Under the Weather

Rewriting Hydro-Social Narratives in the Thames Basin

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Research Studio: Transitional Territories
Inland-Seaward: The trans-coastal project

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Masters Thesis P5 Report

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Acknowledgements

My heartfelt gratitude to my mentors Taneha and Luca, for their time and patience, and valuable input that has shaped my project in ways I couldn't have imagined since its inception. Thank you Taneha for teaching me how to work with water and for pushing me to think deeply. You have nurtured in me a sensitivity for the subtleties often overlooked in design. Thank you, Luca, for having faith in the project, and for your insightful questions. Your guidance in searching for those answers with me have shaped the trajectory of my work. I have grown as both a designer and researcher as a result of both of your efforts and for that, I will forever be grateful.

To Luisa, Diego, Nikos, and the entire TT studio, Your design critiques and notes were invaluable to me. Watching the evolution of everyone's projects and being a part of such a talented and supportive group has been an honor. I am grateful for the encouragement and shared passion for design that we experienced together.

Thank you, Geert, and the Phillip Spanenberg Travel Grant Committee, for selecting me as a recipient of the grant. I am truly grateful for this opportunity, which has enabled me to collect first-hand documentation of the site, despite the challenges I faced in not being able to travel there in person.

And finally, to my parents, thank you for holding my hand throughout it all from halfway across the world. This wouldn't have been possible without your support and encouragement.

Abstract

As a result of climate change, there has been a shift in the global weather pattern. The hydrological regime in river basins across the world is subjected to unprecedented extreme weather conditions. In the Thames Basin, the narratives about resilience against sudden floods and extended droughts have focussed on sustaining London through large, expensive infrastructural projects. As such extremities become common over time across the basin, the relationship between the megacity and its ecological hinterlands is turning increasingly strained.

The increasing intensity of water-related disasters like droughts and floods across the basin are a sign of disruptions in the flows of the water cycle, and the disproportionate degree of responses to addressing them signifies the biases within the power structures that control the supply, distribution, and treatment of water. The thesis seeks to examine these imbalances of power within integrated river basin management through the lens of urban political ecology to address the inequalities in how citizens in different settlements across the basin are exposed to water risks in terms of compromised quantity and quality of water.

In addition to seasonal flooding risks, the entire basin is subjected to threats to water security as a result of population growth, changes in rainfall patterns, and high levels of pollution. This threat to water security is affecting the countryside's ability to sustain its agricultural practices in the face of declining national food security. The project further seeks to adopt a site-sensitive approach to water risk management that acknowledges the water needs of the countryside. Moreover, with its position upstream of the basin, the actions towards water management taken here to slow the river and increase groundwater infiltration could help reduce the intensity of fluvial flooding downstream and work towards recharging fresh water supplies.

Key Words:

Water Sensitivity, Climate Sensitive Urban Design, Thames Basin, Ecosystem Based Adaptation, Integrated River Basin Planning

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01 Introduction

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1.1 Problem Field: On Weather and Water

Changing Climate, Changing Weather

The climate crisis with its pressing need to lower the global temperature is most personal and tangible to us, in how we experience weather in our day-to-day lives.

> "Weather exists as an atmosphere that can be measured, it exists as an environment that is lived and it exists as time in which we experience humidity, pressure, temperature, and more".
> (Parikka & Dragona, 2022)

A weather pattern is defined by variables like temperature, atmospheric pressure, cloud formation, wind, humidity, and rain and it is influenced by the earth's motion in space, and the distribution of solar radiation on the surface of the earth. The temperature and pressure difference between the poles and the equator drives the motion of jet streams that carry weather systems from the west to the east.

The global weather system is transforming under the influence of climate change, and this has could mean a complete shift in how we define and understand local weather in our respective contexts. There is an emerging field of study in climate science that is trying to relate the rapid warming of the Arctic region with a potential global redistribution of weather patterns. As the polar ice caps are warming at a rate that is twice as fast as the global average, the temperature difference between the poles and the equator is dropping. This in effect would result in weaker jet streams with increasingly erratic waves, and a projected northward shift of the North Atlantic jet stream which directly impacts North America and Europe. Such a North Atlantic jet stream shift would in effect have an impact on the frequency and magnitude of extreme weather events across a broad portion of the Northern Hemisphere (Osman et al., 2021).

Over the past decades our collective experiences across the globe are marked by experiences of unprecedented extreme weather events that are attributed to anthropogenic influences. These weather events are extreme as they show a marked deviation in intensity, severity and suddeness in their occurance. For example, the 2020 heatwave in Siberia from January to June was made 600 more times likely by human-induced climate change (Dune, 2020), and the occurrence of such extreme events in the form of flooding, droughts, and heatwaves is expected to become more frequent with increasing global warming. (Seneviratne et al, 2021).

Changing Weather, Changing Water Cycle

The project focuses on two specific manifestations of these extreme weather events - flooding and droughts and tries to study the destruction in its wake as symptoms of disruption to the water cycle. Climate change has altered the water cycle since the mid-20th century and continues to play a role in increased total evaporation, precipitation, humidity, and moisture transfer at a global scale (Bosilovich et al. 2005; Held and Soden 2006; Huntington 2006), which is driving increased drying and longer droughts in semi-arid and arid regions and increasing precipitation and peak streamflow (Trenberth and Asrar 2014). The global water cycle has in effect become more intense, and its effects at the local scale relate to how we use land and shape water systems.

Studies published since 2019, have addressed the need to highlight disruptions in the water cycle beyond the 'Blue water' ie. the water in the rivers, lakes, and aquifer stores that we directly draw from. A large share of the water cycle flows as 'Green Water' through soil moisture transfers, and transpiration in plants, and large disruptions in these flows are seen since the Holocene Era (Wang-Erlandsson et al., 2022)

The project aims to look at how these disruptions to the water cycle translate into political and environmental consequences, within the context of the Thames Basin where extreme annual weather variations triger civic loss and restrictions as a result of flooding and drought.

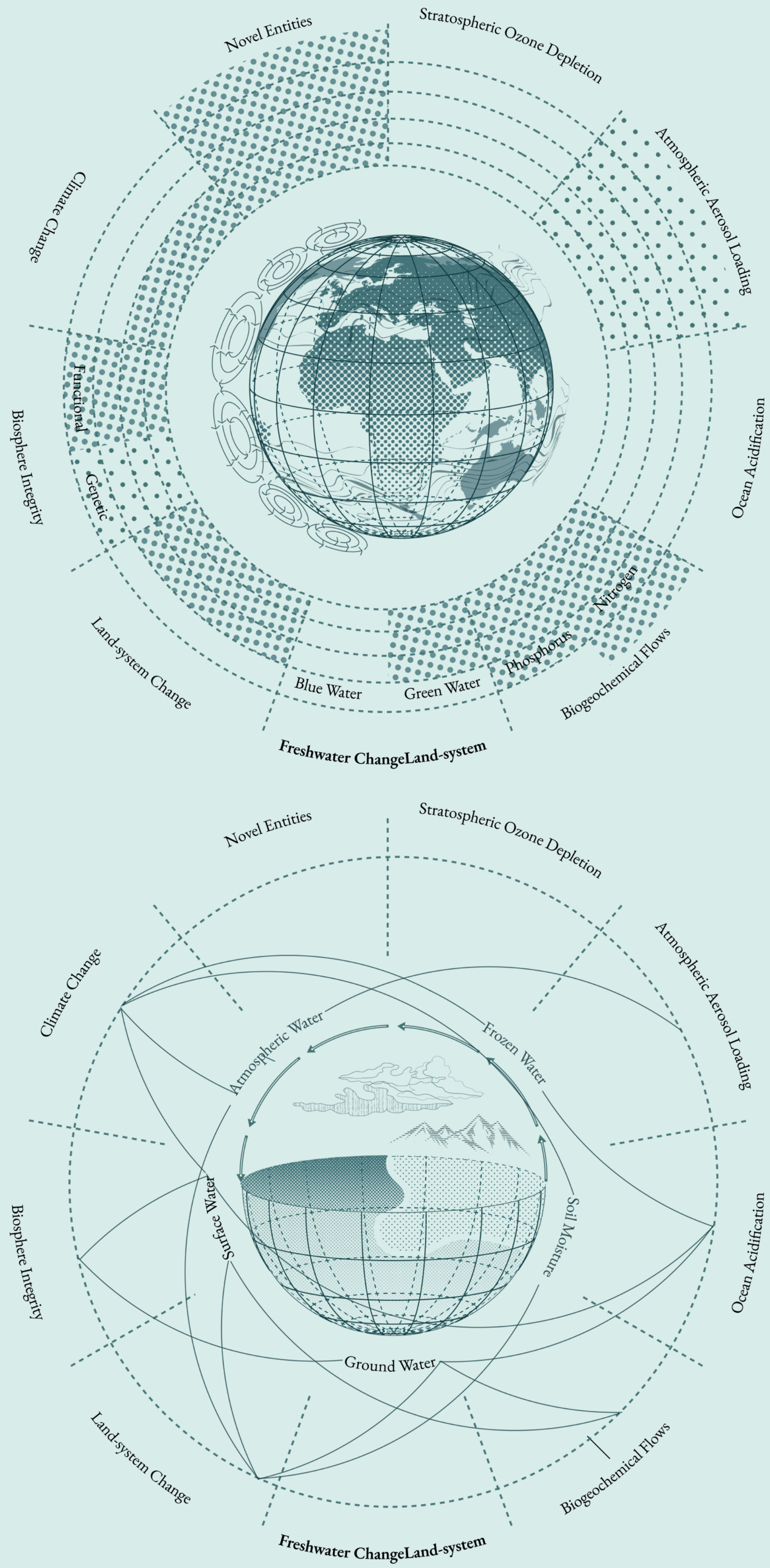

Fig 1: Planetary Boundaries Framework and its interconnection with the hydrological cycle (Adapted from figure by Stockholm Resillience Centre)

1.2 Problem Field: On Weather and Time

Designing to cope with unpredictable weather extremes is to recognize the patterns and time frames that nature operates in. Throughout history, infrastructural projects have allowed us to appropriate resources beyond the spatial limits of a site, and 'replace temporal process' to support our constantly growing idea of growth. As William Sherman highlights in his text 'Fields in Flux', such projects were justifiable at the time since they delivered a steady and predictable flow of resources to support economic progress despite nature's volatility. This allowed the creation of projects that were disengaged from their local context and exempt from being held accountable for the social and ecological systems it disrupted. Such design models were based on the premise of stability and the control of centralized authorities. In the current era of increasing climate uncertainties, it is necessary to reconsider the norm that we have fallen into. As Sherman puts it -

> "The long-term impact of our technologically driven, consumer culture necessitates a critical reconsideration of the failings of this modern apparatus as a precondition for design."
> (Burns et al., 2005)

A shift in our understanding of design would be to return to engaging with nature's time-based processes rather than form alone. Working with this domain of time in design where as Piere Bélanger describes, 'processes and projections converge, coincide and collide', presents an opportunity to propose new systems of intervention (Bélanger, 2017).

Designing for water management in scenarios of drought and flooding would mean recognizing both the seasonal shifts of rainfall events and their duration and how this affect the daily variations in the river's discharge levels. Through acknowledging the time scales within which the hydrological system operates, the goal would be to work towards water cycle restoration and attempt to rehydrate the earth through rainwater retention and infiltration into the sub-surface while decreasing the socio-economic disruptions caused by flooding.

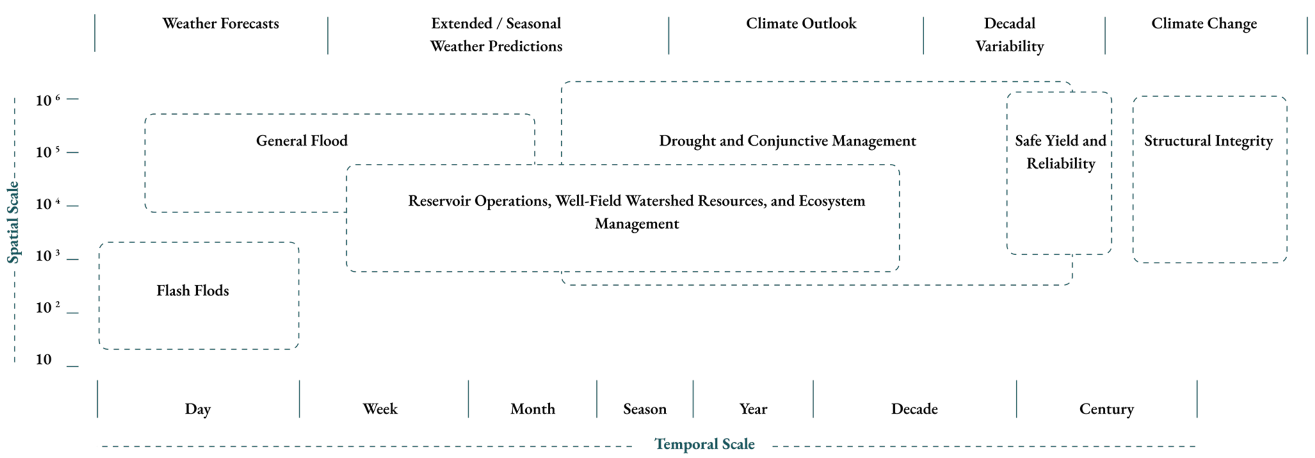

Fig 2: Diagram showing how water resource issues vary in both space and time. (Soroosh Sorooshian1, Martha P. L. Whitaker1,* and Terri S. Hogue, 2002)

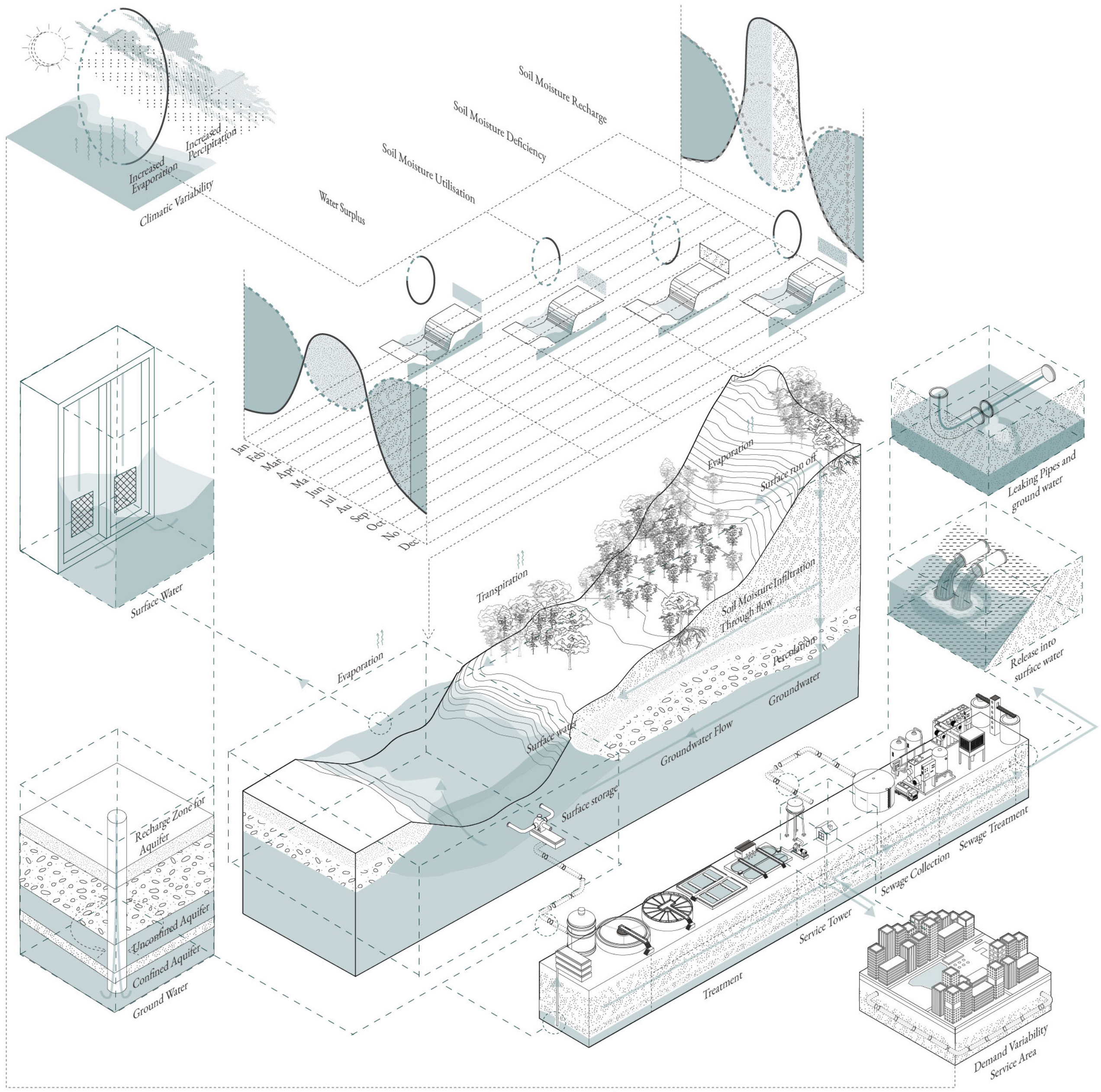

Fig 3: Synthetic Diagram that shows weather and social variables that control the hydrosocial cycle (Author)

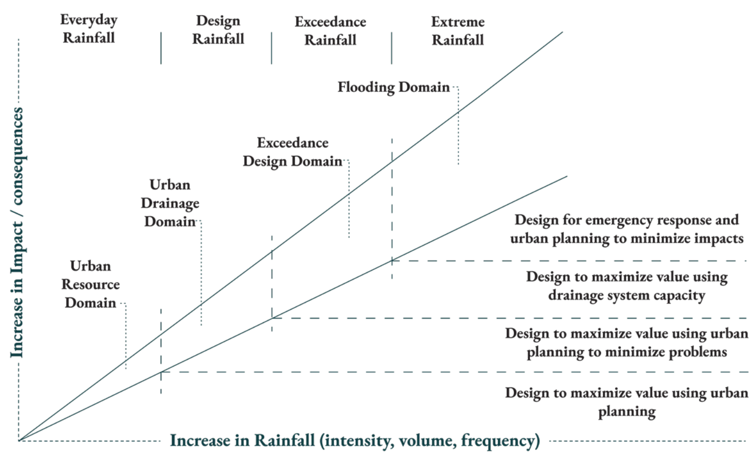

Fig 4: Diagrammatic representation of the four domains of urban watermanagement (Fratini et al, 2012)

1.3 Position: On Looking past the 'God Trick'

The position I've adopted in my design is influenced by Donna Haraway's essay on Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. The essay examines the concept of objectivity in the sciences within the context of feminist inquiry. One aspect of the essay that greatly influenced my approach to the project is Haraway's critique of the "god trick" and the importance of engaging with situated knowledge.

Haraway points out that while objectivity is often presented as neutral, it is actually influenced by power relations and conceals specific positions. The "god trick" represents a perspective that renders all other positions invalid and subjective, thereby denying the expression of diverse voices.

"The 'god trick' is a 'a conquering gaze from nowhere'. This gaze is claimed to be immaterial while materializing what it embraces (particula ly how bodies matter: which bodies have which meanings, which bodies are deprived of meaning, and how bodies (and meanings) materialize), it is claimed to have the capacity to see, but is itself unseen."
(Harraway,1988)"

By highlighting the limitations of objectivity and the detrimental effects of the "god trick," Haraway emphasizes the necessity of embracing situated knowledge. Situated knowledge acknowledges the specific context in which knowledge is produced, allowing for a more nuanced and inclusive understanding of the world.

"Situated knowledges work like an apparatus of producing a more adequate, richer, better account of a world, in order to live in it well and in critical, reflexive relation to our own as well as others."
(Harraway,1988)

The critique of the "god trick" and the call to engage with situated knowledge shaped my approach to the project, leading me to question dominant narratives and consider multiple perspectives in order to challenge the prevailing power dynamics and foster a more inclusive and empowering design.

The prevailing water paradigm, influenced by the god trick, often portrays river basin management as dependent on highly technocratic solutions, implying that collective sacrifices are necessary to sustain a system that disproportionately benefits certain areas at the expense of others. It is this underlying assumption that prompted me to delve into subjective understandings of the problem statements and focus on reimagining the concept of 'the countryside'. I sought to engage with local land uses and characteristics within the smallest scale of land typology that I ultimately adopted. By doing so, I try to explore alternative approaches that address the specific needs and contexts of different areas within the basin.

The essay advocates for the idea that knowledge should not be rigidly confined to categories but should instead acknowledge the simultaneous and interconnected nature of diverse perspectives, thereby opening up possibilities for transformative thinking. In my own work, I actively seek to learn from various disciplines such as engineering, ecology, environmental history, eco-critical theory, and economics. However, it is important to acknowledge that these perspectives alone do not fully encompass the complexity of the issues present in the basin. I made a deliberate choice to engage with specific notions that have direct spatial translations and the potential to challenge the prevailing water paradigm. The limitations of my study lie in the perspectives that I was unable to include.

Furthermore, an important aspect of my project involves rethinking modernity through situated design practices and acknowledging the agency of the knowing object. The concept of the 'knowing object' serves as a reframing of traditional notions of "objects of knowledge". This reframing is intended to transform the subject from a passive object into an active agent. In the context of my project, this perspective specifically applies to the River Thames and the various species that I actively engage with through my design.

Harraway emphasizes the importance of including "fantastic or imaginative elements" in our pursuits of knowledge. In the context of my project, this pertains to shedding light on the "neglected" and "overlooked" aspects that often go unnoticed. These elements are necessary to stimulate our understanding of reality and construct a reasonable claim to objectivity, as opposed to "being plagued by breathtaking denials and repressions"

""The codes of the world are not still, waiting only to be read. The world is not raw material for humanization; [...] the world encountered in knowledge projects is an active entity. Presenting the world/nature/object of study as inactive is how power relations enslave, colonize, and dominate"
(Harraway,1988)

Harraway emphasizes the importance of including "fantastic or imaginative elements" in our pursuits of knowledge. In the context of my project, this pertains to shedding light on the "neglected" and "overlooked" aspects that often go unnoticed. These elements are necessary to stimulate our understanding of reality and construct a reasonable claim to objectivity, as opposed to "being plagued by breathtaking denials and repressions"

The notion of extending agency to the non-human and neglected elements and integrating them into the reframing of the hydro-social narrative aligns with Bruno Latour's perspective on the flaw in the European project - the nature/culture division. In the context of this project, this view has been perpetuated by a hierarchical approach that excludes non-human species, and non-urban citizens. This perspective, which is essentially the "god trick" in use in the Thames River basin management, disregards the agency and interconnectedness of non-human entities. ' As a final critique of this "God Trick" in use, I would like to end with Dipesh Chakrabarty's words on how it contributes to our inability to address environmental challenges effectively.

"The more humans created a human-dominated world order, an order of life, the more we got rid of most of the wildlife that could have threatened it. And we developed mechanisms for dealing with 'natural' disasters, ranging from technology to insurance. The only predators we have left now are viruses, bacteria, and other microbes.. "
(Chakrabarty,2020)

02 Context

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2.1 Introduction

The Thames River Basin is located in South East England and is bound by the Costwold Hills to its extreme west and feeds into the North Sea. Since its emergence over 30 million years ago in the Cenozoic era, the River Thames has transformed from a 'great, fast-flowing tropical jungle river' to the domesticated tributary we see today (Ackroyd, 2008). Within its large geological lifespan, the riverine landscape of the basin has been dramatically modified to sustain the growth of London from a strategic port settlement into one of the first megacities of the world.

> "The Thames has been a highway, a frontier, and an attack route; it has been a playground and a sewer, a source of water and a source of power."
> (Ackroyd, 2008)

The River Thames has been one of the most intensely managed rivers in Europe, and as one moves from its source in the countryside of Gloucestershire towards it's estuary, the flood plains transition from its unconstrained or semi-natural state to one heavily controlled by a system of embankments, weirs, sluices and locks (2021).

Overview of Challenges Today

A combination of human and climatic variables is pushing the entire basin into a state of increased water risks, from seasonal flooding, drought, and exposure to high levels of pollutants. The aftermath of the Londons' boom since the industrial revolution, and the continued pressure to sustain it as the world's financial capital have led to heavy modifications of the River Thames to manage these risks near it. Without these measures in place, many regions of London along the tidal stretch of the basin would be inundated with tidal flood water up to twice a day (2021).

As the basin is subjected to weather extremes with our changing climate, the varied spatial forms of rurality and urbanity in the basin are united by experiences described as 'flooding in a drying basin'. Intense rainfall events are washing increasing agricultural and urban runoff as pollutants into surface bodies (2008), and triggering the release of untreated sewage from combined sewer systems into river bodies as a 'sometimes necessary and permitted to prevent flooding homes, gardens, streets and open spaces' (2022).

With the rising summer temperatures that the semi-arid region of South-East England is subjected to each year, the groundwater and surface water reserves are unable to adequately replenish themselves driving a condition of drought. The record heatwave in the summer of 2022 caused the river levels to reach the lowest marks in nearly a century and forced Thames Water, the water company servicing the catchment area, to issue a hosepipe ban that directly affected over 10 million people (2022).

The ripple effect of such events disrupts everyday life at a range far from the site that is directly impacted and beyond the time it takes for flood waters to recede or freshwater stores to recharge themselves. The Environmental Agency estimates that for each person directly affected by flooding, sixteen others are affected by a disruption in services like transport, and power (2021). Crop Failures of up to 50% in the summer of 2022, were predicted as a result of extreme heat, low rainfall, and limited abstraction rights afforded to farmers in the United Kingdom (2022).

Within this challenge of adapting to extreme climatic variables lies the need to reconsider the tendency to depend on highly engineered technocratic solutions. Water pipelines, from as far back as the Victorian Era are unable to handle the current stormwater overflow loads, and are working past their design limits. Mismanagement of these water supply pipelines and the inability to fix leakages for decades have further compromised the water security of the basin (2022) and exposed other parts to floods from sudden pipe bursts (2023).

Thames Water criticised over lack of investment in sewage treatment works

Campaigners say most sites cannot cope with amount of wastewater, raising risk of raw discharges into rivers

Analysis suggested three-quarters of facilities in the upper Thames area lacked capacity to deal with the amount of wastewater from the population. Photograph: Cultura Creative Ltd/Alamy

Thames Water hosepipe ban to start on 24 August

17 August 2022 · Comments

GETTY IMAGES

Thames Water CEO Sarah Bentley said implementing the ban had been a "difficult decision"

Thames Water has announced a hosepipe ban for 10 million customers across the south of England.

Thames Water: Protestors demand halt to sewage spills

18 March 2022

NIKI HINMAN

Protestors called on Thames Water to stop polluting local waterways

Banner-wielding protestors banging drums, pots and pans have demanded Thames Water clean up its act and stop spilling sewage into rivers.

Source of River Thames dries out 'for first time' during drought

Head of the Thames is now more than 5 miles downstream as forecasters warn of further high temperatures to come

It's time to WAKE up! Furious campaigners launch bombshell appeal to sue water regulator

Untreated sewage was released into the seas and rivers around the UK more than 770,000 times over the course of 2020 and 2021.

By OLLIE CORFE
07:20, Mon, Jan 16, 2023

UK Utility Probes Data Centers' Water Usage During Drought

- Data centers compete with consumers for drinking water
- UK is in a drought, recording its driest July in 90 years

Burst Thames Water pipe at Crookham Common Reservoir sees homes left with supply issues

Thames Water engineers are working at the site on Sunday in a big to resolve the problem

Some people are experiencing low water pressure or no water at all (Image: Erin Black/Plymouth Live)

11 water companies - including Thames Water - must return almost £150 million to customers for failing on targets

3rd October 2022

Protest against Thames Water in Port Meadow

Fig 5: News paper headlines from 2022: Accounts of hose pipe bans, and protests against sewage discharge and water loss
Source | Express, The Gaurdian, BBC News

2.2 Historical Precedents to Narratives about Resilience

The Growth of London and the River Thames

The Thames Basin is a single hydrological unit defined by its terrain, and its multiple tributaries from both the countryside and the dense core of London, all draining within the Thames River. While the Upper Thames catchment is a freshwater source, the lower Thames is a tidal zone and is more susceptible to flows and risks coming in from the seaside. It was this position in the tidal zone of the Thames that initially allowed London (then Londinium) to grow as a port under the Roman occupation. The growth of London since then is rooted in how it appropriated both the water and the floodplains of the River Thames.

The conditions that drove our very ideas about urbanity across time are directly reflected in alterations to the river, near London. Trade drove the growth of the city, and the link between its constantly evolving spatial demands and the River Thames was set in stone since the city was rebuilt after the Great Fire of 1666. Sloped private gardens meant for noblemen that led into the river were replaced by wharves and jetties to support the increased influx of merchants. Networks of narrow streets and standardized houses were designed in relation to the river, and the city grew to support the immense traffic of ships and goods (Ackroyd 20008).

London's population continued to grow in the subsequent centuries as a result of the industrial revolution. The water infrastructure at the time was a combination of privies, cesspits, narrow stormwater drains, and the activities of the night soil collectors who either sold human wastes to the surrounding rural hinterlands or disposed of them directly into the River Thames. By the early nineteenth century, a series of outbreaks of cholera, exposure to extreme pollution, and advances in the science behind germ theory created the impetus needed to bring about Joseph Bazalgette's sewage system. The large system carried the wastes of the city into the Thames Estuary and transformed both the River Thames and several tributaries that ran through the city. Several rivers are now buried underground and reduced to sewers or runs as subterranean 'shadow rivers'. One such river, the Fleet occasionally resurfaces to flood basements along its course (Ackroyd 2008). Embankments were constructed along the River Thames to conceal the sewers and additionally act as a flood wall. This highly engineered constrain to the rivers width has significantly increased its velocity, and in turn the risk of drowning.

Londons relationship with the Thames played a definitive role in shaping the culture of urbanity in a fast growing mega city, from the private domestic sphere to the technological networks that facilitated the growth of the city. Our conceptions of urban needs grew in relation to water infrastructure. Infrastructure and techno-scientific solutions to threats in the urban space (like limited water supply and pollution) were presented as 'modernity itself'. While diverse and sophisticated urban water systems were in use in pre-industrial times, the Victorian water system took root globally and came to define how we've set the standards to maintain personal hygiene and public health (Gandy, 2017).

London and its Ecological Hinterlands

William Wordsworth in a poem 'Composed upon Westminister Bridge' likened London to the 'mighty heart' that the River Thames glided into as it cut through the valleys and rocks 'at his own sweet will'. In reality the river has remained a contested territory and resource throughout the history of London's relationship with its hinterlands as made apparent in the works of Environmental Historian, Vanessa Taylor.

