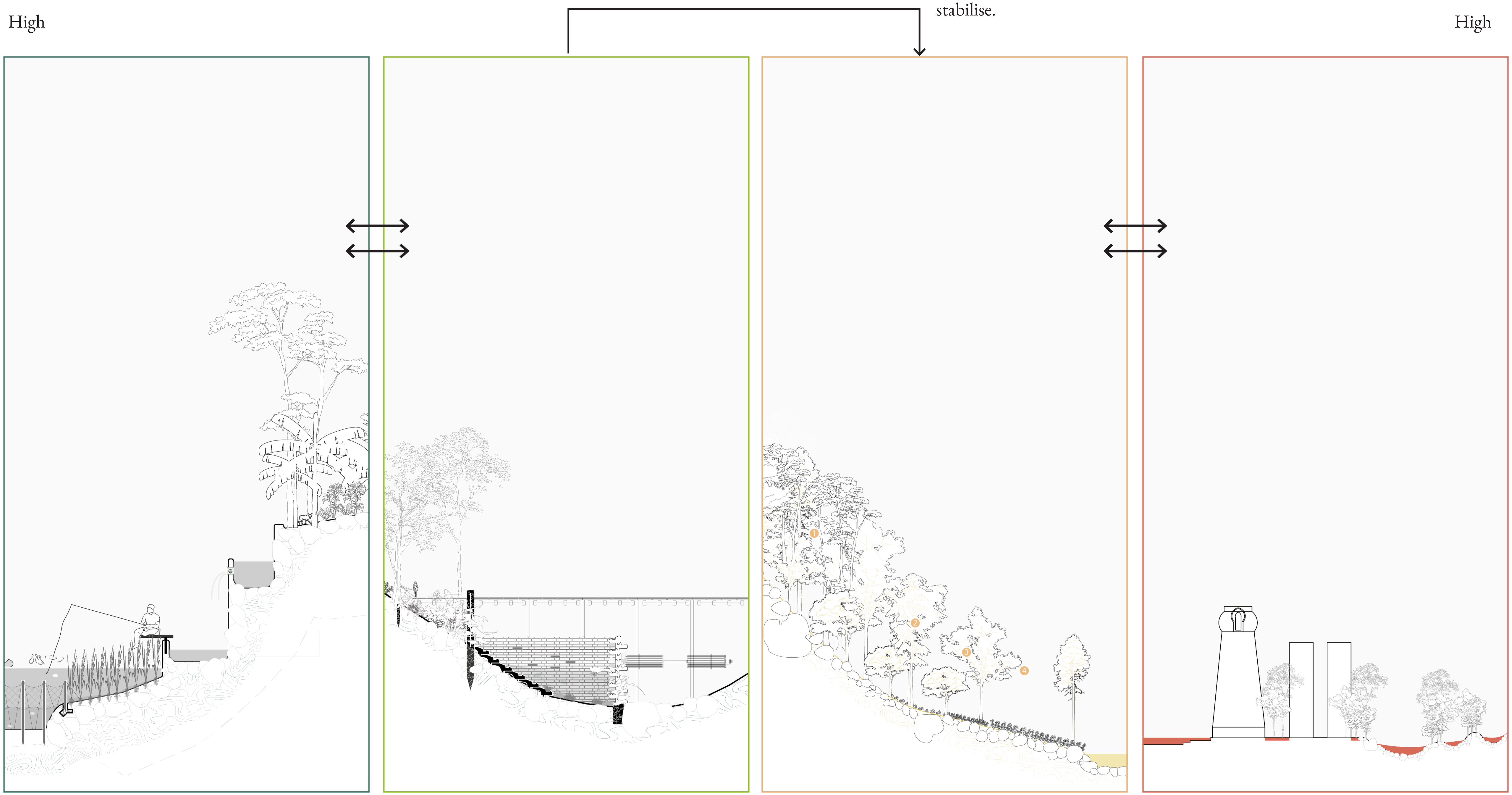


Systemic Interrelations

Water is shared in case of deficit in Vaigai river basin until the system able to re stabilise.

High

High



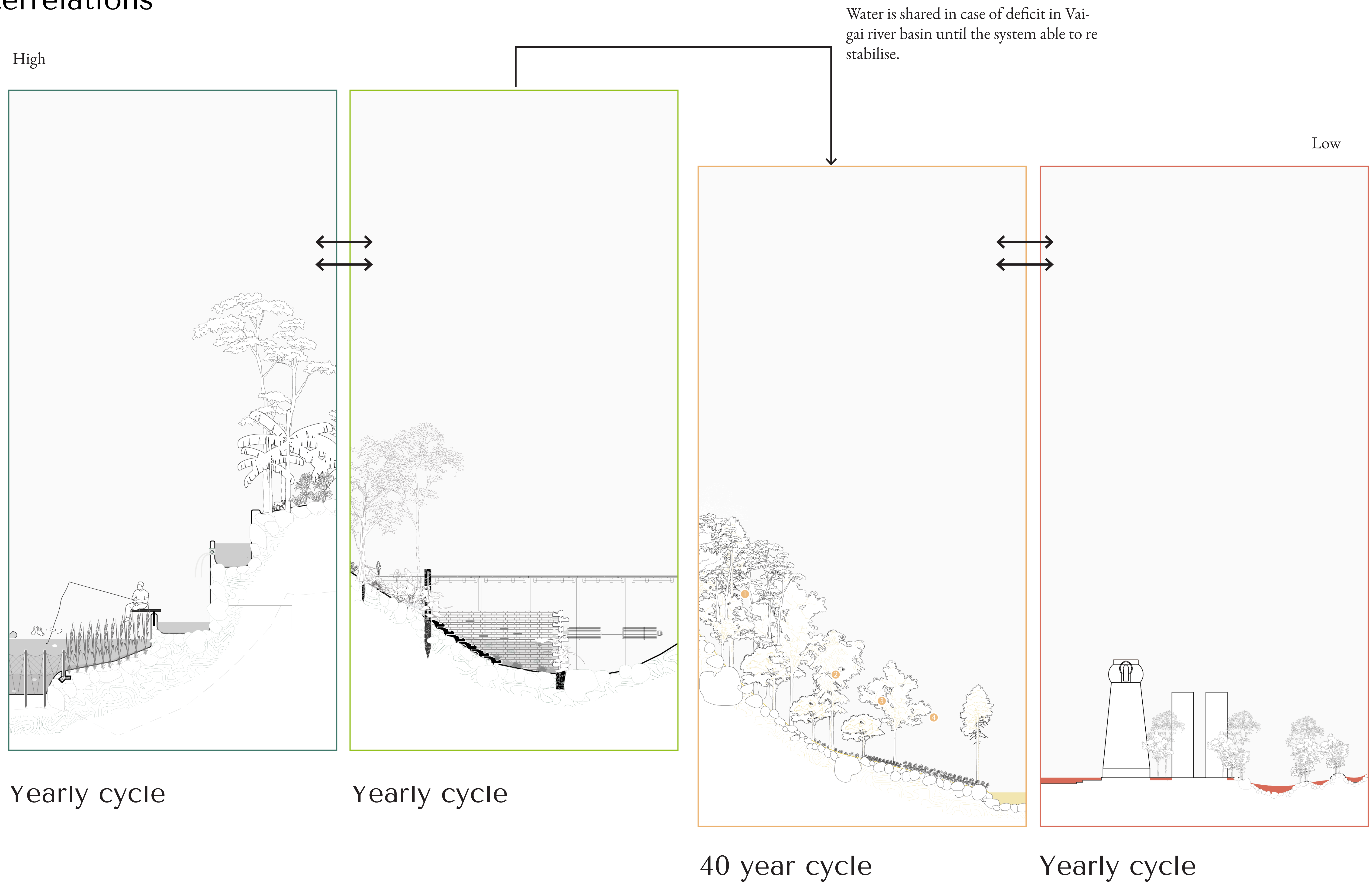
Yearly cycle

Yearly cycle

40 year cycle

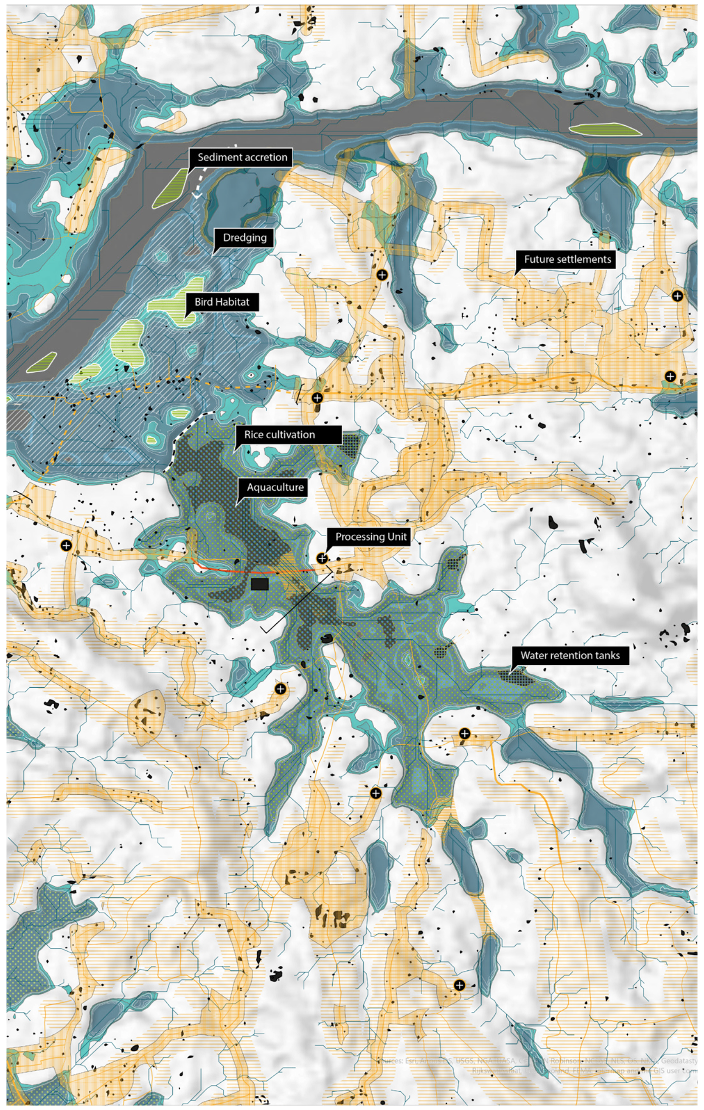
Yearly cycle

Systemic Interrelations

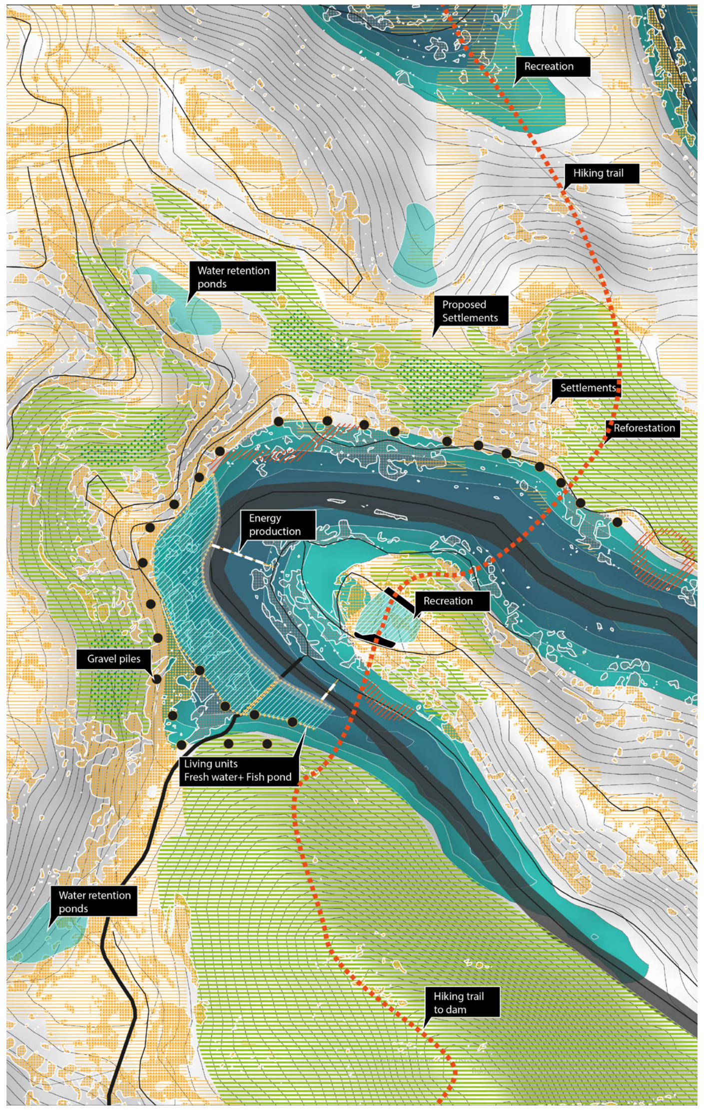


Local Scales