> "Rivers provide a vivid example of the way cities are connected to their economic and ecological hinterlands and "involuntary neighbours" by flows of water, sewage, pollution and refuse, as well as trade. They force you to look beyond what Barry Doyle has referred to as the 'sealed' boundaries of local governments."
> (Taylor, 2015)

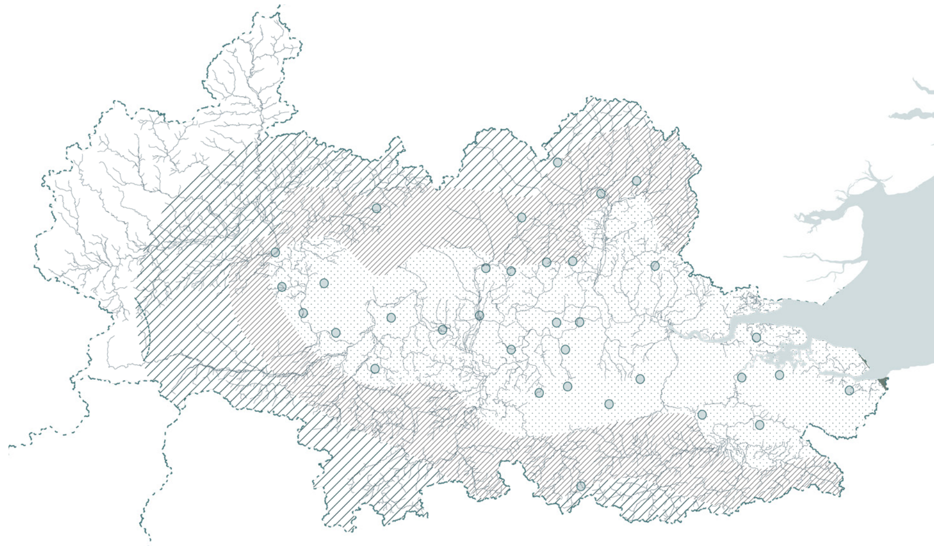


Fig 6: London's relationship with its hinterlands in the medieval period as defined by travel distances from various trading ports through waterways.

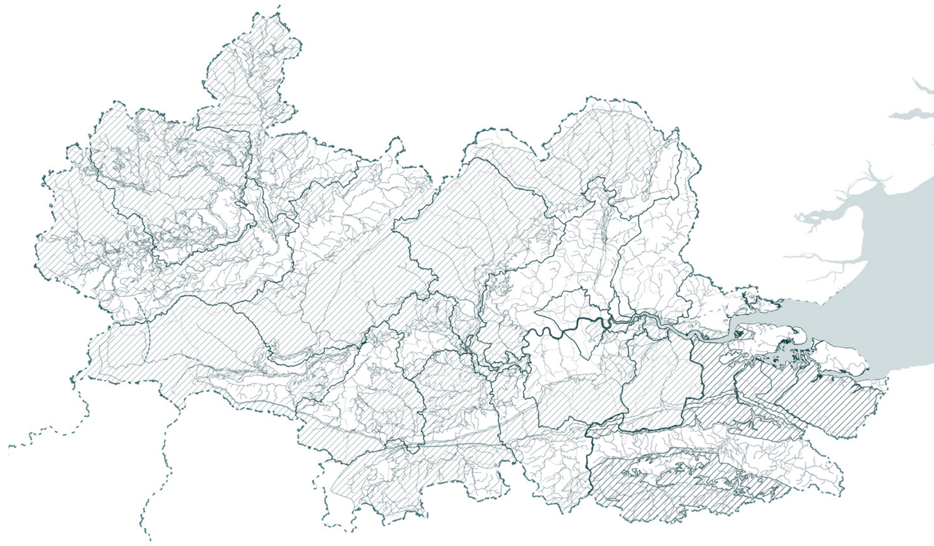


Fig 7: Map showing an integrated management of the basin with resources transposed to London from other parts of the basin. Debates since the 19th century drove the recognition of a catchment board to manage the distribution of local reserves of ground and surface water to service Londons Growing Demand.

Fig 8: Map showing the division of the basin marked by the water companies domains of responsibility.

Water Infrastructure is a critical component in defining the urban landscape. It serves as a focal point in describing both the materiality of urban space and the relationship between the human body and urban technological networks. Its the relationship between London and its agrarian countryside (Gandy, 2004).

The "bacteriological city" emerged in the 19th century due to advances in epidemiology and microbiology, new forms of technical and managerial expertise in urban governance, the increased use of financial instruments like municipal bonds, the establishment of new policy instruments, and the political marginalization of agrarian landed elites. These factors allowed the newly emergent industrial bourgeoisie, public health advocates, and other voices to exert the greatest influence in defining the strategic urban vision (Gandy, 2004).

Although improving the water supply was relatively easy given the scientific and political backing the project received, handling wastewater was difficult and expensive. In addition to the growing use of synthetic fertilizers, the installation of water closets and the growth of cities made it difficult for night soil collectors to sell their products. The modern city shifted away from a cyclical interaction with a rural hinterland towards a focus on nature as a source of leisure (Gandy, 2004).

The ditribution of this infrastrucutre also played a role in highlighting the disparity between urban and rural areas. The development of piped infrastructure with a constant water supply and sewerage was a reality that was limited to the urban centers of England. Rural areas still relied on wells, ponds, and streams and continued to do so till after World War II. Internal baths and toilets were common in urban middle-class homes in the late 19th century, but it wasn't until the 1950s and '60s that they became widespread in poorer homes (Taylor, 2015).

Since the mid 19th century, the river Thames itself has remained a contested territory. The two main issues have broadly framed London's relationship with other settlements in the basin. The first brought up the question of just allocation of clean and sufficient drinking water. The second, involved debates surrounding sewerage, land drainage, and flood protection (Taylor, 2015). The river has long been both a dumping ground and a source of water for the growing city, but by the late 19th century, these dependencies had shifted along the river, and beyond the city's outskirts with abstraction rights secured in its upstream freshwater zone of the basin and sewage outfalls and port activities moved down-stream towards its estuary (Taylor, 2015). Londons relationship with its upstream and downstream hinterlands were thus a result of long standing disagreements in how the river could be modified to service the cities economic interests as opposed to local rights.

The Socio-Political Dimension of Water Abstraction Rights

The concept of watershed democracy emerged in the early 20th century and advocated for local control of water resources. This approach emphasized the importance of community involvement and democratic decision-making in water management.

In contrast, the ecological hinterland approach views water resources as part of a larger ecosystem and emphasized the need for centralized management to protect the water security of the entire region with a focus on London's growing demand.

The conflict between these two approaches has been a defining feature of water management in the Thames Basin and has been shaped by broader political and social factors such as the growth of the environmental movement, the rise of neoliberalism, and the increasing importance of scientific expertise in water management.

By 1968, the boundaries of a river basin came to define the natural boundary for water governance in the UK. The period leading up to this saw growing debates about groundwater abstraction rights to sustain cities at the cost of the drying out of local rivers, and moves for the Greater London Council to take charge of the management of the river as it was 'Londons River'. The idea of an unelected authority managing the river and water services that have a direct impact on every Londoner was deemed "inconceivable", given that the city of London constituted 70% of the population and the financial base. The move was shut down, but political debates like this brought forward skepticism about whether watershed management was a cover for the greater dominance of mega-cities like London.

The Socio-Political Dimension of Drought Management

Water stress has been a persistent issue in the United Kingdom since the early nineteenth century. To fully comprehend the recurring droughts, it is important to examine their course and distribution, as well as the changing social and technocratic frameworks that have influenced how we have come to define 'normal' and 'rational' consumption patterns, and the role of 'active citizens' or 'passive consumers' in water management practices.

Historically, drought events were never attributed to natural causes alone. There have been instances of produced scarcity (Swyngedouw. 2004) as a result of institutional mismanage-

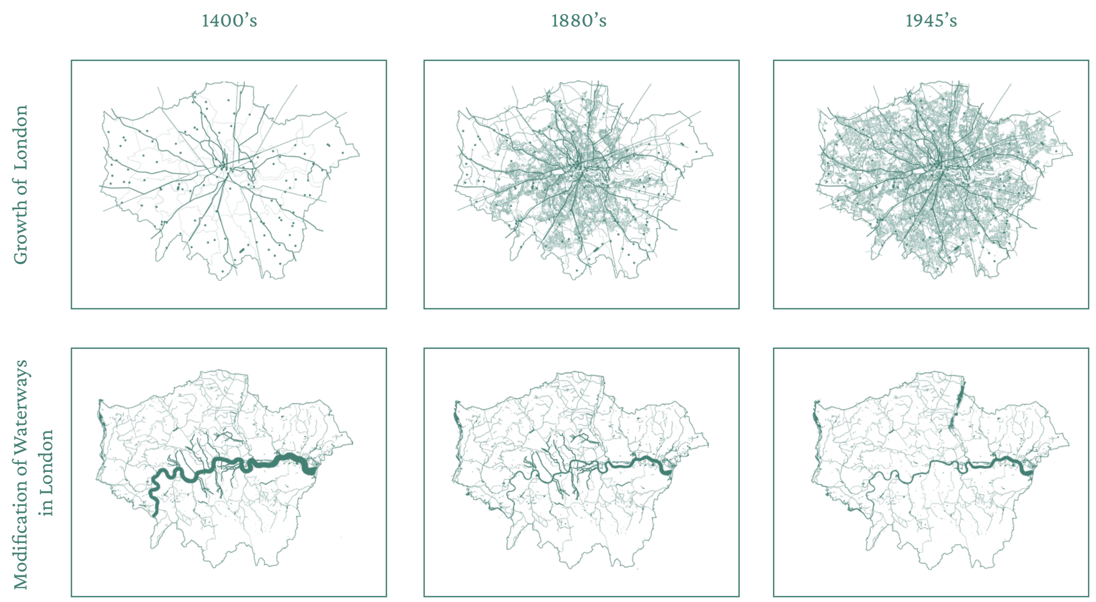


Fig 9: Growth of London and the transformation of the waterways

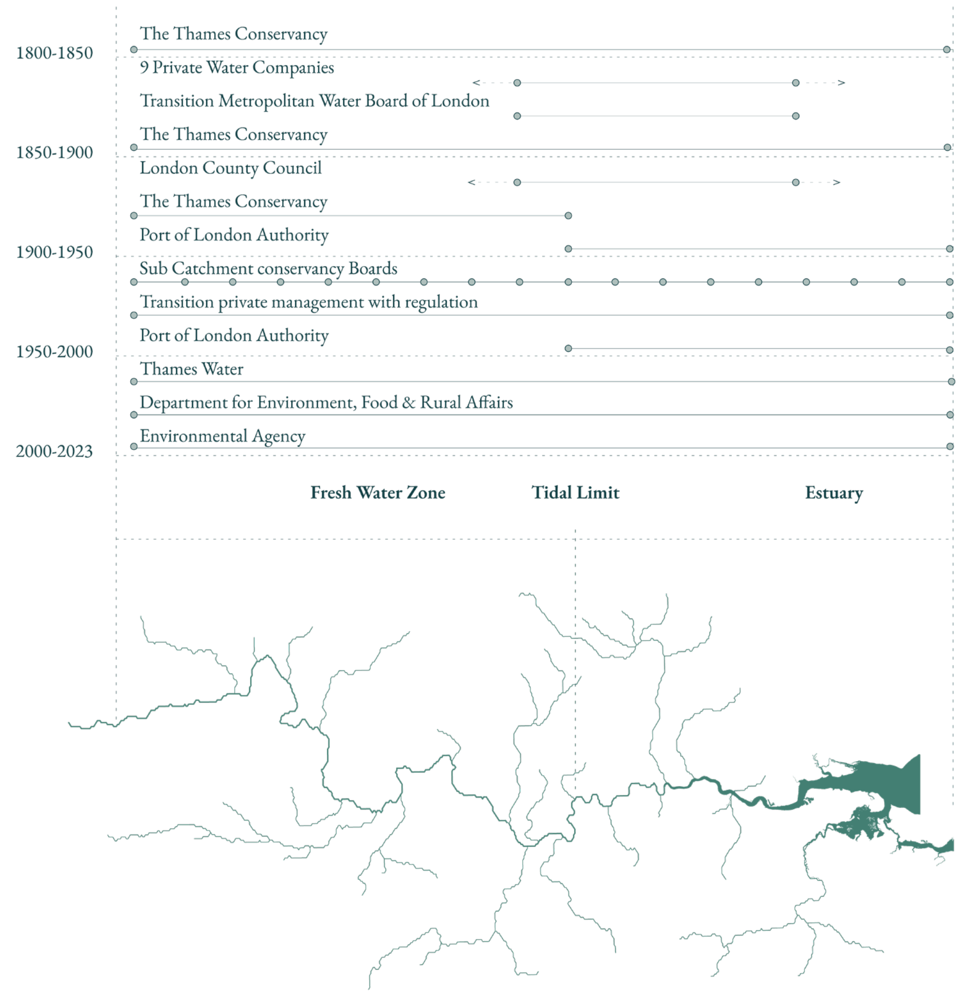


Fig 10: Division of the Rivers Management over the years

Fig 11: Beckton Sewage Treatment and Desalination Plant at the Thames Estuary
(Source Thames Water)

Fig 12: Pastic from Londons Waste lining the shore at the Thames Estuary in Kent
(Source: BBC)

ment. Public outcry following such periods of drought has revealed disagreements over ownership and the scale at which water management must be addressed. Additionally, urban and rural contexts are exposed to varying degrees of vulnerabilities as a result of different hydrological characteristics, consumption patterns, and resource management options (Cole and Marsh, 2006).

The drought in 1921 which affected a large part of England and Wales, was most notable as it bought up the perceived failure of water districts to share resources. Since the drought of 1934, there have been proposals by engineers to create a national water grid. However, these were dismissed by politicians as uneconomical. The same debate recurred in 2006 when the Institute of Civil Engineers proposed a nationwide integration of infrastructure which was rejected by environmental regulators and water companies alike, who opted for cost-effective control that favored pipeline leakage control and demand management. 1973 saw a more decisive move to have the creation of ten regional water districts and calls for resource management at a catchment level rather than one based on administrative boundaries.

The prevailing public narratives surrounding water supply and distribution infrastructure and the decisions taken in response to them affect the 'spatial dimension of drought vulnerability'. Centralized infrastructures of water supply and distribution provide a level of supply security during drought, but they may also enlarge the spatial scale of drought by connecting distant places. Wider connectivity through such nationalized grids also brings up questions about cost, environmental quality, and the capacity for equitable distribution.

The management of water supply has shifted from private companies to municipal and public management, and back to private hands between the 1800s and 1989. These shifts in defining the institutional frameworks responsible for regional water security were accompanied by polarised debates that sought to blame either the negligent providers or wasteful consumers.

> "The environment emerging as a major player in this drought is an important counterweight to the model of ever-expanding consumer entitlements."
> (Taylor, 2011)

In recent years, there has been renewed criticism of the privatised models inability to value people and the planet over profits and calls for re-nationalization. Political economists point that the ten water companies in England prioratizes shareholder returns over public welfare leading to under-investments in infrastructure and its failure to addequately manage drought and pollution. Since privatisation, no new reservoirs were constructed in the UK to combat drought. Land that was bought for the purpose of building reservoirs are now sold off to build homes (Buse, Bayliss 2018).

The Socio-Political Dimension of Operationalizing the Flow of the River

Since the 1900s there were tensions surrounding the management of the tidal zone of the river by the Greater London Council (GLC) and the newly stated Port of London Authority (PLA) in 1909. Their disagreement centered around prioritizing developments along the estuary that framed the river as either a drain or a trading port.

Estuarine marshes were considered 'desolate wastelands' by the engineers of the GLC, who were proposing reclamation projects to provide space for industries and reduce flood defense costs. By the 1960's several waste disposal authorities around South East England were competing for reclaimable marshland space. London's sludge at the time was being shipped to the outer estuarine region since 1889.

Dredging the silt in the estuary was a major expense to the PLA, and it was compounded by the accumulation of pollutants in the mud reaches by 1947. The dredging itself was dumped in the outer estuarine region. Further investigations into the siltation and pollution levels revealed that these dredgings were returning upstream with the tidal flow. This led to the development of s silt lagoons at Rainham and Cliffe Marshes in Kent.

Local communities in Kent and Essex were resentful of their lack of say in the actions of both the GLC and PLA. Projects to convert salt marshes like the Stoke Ooze on the Hoo Peninsula into a sewerage treatment plant were met with local opposition that refused to be 'Londons Dustbin'.

There was growing tension between 'technical competence and 'public control' until the environmental movement grew stronger in the 1970s. By the 1980s the PLA and GLC were working with Natural Conservancy Councils and London as a city was losing its institutional control of the key functions of water resources and sewerage, with the rise of water companies and local river conservation boards.

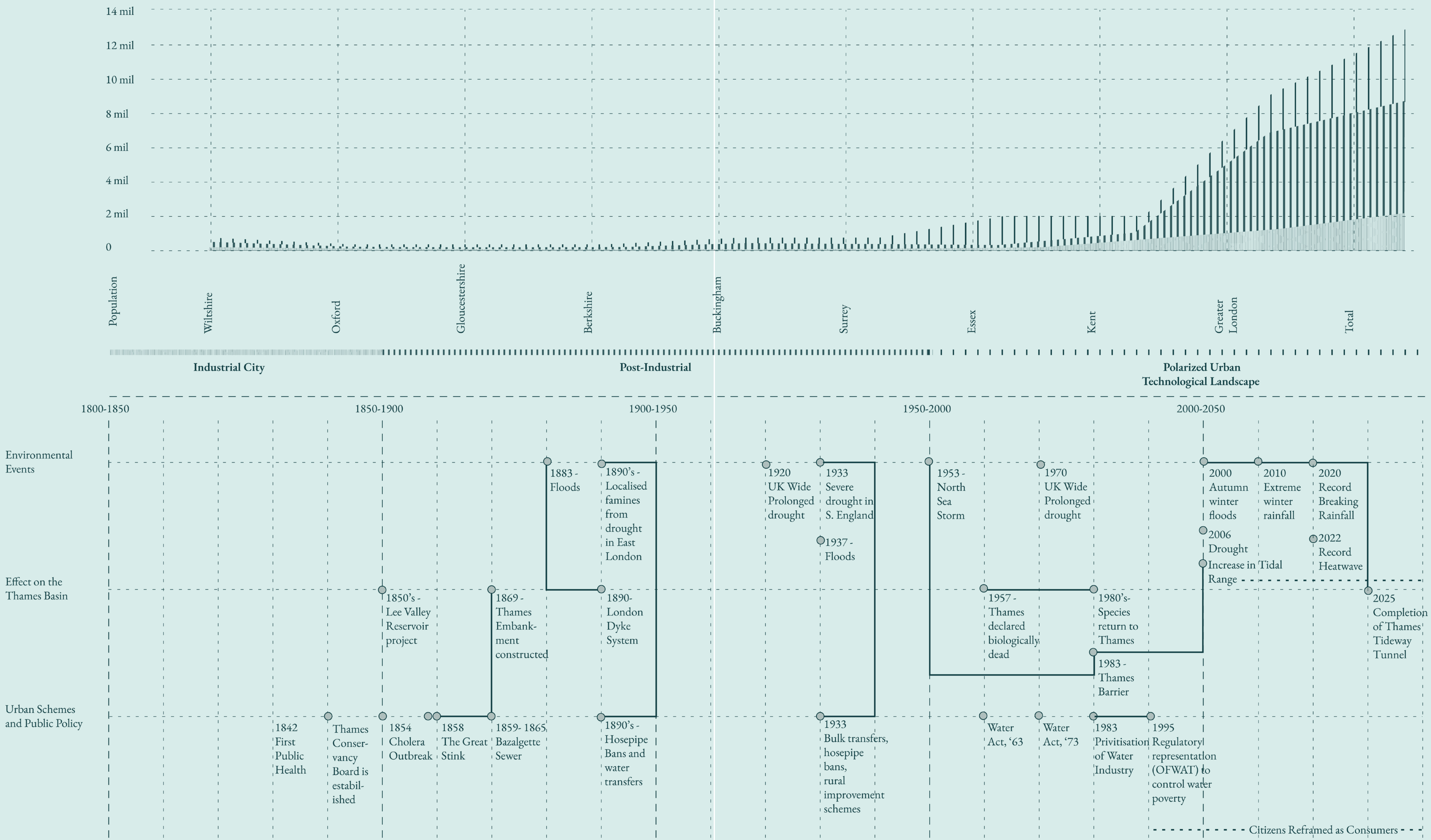


Fig 13: Timeline of environmental events and urban schemes that have shaped the Thames Basin

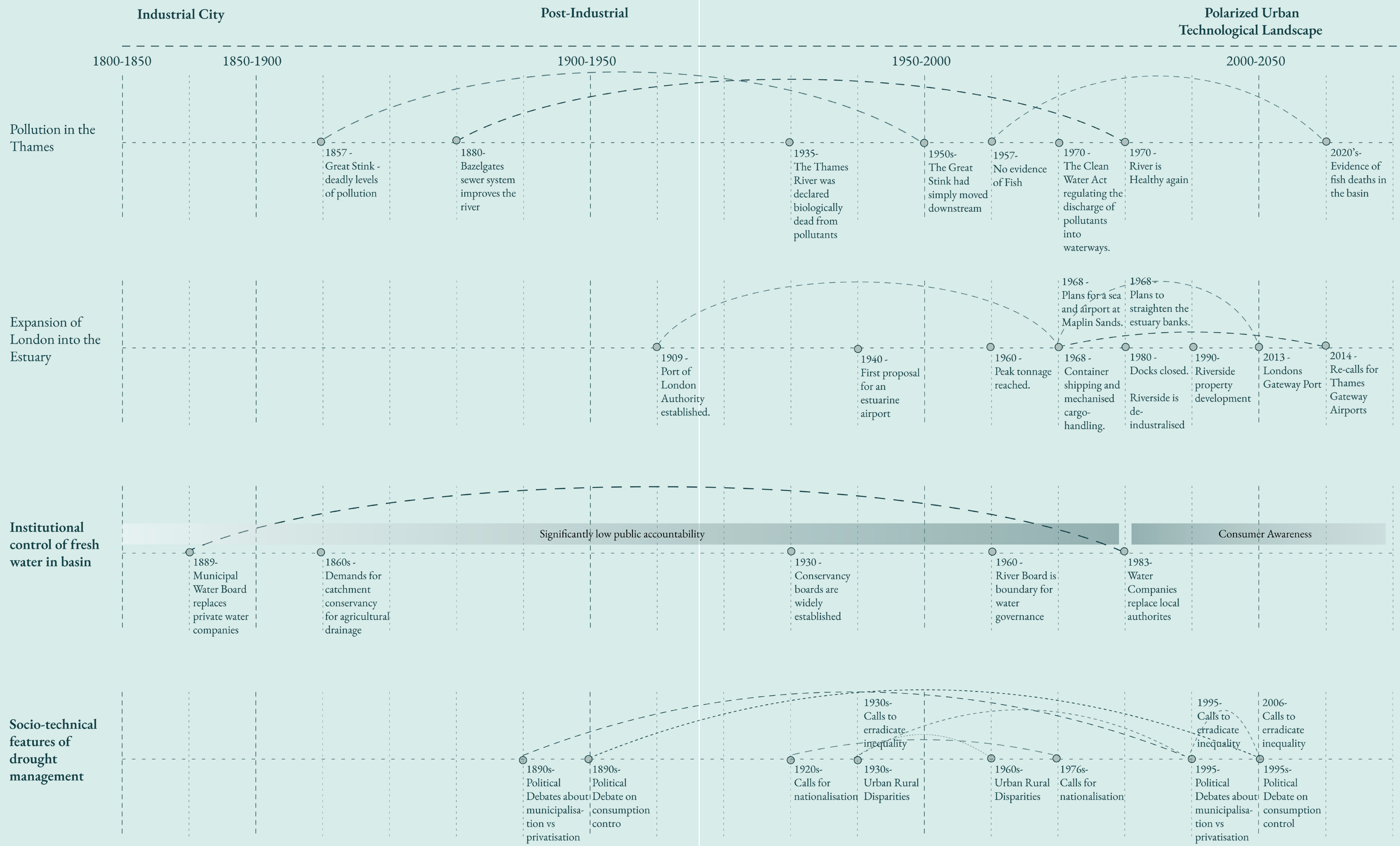


Fig 14: Historical Parallels in the Thames Basins Management

Public Discourse

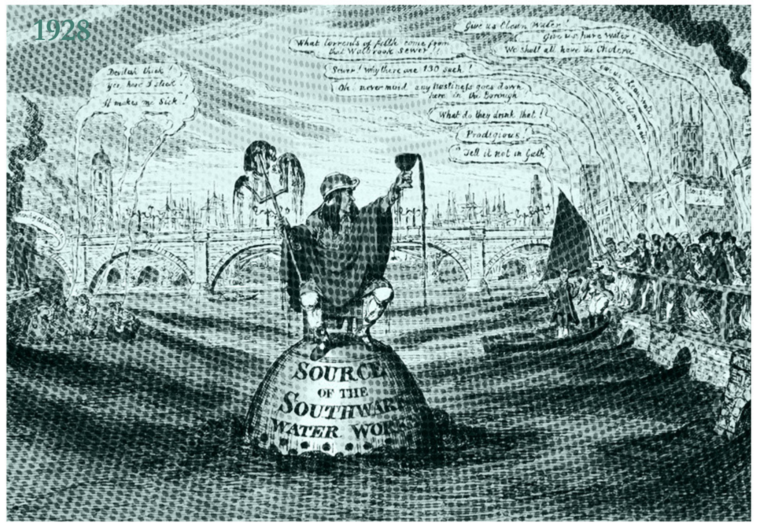


Fig 15: Criticism against South Water works in the 19th Century (Source Crikshank, G. (1832). Source of the Southwark Water Works. cartoon)

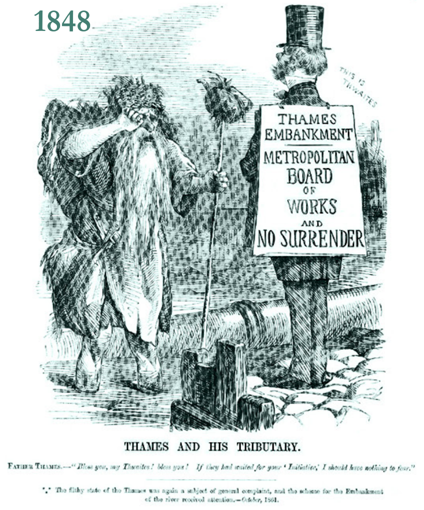


Fig 16 : The Metropolitan Water Board meeting Father Thames

Fig 17: Criticism of UK's Flood Defence Expenditure (Source: Yorkshire Enterprise Network)

Fig 18: Criticism of the Hosepipe Bans amid news of leaking pipes (Source: Telegraph)

Depictions of the Thames River at the Intersection

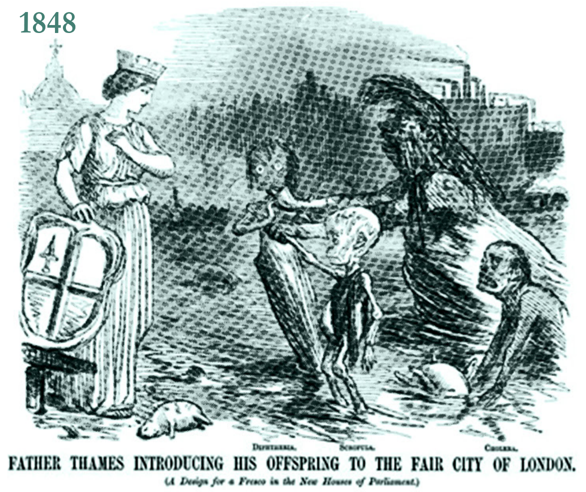


Fig 19: Father Thames introducing his offsprings (Source: British Library)

Fig 20: The River Thames a a Highway Man - ‘your money or your life’

Fig 21: Accounts of the Great Flood of 1928 (Source: Illustrated Police News)

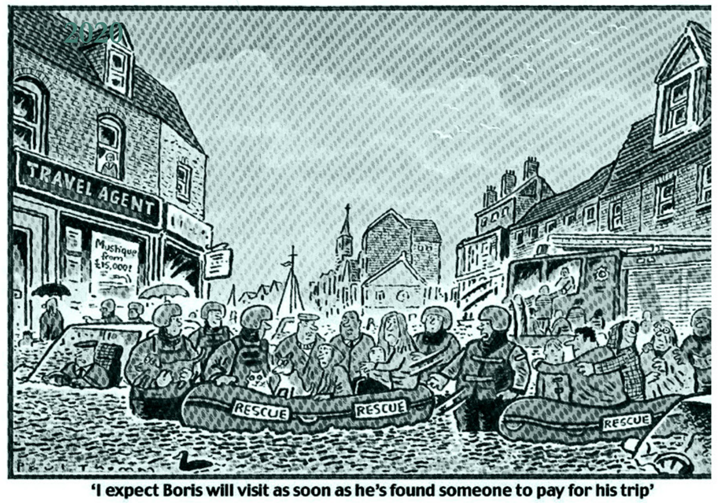


Fig 22: Accounts of Political Indifference to Londons Flooding (Source: Political Cartoon Society)

The Personal Sphere and its connection with the Water Technology

Fig 23: A water carrier from the 1700's

Fig 24: Dry Washing instead of Baths in Georgian England

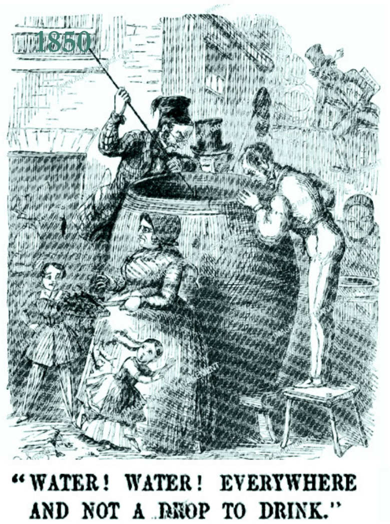


Fig 25: Water water everywhere and not a drop to drink poster (Source: World History Archive)

Fig 26: The Advent of private bath tubs

Fig 27: Diktats of the drought police (Source: Daily Mail)

2.3 Future Challenges in the River Basin

> “Twenty-first-century London faces a dilemma in relation to increasing flood risk. On the one hand, a technocratic solution, rooted in a continuation of the engineering-led responses to flood risk used in the past, would inevitably point to a new generation of defensive structures far larger than those currently in use.”
> (Gandy 2017)

The history of London’s growth and its relationship with its hinterlands in the basin is worth exploring because the logic used to justify those transformations is still being wielded to legitimize similar interventions to combat water risks due to climate change.