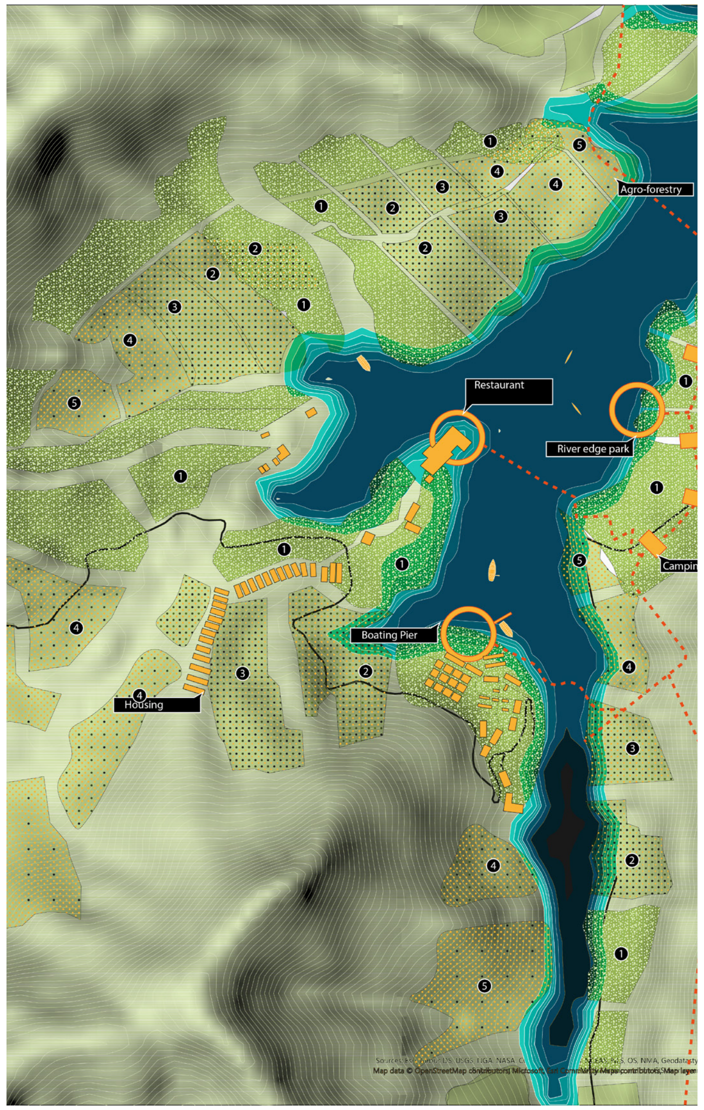
Kodanad



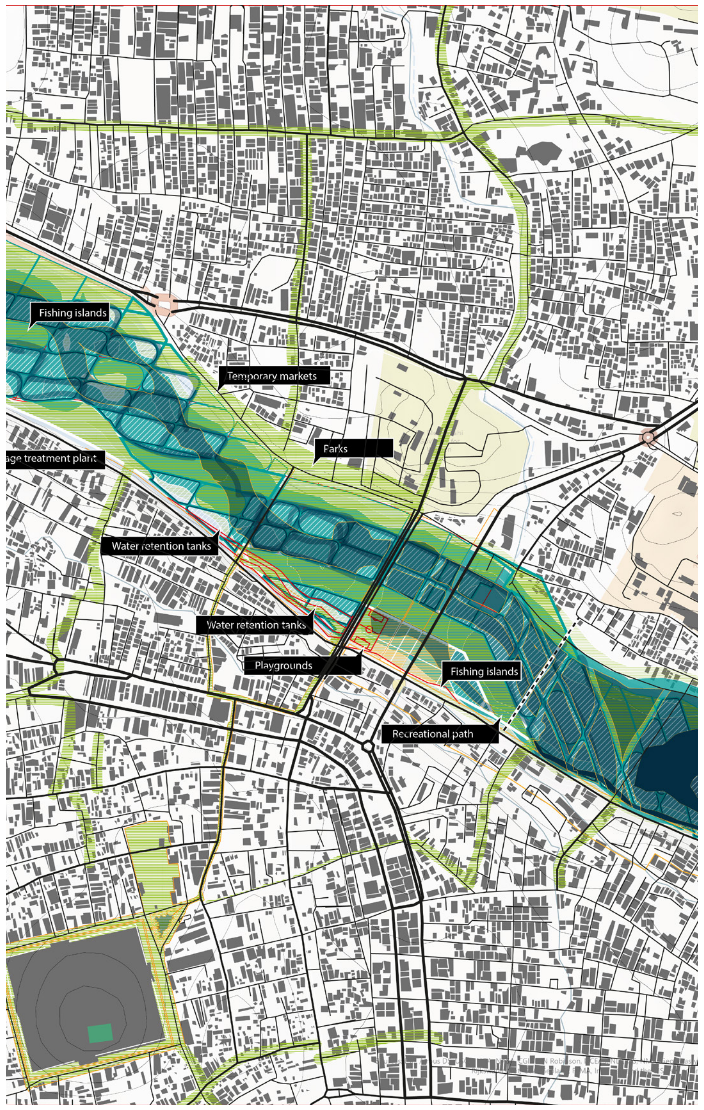
Idukki



Megamalai

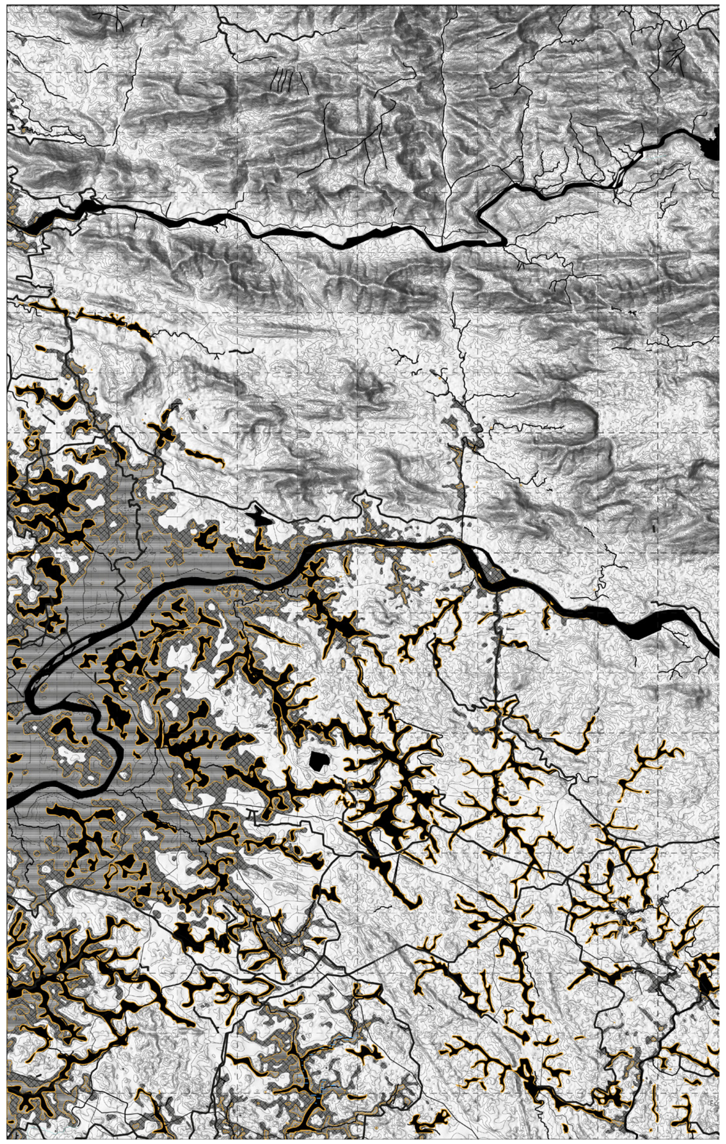


Madurai

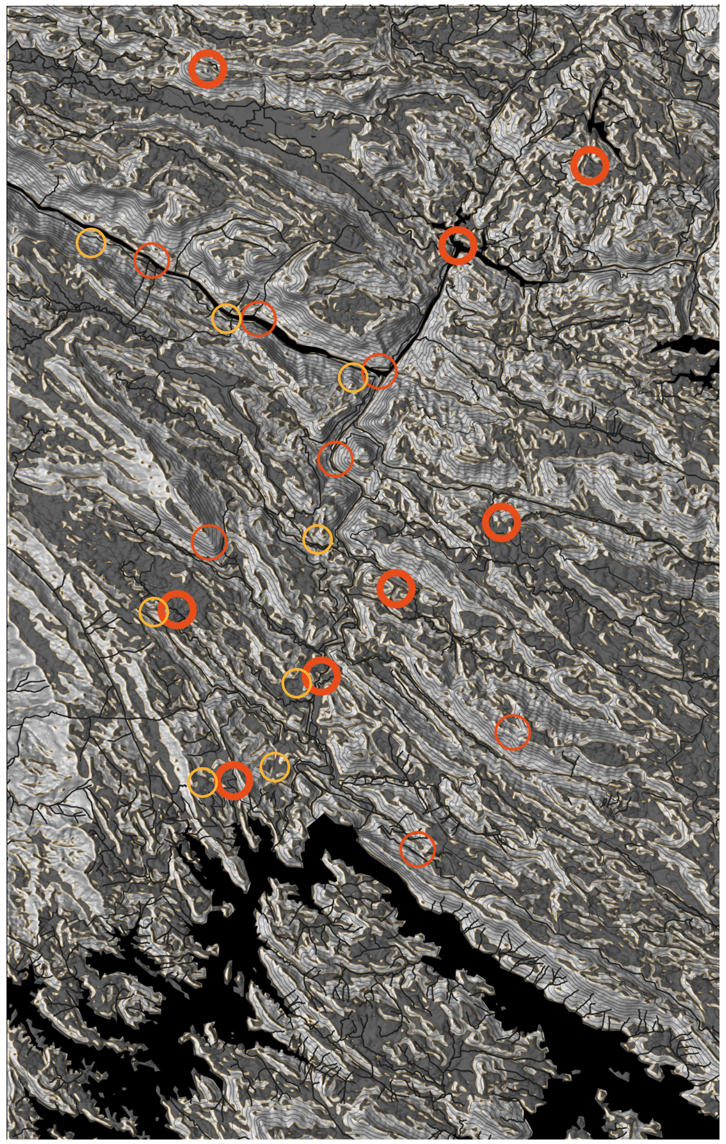


Patterns of territorialisation