An example of this would be the Thames Tideway Tunnel that is being built despite massive opposition to combat pluvial flooding in London by taking the pressure off Bazelgate’s sewer system. The project is executed by Thames Water to service Inner London alone and has been presented to the public as a ‘necessary extension to the legacy of the Victorians’. The £3.8bn pound is to be paid for through Thames Water’s 15 million customers across the basin through their bills, while a majority of them continue to struggle with combined sewer systems working past their design limits in heavy rainfall events within their localities.

London’s susceptibility to flooding and as a result of both tidal and riverine flooding risks had made the imposition of the Thames Barrier necessary to protect not just the city, but the wider UK economy. In a scenario where the barrier locks to prevent tidal flows from entering inward at the same time as a high fluvial flow, the region upstream of the barrier would be inundated with fluvial flood water. Besides this, the Thames Barriers design limit is until 2070, beyond which it would not be able to resist the risks compounded by sea level rise.

When it comes to other forms of flooding risks in the larger context of the basin, there is noted disjuncture between democratically elected local planning authorities and their ability to intervene in flood control as a result of a lack of funds and the predominant model of privatizing and outsourcing public services (Gandy, 2017).

Furthermore, the continued dependence on hard infrastructural solutions, like improving the deteriorated underground pipe network to cope with urban flooding, is becoming unaffordable, and impossible without complex negotiations with various parties in the United Kingdom (Ashley et all, 2019).

The UKCP18 Regional Climate model predicts an increase in winter precipitation and a decrease in summer precipitation over the course of this century. The impact of these rainfalls is

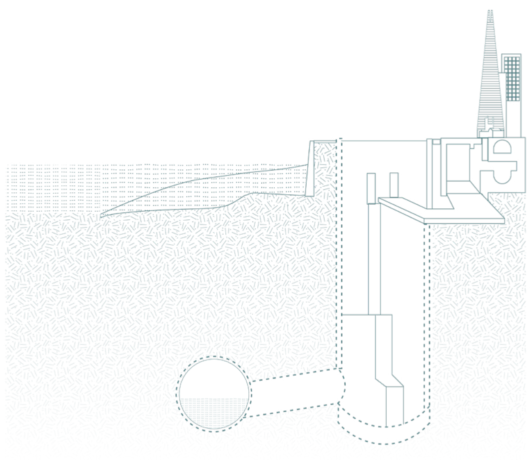


Fig 28: Section of the Thames Tideway Tunnel which serves Inner London alone

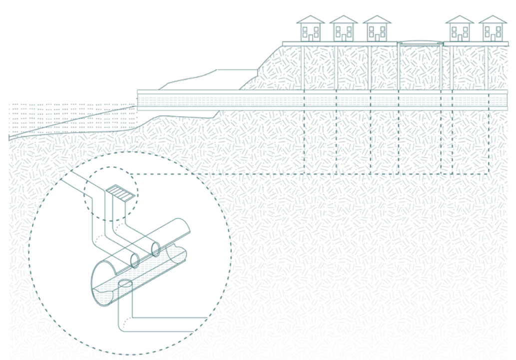


Fig 29: Section of Combined Sewers System carrying sewage and storm water across the basin (Author)

Event	Urbanisation	Climate Change	Combined
Pluvial/Sewer Flooding	⇧Impervious Cover	⇧ Rainfall Intensity	⇧ Overflow Volumes
	⇧Population	⇧ Rainfall Amount	⇧ Property Flooding
	⇧Surface Runoff	⇧ Wetter Winters	⇧ Population Affected
		⇧ Extreme Summer	⇧ Sewer Flooding
		⇧ Basement Flooding	
		⇳ Summer Events	
Fluvial Flooding	⇧Flood Risk	⇧ Flood Risk	⇧ Flood Risk
	⇧Flashy Response	⇧ Annual Peak Flow	⇳ Flooding
	⇧Flood Frequency	⇧ Flood Frequency	⇧ Flood Frequency
	⇩Natural Mitigation	⇧ Winter High Flows	⇧ Economic Costs
	⇧Densification	⇳ Summer High Flows	⇧ Population Affected
		⇧ Volumes	
Groundwater Flooding	⇩Infiltration	⇩ Groundwater Levels	⇳ Groundwater Floods
	⇧Flood Risk	⇳ Flood Risk	
		⇩ Recharge	
Point Source Pollution	⇧Pollutant Loading	⇩ Dry Weather Flows	⇧ Concentration
	⇧Water Consumption	⇧ Precipitation	⇧ Amonium ⇩DO
Diffuse Pollution	⇧Urban Surfaces	⇧ Dry Weather Flows	⇧ Pollutant Flushing
Flow Regime	⇧Low Flows	⇩ Annual lows	⇩ Pollutant Dilution
River Temperature	⇧Temperature	⇧ Temperature	⇧ Temperature
	⇧Diurnal Fluctuation	⇧ Temperature	⇩ DO

Key: High Concentration | Med Concentration | Low Concentration
⇧ Increase | ⇩ Decrease | ⇳ Increase and Decrease

Table 1: Confidence assessment of evidence on future direction of change in urban flooding and water quality in Thames Basin (Adapted from Hutchins et al., 2018)

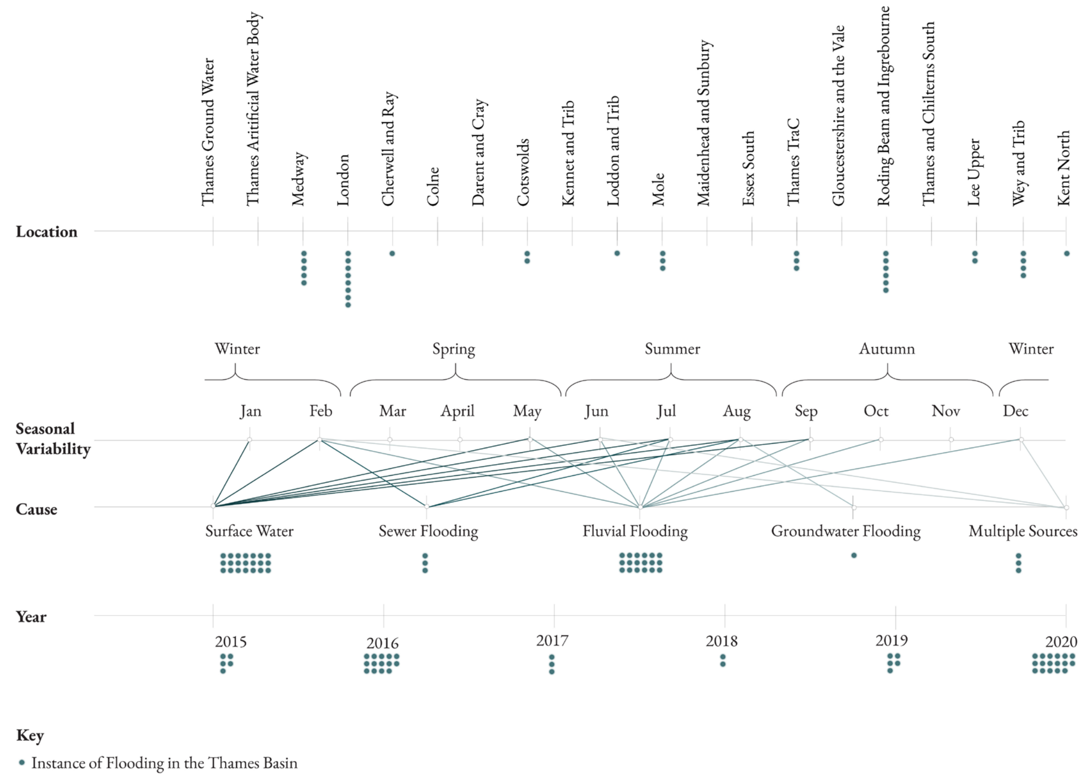


Fig 30: Instances of different forms of flooding in the basin over the past five years(By Author from data published by Environment Agency, 2021)

a result of the nature of the terrain, the permeability of the surface and subsurface, the type of rainfall event, and the nature of the floodplains. The projected rainfall could lead to higher river levels than the Thames can accommodate, especially with greater peak flows downstream.

Additionally, the basin houses the densest population concentration, with higher than average water demand per household in a semi-arid climate zone. This coupled with the fact that almost 50% of rainfall is lost to evaporation creates increasing instances of drought during exceedingly hot summers, which strains both ground and surface water reserves, and drains soil moisture levels.

2.4 A Basin in Deficit

Defining a Deficit

A river basin unites its hydrological flows - precipitation, evapotranspiration, runoff, and groundwater recharge. Groundwater flow, on the other hand, goes beyond the catchment boundary and depends on geological parameters like porosity. Hydro-social flows operate within the otherwise closed system of surface and atmospheric water transfer. It undermines this unity of flows when it imports water from other basins, or exports waste water outside its catchment basin. Maintaining an account of how the hydro-social flow affects the equilibrium of the hydrological cycle of the basin, defines how far we have deviated from a state of 'hydro-social balance' (Merret, 2007), which is a potential goal for regional water planning strategies when the economic demand for water can be sustained all year round despite the seasonal variation in precipitation and temperature. The hydro-social demand, - includes the water lost in circulation due to evaporation in supply leakage and evaporation of runoff.

A catchment water deficit is when the total precipitation within the basin is unable to sustain the following conditions

i the economic demand for water from households, agriculture, mining, manufacturing, construction, and service sectors.
ii the population's economic demand for food, using domestic rain-fed or irrigated farming or from food imports financed by the basins commodity exports
iii a sustainable rate of groundwater abstractions
iv maintenance of instream river flows above a defined minimum.

Extended Forms of Water Dependecy

The water demands to sustain a population goes beyond just the direct amount of water consumption per capita. It extends to the water embedded in the products we consume, specifically biotic products. At the intersection of food and water insecurity lies the tendency of territories to import produce when their agricultural practices are unable to secure their own demand. This reliance on territories in the basin can be attributed to conditions like soil characteristics, land rights, labor skills, farm budgets, and pest control in addition to water availability for irrigation. Importing food is in turn also importing an amount of water physically embedded in it through irrigation during cultivation from the basin it was grown in. This is referred to as Virtual Water (Allan, 2003) and has been used by policymakers to describe the state of the United Kingdoms Food Security. The UK currently imports 40% of its food, and in the state of increased water stress due to droughts and limits to farming abstraction rights, its dependency on global basins could increase.

The Thames Basins Performance

Within the Thames basin, the drivers of deficit are population density, water-intensive productivity which includes the water used in manufacturing and cooling infrastructural outposts like data centers that aid the finance and service sector, irrigation demand, and low rainfall. When describing the performance of the basin according to the criteria mentioned in the previous section, it is apparent that it is approaching a state of deficit

Firstly, there are reports of illegal groundwater abstraction that threaten the sustainability of the yield, since groundwater accounts for 40% of the basin's supply needs.

Secondly, The rate of abstraction in most surface stores is past their sustainable limit as published by the Environmental Agency. As of 2006, there was a deficit of 73 million cubic meters per year raising concerns about the security of supply. This is a result of the basin's high population density which is around 4 times more than the rest of England. This has to be coupled with the understanding that water as a resource is a privatized commodity that reframes citizens to consumers. Thames Water controls all stages of the hydrological cycle including the supply infrastructure whose negligence has led to substantial leakages. In 2007, it was calculated that 'five cubic meters supplied represents only one cubic meter consumed' (Merret, 2007).

Thirdly, a majority of the basin's food needs are met through purchases given its low food output, and financed mainly by London's export of services.

Finally, there are increasing instances of the basin's water level receding well below the minimal mark as a result of unprecedented heat waves that show large deviations from previous readings since the late nineteenth century. Climate change, population growth, and production pressures are tipping the Thames Basin deeper into deficit. Climate change scenarios project an increase in winter and decrease in summer rainfall for the Thames (Bell et al., 2012), . Greater intensity of summer heatwaves are impacting river water levels, effective precipitation, and the terrain's infiltration capacity to recharge ground water reserves, and increased evaporation from reservoirs and supply pipelines.

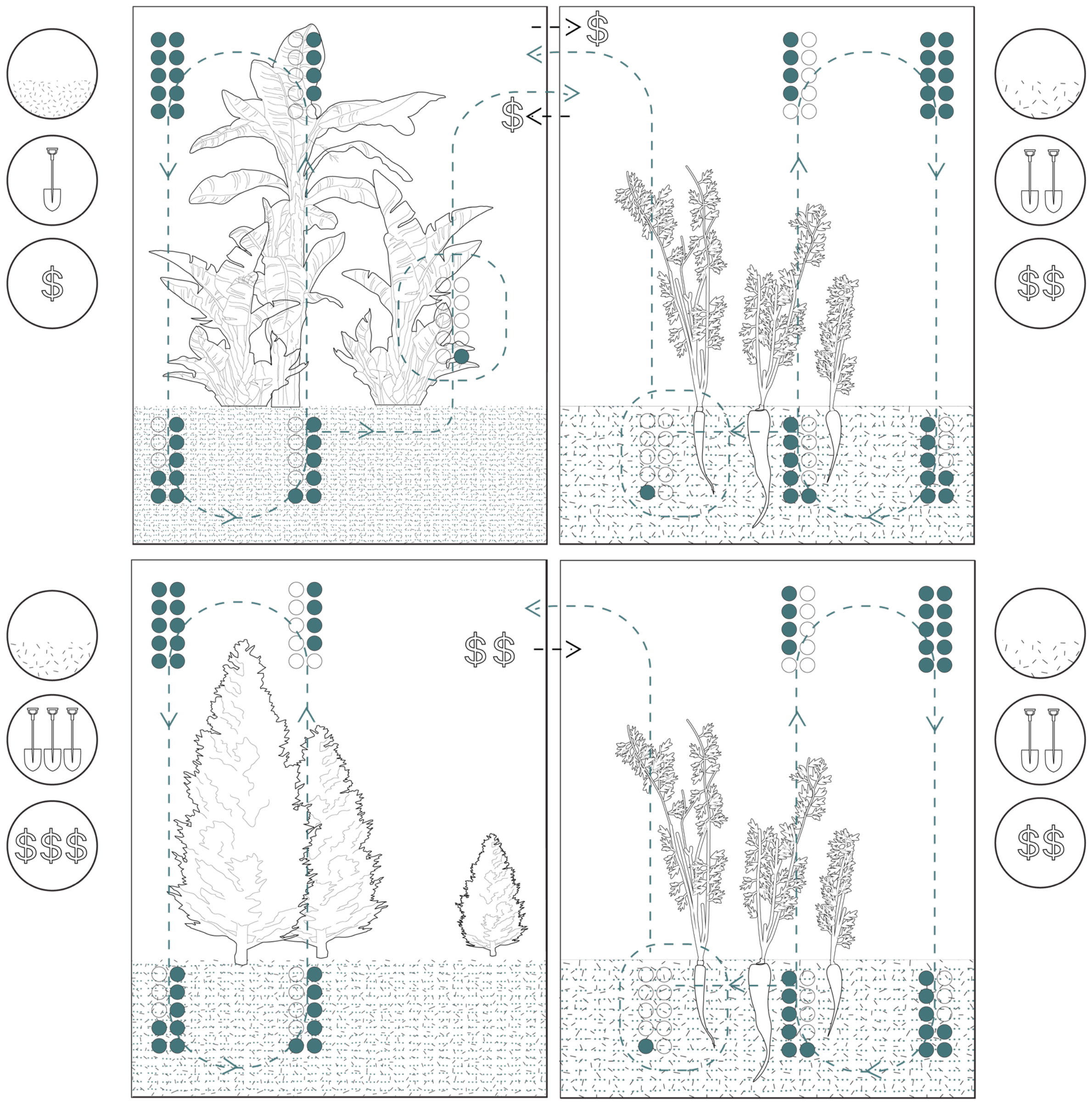


Fig 31: Representation of Virtual Water transfers
A large part of the water used to irrigate crops re-circulates within the hydrological cycle of its own basin, while a small portion is still physically embeded in the produce that is globally exchanged (Author)

03 Problem Focus

[Contents]

3.1 Disjunctures in the Basins Management

On Flooding and Drought

Flooding and Droughts are not independent occurrences but events that are inextricably linked across the spatial limits of a river basin and cyclical seasonal shifts. Despite this understanding, most policy frameworks on hydrological risks tend to focus on either flood risk or drought risk separately, neglecting their interconnected nature.

Experiences of weather shifts have resulted in extremely dry months followed by very heavy rain. In 2022, Southern England plunged into the driest July recorded since 1836, resulting in widespread drought. This led to exceptionally low flows in the chalk streams which had a direct impact on many of the species that depend on its cool, unpolluted flow to survive (Thames River Trust,2022). Chalk streams are rare ecosystems with 85 % of the world's chalk streams located in England and the majority of which are located in Southern England. Such periods of drought are succeeded by torrential rains, resulting in flash floods. Such extremities in weather patterns are linked to global weather circulation patterns, which indicate higher variability, contributing to rapid flood-drought cycles. There have been studies that indicate that disjointed efforts to mitigate either end of the flood-drought cycle may unintentionally lead to the other hydrological extreme (Ward et al, 2020). In the example of reservoir management alone, flood protection favors low water storage with adversely affects drought preparedness. Conversely, drought preparedness necessitates high water storage leading to overtopping or failure in the event of extreme rainfall.

In the context of the Thames Basin, there is extreme distrust between local citizens and Thames Water Company which is investing intra-basin water transfers and reservoir constructions despite public opposition. In protest against the proposed Abington super reservoir which is designed to hold 150 bn liters of water, has been compared to a "giant flan case full of water dumped on a marsh" and identified as a threat to the hundreds of homes surrounding the site by local protesters (Inman, 2023).

On Catchment Dynamics

River systems within each basin display a hierarchical tree-like pattern in which small streams feed into larger rivers, which eventually converge at the main tributary. The dynamics of the flow change both according to the stream order and the position of the water body within the river basin, i.e., within its upstream or downstream catchment.

Research shows that smaller rivers demonstrate a rapid response to intense rainfall , leading to localized flooding when tributaries overflow their banks (Cloke, 2019). These rivers, often unnoticed, pass through urban areas until a flood warning event brings attention to their presence.

Planning river management in response to upstream and downstream riverine dynamics is key to integrating land and water management in response to flooding and drought adaptation. There is evidence to show that upstream measures have the potential to retain water in the landscape and reduce flood risk downstream by capturing or delaying the flow upstream, while also remediating drought risk through infiltration. Additionally, the upstream riverine dynamics are also governed by high rates of erosion and low sedimentation deposition, which necessitate planning, engineering works, and local negotiations to create the means for this alteration to the flow.

Impacts of Flood Control Measure on Drought

	Hazard	Exposure	Vulnerability
Reservoir	(+) Can be used for water supply during drought (-) Lowering reservoir levels can lead to lower water availability downstream (-) Water loss due to evaporation	(-) Increased development downstream can lead to increased exposure	(-) Supply-demand cycles and reservoir effects (i.e. higher extraction and overreliance on reservoir)
Storm water control and upstream measures	(+) Storage of water for evaporative cooling and water source during drought (+) Upstream contour bunds and gully plugs to reduce runoff (and soil erosion) increase groundwater recharge		
Subsurface storage	(+) Managed aquifer recharge to reduce peak flows can increase water availability during drought		(+) Underground Taming of Floods for Irrigation (UTFI) to mitigate floods are effective in enhancing groundwater availability making irrigated agriculture less vulnerable to droughts than conventional rainfed agriculture
Agricultural practices and land use changes	(+) Reservoirs & land use management can reduce both drought and flood risk (-) Reforestation can lead to decreased dry season flows (+) Reforestation can reduce irrigation water extraction on irrigated land	(-) Reforested land may be needed for food productionv (+) Establishment of plantations can increase economic return of degraded land	(-) Wrong flood forecasts can lead to b higher drought vulnerability (-+) Competition between agriculture and forest socio-economic gains

Impacts of Drought Reduction Measure on Flooding

	Hazard	Exposure	Vulnerability
Reservoir	(-) High reservoir levels can lead to susceptibility to overtopping and dam failure in event of high discharge	(-) Increased development downstream of dams can lead to increased exposure	(-) Supply-demand cycles and reservoir effects (i.e. higher extraction and over-reliance on reservoir)
Storm water control and upstream measures	(-) Increased infiltration leading to flooding because of substantial groundwater recharge (+) Area downstream can experience reduced flood hazard as more water captured/delayed upstream		
Subsurface storage	(-) Continued pumping of groundwater during dry periods can lead to land subsidence and permanent reduvction in storage space (-) Area downstream can experience reduced flood hazard as more water captured/delayed upstream		
Agricultural practices and land use chang-	(-) Overdraft of groundwater leads to lowering of water table, resulting in subsidence and lower water storage (-) Enhanced rainfall infiltration in dry areas can lead to waterlogging during heavy rains (+) Successive dams for soil and water conservation can be favorable for flood hazard (-) Changing to high water-use efficiency crops could increase flood risk due to low evaporative losses (+) Reforestation can lead to increased dry season flows if soil infiltration capacity improves (-) Wrongly implemented water harvesting interventions may result in increased topsoil erosion and gully formation	(-) Cultivating floodplains increases flood exposure (+) Reduces exposure to floods and shortens flood periods	(+) Better early-warning can lead to decreased drought and flood vulnerability (-) Reforested areas susceptible to tree mortality (which can increase peak flows) in response to fires, pest and diseases

Table 2: Providing an overview of how flood and drought management efforts disproportionately effect one another (Adapted from Ward et al, 2020))

3.2 Dichotomies in the Basin

From the literature and reports published about the state of water management and the power struggles embedded in the appropriation of the basin's hydrological system, it is evident that there exist three separate dichotomies in the basin. With water specifically, there is the inability of selected sites in the basin to handle extreme rainfall events, and an inability for the current water infrastructure to adequately store rainwater, creating the need for additional reservoirs, or intra-basin transfers to sustain its water demands. Then there is the differential treatment of the needs of the city and the countryside. While London's need to adapt to extreme weather events is met with projects costing billion-pound investments, activities in the countryside face restriction as a result of flooding, exposure to pollution, and droughts. Lastly, the preference given to investing in London's resilience against water risks has created a cluster of highly engineered sub-catchments around its tidal zone, whose design limits are constantly tested by the rising pressures of the climate zone. Meanwhile, the rural floodplains in the Upper Thames Catchment are susceptible to seasonal flooding as well.

The research questions seek to address these identified problems under an integrated river basin strategy.

Dichotomy under Investigation	Research Question	Problem Focus
The City and the Countryside	2.1 3.1	The need to reframe the are lying outside greater london- from an ecological hinterland to a part of a watershed democracy. The need to reduce the imposition of negative externalities of improper urban water management on these spaces
Seasonal Flooding and Drought Challenges	1.1 3.2	The need to reduce socio-economic losses due to the inability of the current urban water system to cope with extreme weather events.
Upstream and Downstream Catchment Dynamics	1.1 4.1 4.2	The need to de-engineer the upstream catchments to manage both its own and the flooding risks of the highly engineered catchments downstream.

3.3 Research Question

As the Thames Basin is subjected to increasing instances of (1) **extreme weather events**, what is a (2) **new form landscape design** that can sustain (3) **water security and agricultural productivity** while (4) **regulating imbalances in the hydrosocial cycle?**

Sub-Research Questions

(1)

1.1 How can a form of planning that is responsive to the temporality of natures processes, adapt to uncertain intensities and frequencies of seasonal droughts and floods?

(2)

2.1 What are the historical precedents that need to be examined and redefined in rewriting the water paradigm of the basin?

(3)

3.1 What is the new role of the countryside in working towards securing food and water self sufficiency?

(4)

4.1 What are the context responsive ways in which different forms of flooding events in the basin can be reframed from a risk to an oppurtunity?

4.2 What are the actions that can be taken upstream, to relieve the extremes of climate change related risks across the basin?

04 Methodology

[Contents]

4.1 Research Framework

[Motivation and Relevance]

To understand the extend of climate security that can be achieved in the boundaries of a River Basin.

[Problem Field]

Water risk management in the face of increasing frequency and intensity of extreme weather events.

[Key Words]

Water Sensitivity, Climate Sensitive Urban Design, Thames Basin, Ecosystem Based Adaptation, Integrated River Basin Planning

[Location]

Geological Boundary	:	Thames River Basin
Regions	:	South Eastern England, United Kingdom
Counties	:	Essex, Kent, Hertfordshire, Buckinghamshire, Oxfordshire, Gloucestershire, Berkshire, Wiltshire, Hampshire, Surrey, Greater London

[Problem Statement]

The increasing instances of human losses in the face of extreme weather events like flooding and drought are a result of improper management of the water cycle within the confines of the Thames Basin. The responses to these crises have been an increased dependence on technocratic and heavily engineered interventions in the basin's hydrological system. The current mode of adapting is indicative of power structures that enable control (down to the restrictions in the consumption of water in the case of droughts), without being held accountable for improving or replacing the existing infrastructure to keep up with the increased pressures of climate change and population increase.

[Research Aim]

To propose an alternative approach to water management that shifts dependency away from mono-functional hard infrastructure to solutions that utilize all forms of water as a potential opportunity.

[Theories and Concepts]

Environmental History, Urban Political Ecology, Landscape Ecology Thinking, Water Resource Economics and Management

4.2 Methods and Outcomes

Methodology:

- Understanding the history of water politics to redefine the role of the ecological hinterlands — HU SA
- Documenting the locations affected by existing risks in the basin as a result of neglect, or lack of timely investment — MR
- Documenting the different degrees of engineering and urbanity in the basin — F
- Collecting geo-tagged information from stakeholders about their lived experiences of dealing with weather extremes — F SA
- Geographical reading of the basins water risks — LR AC
- Abstraction of rivers flow based on projected meteorological data — LR
- Creating a set of actions of adapting to risks — RD SA
- Proposing a Syntax for how they relate and can be applied — RD SA LR
- Socio-Environmental Cost-Benefit analysis of the set of actions created — HM AC RD

Expected Outcomes

- To form a critical justification to shift from the current urban water system, and address the social dimension of water infrastructure.
- A strategic framework at a macro scale to reduce pollution, and socio-economic losses during flooding and drought events
- Site responsive interventions at meso and micro scales that reduce loss of rain water to evaporation within the basin
- Proposal for a form of landscape infrastructure that reframes the various categories of flooding events from a risk to a potential to increase infiltration in the basin
- Proposal for a form of agrarian urbanism, whose water demands are not compromised under the pressures of low reserves and high competition for water
- Evaluation of the proposed design

Key to Methodology:

Historical Text Review	HR	Statistical data analysis	D
Literature Review	LR	Field Work	F
Mixed Media Review	MR	Stakeholder Power Analysis	SA
Analytic cartography	AC	Research through Design	RD

4.3 Analytical Framework

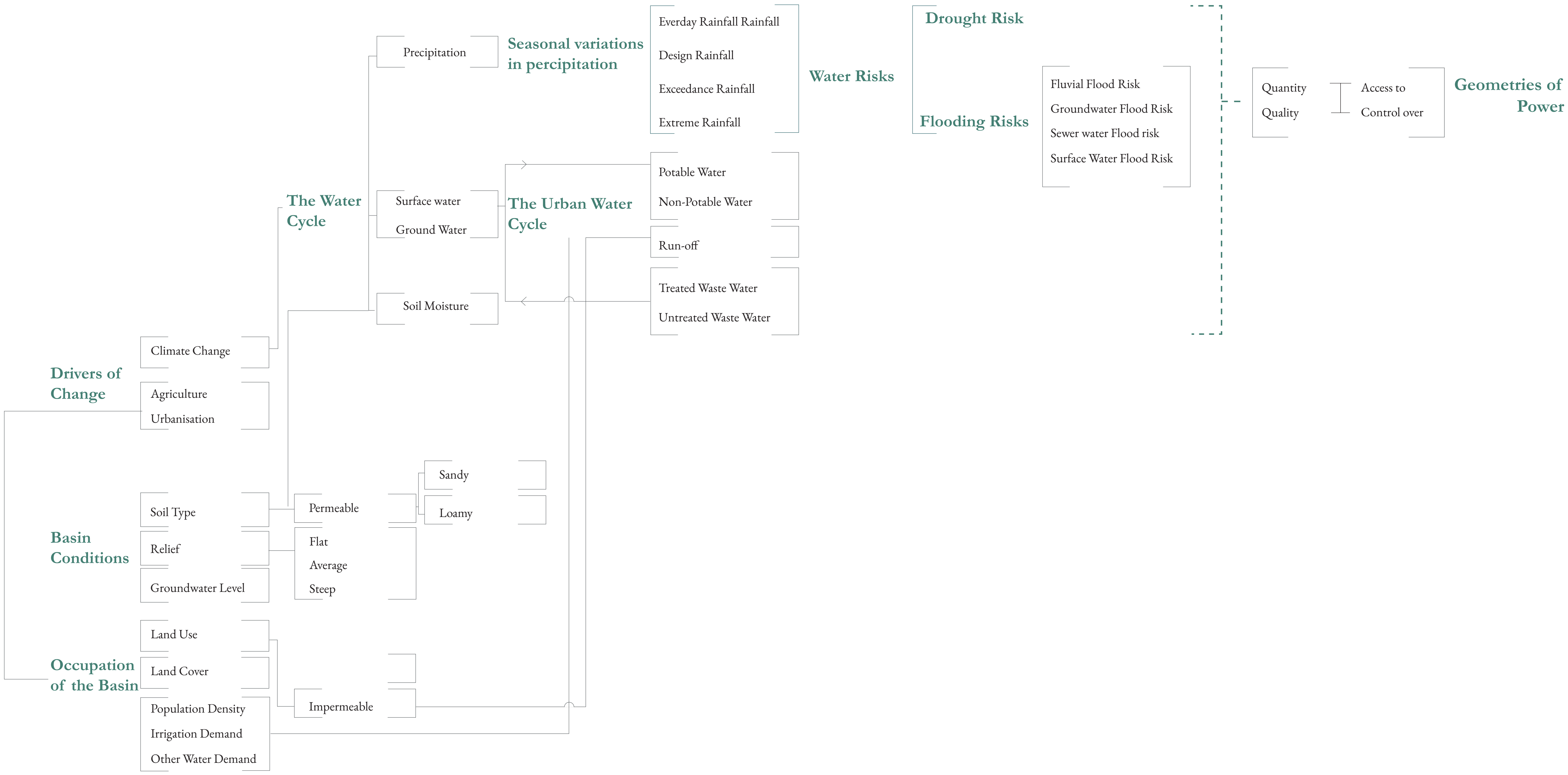


Table 3: Analytical Framework

05 Frameworks

[Contents]

5.1 Theoretical Frameworks

The Theoretical framework highlights the different bodies of work that have influenced the argument posed by the project. The body of work produced by environmental historians, and urban geographers, specifically those involved in a political ecological reading of urbanization, have revealed the unjust appropriation of the basin that lies below the surface of the narrative surrounding 'resilience'. Such forms of accumulation, and lack of neither accountability nor fiscal ability to keep the urban projects of the past functioning under the pressures of climate change have resulted in water risks that appear disconnected. Accounting for the seasonal flows of rainfall, and its performance in attaining Hydro-social Balance, through the framework provided by water resource management helps mark how the components of the urban and rural fabric and its patterns of consumption are driving a deficit in resources. The future paradigm to resolve this imbalance, as uncertainties surrounding weather patterns continue to escalate as made evident by the projection UKCP18 published by the Met Office in the United Kingdom, would be to adopt designing in tandem with natural processes and reframing flooding events as an opportunity.