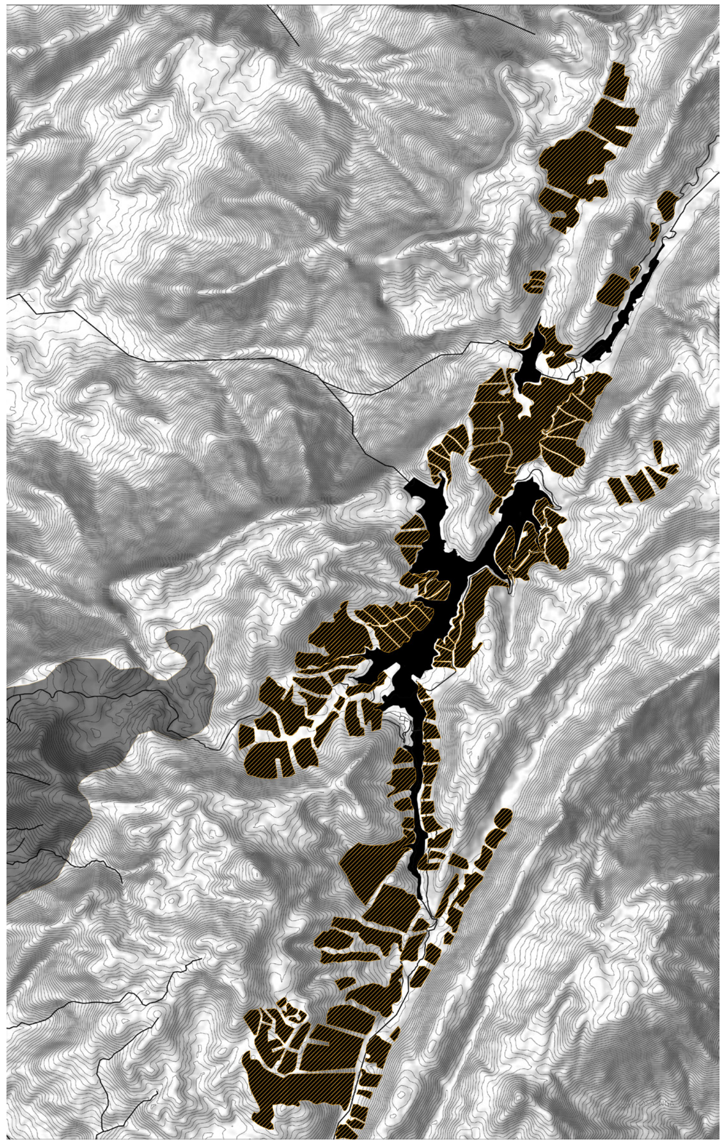
Branced



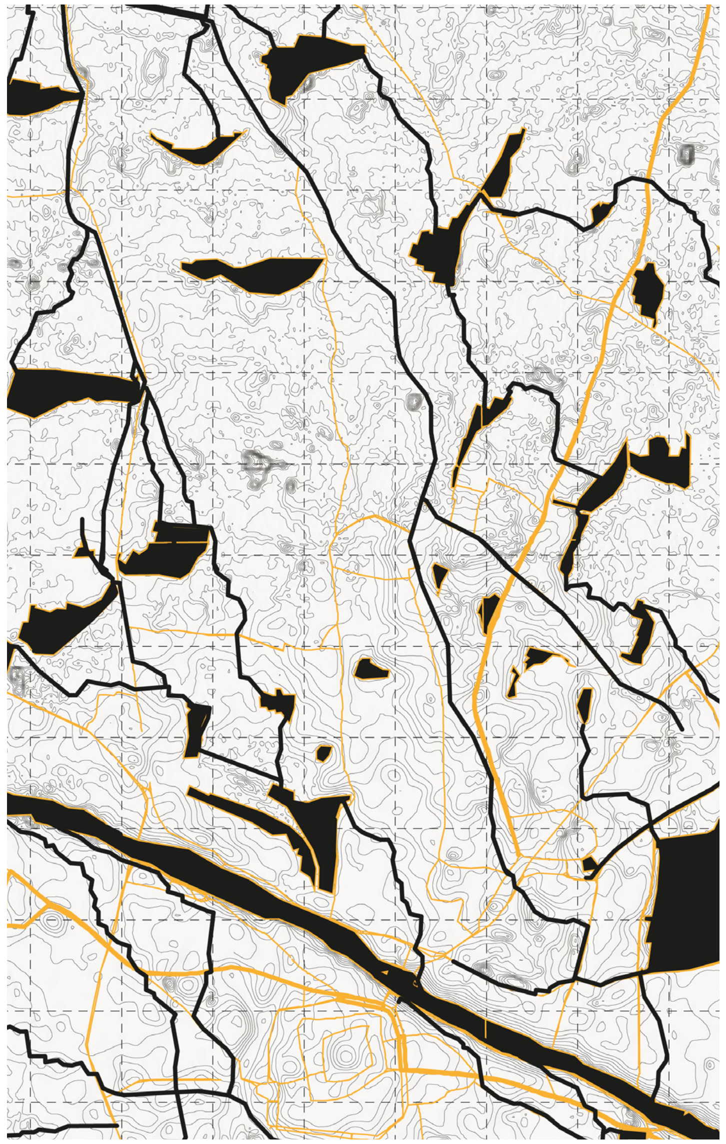
Islands



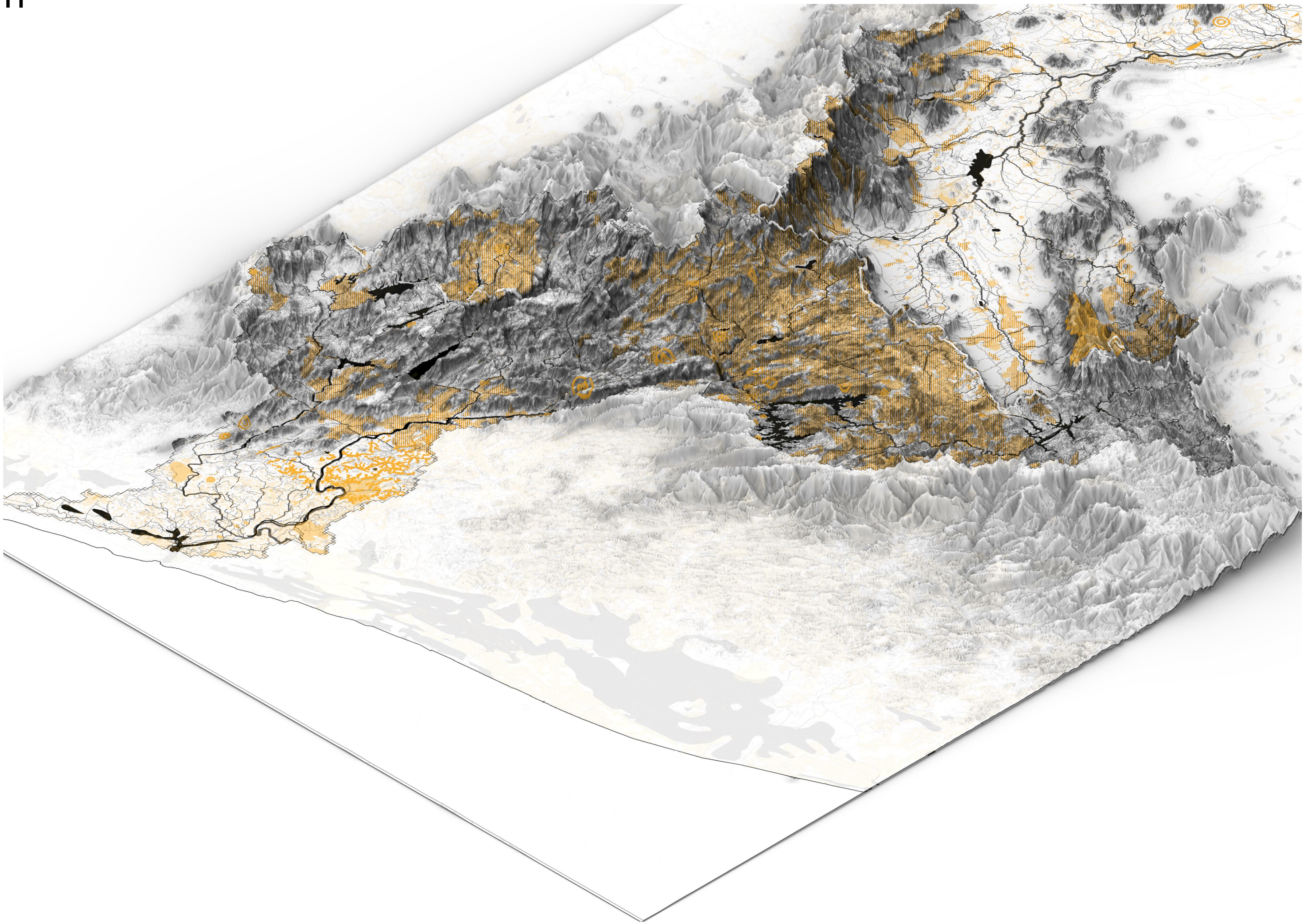
Fingers



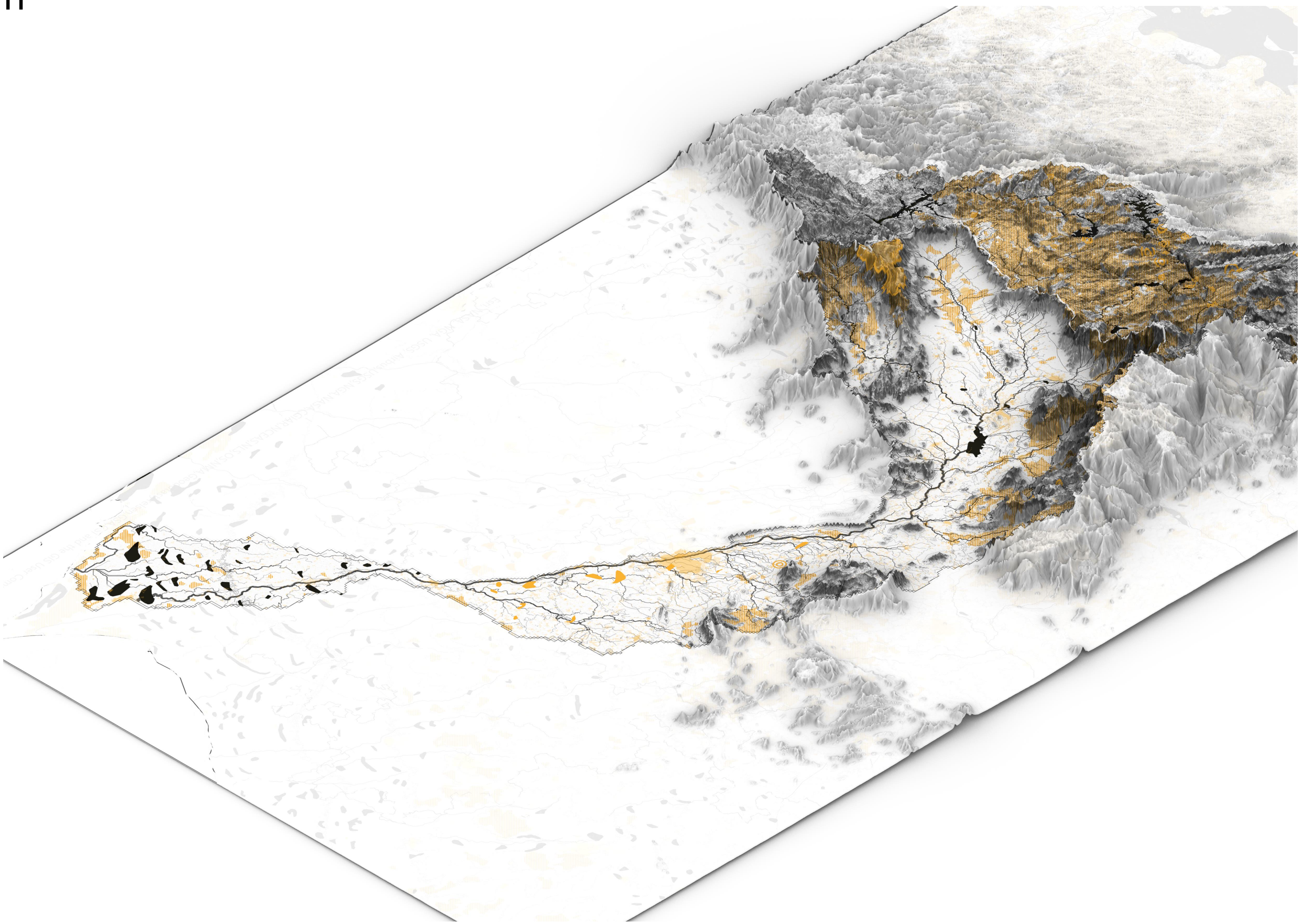
Network [River+Road]



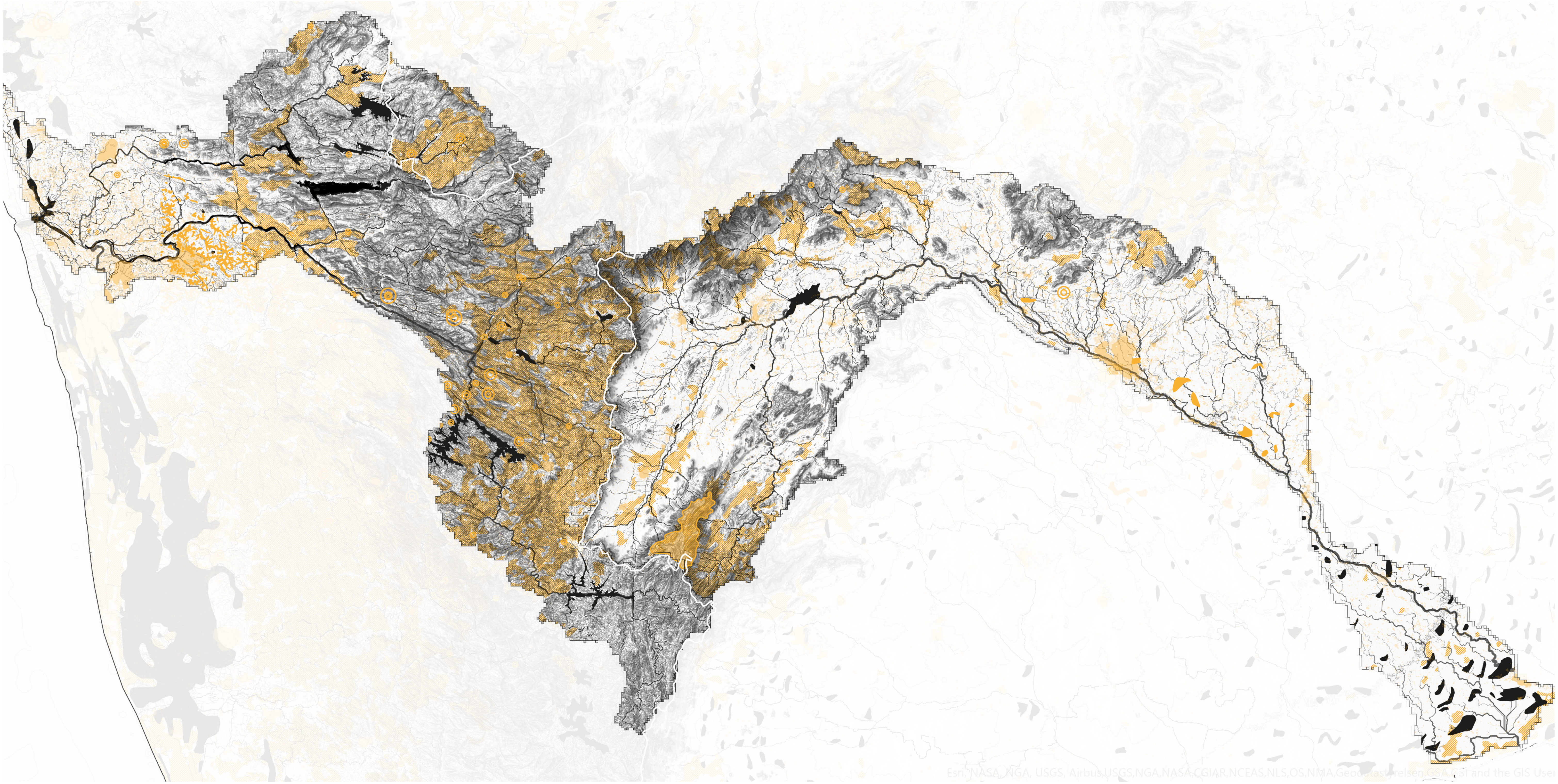
Periyar River Basin



Vaigai River Basin



Territory


Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User

Sequencing action

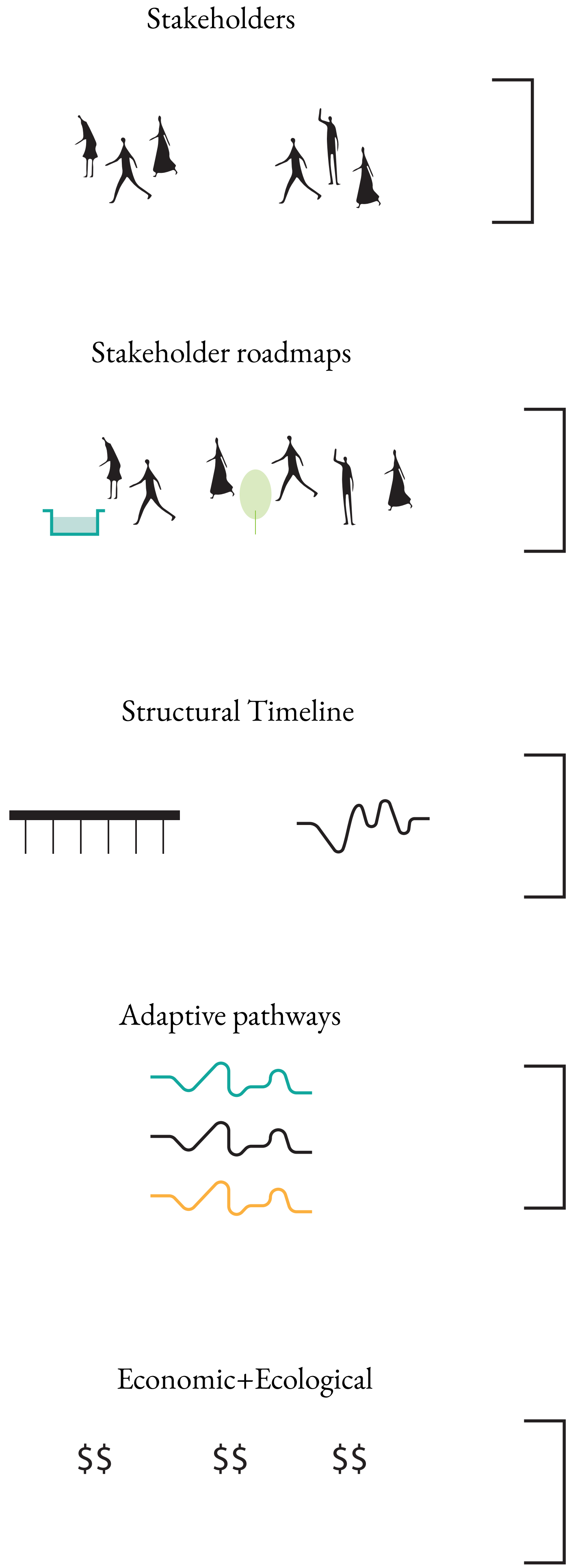
01. Recognition & Social activation

02. Procedural phase

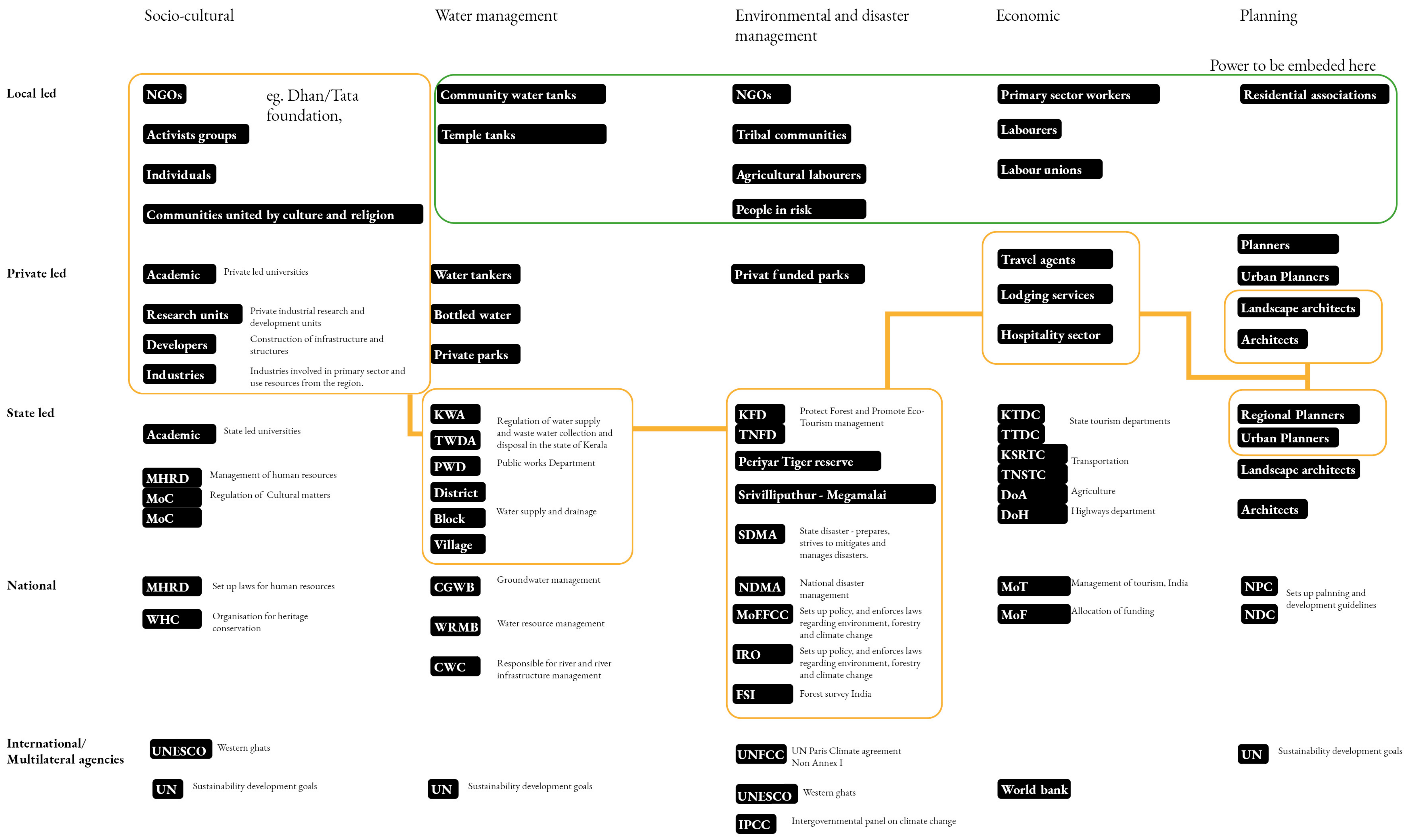
03. Structural phase

04. Programmatic phase

05. Ecological-economic stage



Stakeholders

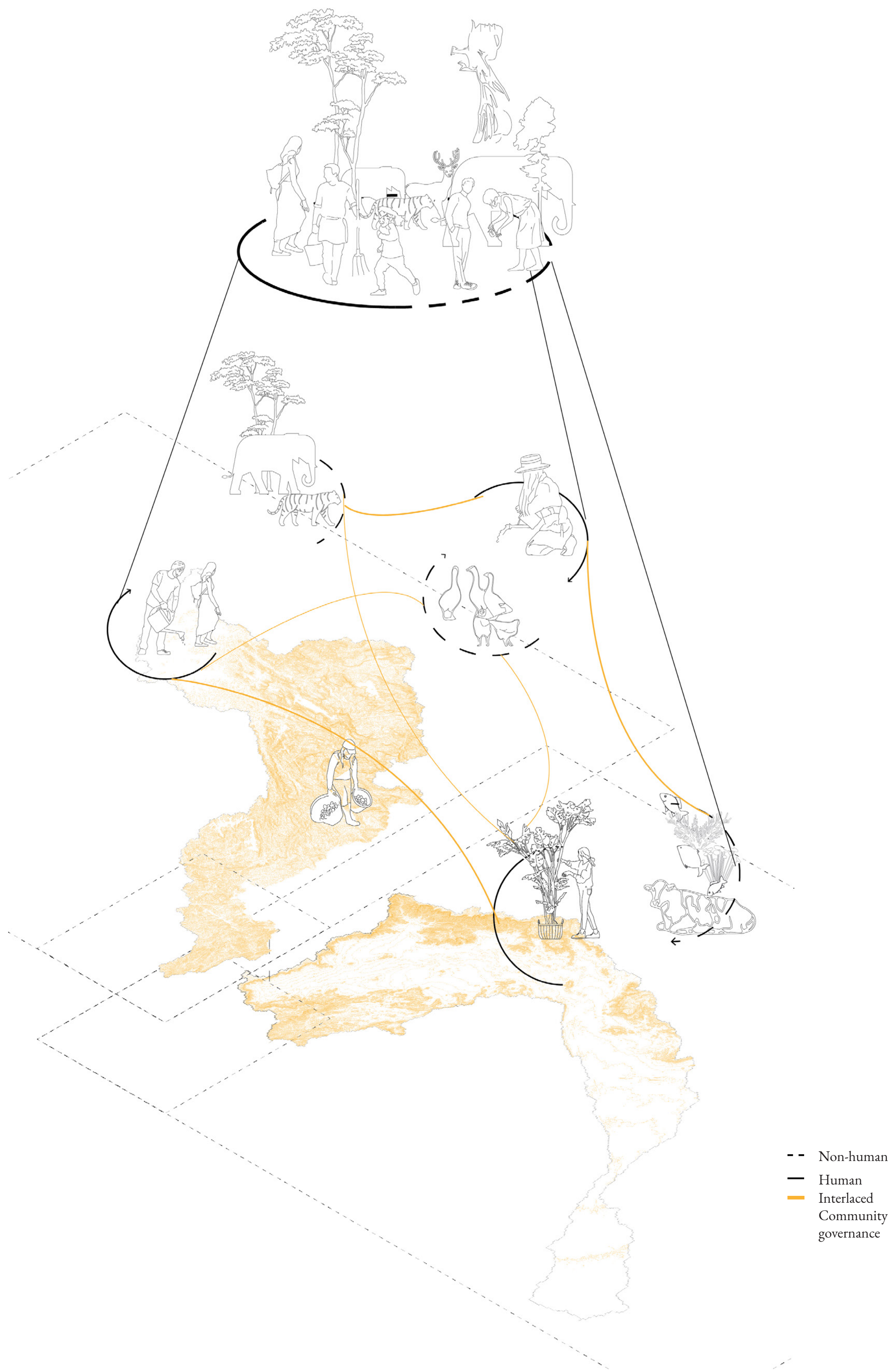


Highest power stakeholders

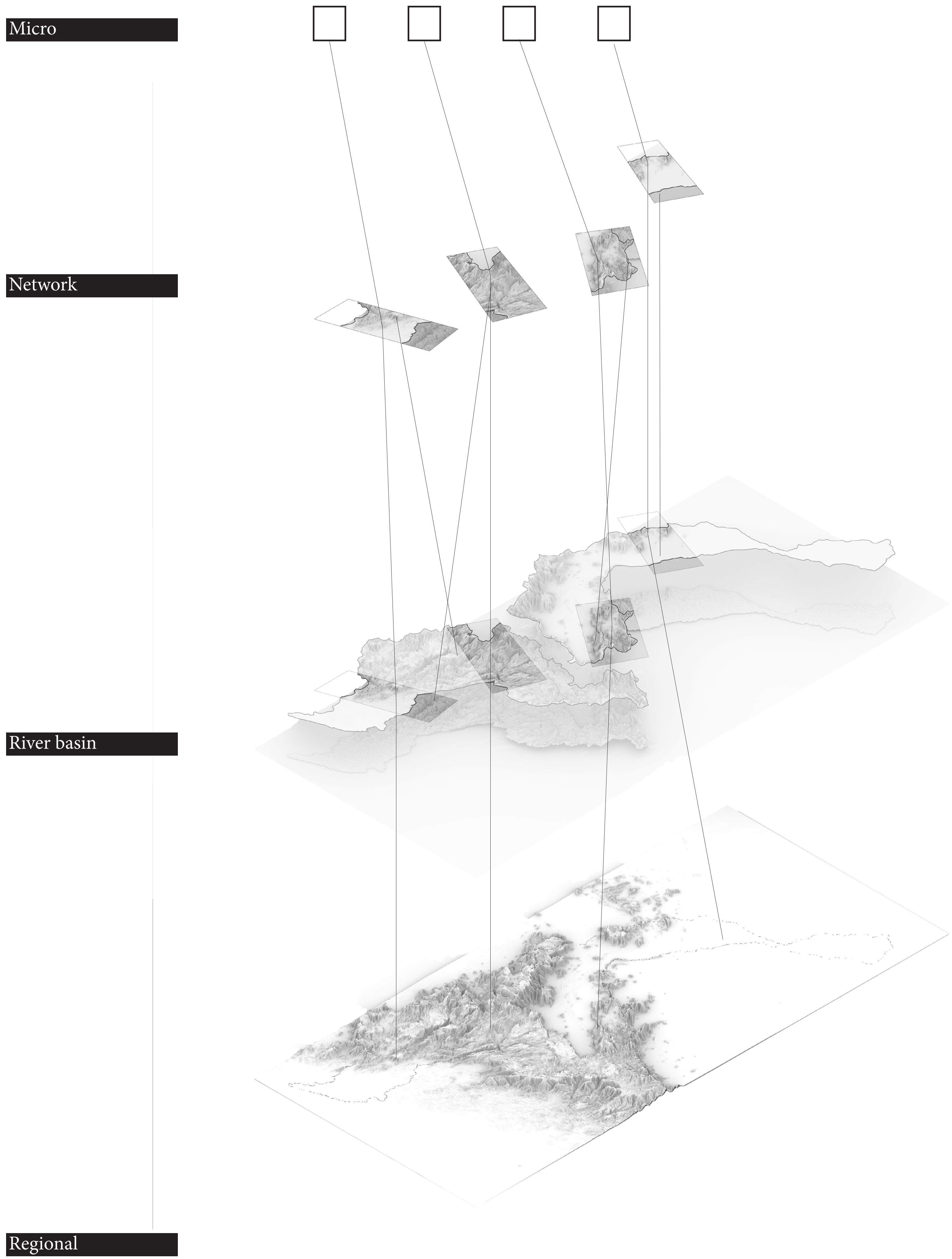
Transition of power

Fig 98 Stakeholder chart by author

Phasing

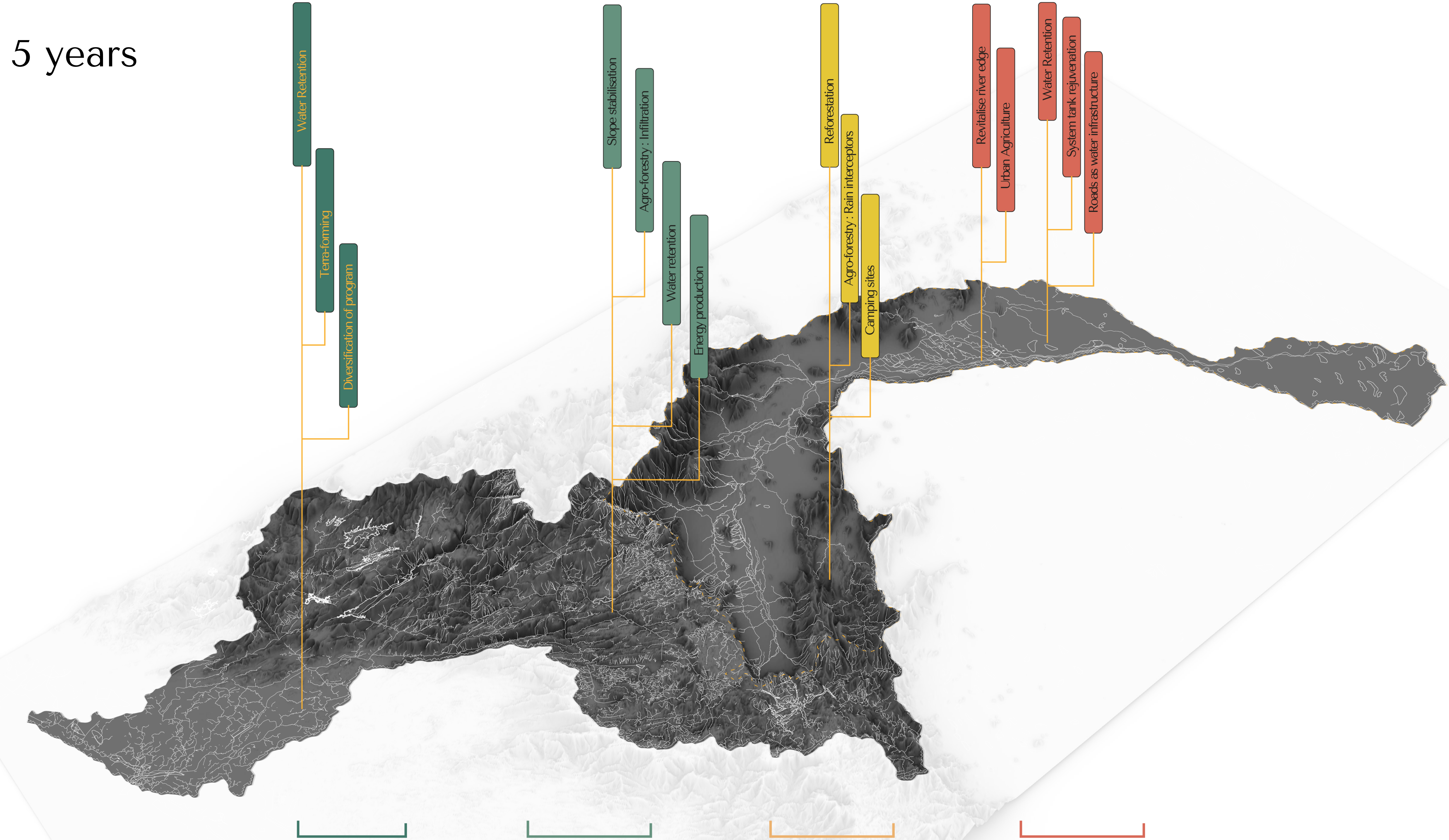