The bodies of work mentioned in the following sections are described in order of how they shaped an understanding of the past, present and future paradigms of water management in the basin.

In a way, the framework attempts to delve deeper into the past to both comprehend the present and forecast the future. It also seeks to consider aspects that are often disregarded in the dominant narrative of "how we got here," redirecting our attention to the parts of the Thames Basin that are frequently overlooked in the modern approach to water resilience and management. I would use the term "Anamnesis" to describe this endeavor, as it can be loosely interpreted as the recollection of a former existence. This direction is precisely what I am pursuing with my design as I seek to identify design practices that predate the current paradigm of overiding natural cycles instead of working with them. This is also to trace how past and present practices have left a permanent impression on the lay of the land and the regime of the river.

Examining Historical and Political Precedents

Urban Political Ecology

Urban Political Ecology tries to frame the process of urbanization as the continuous transformation of nature, thereby blurring the boundary between the definitions of natural and cultural. Environmental and social changes influence each other in producing the physical environment over time. The form of this gradual and continual transformation of the environment is dependent on the specific historical, political, and economic conditions that facilitated it. The results of these processes are in effect never socially or ecologically neutral. Actions taken to enhance the quality of certain places might be at the cost of displacements and losses at other places. Such decisions are made as a result of the social power relations in place, and it is these 'geometries of power' that ultimately decide who has access to certain resources and in what quantity. (Swyngedouw et al., 2002). This perspective when applied to urban water systems offers a way to combine discussions about space, technology, landscape, and infrastructure.

> "Water lies at the intersection of landscape and infrastructure, crossing between visible and invisible domains of urban space." (Gandy, 2017)

Environmental History

A look into the environmental and social history of the Thames Basin, reveals the political challenge of governing a hydro-geological entity. The works of historians Vanessa Taylor, and Glen'O Hara reveals the legacy of disputes that shaped the politics of water issues in the United Kingdom - from flood mitigation strategies to water abstraction rights and distribution. This understanding when combined with political-ecological thinking, reveals the role that power structures at the time played in appropriating the basin to carry forward its interests.

Eco-Critical Literature

Eco-criticism is an interdisciplinary field that examines the relationship between humans and the natural world through an understanding of both literature and ecology. It analyzes how nature has been portrayed in works of art and uncovers the subjective personal experiences of each era. Through the works of authors such as Peter Ackroyd and Raymond Williams, eco-criticism has revealed how this human-nature relationship has both changed and yet retained some of its original essence. Eco-criticism allowed me to compare contrasting accounts from the same time period or similar accounts from different periods to understand how contested the Thames basin is as a territory or what the idyllic countryside represents. In addition to commentators like Ackroyd and Williams, I also referred to contemporary researches such as "Making up the British Countryside: A Posthuman Critique of Country Life's Narratives of Rural Resilience and Conservation" (Duggan and Peeren, 2020) and "The Pastoral Depiction: Brexit and Eco-criticism" (Garrard, 2020) to explore how nature and the countryside are perceived today.

The Hydro-social Balance: Defining a Deficit

The book 'The Price of Water: Studies in water resource economics and management' by Stephen Merrett is an account on water resource management from an economist's perspective. The circulation and use of water are described within a catchment scale to trace hydrological flows such as precipitation, evapotranspiration, runoff, and groundwater recharge and maintain accounts of it to measure the basin's performance in achieving 'Hydrosocial Balance'. He addresses the theme of 'catchment water deficits' in the 21st century, and how informed management can help control the repercussions of shifting between surplus and deficits (Merrett, 2007).

The book further presents a critique and in turn presents a renewed look at the theory of Virtual Water Transfers, initially presented by geographer Tony Allen to describe the hydro-politics of the Middle East and its water needs of food production. Virtual water is simply the water embedded in a product, through its consumption across the value chain. Within the domain of agricultural water demands specifically, if a region is unable to maintain domestic crop self-sufficiency with the water available within it, it is reliant on importing food. This means it is dependent on water in other basins to sustain its population. Economically, this would be a problem if the dependent region is unable to finance this food import through its exports.

The text highlights the complexity of sustaining the resource needs of a population within the constraints of uncertainties of demand and rainfall, and addresses the possible global reality of more basins functioning in states of deficits as a result of climate change and unsustainable water management.

Landscape Thinking : Reframing Infrastrucutre and Urbanism

Landscape as Infrastructure

Landscape Infrastructure brings in the potential of engineering ecologies to move past our increased dependence on technological systems to sustain life in cities. It presents three positions of design - a systemic view of infrastructure and the scales of influence that control their operation, resisting the tendency to conform to traditional definitions of either urban or ecological, and viewing landscape infrastructure as a live temporal subject that is prone to 'growth, movement, migration, displacements, destructions, and disasters'. Landscape Infrastructure as a result intends to create adaptive systems that respond to changing climates, resources, and biophysical processes. (Bélanger, 2017)

Landscape Urbanism

The book 'Landscape Urbanism' is an overview on utilizing the medium of landscapes to intervene in cities whose architectural order is inadequate in dealing with social, technological, and environmental change. The chapter on the idea of agrarian urbanism reframes the urban relationship with the organic farmlands through landscape ecological thinking. The city and the country are in this regard engaged symbiotically in each other's formation rather than 'defining each other through binary opposition' (Waldheim, 2016).

The chapter proposes an alternative historical reading of how the forms of cities grew in response to rather than despite the spatial demands of agricultural production. Two notable examples, in this regard, are german architect Ludwig Hilberseimer and Italian urbanist Andrea Branzi. Hilberseimers New Regional Pattern proposed in 1949 rested upon a composition of semi-autonomous settlement units that combined housing, farming, and commerce and a focus on the pedestrian experience. Branzi's proposals on the other hand were a politically informed critique of the failings of the modern city. Both projects called for wielding landscape design as a medium to redefine the role of the agrarian in organizing both public and private space.

Understanding the Role of Nature in Design

“Nature is the Dummy” is an essay by Douglas Spencer that explores the relationship between nature and the built environment, and argues that nature has been used as a “dummy” or a “prop” in urban design and planning.

Spencer argues that the concept of “nature” has been constructed as a passive and static entity that can be incorporated into the built environment for aesthetic or functional purposes, without considering the complex and dynamic processes that shape ecosystems. He suggests that this approach to nature is not only problematic from an ecological perspective, but also perpetuates a limited understanding of the relationship between humans and the environment.

The essay also critiques the role of design and planning disciplines in perpetuating this narrow understanding of nature, and suggests that a more critical and interdisciplinary approach is needed to address the ecological and social challenges facing urban environments.

The essay raises important questions about the relationship between nature and the built environment, and challenges designers and planners to think more critically and creatively about how to integrate ecological principles into urban design and planning.

Reframing Flooding

Managing flooding: from a risk to an opportunity

The paper ‘Managing flooding: from a problem to an opportunity’ highlights the fact that responding to water-related extreme weather events is often challenged by more logistical than technical shortcomings, with bureaucratic barriers set against procuring investments for the ‘traditional buried infrastructure approach’. Future practices in flood water management should be moving past the established paradigm of removing rainfall as ‘waste water’ from urban areas, and embracing an integrated approach to the water cycle that maximizes resource recovery from wastewater flows through decentralisation (Ashley et al., 2020).

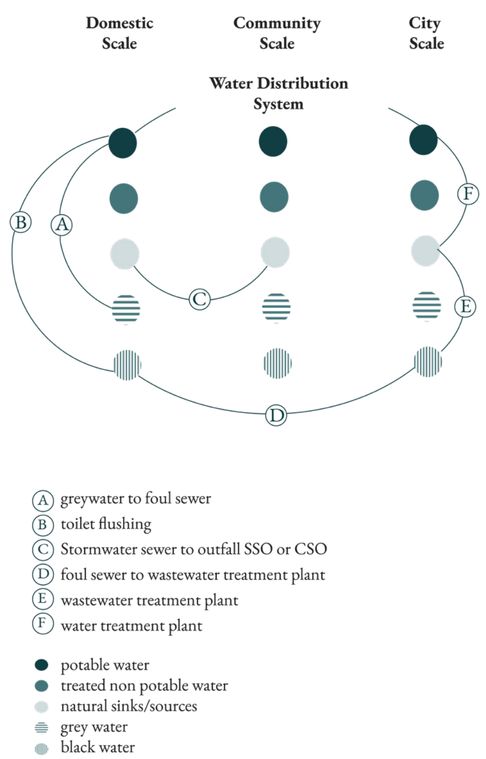


Fig 32: Diagrammatic illustration of traditional water supply with storm and wastewater to a combined sewer system; adapted from (Ashley et al, 2020)

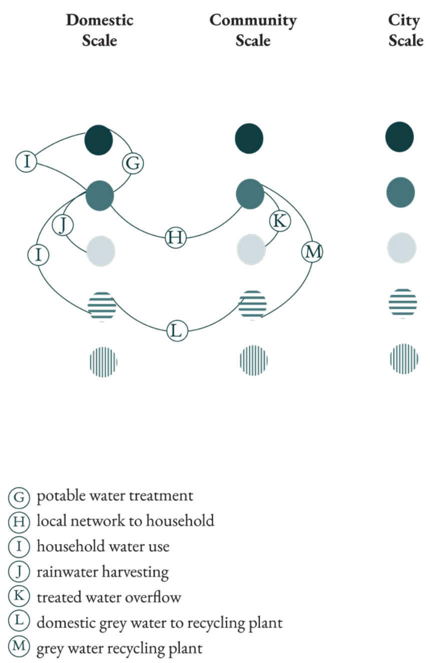


Fig 33: Diagrammatic illustration of a decentralized water system—in this case all of the rainfall is used locally (Ashley et al, 2020)

Politics of Care

Riverhood: Riparian Agency

In his paper "I:River," James L. Smith explores the possibility and practicalities of engaging with rivers and non-human entities. To reconceptualize the role that water plays in our culture, water governance must grant personhood to these rivers.

Water is often viewed as a supply, resource, or service, but it holds significant cultural meaning. The logic of neoliberal tendencies, driven by socio-economic demands, has reduced water to a commodity. To reconceptualize water as more than a commodity and as an active agent, it should be granted rights. In the paper, rights are defined as a codified mode of interaction that recognizes the right bearer.

Environmental debates often involve a conflict of values between human actors, highlighting the need to explore the "hydro-social." This concept refers to how water as a medium reveals inequalities and how its appropriation reveals social relations. Restoring a framework that grants the riparian agency of its own has the potential to expand the just distribution of benefits and risks to both human and non-human entities.

Recognizing water bodies as active agents and participants in a series of interactions that affect both civic and private life could lead to a more balanced interaction of humans with nature. Human and natural enfranchisement can be addressed together to create mutually symbiotic relationships.

> “The answers to these questions have a profound impact on the nature of democracy, for humanity runs the risk of disenfranchising entities that are deserving of protection from molestation and harm at the hands of the powerful. As has been the case in the past, reassessment of rights often leads to disturbing but ultimately productive conclusions.” (Smith, 2017)

Matters of Care

Care is described in the book " Matters of care: Speculative ethics in more than human worlds" as the action of maintaining and repairing the environment to enable the best possible living conditions while interweaving complex ecological webs. As justified by its ethical implications, care expressed through maintenance work is a vital part of building interdependent worlds.The book talks about re-conceptualizing the notion of care not just as something to appeal to sentiments but as a means of examining the politics of caring, or the lack thereof.

Care has the potential to disrupt and reveal neglected activities that could be reframed as "productive" with economic worth. Our actions of caring could displace other notions of care in a hierarchical chain of values within the situated context under examination, and this disruptive potential could be harnessed by using notions of care to engage with and learn about more-than-human worlds.

Another point brought up by the book that resonated with me was on the "temporalities of care," and how the pace at which we need to form and maintain ecological relations could be at odds with the accelerated pace of techno-scientific approaches. These acts of care are reinforced through practices like permaculture. The act of bringing about communal practices through design, which integrates efforts from both human and nonhuman beings, allows renewal and fruitfulness over the continuous depletion of resources. This form of interdependence reinforced by acts of care moves past the romantic idealization of nature and is closer to acknowledging how the natural, non-natural, human, and non-human are eventually entangled in a way that it is pragmatic to say that nothing is natural.

> "Here, making time for care appears as a disruption of anthropocentric temporalities." (María, 2017)

These acts of care are reinforced through practices like permaculture. The act of bringing about communal practices through design, which integrates efforts from both human and nonhuman beings, allows renewal and fruitfulness over the continuous depletion of resources. This form of interdependence reinforced by acts of care moves past the romantic idealization of nature and is closer to acknowledging how the natural, non-natural, human, and non-human are eventually entangled in a way that it is pragmatic to say that nothing is "natural".

On New Narratives

Speculative Fabulation

By engaging with principles in landscape urbanism, this project endeavors to present a reimagined perspective of the countryside as an integral component of the river basin's hydrology, going beyond traditional notions rooted in idealized pastoral landscapes. This reimagining aligns with the concept of speculative fabulation as described by Donna Haraway. Speculative fabulation, according to Haraway, encompasses a mode of attention, a theory of history, and a practice of worlding (Haraway, 2016).

Through speculative fabulation, this project grapples with the entanglements of multiple species, the complexities of ecological systems, and the pressing challenges posed by climate change. Embracing this idea does not entail indulging in mere fictional exploration; rather, it harnesses the scientific potential to address what might appear as a political impossibility: the simultaneous accommodation of nature and the negotiation of technocratic hegemony that treats the basin solely as a resource, disregarding its diverse ecosystem.

By reexamining the past and being mindful of the inherited precedents, this project strives to transcend the constraints imposed by political and technical forces. It seeks to create possibilities for a more inclusive and sustainable approach that recognizes the basin as a diverse and interconnected ecosystem, thereby promoting the harmonious coexistence of human and non-human entities.

Non-Scalability

Ana-Tsing's paper has been pivotal in helping me break free from the constraint of relying on a scalable definition of the "countryside" in the English context. Her paper proposes engaging with non-scalable relational models as a response to the ruin that scalable models have caused. These scalable models nest small project elements within the vision of a larger program, often disguising the heterogeneity of the world. Scalable approaches to nature management have allowed expansionism, suppressing diversity and alternative perspectives. Through a non-scalable approach, we have the opportunity to embrace the non-linearity and unpredictability of nature to create more sustainable and equitable socio-ecological systems. She suggests that "rather than scalable science, the place to start is a critical description of relational encounters across difference." (Tsing,2012). By engaging with multiple definitions of the countryside and its operationalization of both land and riverine systems, there is transformative potential that could call for "forms of collaborative survival."

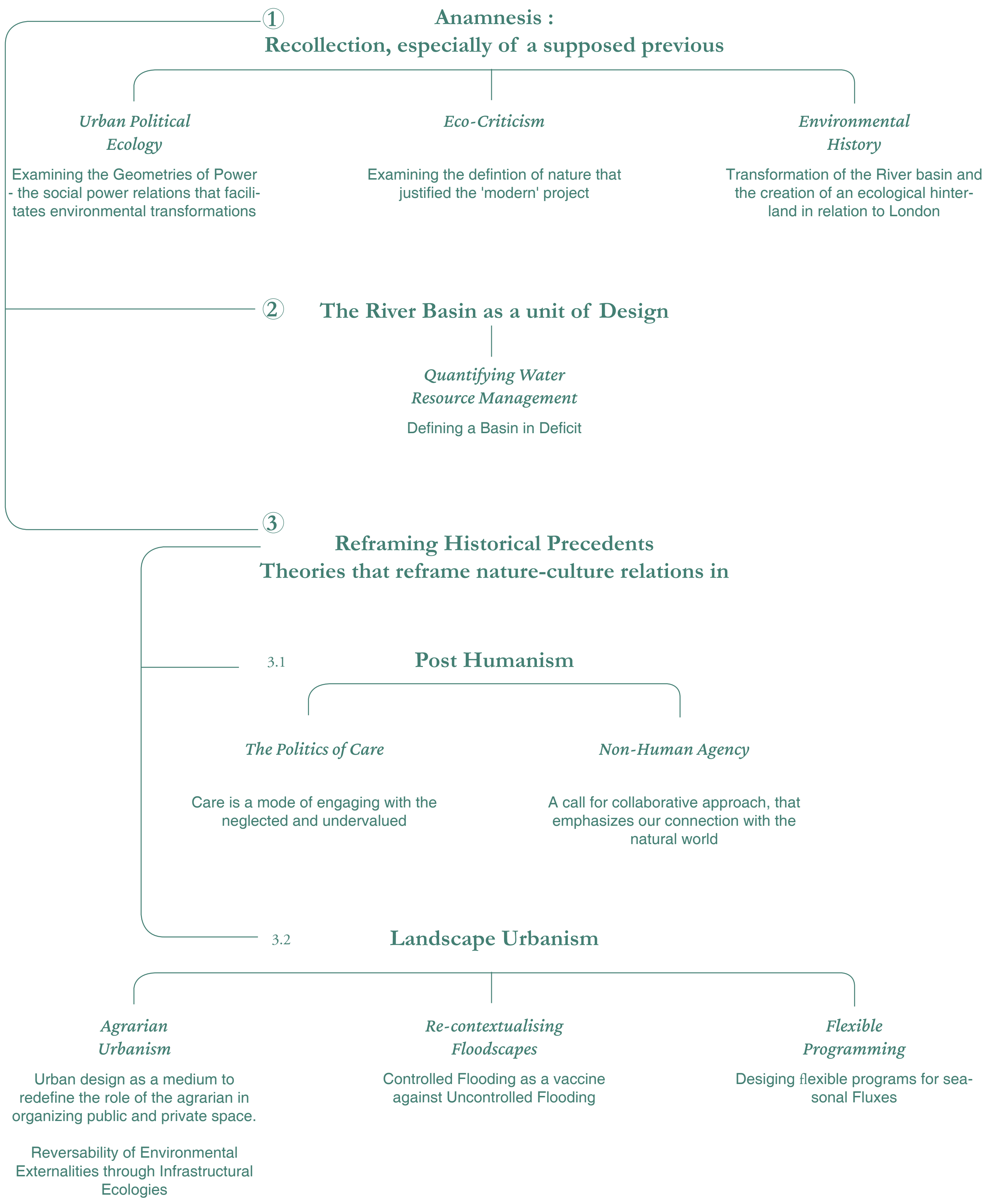


Table 4: Theoretical Framework

5.2 Conceptual Frameworks

From the theoretical perspective offered especially by political ecology, it is evident that the supply, distribution, and treatment signifies a form of hydro-social ordering as a result of the relationship between 'the nature of society' and 'the nature of its water flows' (Swyngedouw, 2009). Geometries of power are at play to control who has access to how much water and in what quantity and what quality.

When designing a new water paradigm in the era of meteorological uncertainty, with increasingly variable rainfall events, the spatial tools we have to reorder the existing patterns of supply, circulation, and treatment include infrastructure n forms of land use and elements that have the potential to direct responsible consumption patterns.

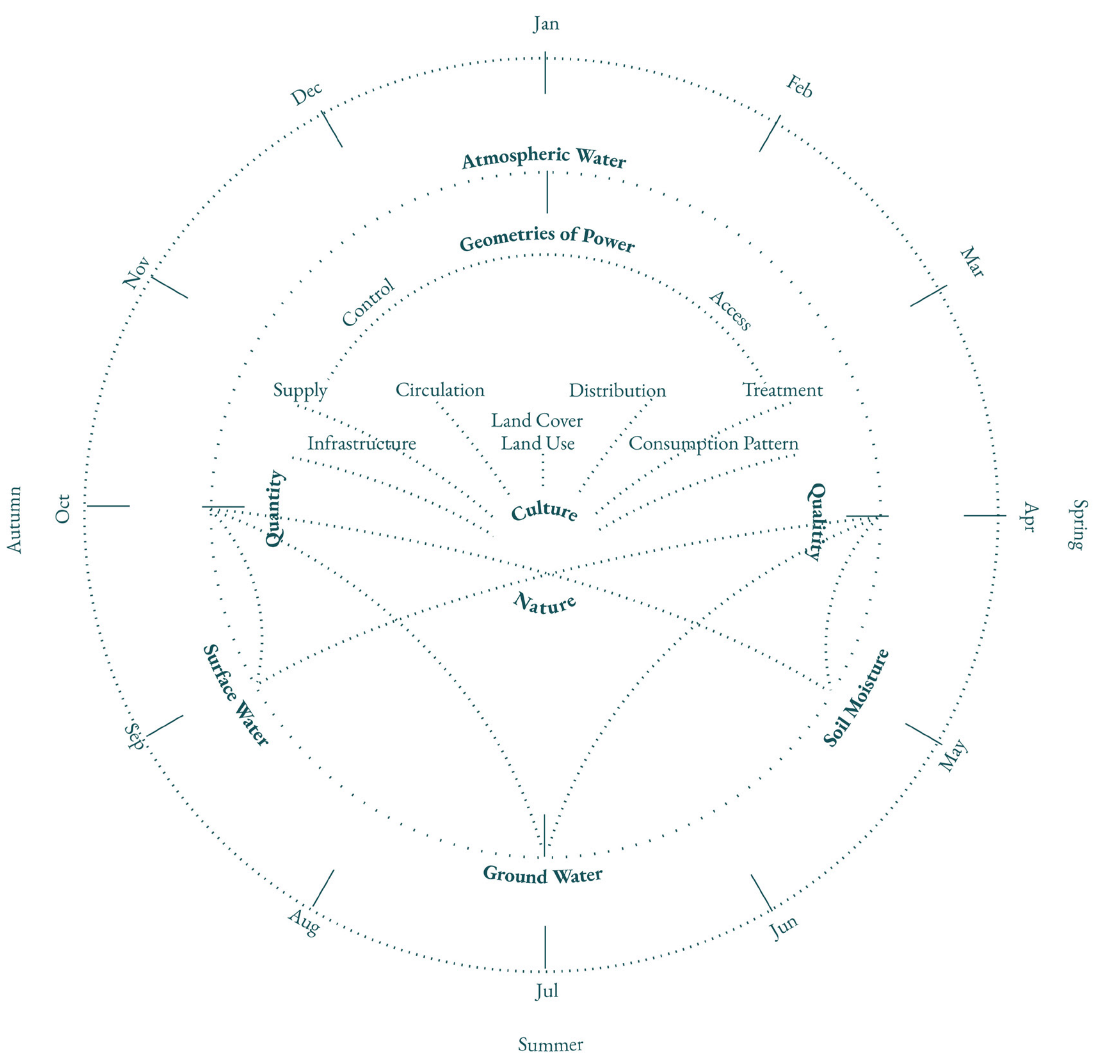


Fig 34: Diagramatic representation of Conceptual Framework

06 Lines of Enquiry

[Contents]

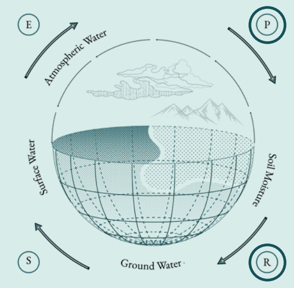
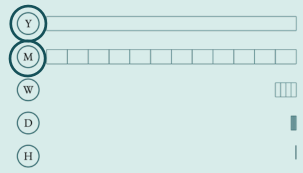
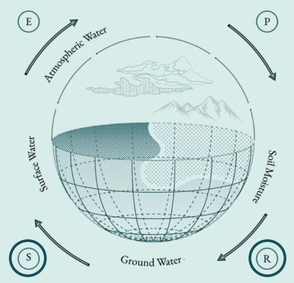
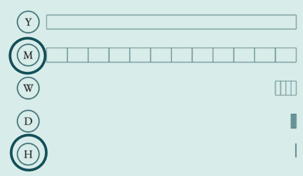
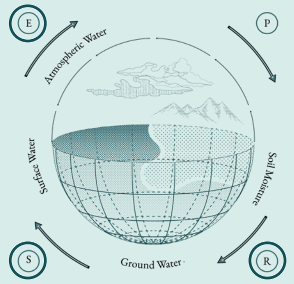
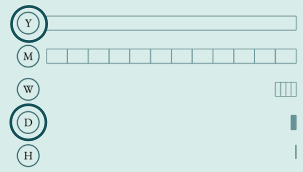
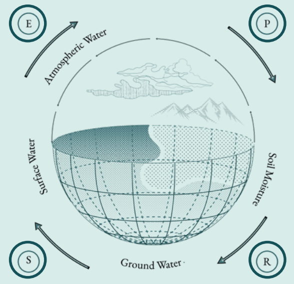
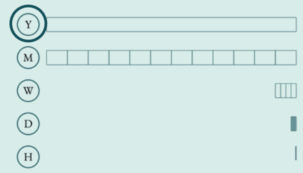
6.1 Introduction

The Lines of Inquiry as an explorative exercise allowed an analysis of the context through the entry points of Matter, Topos, Habitat, and Geopolitics. Each entry point denotes the Substance, Form, Context, and Relationships that define the focus of the exploration through a set of three drawings each - composition, alterations, and limits.

The focus of the project study through this exercise is the 'forms of control in the hydro-social cycle of the Thames Basin' which covers both the deterrents to the basin's ability to maintain a state of hydrological balance and potentials in how this can be reinstated through working with natures principles. Each exploration covers a portion of the cyclical flow of water in atmospheric and physical forms - from evaporation, precipitation, run-off, and storage and tracks how water interacts with forms of habitation in the basin. The time frames for these interactions have been considered, to illustrate how natural cycles that run over large spans of time influence our short-term consumption choices and vice versa.

Within each line of Inquiry, an attempt has been made to create a catalog of different components that influence the subject of investigation. From this catalog, a short-listed set of elements have been represented in the set of drawings. The exercise was to deconstruct each complex system that is governing the subject and accentuating specific elements that could help re-construct the system according to the aims of the project.

Matter explores the factors within the basin that influence annual rainfall distribution, and how this has an effect on the basin's ability to cyclically recharge its flows. Topos looks at the form of the river that varies both from its freshwater catchments upstream to its tidal reaches downstream, and in the hours following heavy rainfall events. Habitat explores how different forms of occupation in the basin, have compromised both the quantity and quality of water circulating in the system. Lastly, Geopolitics looks at the bodies of power that are responsible for mitigating the projected destructive shifts as a result of climate change.

Position on the water cycle	Subject	Time Frames of Focus	Dichotomy Under Investigation
Matter 	The Flow of Clouds, Moisture and Rain		Seasonal Flooding and Drought Challenges Upstream and Downstream Catchment Dynamics
Topos 	Fluxes in the Form of the River		Seasonal Flooding and Drought Challenges Upstream and Downstream Catchment Dynamics
Habitat 	Imprints on Quanity and Quality		Seasonal Flooding and Drought Challenges The City and the Countryside
Geopolitics 	The Cost of Mitigation		Seasonal Flooding and Drought Challenges The City and the Countryside

Key to Symbology:

Precipitation (P) Storage (S)
Run Off (R) Evaporation (E)

Year (Y) Week (S) Hour (H)
Month (R) Day (E)

6.2 Matter

Rain is vital for the replenishment of the Thames River. Almost half of this rainfall is lost to evaporation, a portion feeds the plant life and the remaining feeds the natural flow of the River Thames, from where 60% of the basin's water abstraction needs are met. Rainfall patterns vary across the year, as does the predominant direction of the wind flow which brings in the rain. The composition diagram depicts an interpolation of the sum of the annual precipitation across South Eastern England over the past ten years, with rain intensity decreasing as one moves away from the Atlantic Ocean. The Thames Basin lies within the rainfall contours of 60-80 cm of rainfall with the Upper Thames Region receiving an average of 60 cm of rainfall, making it one of the driest regions in the UK, and the Lower Thames receiving at least 70 cm on an average.

Under the influence of gravity, surface water in the basin is constantly running into the North Sea. To keep this flow persistent, it must be adequately compensated by rainfall, especially at its source. While the distribution of rainfall decreases exponentially as its distance from oceans increases, a theory proposes that expanses of broad-leaved forest covers are exempt from this rule (Makareiva and Gorshkov, 2007). They act as biotic pumps of atmospheric moisture to drive the water cycle on land.

Additionally, there are studies that try to link the effect of other anthropogenic transformations to rainfall patterns, like the Urban Heat Island Effect which increases the frequency and distribution of precipitation. The UHI creates an updraft that increases condensation, resulting in an increase in water vapor and cloud cover over the area, which pushes the precipitation downwind (Steensen et al., 2022).

Subject	Catalogue	Selection
The Flow of Clouds, Moisture and Rain	Global Shifts in Atmospheric Pressure	Air Movement
	Air Movement	Atmospheric Temperature
	Atmospheric Temperature	Evaporation
	Topography	Seasonal Winds
	Height above Sea level	Distance inland from the coast
	Evaporation	
	Seasonal Winds	
	Distance inland from the coast	
	Ocean Currents	

Limits

The limits diagram charts the annual, decadal, and seasonal variations in environmental and anthropogenic variables that influence the hydro-social cycle. Historically there has been a sharp increase in the daily per capita consumption of water and population increase. This is accompanied by changes in the land use cover which influences the distribution and intensity of rainfall within the basin, as it links to the effects that forest covers, and dense urban settlements have on the movement of rain-carrying clouds. Within these changes that took place over large spans of time lies the seasonal variations in both consumption for demand, and environmental variables like precipitation, evaporation, and run-off.