Non-human
Human
Interlaced
Community
governance



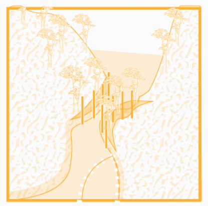
Micro
Network
River basin
Regional

5 years



Water Retention

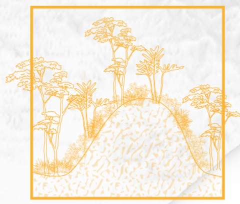
Reduce speed of flow
Protect vulnerable slopes



Reduce barriers to flow

Restore rainforest

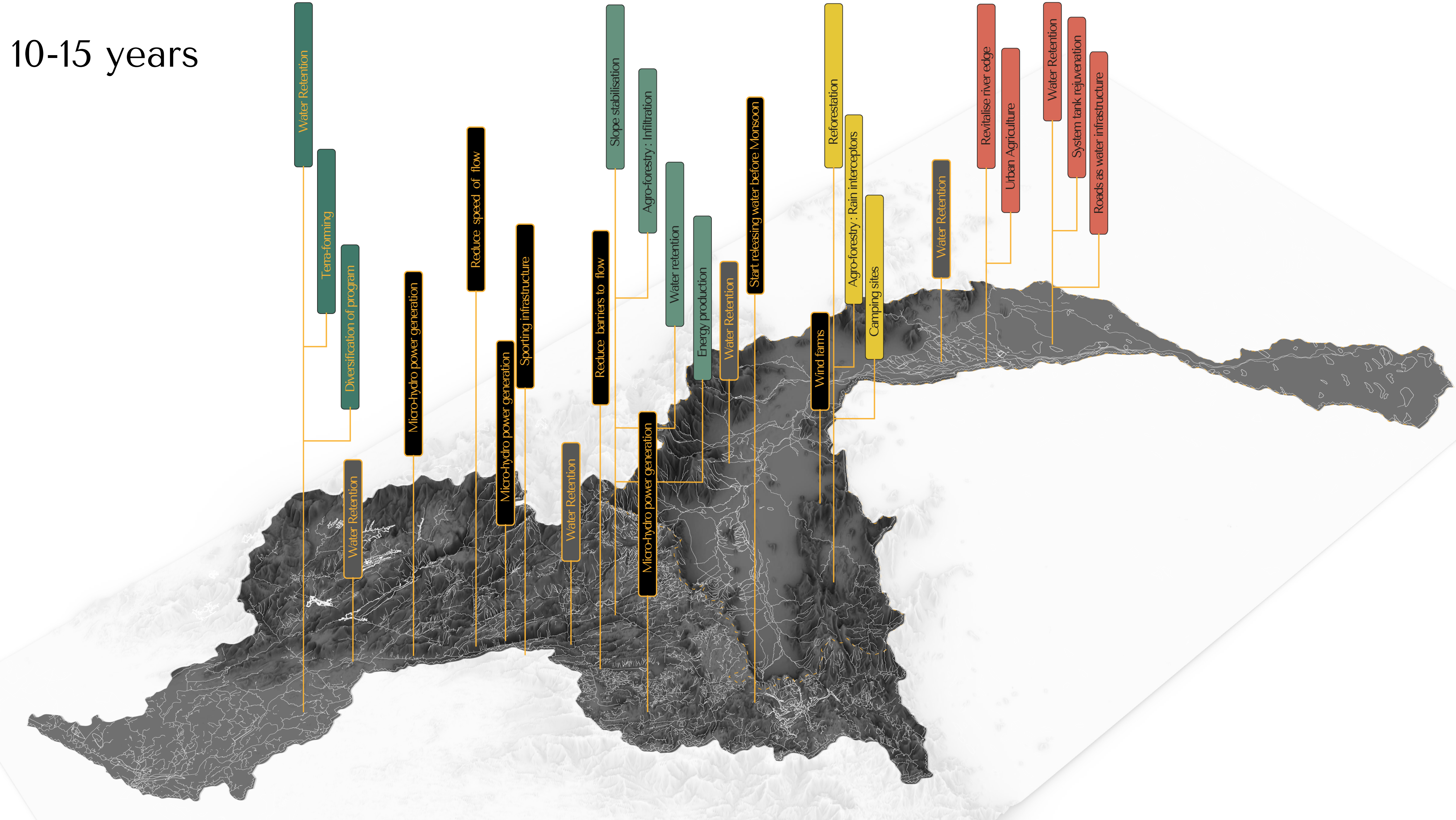
Agro-forestry



Rain dictating cropping
Diversify production

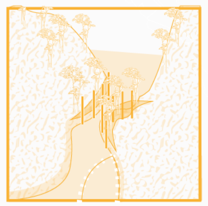
Restore river ecosystem
Water storage

10-15 years



Water Retention

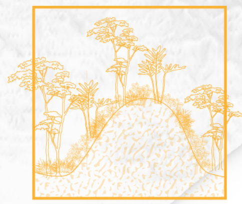
Reduce speed of flow
Protect vulnerable slopes