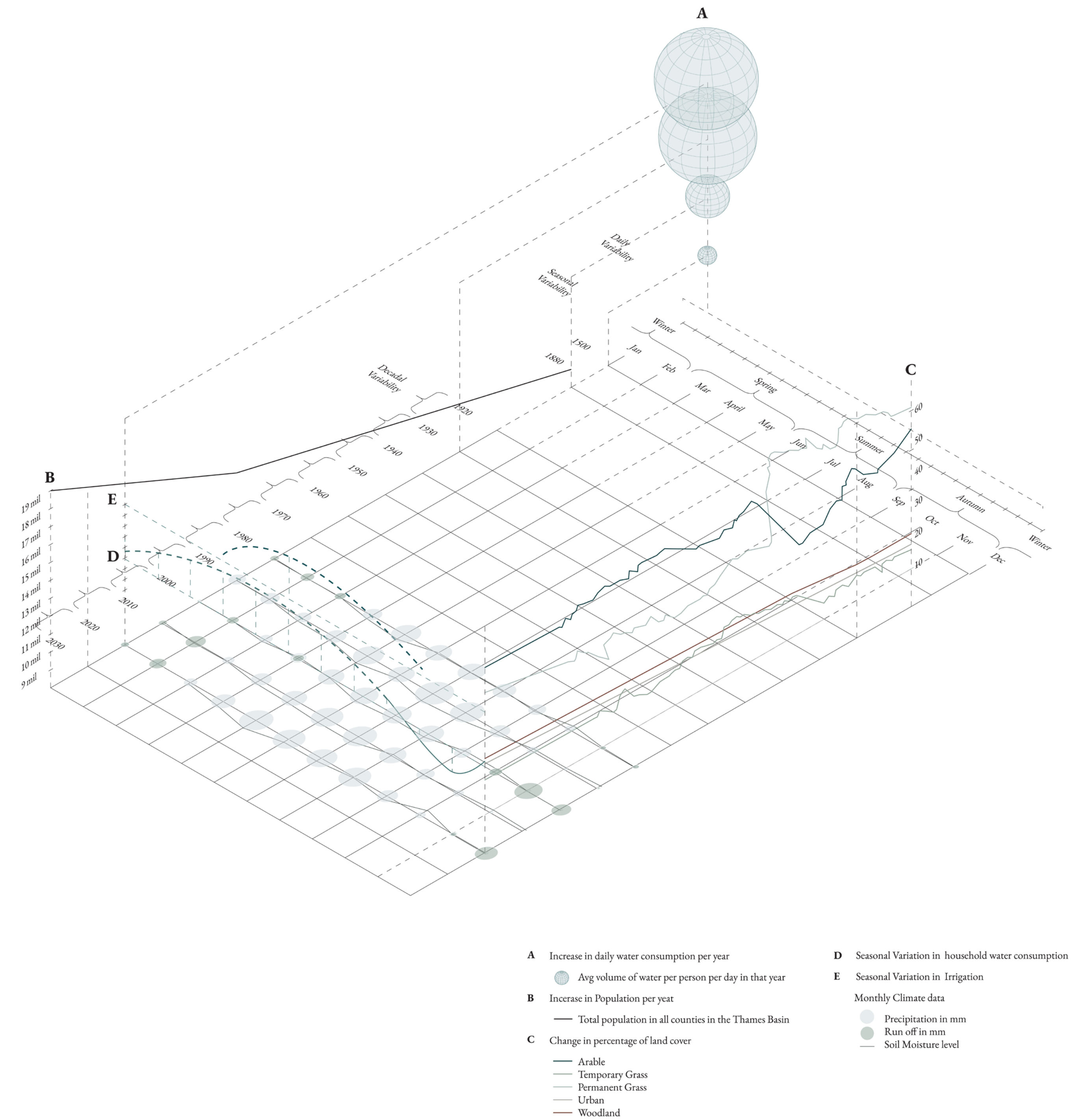


Fig 35: Limits of Matter - Changes in Climatic and Anthropogenic variables over the years

Composition

Legend

- Urban Heat Island
- Precipitation Contours
- Wind Zone Contours
- Seasonal Wind
- Broad Leaved Tree Cover
- Water Body

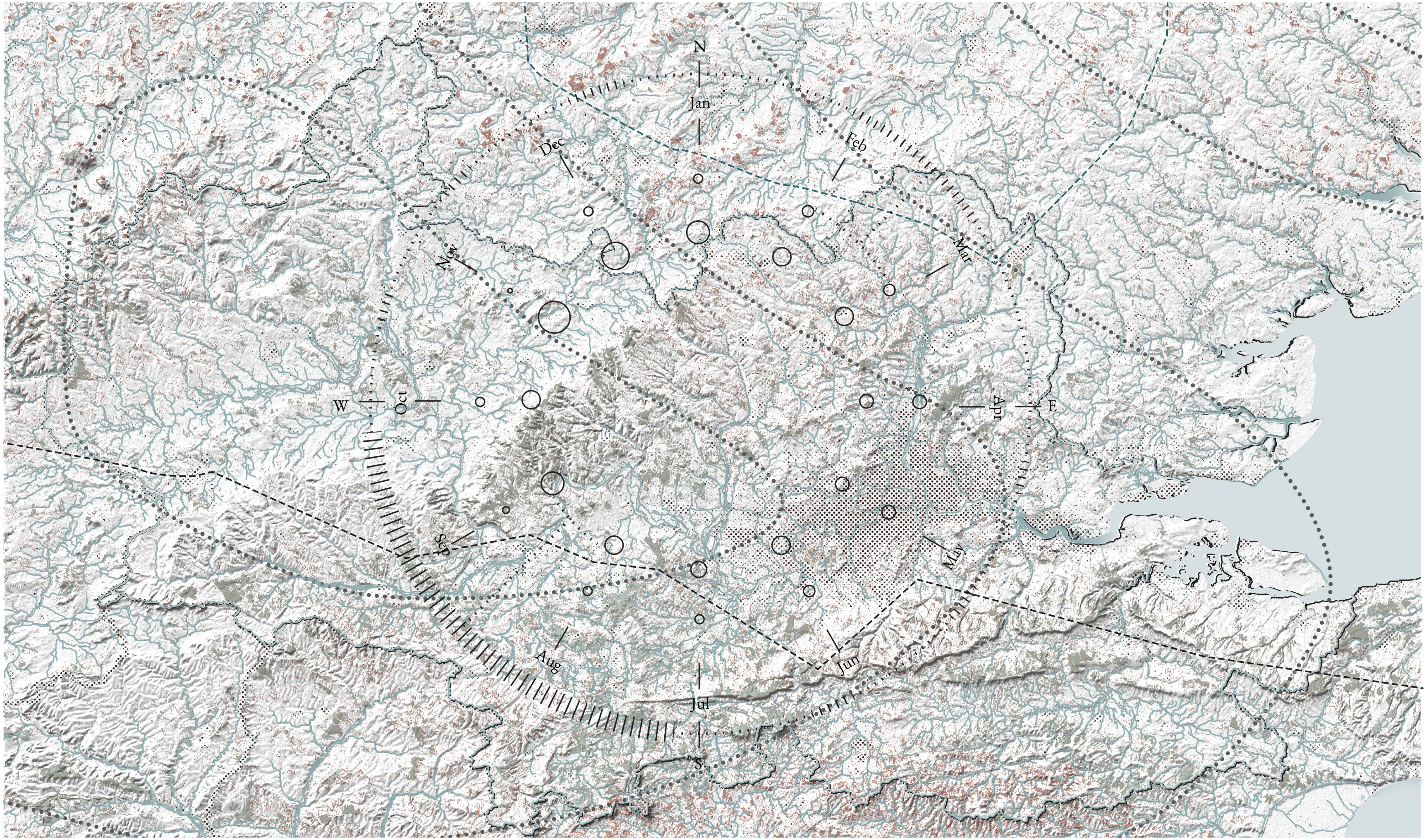
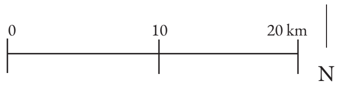


Fig 36: Composition of Matter - Precipitation Trends and Drivers of Rainfall Distribution



Alterations

The alterations diagram brings together the potential of creating a biotic pump in the hinterlands of the basin to bring in steady rainfall, and the effect of the Urban Heat Island near the coast in pushing rainfall downwind and away from the countryside located upstream of the basin. The dense forest cover and urban heat cover both drive local wind flows. On one hand, the biotic pump created by the forests is able to drive enough evapotranspiration that exceeds the rate of oceanic evaporation to create an upward flux of wind that pulls in rain-carrying clouds that are able to replenish river flows and soil moisture storage (Makareiva and Gorshkov, 2007). On the other hand, the higher thermal properties of urban surfaces store excess heat that creates an updraft that increases cloud faction over urban areas, which are often driven downwind. In the context of the Thames Basin, this is generally towards the North East as the predominant wind flow comes in from the South West for the most part of the year.

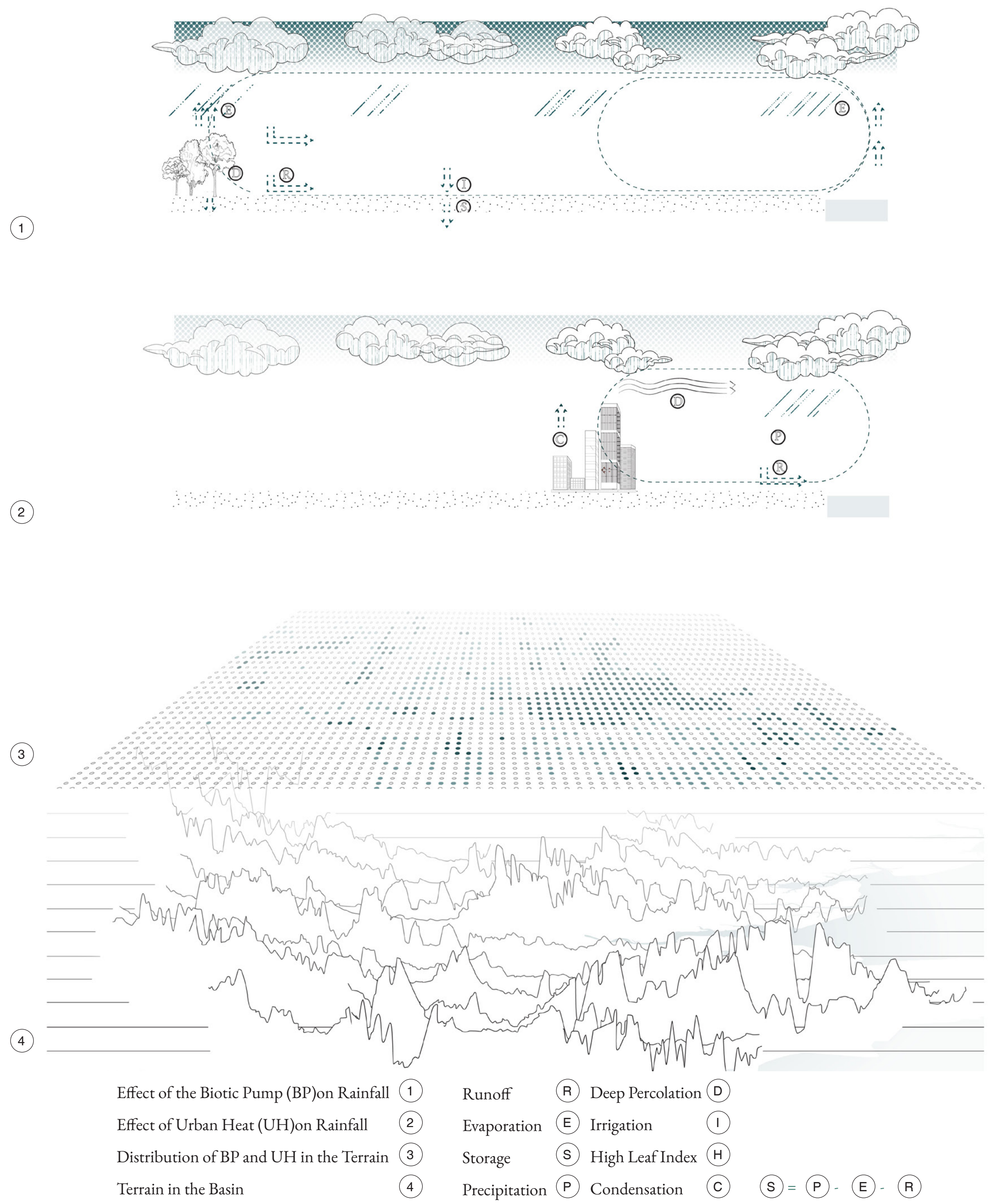


Fig 37: Alterations of Matter - Drivers of Rainfall Distribution

6.3 Topos

Topos looks at the form of the river as its dynamics vary from its upstream catchment to its downstream catchments and the manner in which its flood plains have been appropriated to support increasing levels of urbanity as one moves from the rural headwaters to the Thames Estuary. It further addresses the manner in which the volume of the river changes over a matter of hours as a result of different rainfall events.

These factors when considered together define the risks created by riverine flooding, which can be reframed as an opportunity to recharge groundwater reserves. Practices like creating brush dams in channels, slow down the flow of the river, increases infiltration to recharge the water table under river beds, and reduce the volume of water that feeds into the sea. Instead of focusing on maximizing control over rivers through reservoirs and flood walls, flooding can be studied as a symptom of a healthy river system that sustains different forms of fertile riparian landscapes and helps regulate the hydrological cycle.

Subject	Catalogue	Selection
Fluxes in the Form of the River	Fluvial dynamics	Fluvial dynamics
	Geology of the Basin	Geology of the Basin
	Flood Plain Appropriation	Flood Plain Appropriation
	Morphodynamics of Channel Modification	Degree of Engineering
	Sediment Mass Balance Maintenance Errossive Capacity	
	Degree of Engineering in the Basin	
	Effect of Tidal Pull on Rivers Flow	

Limits

The limits diagram depicts the sqm of flood zones in comparison to the total area of each sub-catchment basin. It further selects a sub-catchment each from the upper, middle, and lower catchments to mark the seasonal variations in the discharge levels at different points of the River Thames over the past 7 years. The largest and most erratic deviations are seen in the Lower Thames.

At the base of the limits diagram are variations of flood hydrographs and the factors that drive their shape. A single hydrograph is a representation of how a basin or a sub-catchment basin responds to a period of rainfall and marks the changes in the discharge of the river during the short period of a few hours of a rainfall event. Gentle slopes of the hydrograph signify the slow rate at which run-off from peak rainfall events meets rivers and indicates a low risk of flooding. When run-off rapidly feeds into the river, there is a higher chance of the river flooding.

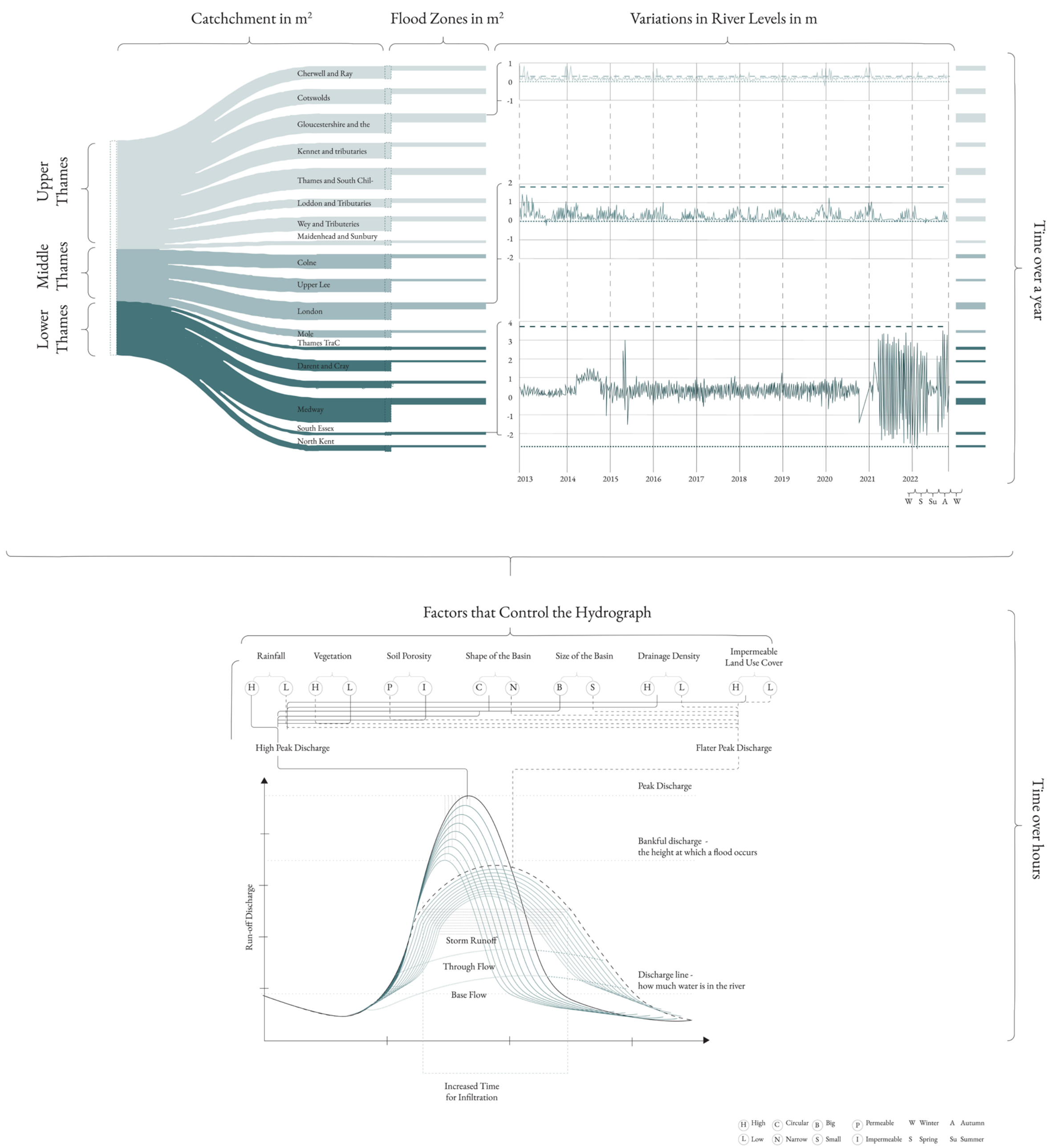


Fig 38: Limits of Topos -Seasonal Variations in the Floodzones

Composition

Legend

Variable Run-off feeding into River Catchment

Modification

- Heavily modified
- Artificial

Groundwater Flooding

Limited Flood Plain Capacity

River Morphology

- Highly Meandering
- Meandering
- Sinous
- Straight

Aquifers

Flooding Risks

- From River
- From Sea

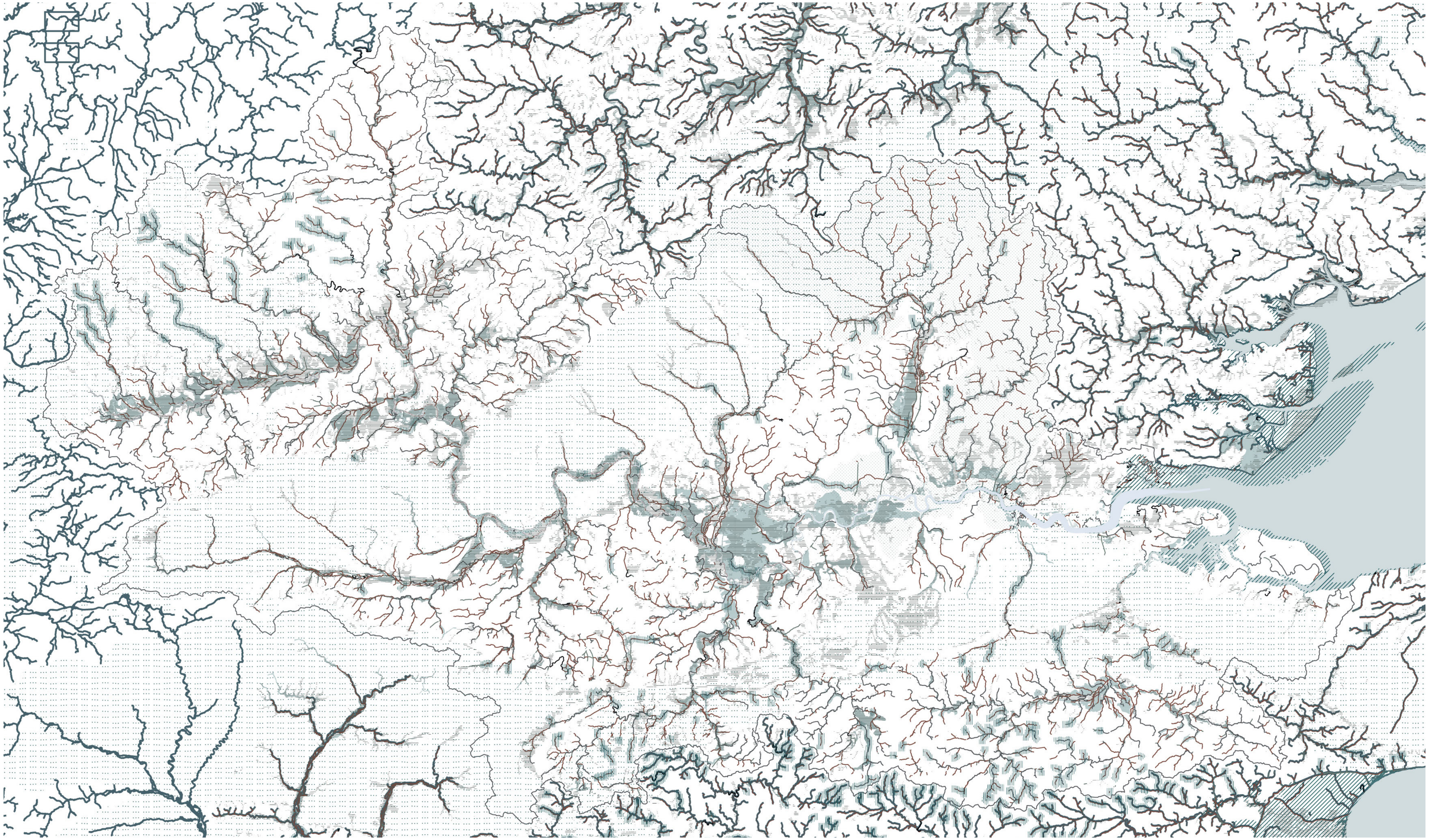


Fig 39: Composition of Topos - The changing form of the River

Alterations

The Alterations exercise was to mark the variation in the degree of urbanity and geology across the primary tributary of the basin. The increase in deposition dynamics naturally creates wider flood plains with faster-flowing water downstream of the river. In the context of the Thames, the natural floodplains are restricted by high embankments creating faster fluvial flows and tidal flows whose flood risks are entirly dependent on the Thames Barrier.

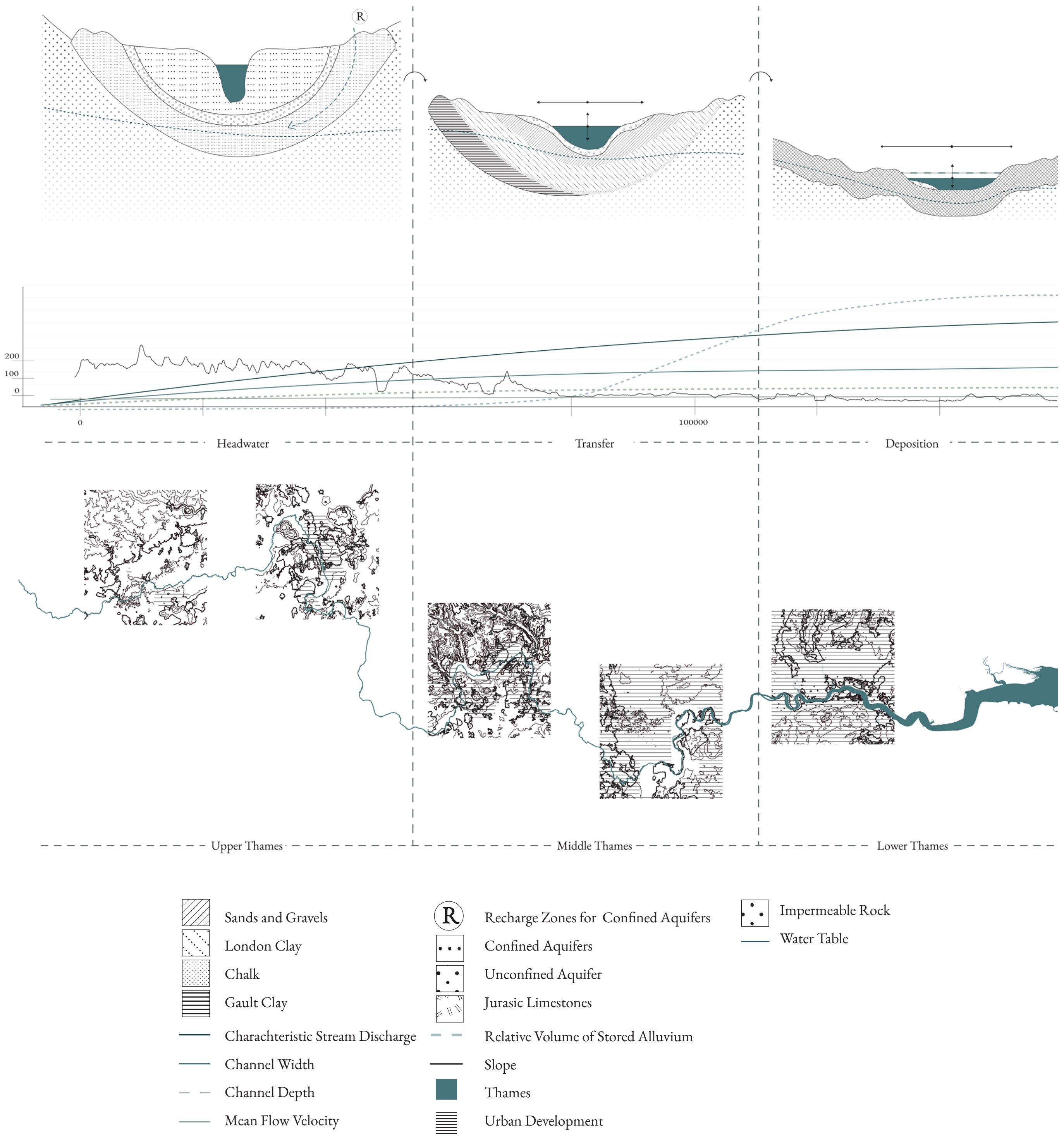


Fig 40: Alterations of Topos - Chaning dynamics of the River

6.4 Habitat

Habitat looks at the anthropogenic pressures on the quantity and quality of freshwater resources in the basin. This section returns to the question of the Basin's performance in a state of the hydrologic deficit as mentioned in chapter 2.4. The composition shows an overlay of the different drivers of deficit - namely population density, productivity density, and water intensity of irrigation. This overlay reveals the economic pressure that adds to the pressure to abstract from ground and surface reserves.

Threats to water quality as a result of run-off and sewage water release have resulted in drops in dissolved oxygen levels threatening aquatic life. Recently, the River was also recorded to have one of the highest concentrations of micro plastics in Europe, exceeding both the Rhine and Danube (Briggs, 2020).

Subject	Catalogue	Selection
Imprints on Quantity and Quality	Abstraction Pressures	Abstraction Pressures
	Chemical Pressure	Chemical Pressure
	Biological Modification of Rivers Ecosytem	Biological Modification of Rivers Ecosytem
	Physical Modification	Physical Modification
	Economic Pressures	Economic Pressures
	Waste Water Management	Waste Water Management Land Drainage
	Land Drainage	
	Degree of Urbanisation	
	Distrurbed Sediment Flow	
	Habitat Loss of Biodiversity	

Limits

Prolonged drought events have been frequent in the UK over the course of the twenty-first century. This is projected to increase with the "risk of water shortages in the public water supply, and for agriculture, energy generation and industry, with impacts on freshwater ecology" (Committee on Climate Change Risk Assessment, 2016).

The diagram shows the performance of the basin in meeting the abstraction limits set by the Environmental Agency, and notably, a large portion is overdrawing resources contributing to reduced flows and drying of the rivers that in addition to threatening water security, has a detrimental impact on the biodiversity that is endemic to the chalk waters of the basin. Additionally, there are records of augmented flows from inter-basin transfers to maintain the water levels of highly urbanized sub-catchments.