Reduce barriers to flow

Restore rainforest

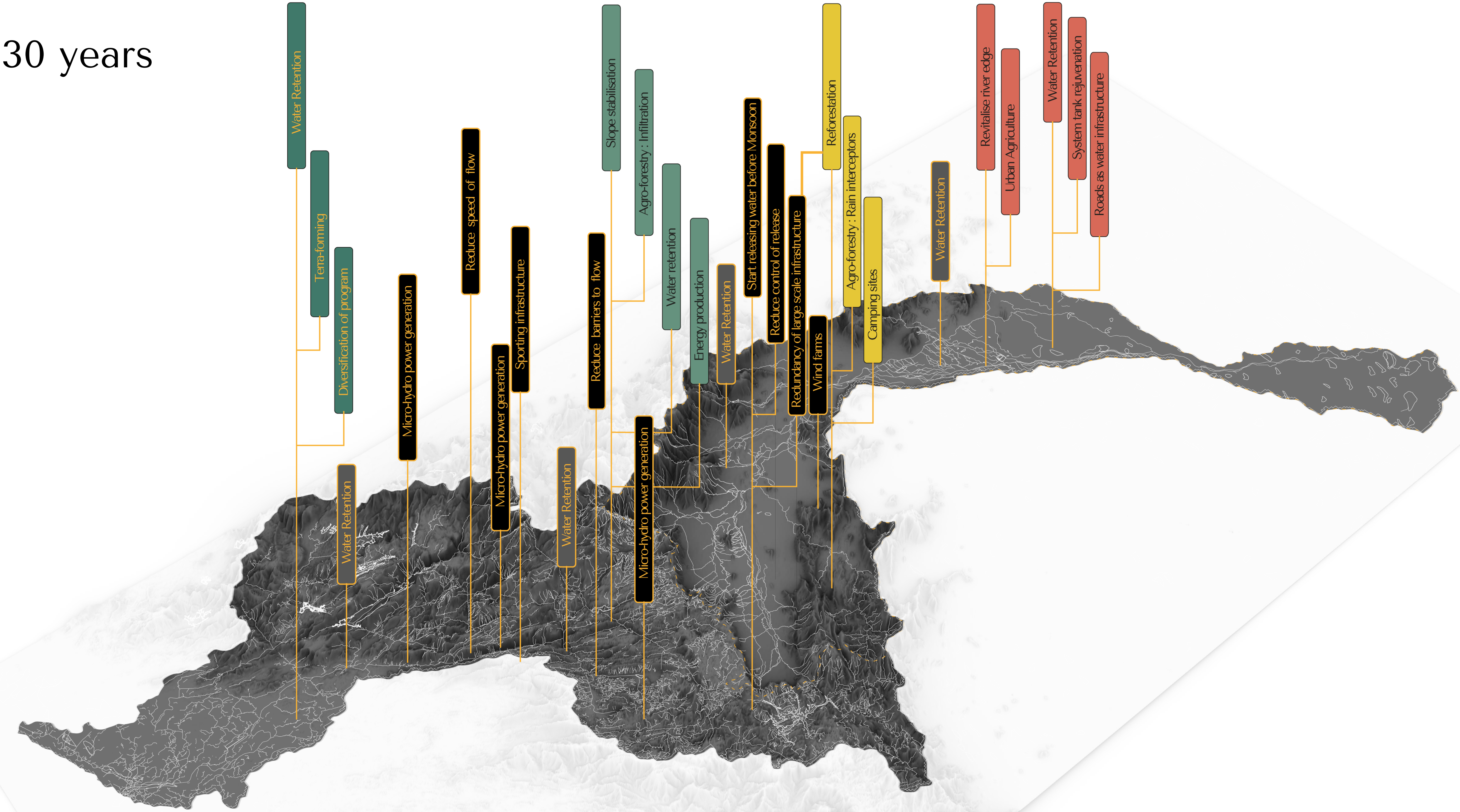
Agro-forestry



Rain dictating cropping
Diversify production

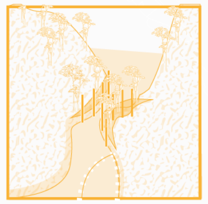
Restore river ecosystem
Water storage

30 years



Water Retention

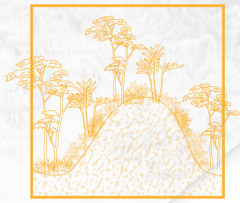
Reduce speed of flow
Protect vulnerable slopes



Reduce barriers to flow

Restore rainforest

Agro-forestry



Rain dictating cropping
Diversify production

Restore river ecosystem
Water storage

Protocols of Care

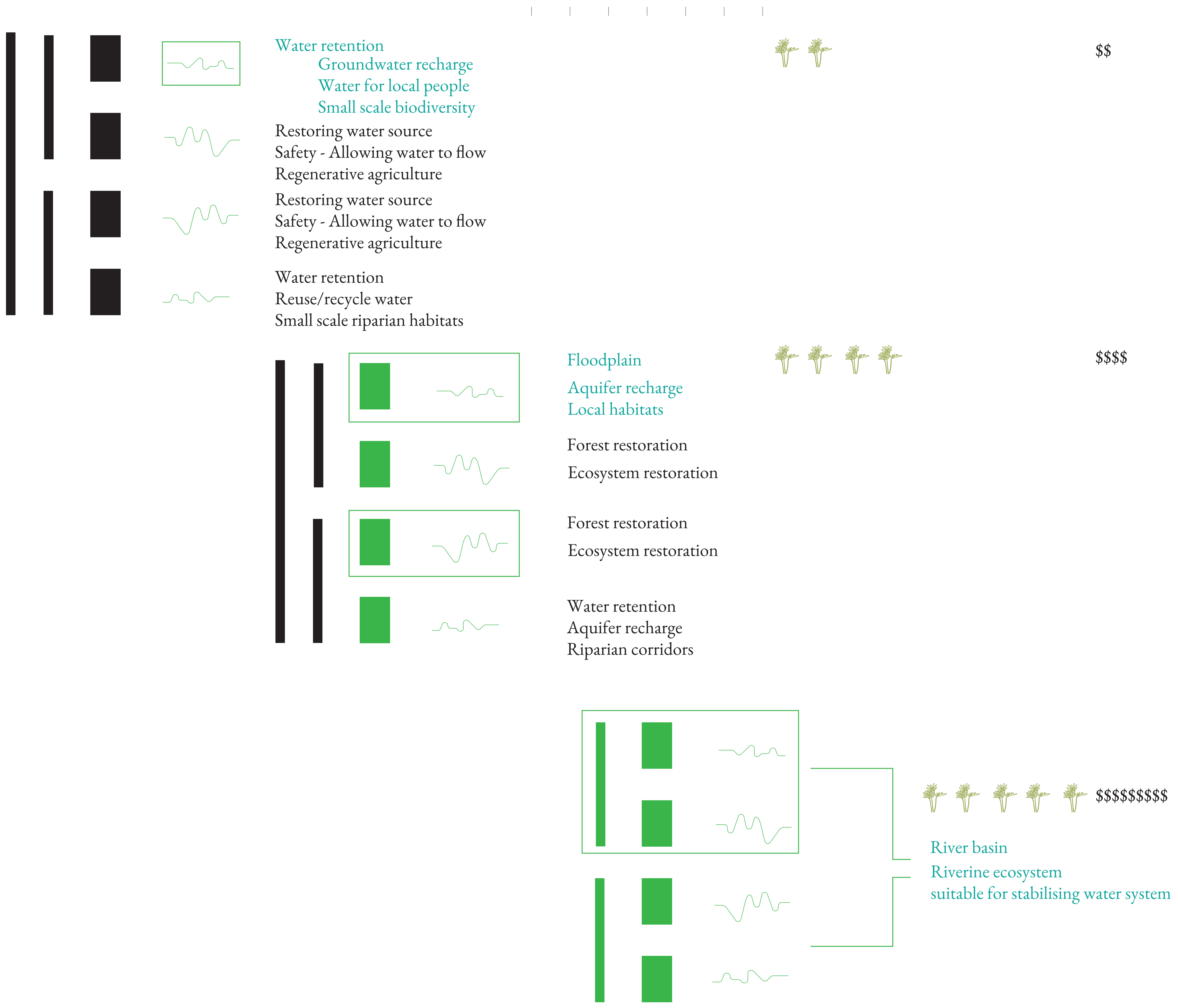
Could ecosystem services be monetised?

Could environmental stewards be compensated with so called capital?

Could the ecosystems western ghats mountain range be compensated for ensuring water safety?