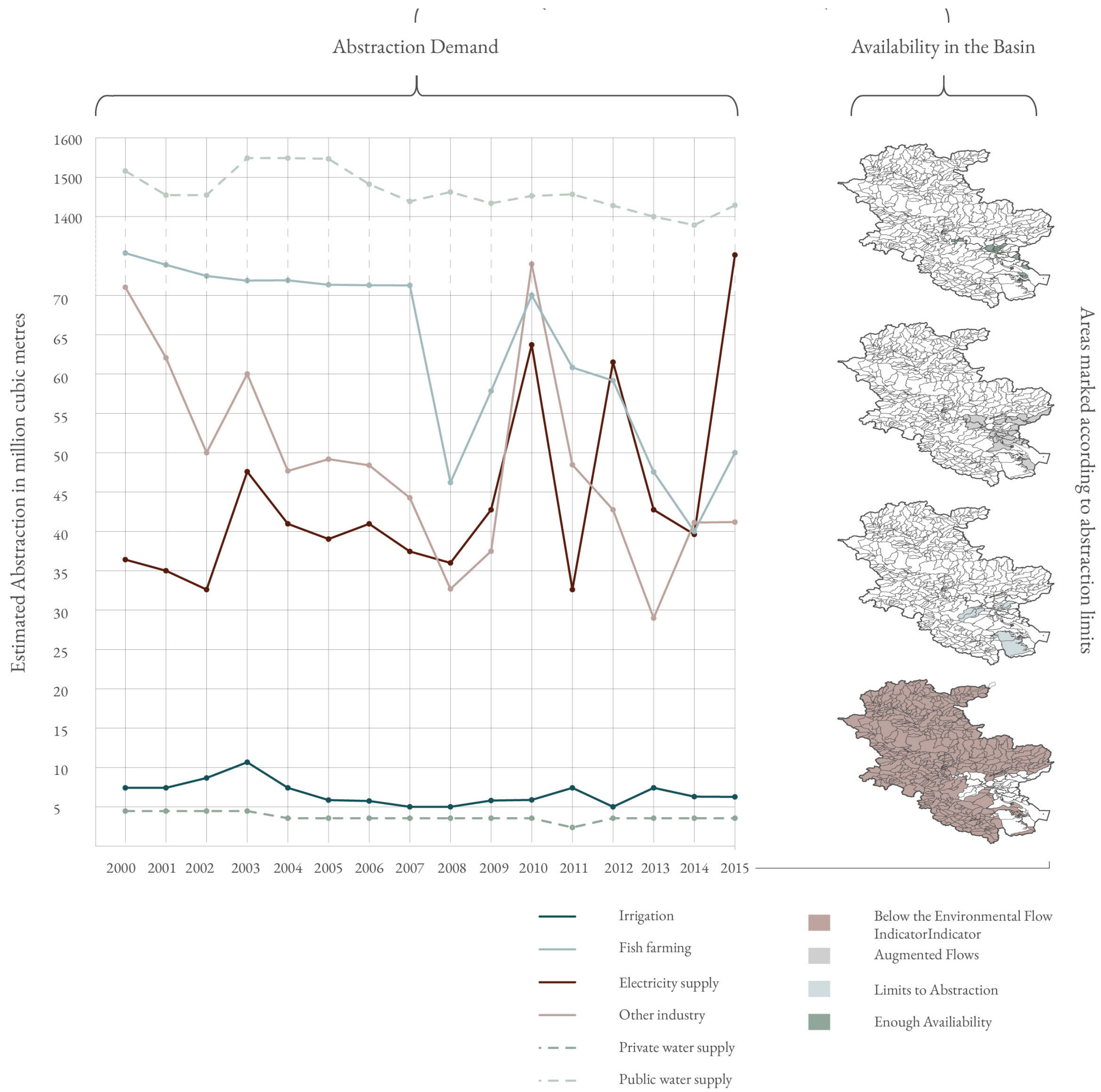


Fig 41: Limits of Habitat - Abstraction Stresses on the Basin

Composition

Legend

Population Density
- 25-3376
- 3376-6726
- 6726-10077
- 10077-13427
- 13427-16778

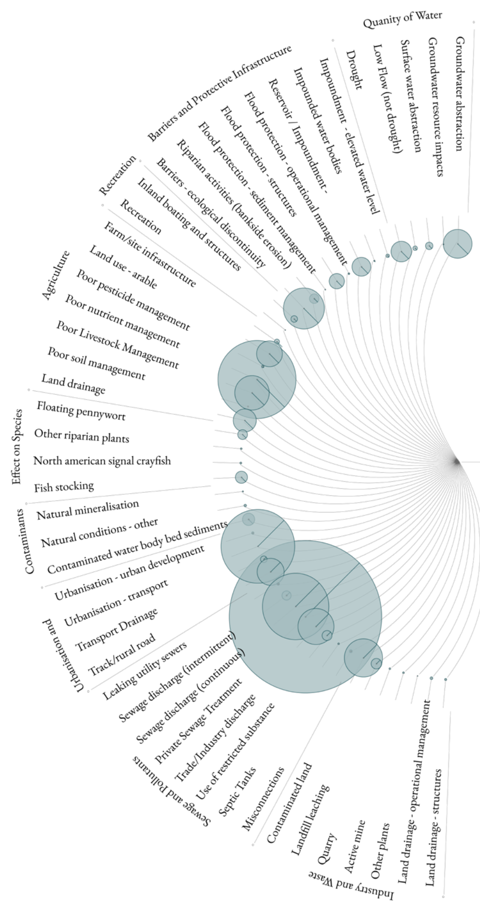
Productvity Density
(GVA per hr)
- 61-84
- 84-99
- 99-121
- 121-154
- 154-196

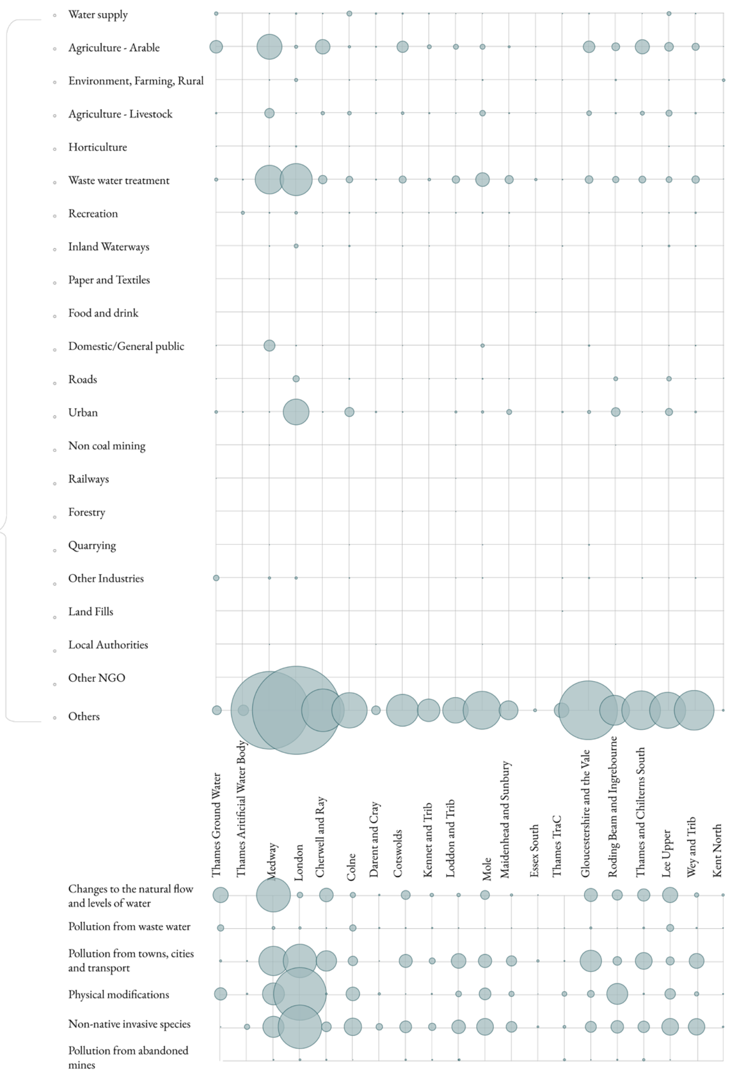
Irrigation Intensity
- High
- Low

Fig 42: Composition of Habitat - Drivers of Water Deficit in the Basin

Alterations

Alterations break down the counts of different instances of reported violations to the standards for quantity and quality of water in the basin from all the sub-catchment basins as published by the Environmental Agency. The business sectors that operate in both rural and highly urbanized settings are responsible for tipping sustainable rates of abstraction, altering the natural flow of rivers, dissipating chemical pollutants, and fostering conditions that allow the growth of invasive species. In some cases, such pressures cannot be linked to a single activity, but show high levels of concentration in sub-catchments like Medway and London in the Lower Thames.





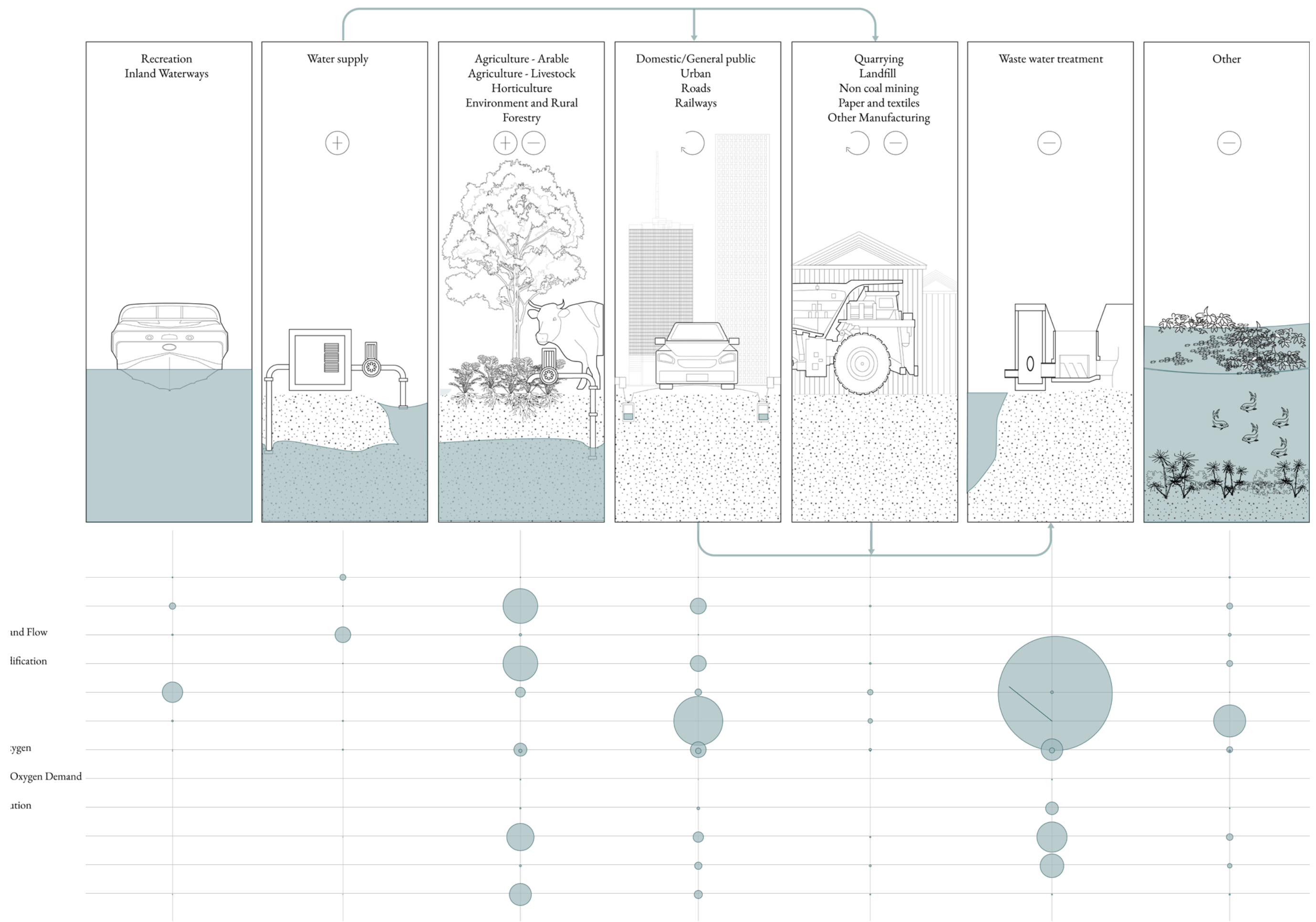


Fig 43: Alterations of Habitat -Reported violations for water quantity and quality standards in the Thames Basin.

6.5 Geopolitics

Modern Urbanism has been described as a social-technical process that is made possible through infrastructural landscapes. Within the domain of water management, this creates a 'hydro polis of waste and water' (Graham and Marvin, 2001). These infrastructure networks are the physical embodiment of 'capital sunk into the city', and represent the interests of the 'socio-technocratic geometries of power'. Infrastructure facilitates urbanism's defense against nature's waverings, but it works within the complex confines of technical collapses which may be set in motion by the uncertainties of climate change.

Within the context of the Thames, there has been a historic trend of investing in engineering the riverine system near London to sustain its growth, amid threats to health security due to extreme pollution and devastating flooding in the 19th and 10th centuries. In the 21st century though such threats are becoming increasing prevalent across the basin, due to the financial inability to replace combined sewage systems which forces the release of untreated wastes into rivers during high rainfall events. Furthermore, investments in flooding infrastructure are not distributed by the extent of its risk, but by the influence of elected representatives of constituencies.

The water resources of the basin and its supply, distribution, and treatment infrastructure is under the privatized control of Thames Water Company, which has been struggling to secure both the funds and local support to construct reservoirs to combat increasing droughts.

Subject	Catalogue	Selection
The Cost of Mitigation	Infrastructural Network of Water Supply and Treatment	Infrastructural Network of Water Supply and Treatment
	Regions of Neglect	Regions of Neglect
	Future Flood Defence Investments	Future Flood Defence Investments
	Future Reservoir Investments	
	Sites of Intra-basin Water Transfer	

Limits

The figure explores the projected cost of climate damages in various sectors like food security and health as opposed to the costs in a scenario where stringent mitigation measures are enforced. Lack of adequate mitigation measures would result in catastrophic disruptions to the GDP of both the Greater London Area, and the surrounding region of South East England, with projected increases in drought and flooding, a decline in agriculture and livestock rearing, and coastal impacts. The economic reading of the effects of climate change in terms of loss of GDP (Rising et. al, 2022) captures 'market and non-market losses and the social dynamics that result in unequal exposure to impacts.

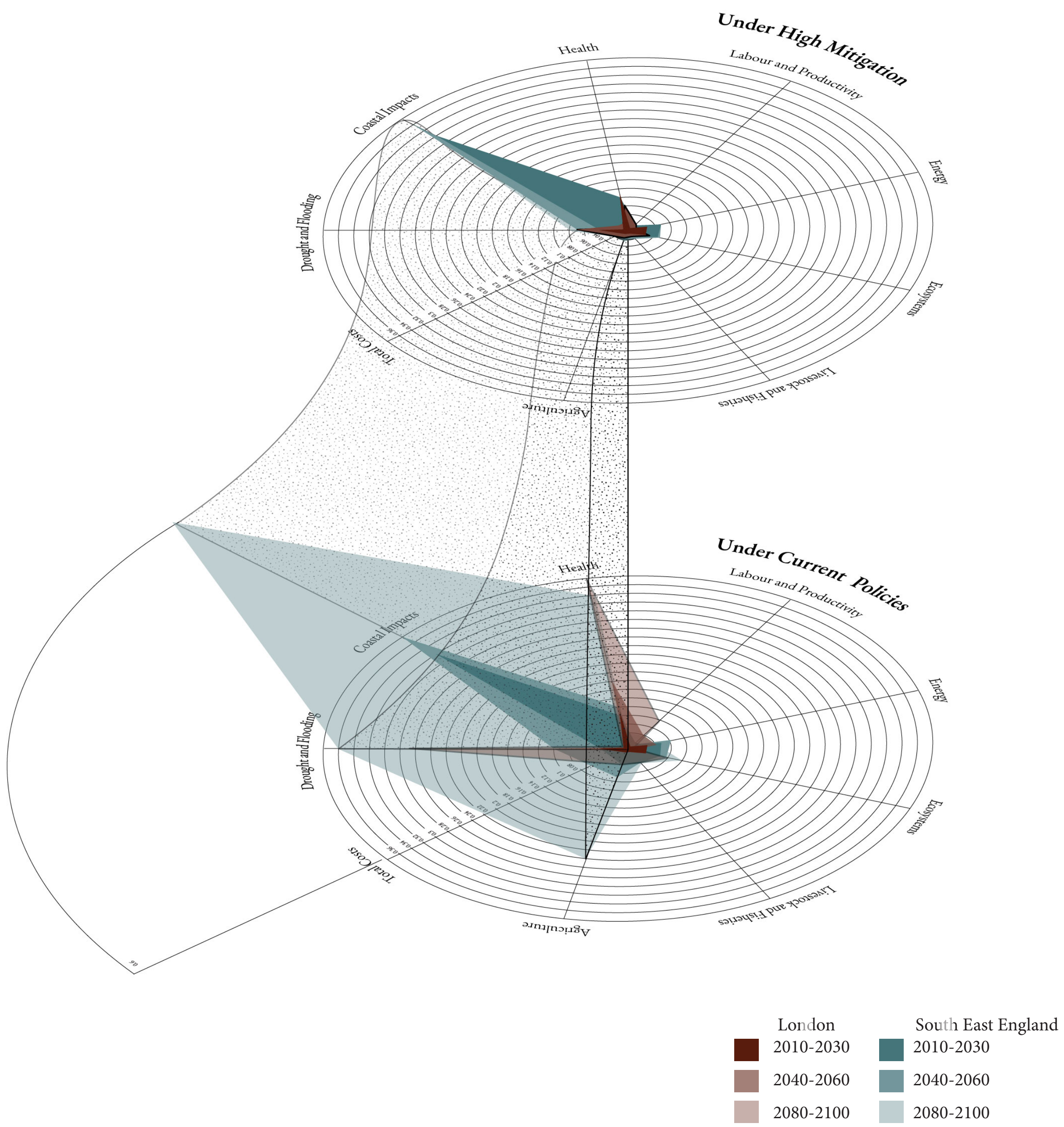


Fig 44: Limits of Geopolitics - Projected costs of climate damages in various sectors,

Composition

Legend

- Artificial Flows
- Highly Engineered
- Neither

Water Supply

- Desalination
- Source
- Storage Reservoir
- Service Reservoir
- Sink
- Junction

Water Treatment Infrastrucure

- Secondary Treatment
- Tertiary Treatment

Pollution Instances

- Discharge in coast
- Discharge in fresh water
- Discharge in estuary

Sensitive to

- Eutrophication
- Records of Untreated Sewage by Volume
- Highest Investments for Flooding Infrastrucure
- Temporary Flooding Infrastrucure

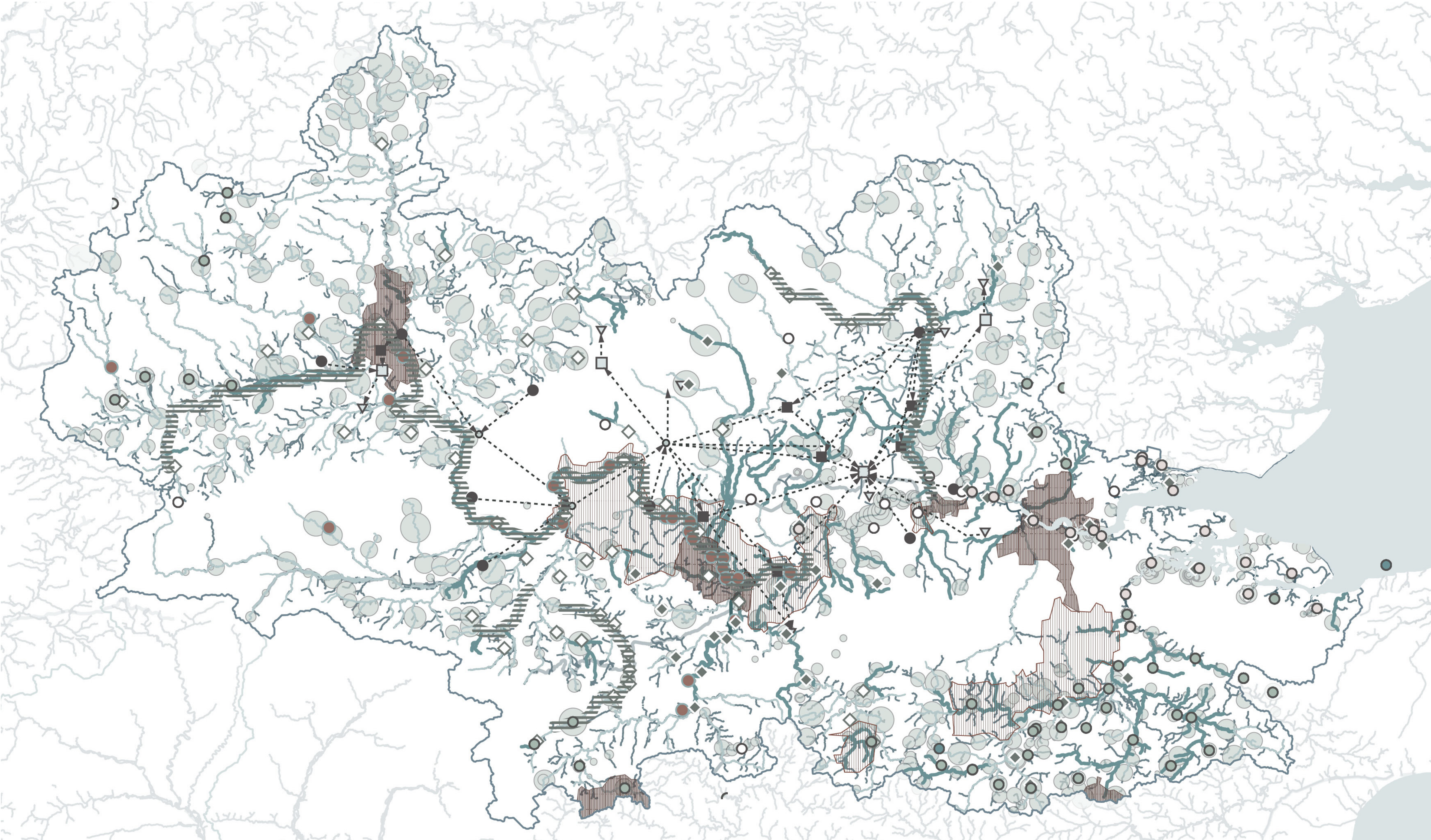
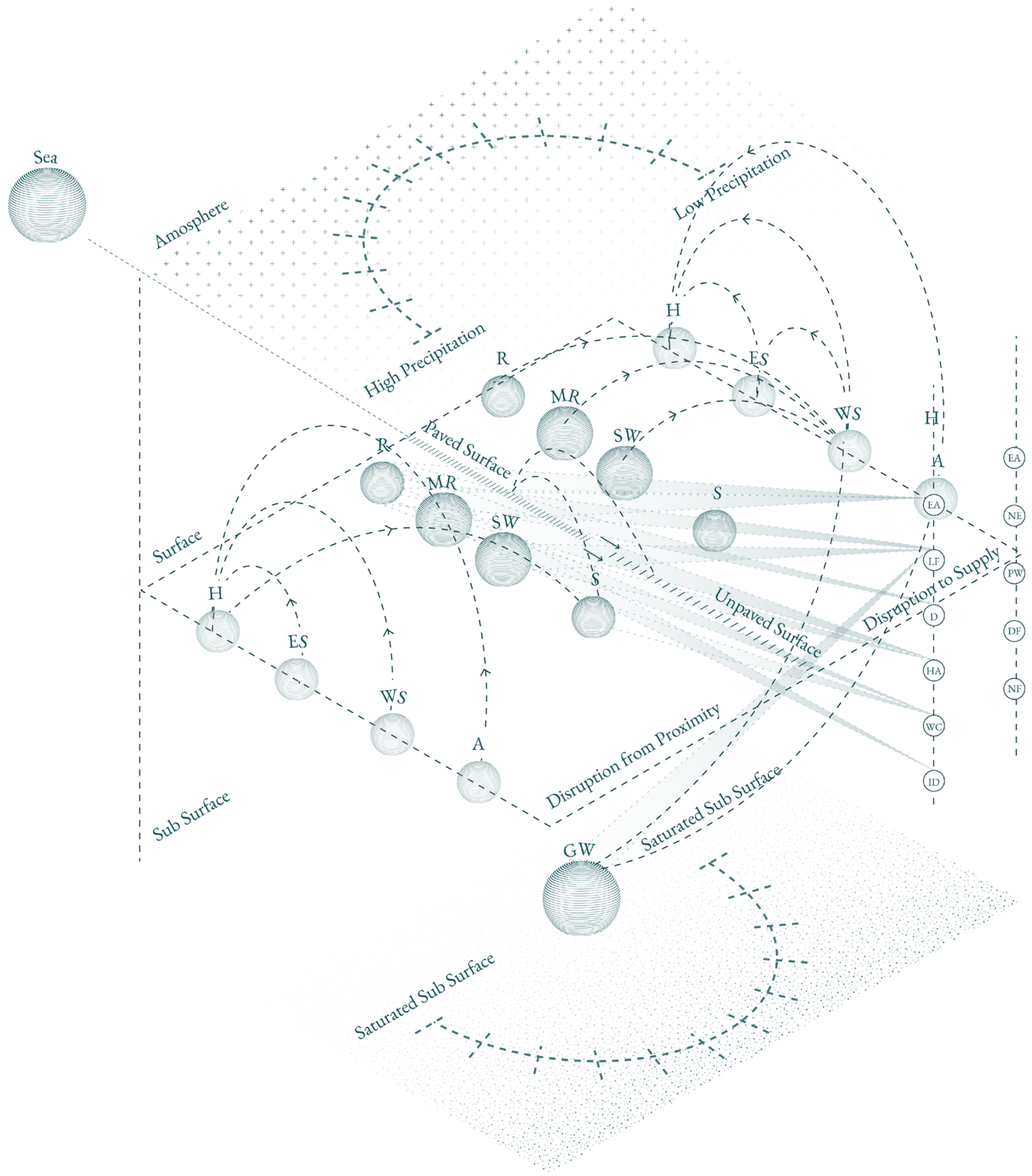


Fig 45: Composition of Geopolitics - Distribution of investments in engineering the riverine system

0 10 20 km
N

Alterations

Alterations highlight the domains of responsibility in maintaining physical security against flood risks and the bodies responsible for securing the cost of living despite how water risks affect the cost of production of electricity, public supply of water, and food.



R	**Reservoir**	H	**Household**	EA	**Environmental Agency**	NE	**Natural England**
MR	**Main River**	ES	**Electric Supply**	LF	**Lead Local Flood Authority**	PW	**Private Water Supply**
SW	**Surface Water**	WS	**Water Supply**	D	**District / Borough Council**	DF	**DEFRA**
S	**Sewer**	A	**Agriculture**	HA	**Highway Authority**	NF	**Natural Farmers Union**
GW	**Ground Water**			WC	**Water Company**		
				ID	**Internal Drainage Board**		

Fig 46: Alterations of Geopolitics -Domains of responsibility in maintaining physical security and affordable costs of living

07 Exploring Definitions of the Countryside

[Contents]

7.1 Many Meanings of the Countryside

> 'Thus at once, for me, before the argument starts,
> country life has many meanings'
> (Williams, 1973)

In the previous chapter, the focus was on the expansion of London and how it necessitated the categorization of surrounding settlements and resources as its ecological hinterlands. This differentiation called for an examination of these spaces and what constituted the rural in contrast to the urbanity of London. The city was a pioneer in modern water infrastructure and a testament to humanity's ability to manipulate nature to support unprecedented growth. While some celebrated this narrative, a growing faction lamented the disappearance of the idyllic countryside amidst the unlivable pollution and congestion. The longing for the lost pastoral landscapes was just as potent as the visions of industrial progress. This idealized view of the countryside that came up in the 18th and 19th centuries was not exclusive to this era, nor was it a true representation of rural life. Even today, the imagery of english pastoral loss was politicized by Leave voters during the Brexit campaign as a sign of the disrupted English national identity (Garrard, 2020). It was necessary to understand how historically and

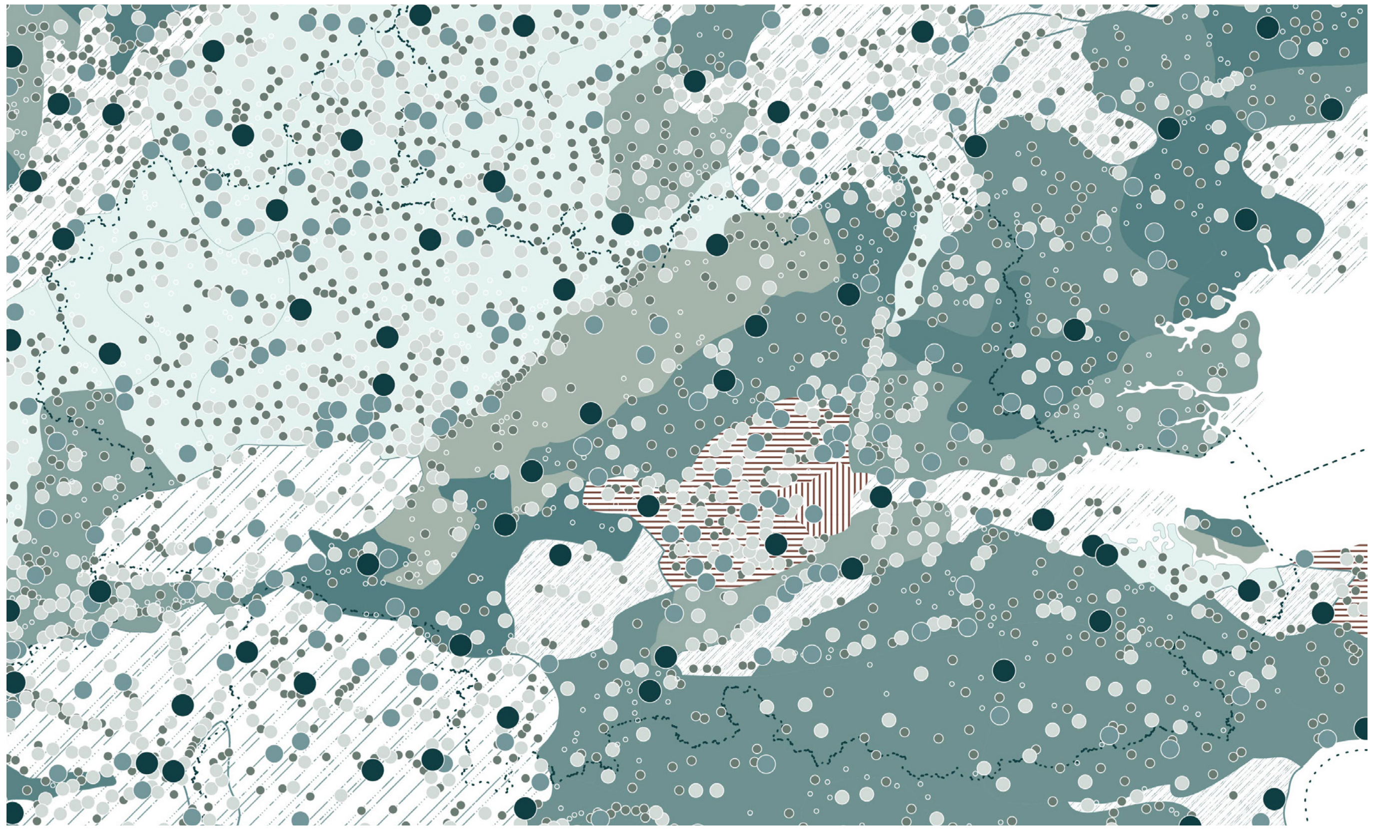


Fig 47: An Atlas of Rural Settlement in England showing settlement patterns in the Thames Basin in the 19th Century (Source : Brian Roberts and Stuart Wrathmell , Historic England)

politically loaded this idea of the 'rural',' the pastoral', or 'the countryside' was before highlighting its hydrological relevance in the future of the Thames Basins' ability to adapt to risks.

Eco-critical theorists combine an ecological and literary understanding of how this idea of the 'English Countryside' is layered and specific to the historic contexts to which they are referred to. Raymond Williams's book 'The Country and the City' unpacks the multiple meanings of the countryside - from its most literal depictions as 'fields', 'farms', and 'forests', to its cultural allusions as 'the pure', and 'the natural' to the political and economic interests that shaped it. His analysis of works of english literature that date from the 12th to the 20th centuries shows that the idea of the 'lost idyllic countryside' kept shifting to bemoan the period before any form of intense transformation. He concludes that this notion was eventually 'a myth functioning as a memory.' Williams look at how the countryside has been imagined and represented in literature and other cultural forms, from pastoral poetry to the novels shows how these representations have reflected changing ideas about the countryside and its role in English society.

The Counter - Pastoral

The idealization of pastoral landscapes persisted, as a response to the realities of urbanization and industrialization. However, to gain a full understanding of the countryside, Williams highlights the need to acknowledge the 'counter pastoral' ie. the counter-narratives that critique the romanticization of rural areas and address the harsh realities they face (Williams, 1973).

The enclosure movement, which took place between 1760 and 1845, is a key example of this. Before this period, the rural areas were the original commons that was, that were jointly cultivated and managed by rural peasantry. By 1845, the enclosure movement saw 6.5 million acres of common lands and wastes transferred to private farming interests owned bythe estates of Britain's landed classes (Cocker 2018). The enclosure movement involved a systemic authorisation of clearances, depopulation, and labour exploitation. While this period may be viewed as a story of growth and achievement to some, it was the substitution of one form of domination for another - the feudal order was replaced by an agrarian capitalist order.

Subsequently, the intensification of farming practices that occurred in modern British agriculture after the World Wars has had devastating consequences on the ecosystems and habitats of the British countryside. These changes have led to significant ecological and cultural impacts. The escalation of nitrogen and pesticide use, along with the use of heavy machinery, has become a common trend in modern British agriculture. Specifically, nitrogen use has led to adverse effects on soil fertility and the health of river systems. As a result, toxic blooms of algae have emerged, which further deteriorate water quality and deplete aquatic life. Essentially, the once intricate ecosystem of the British countryside has been reduced to a "monoculture in a production line" (Cocker, 2018).

The increasing intensification of modern British agriculture has put immense financial pressure on farmers with small land holdings. The demand for economies of scale, higher capital requirements, use of ever-larger equipment and more expensive chemical inputs, and the relentless downward pressure on farm-gate prices by supermarkets and primary buyers of raw produce have made it difficult for smaller farmers to keep up with the impacts of intensification. As a result, large landowning operations have become more favorable, and the number of small-scale farmers in the UK has declined. Graham Harvey, the author of "The Killing of the Countryside," a scathing critique of industrial farming, highlighted that in 1938, there were 226,000 British farmers with holdings of fewer than 50 acres. However, thirty years later, 64,000 of them had gone out of business (Harvey, 1997)

Why Restorative Agricultural Urbanism Can Not Be Seperated From Nature Conservation.

Mark Cocker in his book 'Our Place' establishes a connection between farming and nature conservation in his accuount of the countryside, and how it is managed. He describes the complex web of energy transfers that makes life on Earth possible through processes like photosynthesis and nutrient transfers, leading to the creation of biodiversity -which has evolved into different ecosystems.

In contrast, agriculture is designed to be a closed system initiated and developed by humans, with the aim of producing edible or economically important crops. Although farming has been practiced for thousands of years, its ineffciiencies led to energy loss which escaped human control and was recaptured by wild plants and animals. Farming in England specifically, has shaped and nurtured the complex array of semi-natural habitats and is fundamental in Britain, where an estimated 42.8 million acres are under crops or permanent pasture. Humans, like other keystone species such as sea otters, wolves, and beavers, play a role in creating opportunities for other life forms, and in shaping habitats. An example he provided is that of the skylarks, whose songs are often associated with the countryside.

The movement to 'Rewild Britain' in the 2010s, which relies on Countryside Stewardships, is an extension of this understanding and can be seen as a continuation of earlier initiatives such as Biodiversity Action Plans in the 1990s and landscape-scale conservation in the early 2000s, which were initiated but never fully realized.(Cocker, 2018).

The Paradox In English Environmentalism

Cocker highlights the paradox of English environmentalism, where numerous organizations such as Friends of the Earth UK, the Wetland Trust, Campaign to Protect Rural England, etc., are committed to nature conservation, yet Britain has been stripped bare of its natural inhabitants to an unprecedented level since the last ice age. A report published by the State of Nature presents insight into the health and prospects of British wildlife, with a very wide sample size of species, which has not been attempted before. The report compiled data from over 25 environmental organizations and a wide range of researchers, including mycologists and herpetologists, and analyzed population data of 3,148 species. The study found that 60% of the species had declined in the last 50 years, with 31% having experienced severe declines, and over 600 species being threatened with extinction. Cocker emphasizes that every species represents a unique ecological requirement within a complex ecological network, and their decline reports every nuance of the deterorating British countryside (State of Nature, 2013, p. 7).

In recent times, deliberate efforts have been made to associate the rural landscape with terms such as 'Resilience' and 'Conservation'. These efforts are exemplified in the 2018 special edition of the popular British magazine Country Life, which was guest-edited by Prince Charles. However, these efforts have been criticized for promoting a form of conservatism that serves to reinforce the power of the rural elite (Duggan and Peeren, 2020). The reality is that land in England is concentrated in the hands of a small minority, who are sustained by regressive land tax regimes such as the Common Agricultural Policy (CAP), which allows those who own the most land to receive the most subsidies. The landed elite in England have wielded significant legal and political power to shape environmentalism and define their own role in it. This is evident in the language used by environmental authorities and and organisations when discussing conservancy, which Cocker observes is lacking in agency.

> "'It is a prose style of very little action. In large part, it is a language of powerlessness"
> (Cocker, 2018)

A New Narrative For The Countryside

The predominant view of the countryside has managed to implicitly excludes the economically disadvantaged farmers, women, people of color, and more than human actors and there is a need to pay close attention to how the politics of the rural is constructed when addressing conservation and rural resilience (Duggan and Peeren, 2020). The thesis seeks to explore the potential in furthering the narrative of the countryside through design, but in a more hydrologically restorative way. This examination of ecocritical readings of the countryside and reflecting on the time period they arose in gives a good idea of "who is telling the story, from what perspective and using what strategies" (Duggan and Peeren, 2020) and how this has had a profound effect on meaning-making that furthered the unjust appropriation of nature.

By creating a new narrative for the countryside, we have the potential to construct new meanings that enable a more restorative approach to natural processes, one that takes into account the agency of non-human entities (Haraway, 2004). This idea of reshaping the narrative of the countryside aligns with what Haraway emphasizes as the potency of storytelling. According to Haraway, storytelling is a critical part of creating a new way of thinking about our relationship with the environment. She believes that storytelling can help us create a new "commonplace" that benefits both humans and non-human beings. Haraway sees storytelling as a way of thinking together with others, which can help us to develop a greater sense of empathy and understanding for the natural world. This involves being open to new perspectives and learning from others, including those that may challenge our existing beliefs (Haraway, 2018).

The image on the right is from the art project "Postcards from the Future" and embodies the efforts to open up new perspectives. It portrays paddy fields and a form of agrarian living in the heart of London in the future, which is ravaged by rising water tables and threatened by food insecurity. This vision represents a complete departure from dominant notions about how a city as urbanized as London should develop, challenging them through a single image that brings climate anxieties to the forefront.

Before the exploring the design, In the subsequent sections I try to look at the spatial elements and materiality that define the images of the countryside in relation to land management and riverine management, to see how each sub catchment of the thames basin, performs and which sub catchments can be functionalized to futher an alterative narrative to the countryside.

Fig 48: Parliament Square Paddy Fields - London Adapting to rising water tables through managed flooding to maintain food sufficiency (Source: Postcards From The Future)

7.2 Perspective that Frames the Countryside

Perspective into Land Management that Frames the Countryside

Rural areas can be defined differently based on the purpose and location of the definition. Typically, they are characterized as areas with low population density that are located outside of urban centers. Criteria used to define these areas may include factors like population density, land usage, and economic activity. Additionally, administrative or political boundaries such as counties or municipalities may also be used to define rural areas.

The Department for Environment, Food & Rural Affairs (DEFRA) in the United Kingdom defines areas as urban if they contain settlements with more than 10,000 people within the Lower-layer Super Output Areas (LSOAs). These LSOAs are small geographic areas that are defined to improve the reporting of small area statistics in England and Wales. This definition of rurality is specifically to address socio-economic challenges and oppurtunities to both buisnesses, and general quality of life. The classification has been applied to a range of geographic datasets including the lowest tier local authorities in the uk , which includes local authority districts,unitary authorities, metropolitan districts and London boroughs. As a result LAD's (Local Authority Districts) are ranked on a six point scale from mainly rural to urban with major conurbation, based on the share of the resident population that resides in rural areas within the LSOAS.

The limitation in this defintion is that it is an oversimplified view of the complex and diverse nature of urbanity and rurality. Since this classification is not based on landscape, land-use, policy, or financial characteristics, there may be Local Authority Districts (LADs) that are categorized as "Urban" despite having vast areas of open countryside in terms of landscape. The figures below depict a side-by-side comparison of the definition of urbanity and the actual landscapes or land use distribution it fails to account for. For a more detailed comparison, the visualisation on the following pages attempts to provide an in-depth analysis of the nuances within the Rural-Urban Classification definition within the Thames Basin area. All the Local Authority Districts (LADs) within the basin fall within the 5 out of 6-point classification scale, ranging from Mainly Rural to Urban with a large conglomeration. The size and number of LADs falling within each of the 5 categories are compared with the actual size of the basin. The land use composition within the basin has been represented through points and as a percentage of the whole to enable comparability.

The interesting point to note is that the land use composition across different categories, including Mainly Rural, Largely Rural, Urban with significant rural and urban with city and town, is found to be more or less the same. Even within the highest degree of urbanity, Urban with major conurbation, there are land use compositions comparable to that of Mainly Rural.

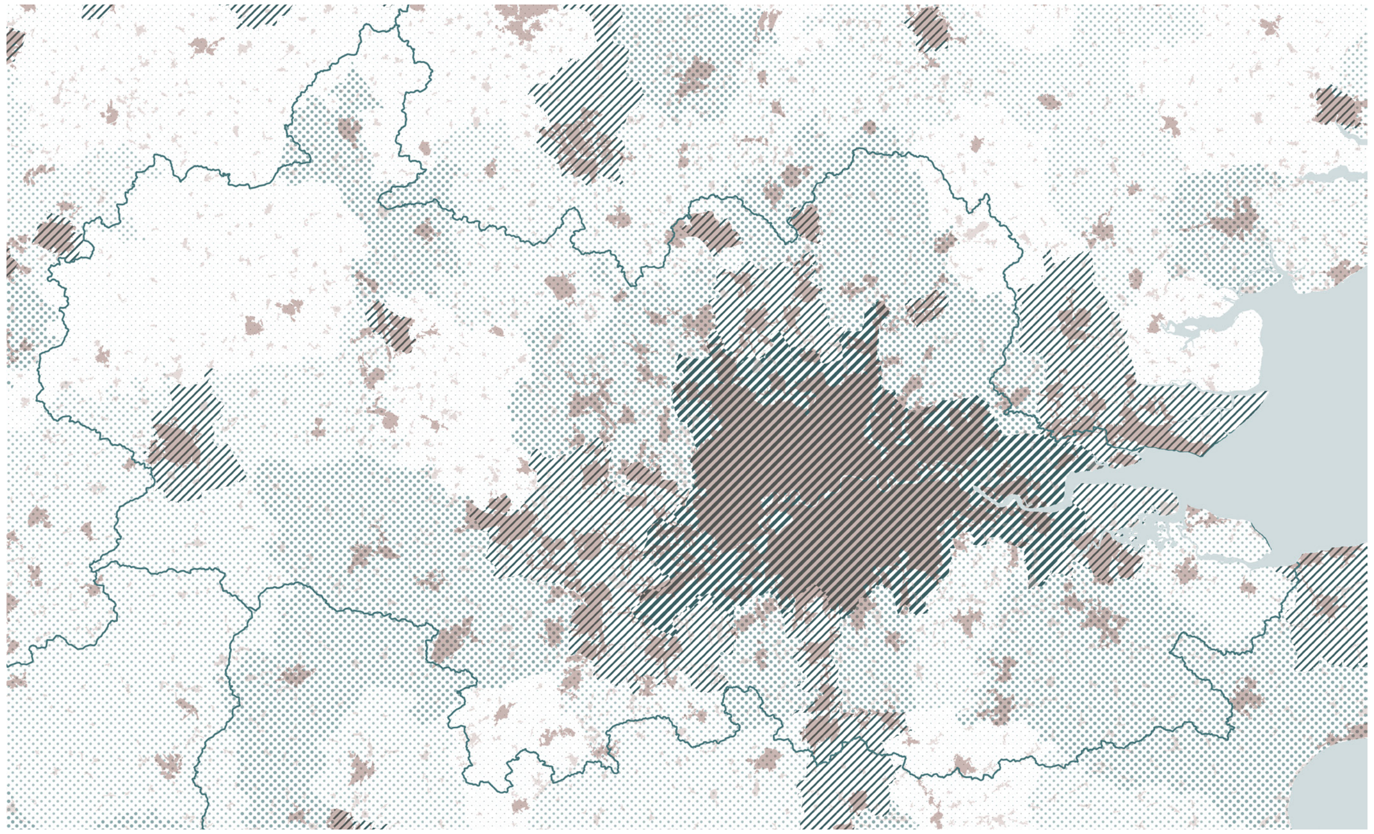


Fig 49: Urbanity and Rurality of the Administrative Divisions in the Thames Basin

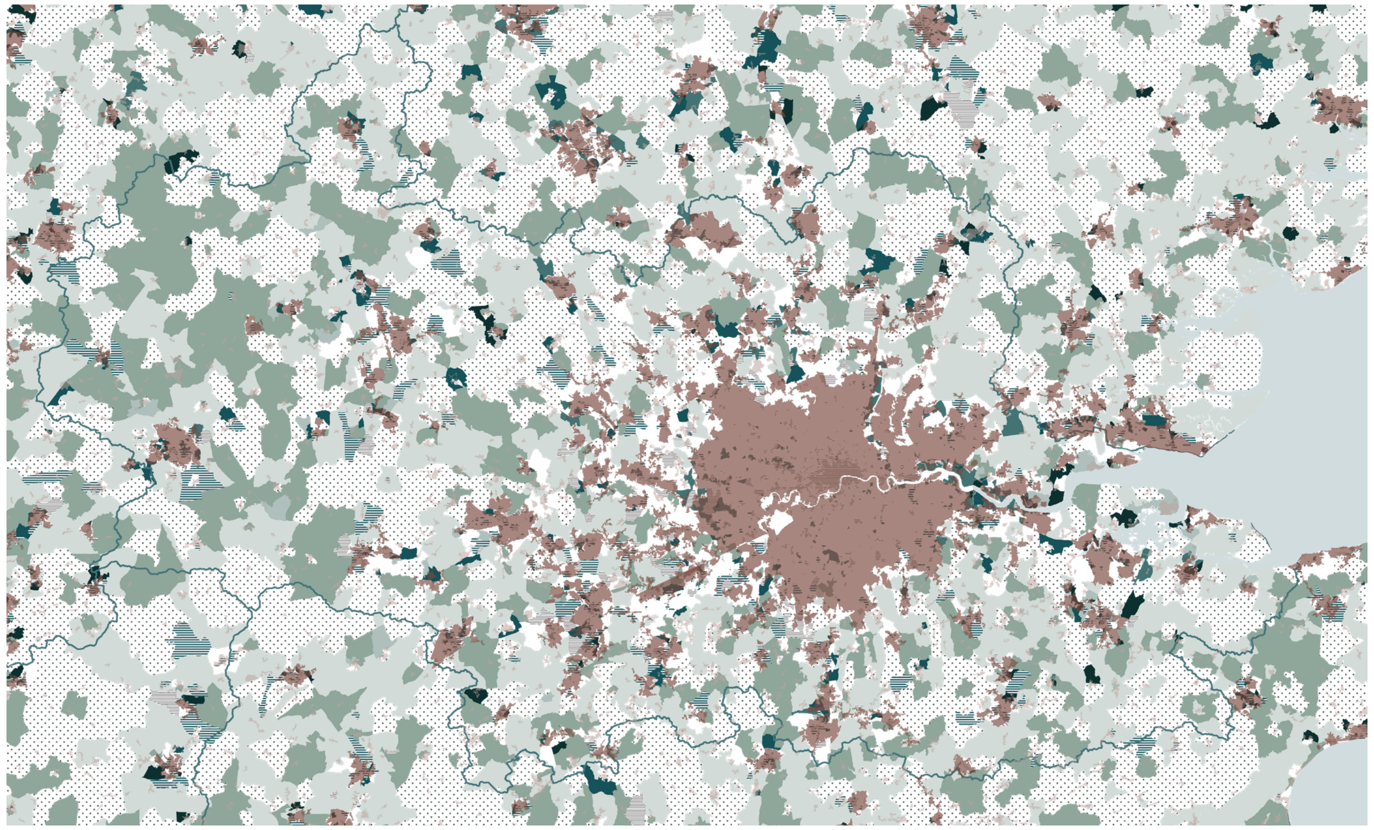
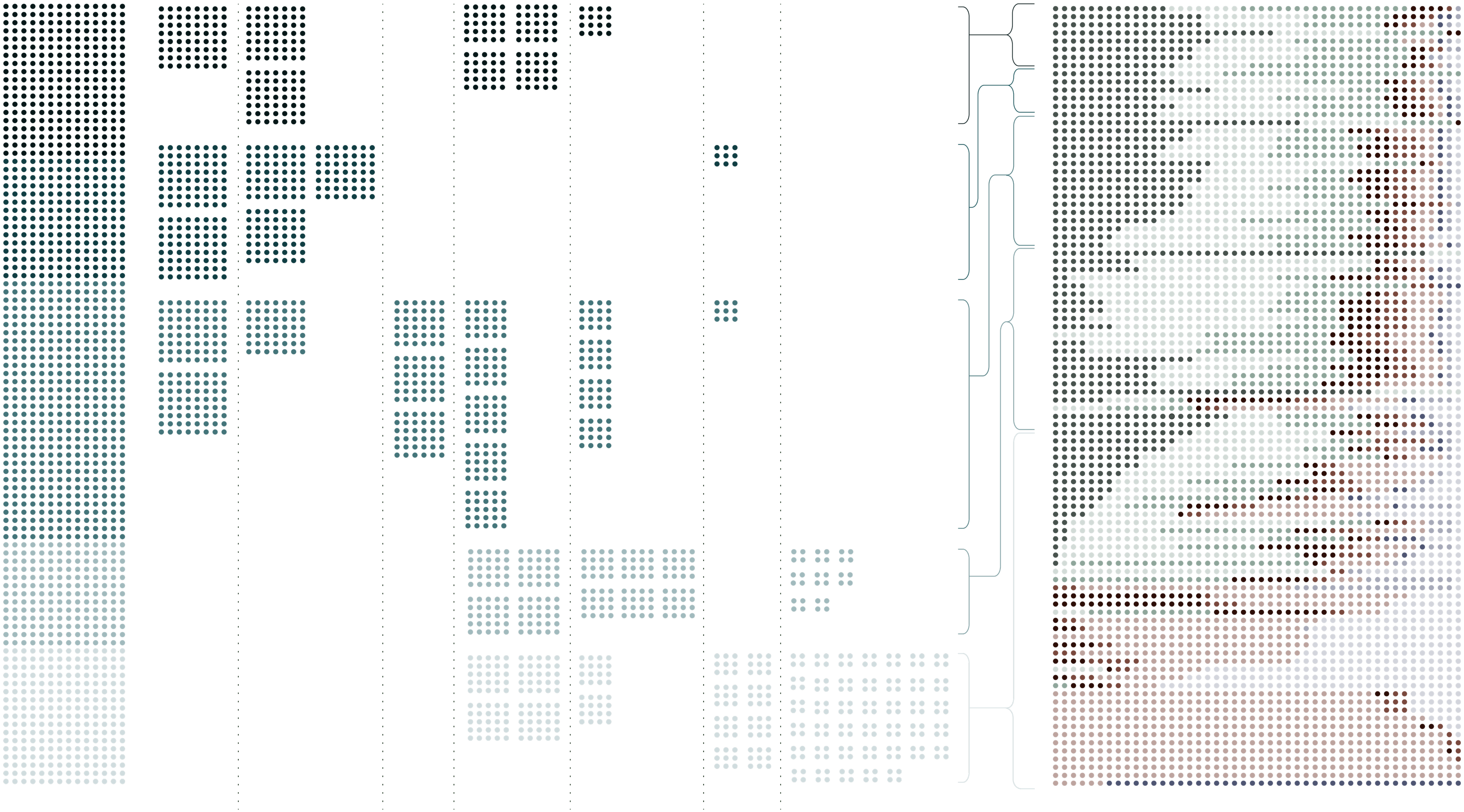


Fig 50: Land Use Distribution in the Thames Basin



- Mainly Rural
- Largely Rural
- Urban with significant rural -Predominantly urban
- Urban with city and town
- Urban with major conurbation

Fig 51: Composition of Urban Rural Classification in the River Basin

- Traditional Countryside
- Rural with core services
- Rural with Mining
- Admin and Hospital
- Retail
- Business
- Manufacturing, energy & utilities
- Business Parks
- Industrial

Conclusions

The design hypothesis aims to leverage the hydrological potential of reviving an active countryside. To achieve this, the analysis combines the definition of urban and rural settlements, which are classified based on population density within a built environment, with the traditionally neglected factor of explicitly rural land uses and the traditional countryside. A multivariate analysis was conducted using QGis, where a suitabilty to be considered the countryside has been assigned based on the both low population desnity and rural land use.

These findings were then used to understand the composition of subcatchments, in terms of built-form settlements and open space land uses. It was found that, with the exception of the sub-catchment containing Inner London (i.e., Thames Trac), all other catchments show equal capacity to create a new countryside that can accommodate soft infrastructural responses to extreme weather events.

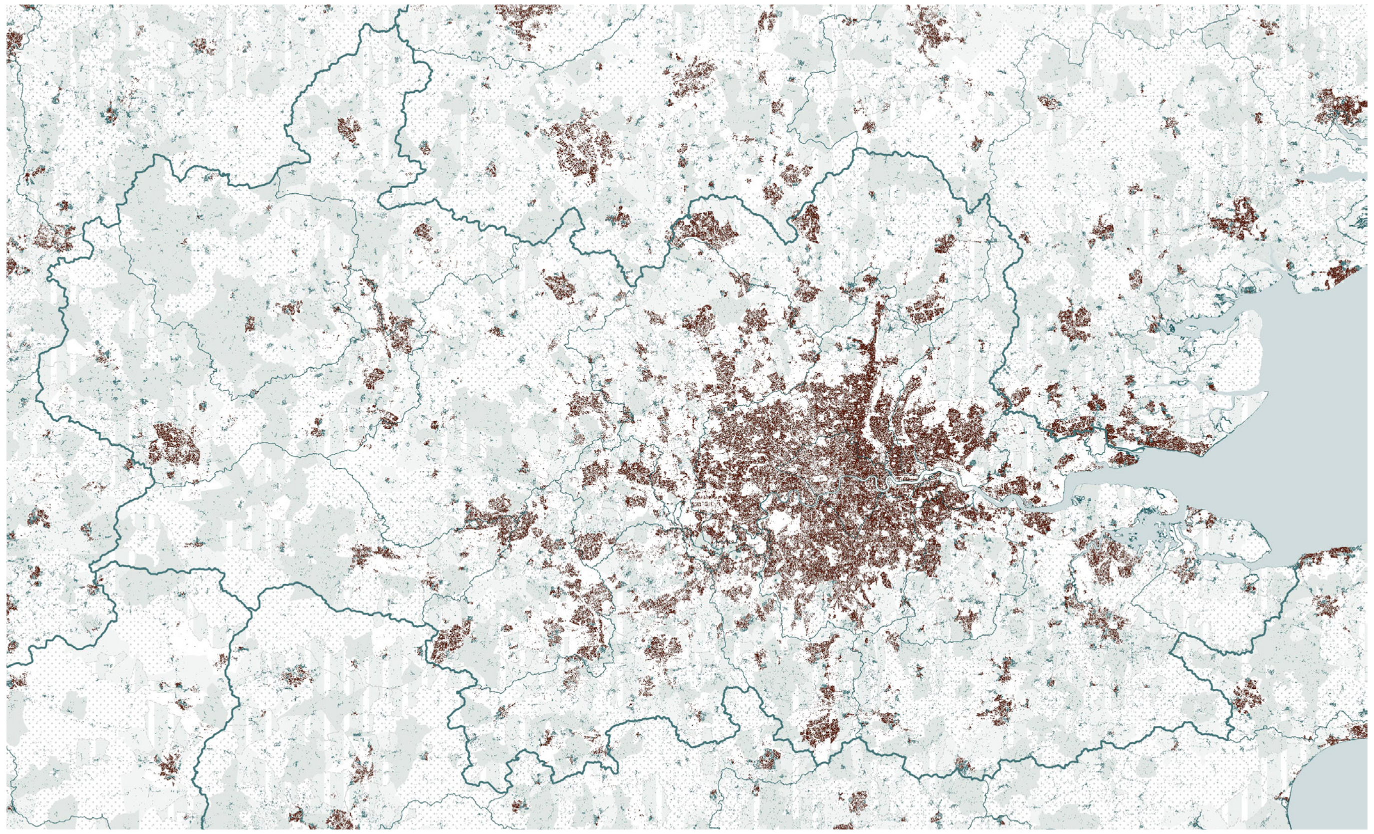


Fig 52: Using a Multi-criteria Suitability Analysis to mark the city and the countryside

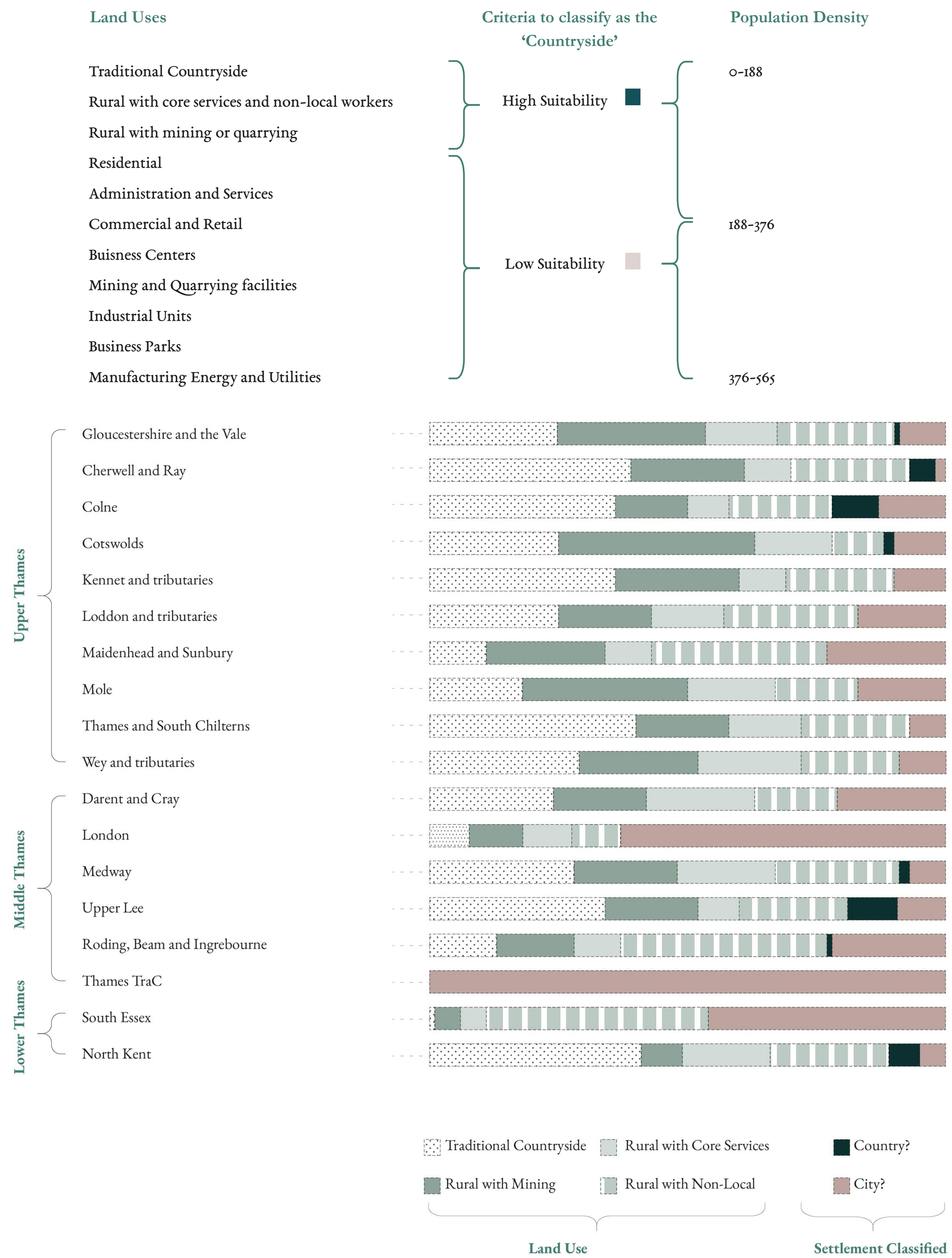


Fig 53: Distribution of Urban -Rural Classification in the Subcatchments

Perspective into Riverine Management that Frames the Countryside

The River Thames has been controlled by different forms of infrastructure that were designed to fulfill various roles according to the prevailing historical context, thus furthering the aesthetic separation between the urban centers of London and the countryside. The navigable waterways surrounded by mills in the freshwater part of the river, draw a sharp contrast against the heavily engineered channel at London.

It's been assumed that there were weirs on the river since the earliest settlements began to use its waters. Weirs of various kinds, for instance, were used to control the flow of the river, facilitate transportation, grind flour in mills, and fish. In the 17th century, the wealthy mill owners were powerful enough to resist London London Authorities' attempts to clear the river of obstructions. The interests of these Riparian Landowners were furthered by the Thames Navigation Commission, and they had the authority to levy tolls on boaters who used their waterway and control the flow of the river. However, as economic and social circumstances changed, many weirs fell into disuse and were replaced by locks. Many weirs in England are now collapsing in the face of extreme weather events, highlighting the impact of changing circumstances on infrastructure (Ackroyd,2008).

The construction of the railway and the increase in London's material demands for construction led to more frequent trains and the switch from the river to rail as the preferred transportation mode. The Thames Commission, which was responsible for managing the river, was replaced by the Thames Conservancy in 1866 as the former was unable to collect enough money from the maintenance of the river from the declining tolls collected (Wenham, 2014).

Leisure has also played a crucial role in the story of the Thames. Pleasure boating has both soared and dipped in popularity over different periods of history, as growing economies encouraged more leisure activities. The Victorian era witnessed a significant shift in the river's use, as it transformed from a great commercial highway to a vast pleasure stream. However, the higher reaches of the Thames remained obstructed by antiquated weirs, and there were lobbyists in 1886 who argued that the Thames was no longer a place for a holiday, given its congestion by passenger boats and riverside camping (Wenham, 2014). River activity declined during the World Wars, but between 1956 and 1973, the number of locks and registered vessels appearing more than doubled (River Thames Alliance, 2005). In 1974, the Thames Water Authority took charge of the river, water supply, and flood control (Wenham, 2014). Today, pleasure boating is not as intense, and boat operators are affected by the sharply rising cost of housing in South East England from the 1990s.

Downstream, the river was modified to accommodate the growth of London and address a severe pollution crisis. The embanking of the Thames is considered a key point in the timeline of modernity's discourse on the framing of nature within an engineering ideology. The creation of the embankments fundamentally transformed the Thames into managed capital, accomplished through a "regime of discipline" that subordinated pre-modern deviance to engineered modernity (Oiver 1982).

The following page attempts to classify and map the different forms of infrastructure that frame, obstruct, channelize, cleanse, and alter the river through the various roles that are afforded to it. Its spatial distribution is underlain by a map with the administrative definition of urbanity and rurality as determined by population density, to draw inferences about whether the urban-rural divide can be ascertained from it.