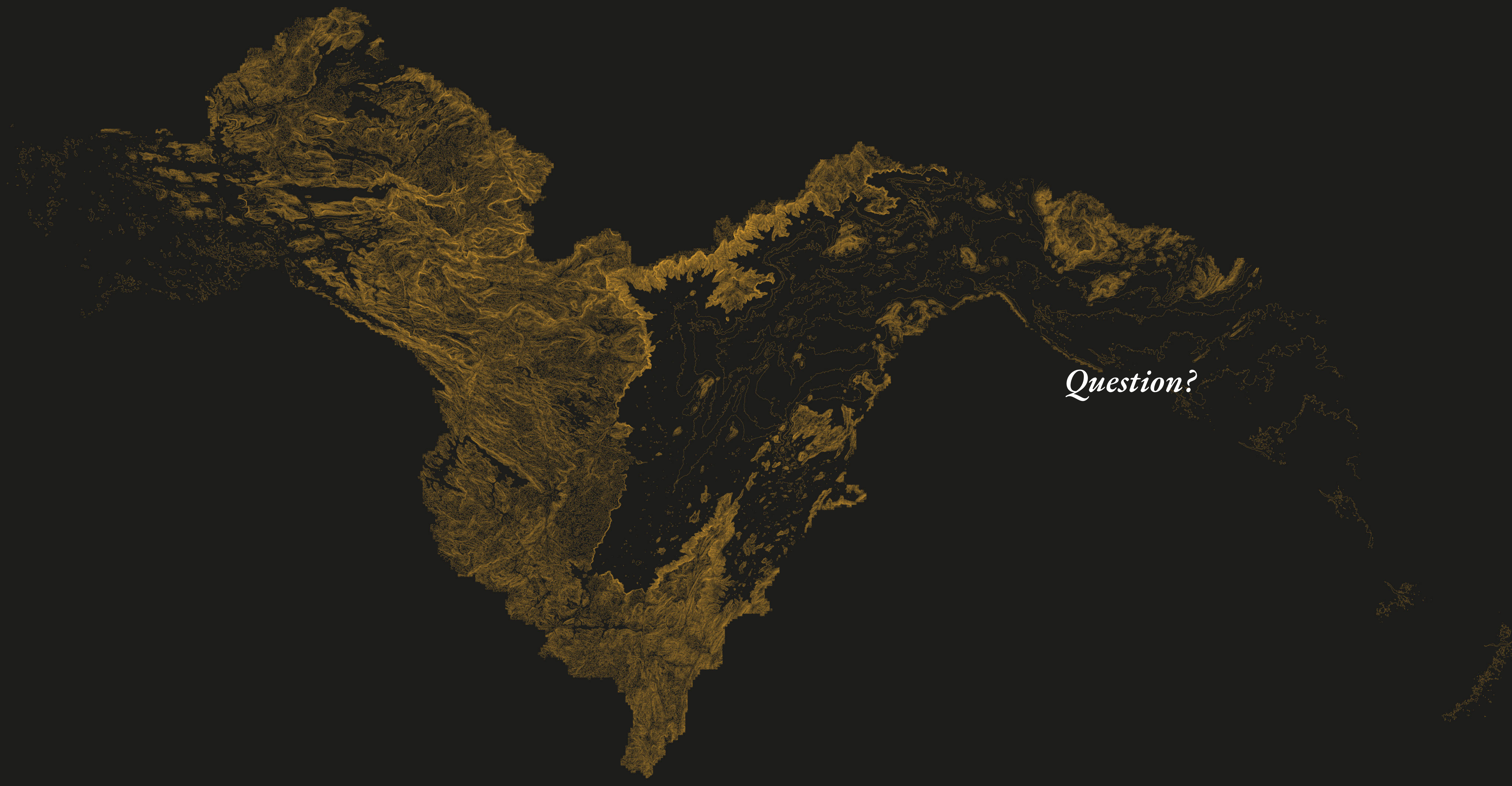
Could an upstream region which restores and safe keeps its ecosystem for the benefit of downstream consumers gain profit for the resources they provide?

Could restoring and maintaining the systemic function of each local level in agreement for the larger good be an solution?




idea


KOMATSU


Question?

Stakeholders

Power to be embeded here

	Socio-cultural	Water management	Environmental and disaster management	Economic	Planning
Local led	**NGOs** eg. Dhan/Tata foundation, **Activists groups** **Individuals** **Communities united by culture and religion**	**Community water tanks** **Temple tanks**	**NGOs** **Tribal communities** **Agricultural labourers** **People in risk**	**Primary sector workers** **Labourers** **Labour unions**	**Residential associations**
Private led	**Academic** Private led universities **Research units** Private industrial research and development units **Developers** Construction of infrastructure and structures **Industries** Industries involved in primary sector and use resources from the region.	**Water tankers** **Bottled water** **Private parks**	**Privat funded parks**	**Travel agents** **Lodging services** **Hospitality sector**	**Planners** **Urban Planners** **Landscape architects** **Architects**
State led	**Academic** State led universities **MHRD** Management of human resources **MoC** Regulation of Cultural matters **MoC**	**KWA** **TWDA** Regulation of water supply and waste water collection and disposal in the state of Kerala **PWD** Public works Department **District** **Block** Water supply and drainage **Village**	**KFD** Protect Forest and Promote Eco-Tourism management **TNFD** **Periyar Tiger reserve** **Srivilliputhur - Megamalai** **SDMA** State disaster - prepares, strives to mitigates and manages disasters.	**KTDC** State tourism departments **TTDC** **KSRTC** Transportation **TNSTC** **DoA** Agriculture **DoH** Highways department	**Regional Planners** **Urban Planners** **Landscape architects** **Architects**
National	**MHRD** Set up laws for human resources **WHC** Organisation for heritage conservation	**CGWB** Groundwater management **WRMB** Water resource management **CWC** Responsible for river and river infrastructure management	**NDMA** National disaster management **MoEFCC** Sets up policy, and enforces laws regarding environment, forestry and climate change **IRO** Sets up policy, and enforces laws regarding environment, forestry and climate change **FSI** Forest survey India	**MoT** Management of tourism, India **MoF** Allocation of funding	**NPC** Sets up palnning and development guidelines **NDC**
International/ Multilateral agencies	**UNESCO** Western ghats **UN** Sustainability development goals	**UN** Sustainability development goals	**UNFCC** UN Paris Climate agreement Non Annex I **UNESCO** Western ghats **IPCC** Intergovernmental panel on climate change	**World bank**	**UN** Sustainability development goals

Highest power stakeholders

Transition of power

Fig 98 Stakeholder chart by author

Stakeholder roadmap

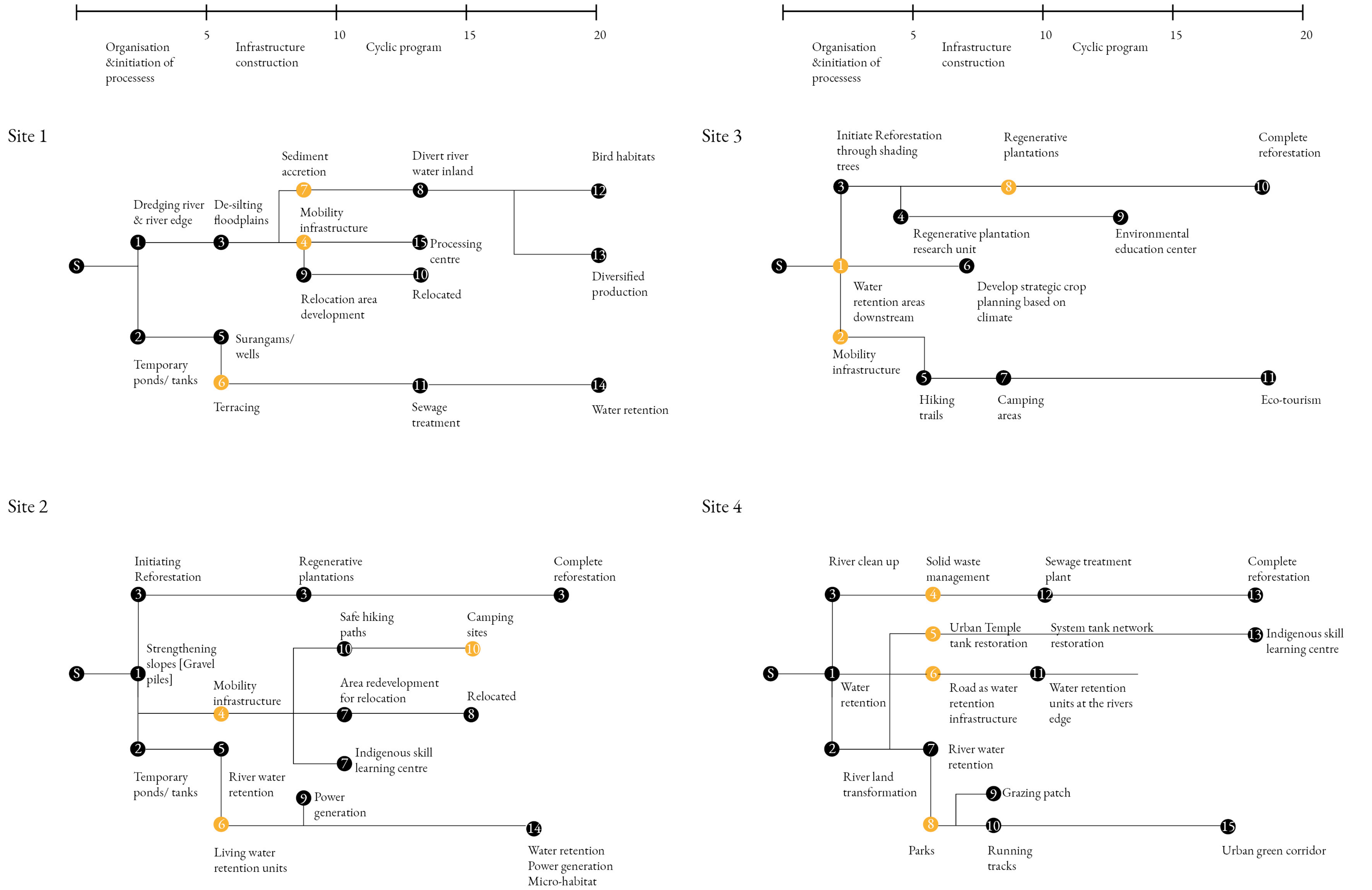
		Stage 1	Stage 2	Stage 3	Stage 4
Local led	**Local**	**Citizens organise** local vulnerable communities with the help of NGOs, along with the state to set up **workshops** for **immediate temporary resilient measures** with the municipality aiding their efforts by providing space and infrastructures. Gather **indigenous knowledge** for propagating learning local understanding of ecological management and skill building. By **employing skilled locals** from the region.	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.	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.	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.
	Network + Interstate	**Organise cross-community interrelations** for careful co-ordination of each others interest.			
Private led		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.	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.**	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**	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,	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.	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.	
	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.			
International/ Multilateral agencies		International commissions help national organisation in **setting up goals** for the future and in certain cases financially aid for sustainable transitions with developed world.	An adaptive pathway here could be international organisations could fund for testing such nature based projects in the region.		

Current situation

5 10 15 20 25 30 years

Fig 99 Stakeholder roadmap chart by author

Structural Time-line



S Social activation S Milestones

Fig 101 Structural timeline by author