Fig 54: Hart's Weir, 1859.
Source: " The Book of the Thames from its Rise to its Fall, Halls

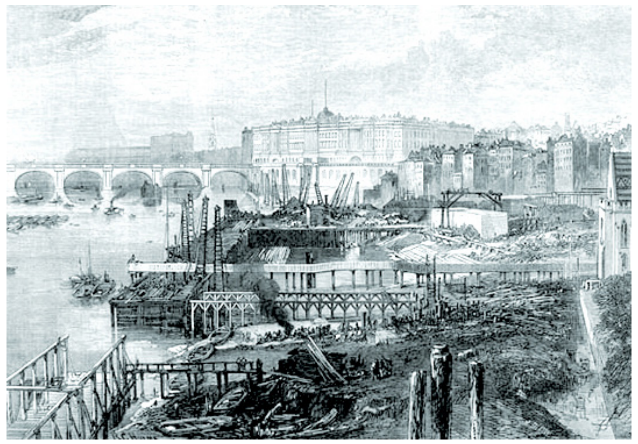
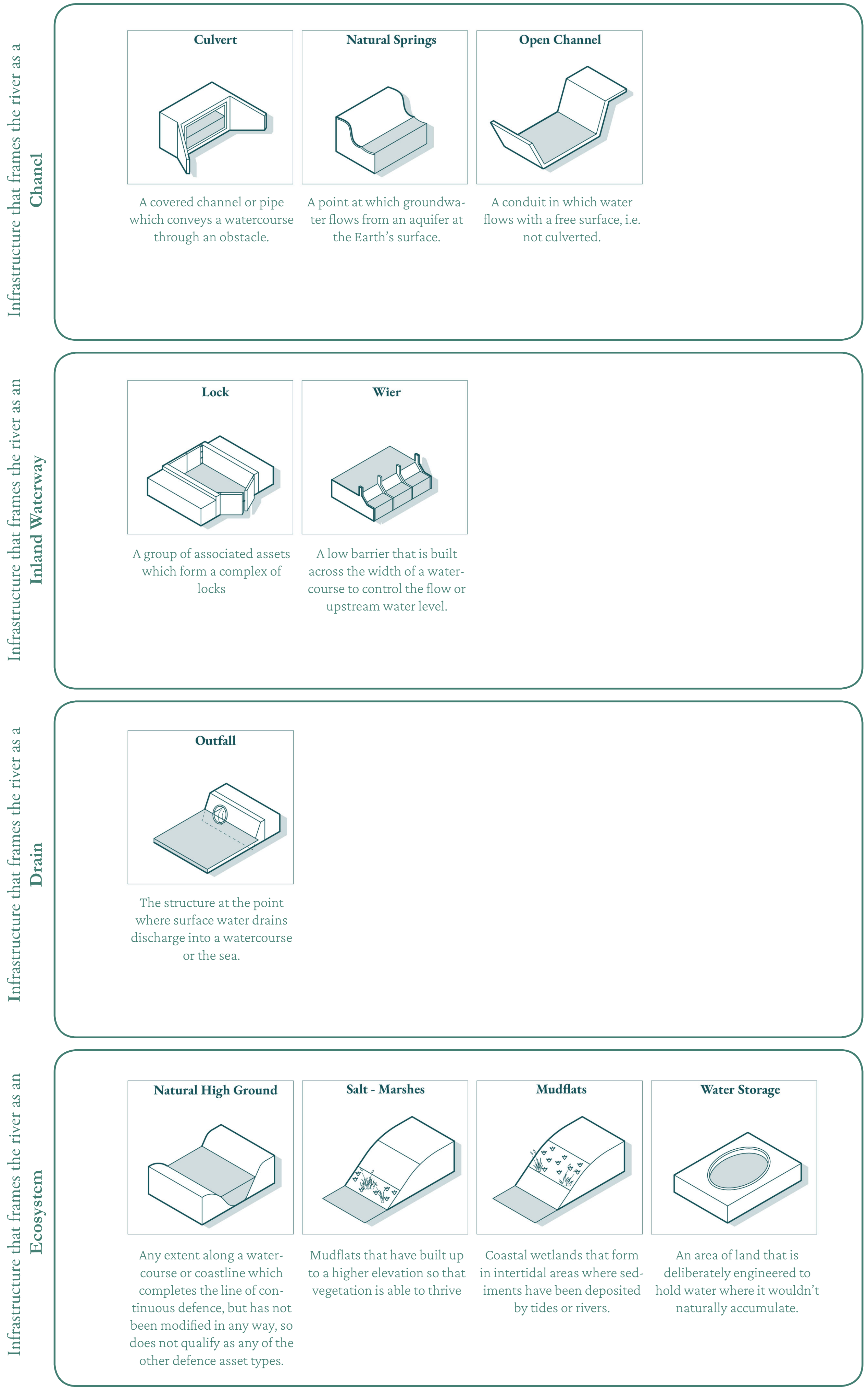
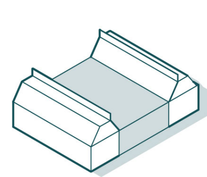


Fig 55: Victoria Embankment under construction in 1865.
Source : The Illustrated London News [London, England] 4 February 1865



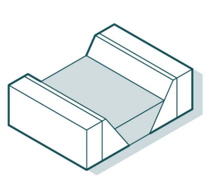
Infrastructure that frames the river as a **Threat to Loss of Property**

Embankment



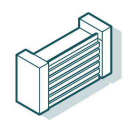
An artificially raised, earthen ridge used in the fluvial, tidal and coastal environments for flood defence, erosion protection, or channel containment.

Engineered High Ground



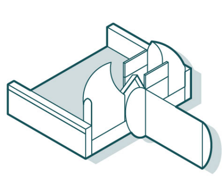
Retained, engineered or otherwise modified ground along watercourses or the coastline, that is not covered by one of the other defence asset types.

In Channel Stoplogs



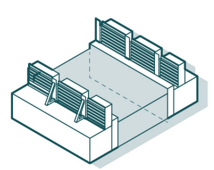
An adjustable structure used to control water levels and flow in watercourses, for water flow management, flood control, and navigation.

Tidal Barrier



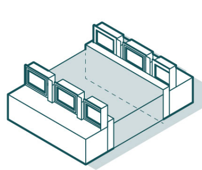
A defense structure against high tidal flows.

Demountable Defence



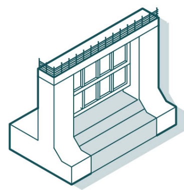
Sections of flood defence that are removable (e.g. for visual amenity or access reasons).

Wall



A wall which is raised above the surrounding land and acts as a barrier against flooding from rivers or the sea.

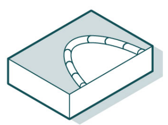
Flood Gate



A gate providing access for pedestrians or vehicles through a flood defence, while maintaining flood protection when closed.

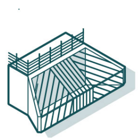
Infrastructure that frames the river as a **Source of Pollution**

Debris Boom



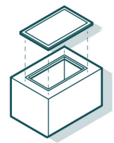
A floating barrier across a watercourse designed to catch debris which could interfere with the operation of an asset.

Debris Screen



A screen that reduces the amount of trash and debris entering culverts, outfalls or channels (where it could cause a blockage).

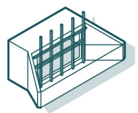
Inspection Chamber



An opening to a confined space such as a culverted watercourse or underground services, providing access for testing, inspecting, maintaining and clearing blockages.

Infrastructure that frames the river as a **Habitat**

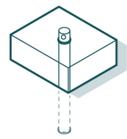
Fish or Eel Barrier



A barrier that prevents the movement of aquatic life into areas that may jeopardise their survival.

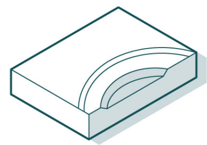
Infrastructure that frames the river as a **Water Source**

Borehole



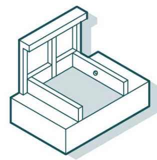
A shaft bored into the ground that is used to extract groundwater via a pump, or to monitor and/or measure water quality and/or quantity.

Spillway



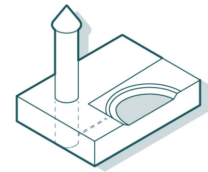
A slope or ramp leading down into water (channel or sea) used for launching/landing boats.

Stilling Basin



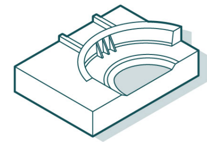
A depressed area in a channel or reservoir that is deep enough to reduce the velocity of the water before it passes further downstream.

Stilling Well



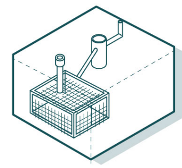
A chamber that is connected to a water body by inlets. The water level in the stilling well will rise and fall with the level in the water body, but will not be subject to the turbulence that may be present in the water body for accurate level measurement.

Reservoir



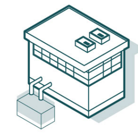
. A reservoir is a large area for storing water which is created or enlarged by artificial means, and the associated impounding and control structures and assets.

Sand Trap



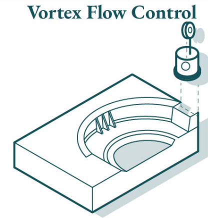
A structure for aerating groundwater and filter sand and soil particles.

Pumping Station



A group of assets which abstracts water from the ground and surface water a

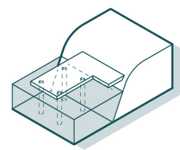
Vortex Flow Control



A flow control structure

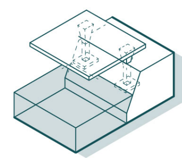
Infrastructure that frames the river as a **Public Space**

Quay



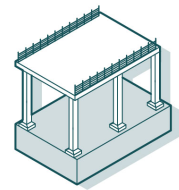
A structure adjacent to or protruding into watercourse or the sea to load or unload boats.

Bridge Abutment



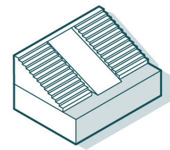
A supporting structure at the end of a bridge span that also acts as a flood defence. It ties into other flood defences and completes the line of defence against high river levels.

Pier



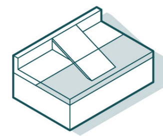
A significant supporting structure built in a channel.

Ramp



A sloped access route between two different levels.

Slipway



A slope or ramp leading down into water (channel or sea) used for launching/landing boats.

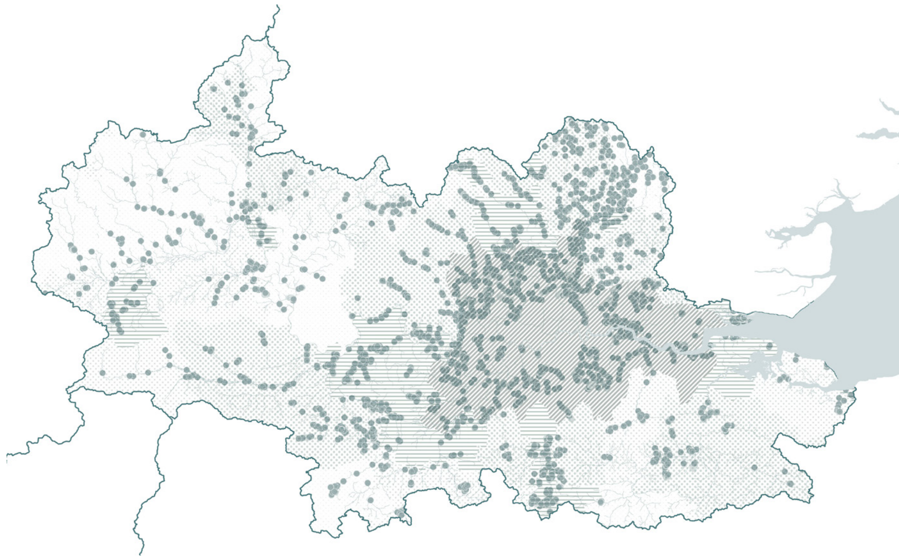


Fig 56: Infrastructure that frames the river as a **Chanel**

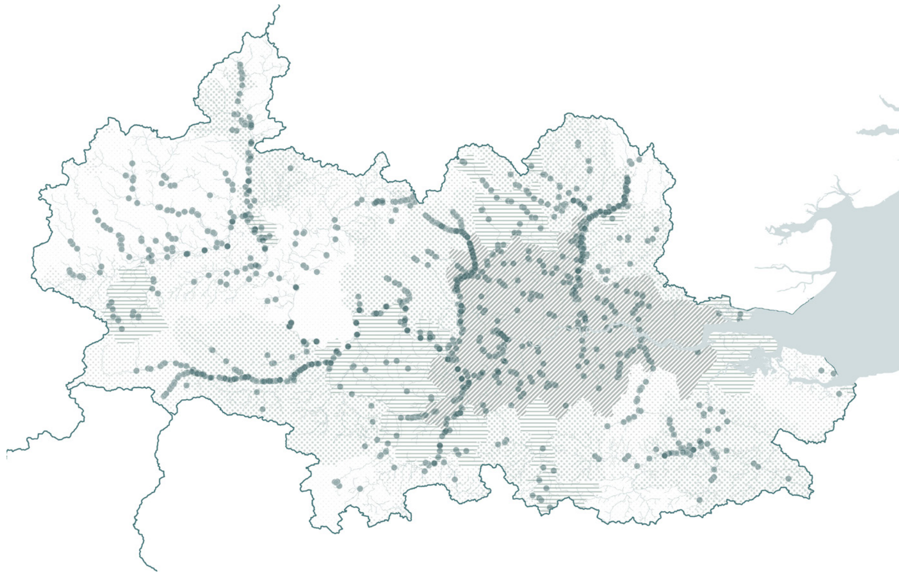


Fig 57: Infrastructure that frames the river as an **Inland Waterway**

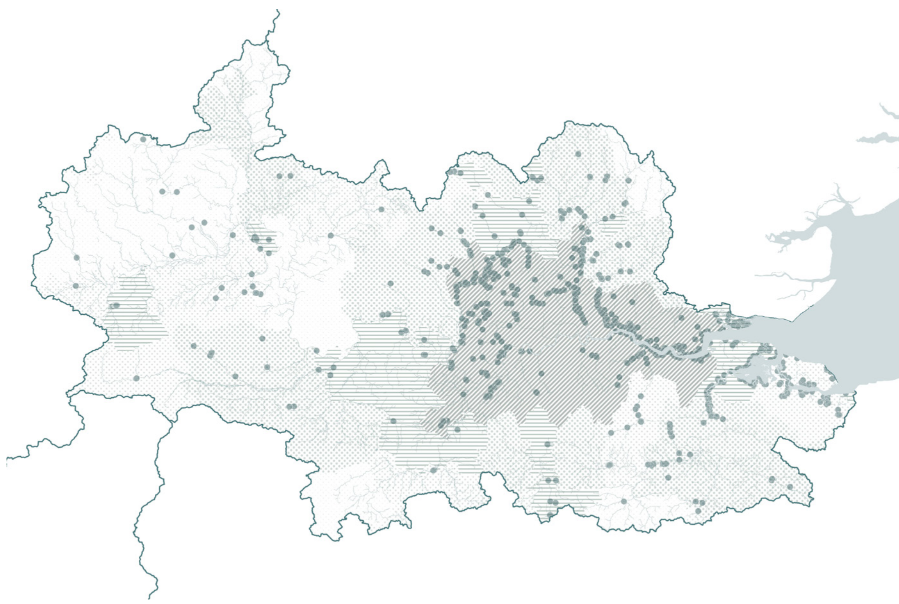


Fig 58: Infrastructure that frames the river as a **Drain**

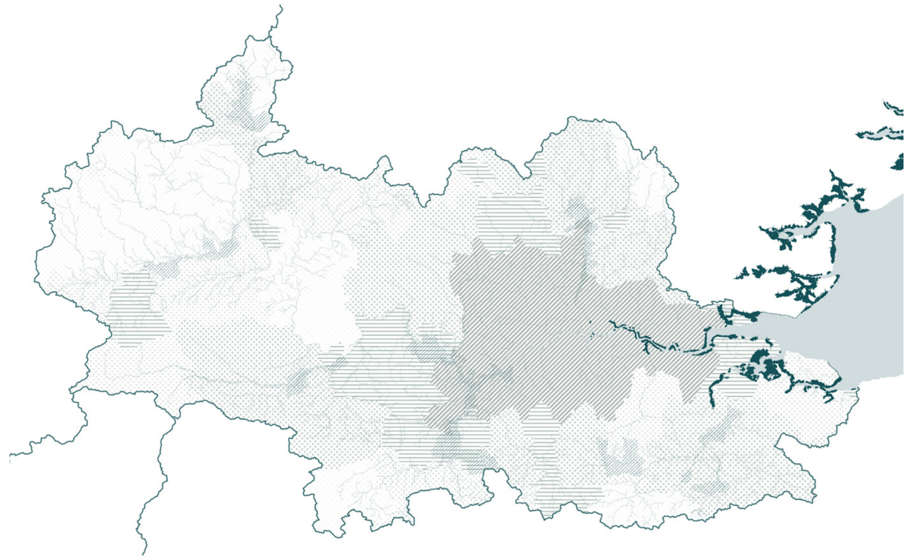


Fig 59: Infrastructure that frames the river as an **Ecosystem**

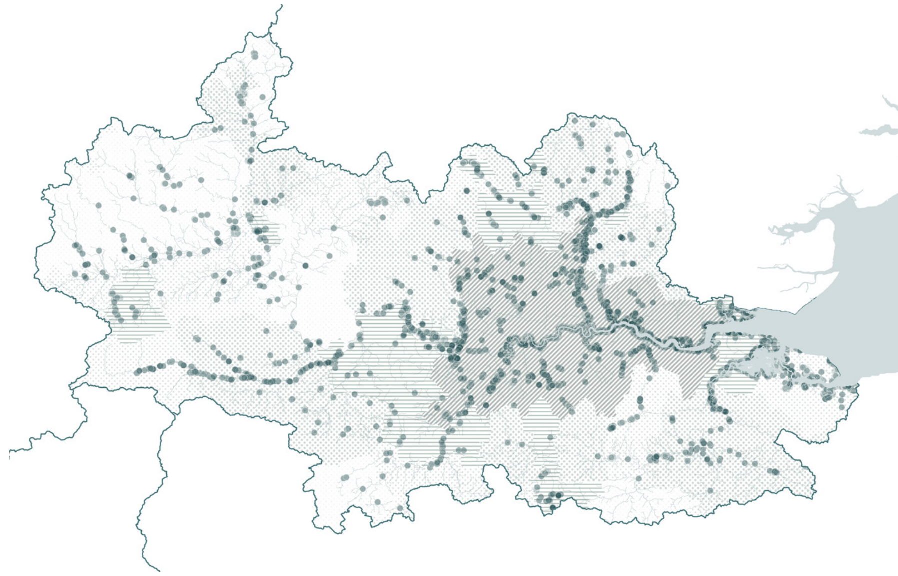


Fig 60: Infrastructure that frames the river as a **Threat to Loss of Property**

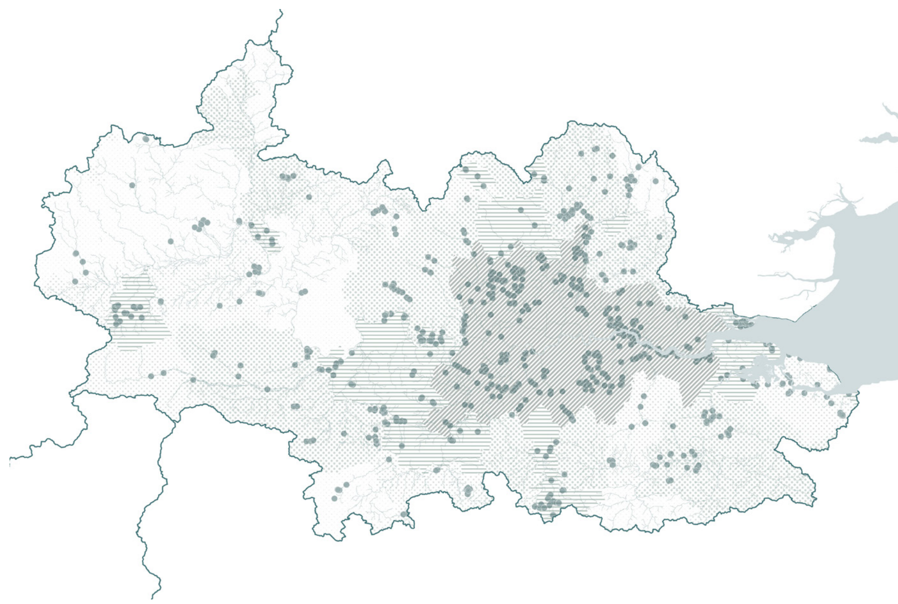


Fig 61: Infrastructure that frames the river as a **Source of Pollution**

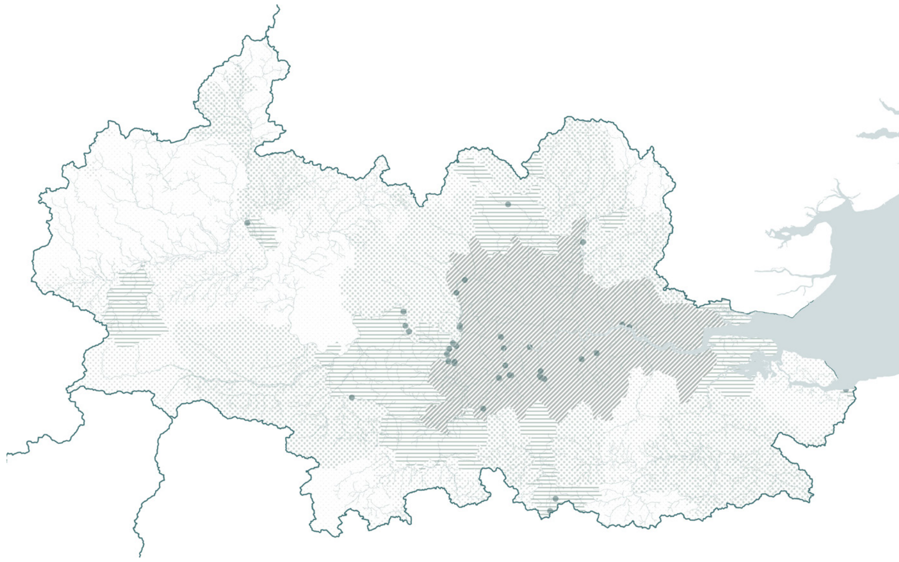


Fig 62: Infrastructure that frames the river as a **Habitat**

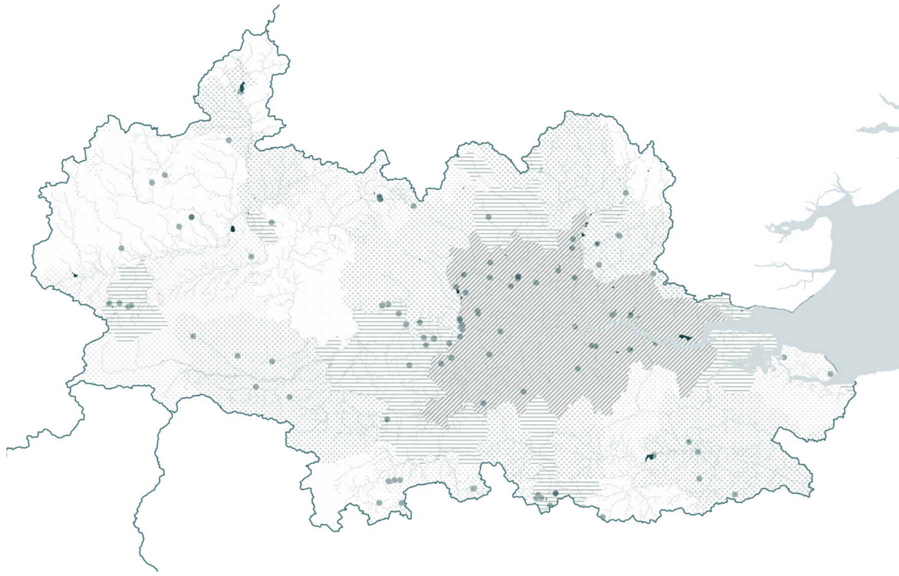


Fig 63: Infrastructure that frames the river as a **Water Source**

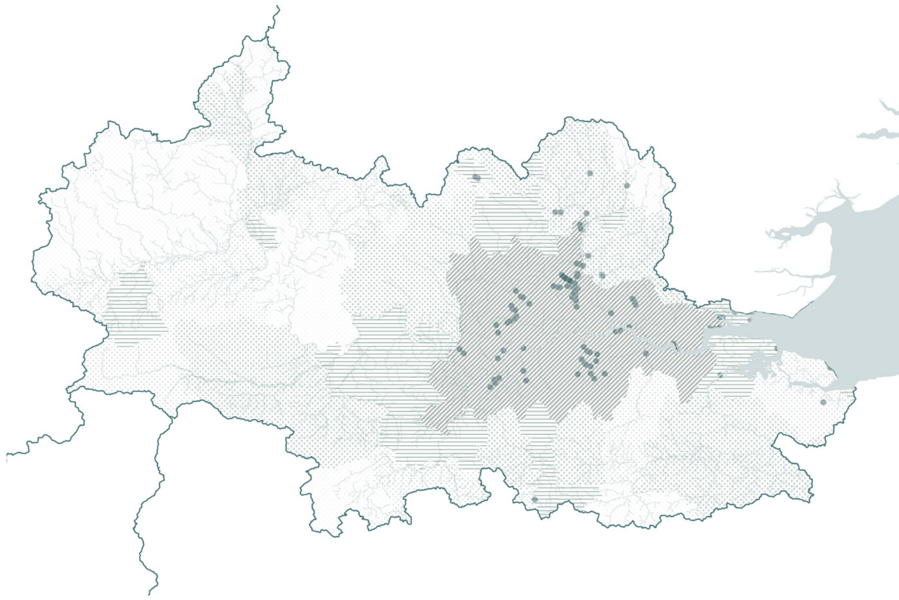


Fig 64: Infrastructure that frames the river as a **Public Space**

Conclusions

There is no clear spatial pattern in which the river has been engineered in relation to the 6 point classification of urbanity defined by Defra and explained in the preceding sub-chapter . However, when breaking down the number of these assets in relation to the sub-catchment it occurs in, it is observed that the Thames and Trac and London sub catchments, where London is located, show a high degree of defensive engineering through embankments and walls. Another notable difference is in Essex, particularly at the estuary which is a zone of high flood risk from both fluvial flooding and sea level rise. This site has historically and continues to be encroached by London's developmental demands, and it shows a similar degree of engineering.

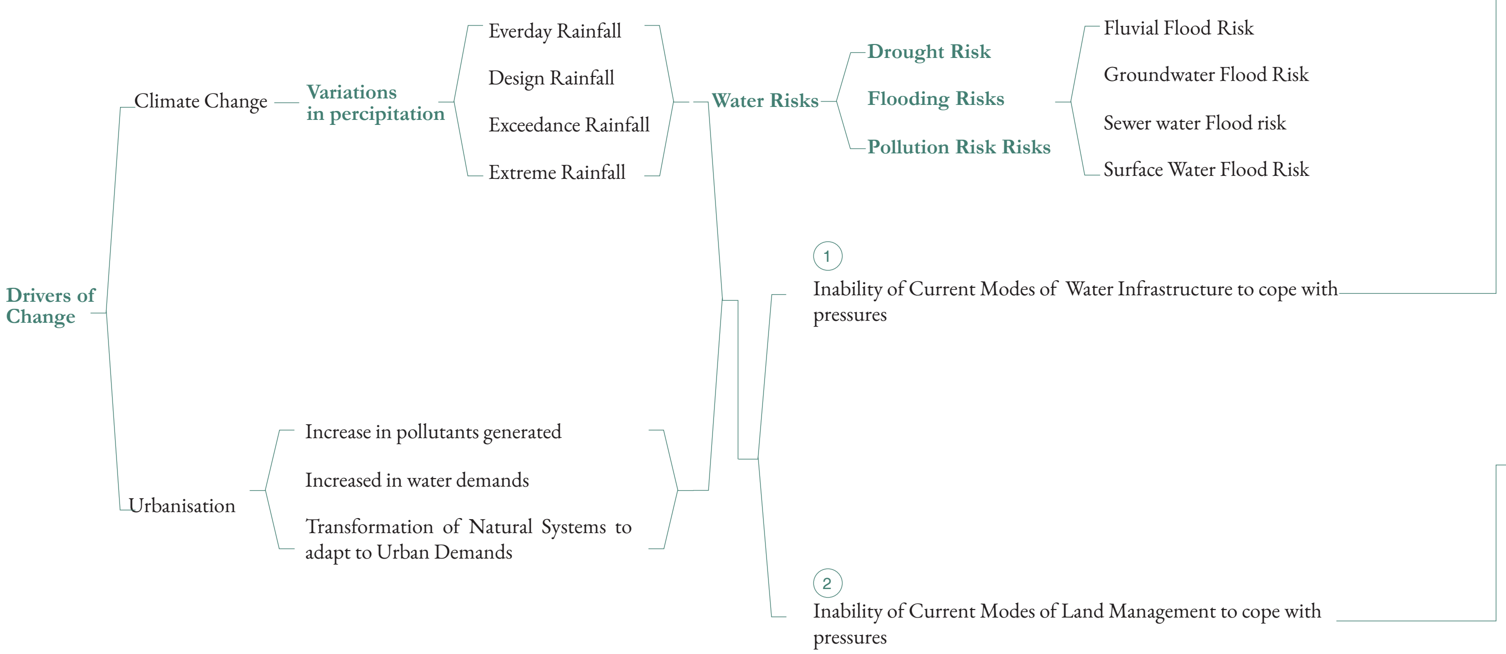
Fig 65: Distribution of Infrastructure in the Subcatchments (Source: Author)

7.3 Framework to Understand the Hydrological Relevance of the Countryside

For my thesis, I am rejecting the scalable definition of the countryside that attempts to delineate the boundaries between the city and the country, as any such attempt could lead to exclusion. Scalable approaches pose the risk of imposing expansionist visions, similar to the top-down approaches taken during previous attempts to modernize and develop (Tsing, 2012).

The beauty of using the idea of the countryside in my design exploration lies in its diverse definitions. Instead of a scalable framework, I propose a non-scalable one that recognizes the English countryside as a description of “relational encounters across difference,” as introduced by Anna Tsing in her work on how the real world can not be reduced to precision nested scales. I hope to use the multiple definitions of the countryside and its operationalization of both land and riverine systems to create alternate visions for the countryside through “forms of collaborative survival.”

This break from a scalable to a non-scalable approach, which values the transformative potential of diverse relationships, could advocate for more context-sensitive and locally situated practices instead of top-down impositions.



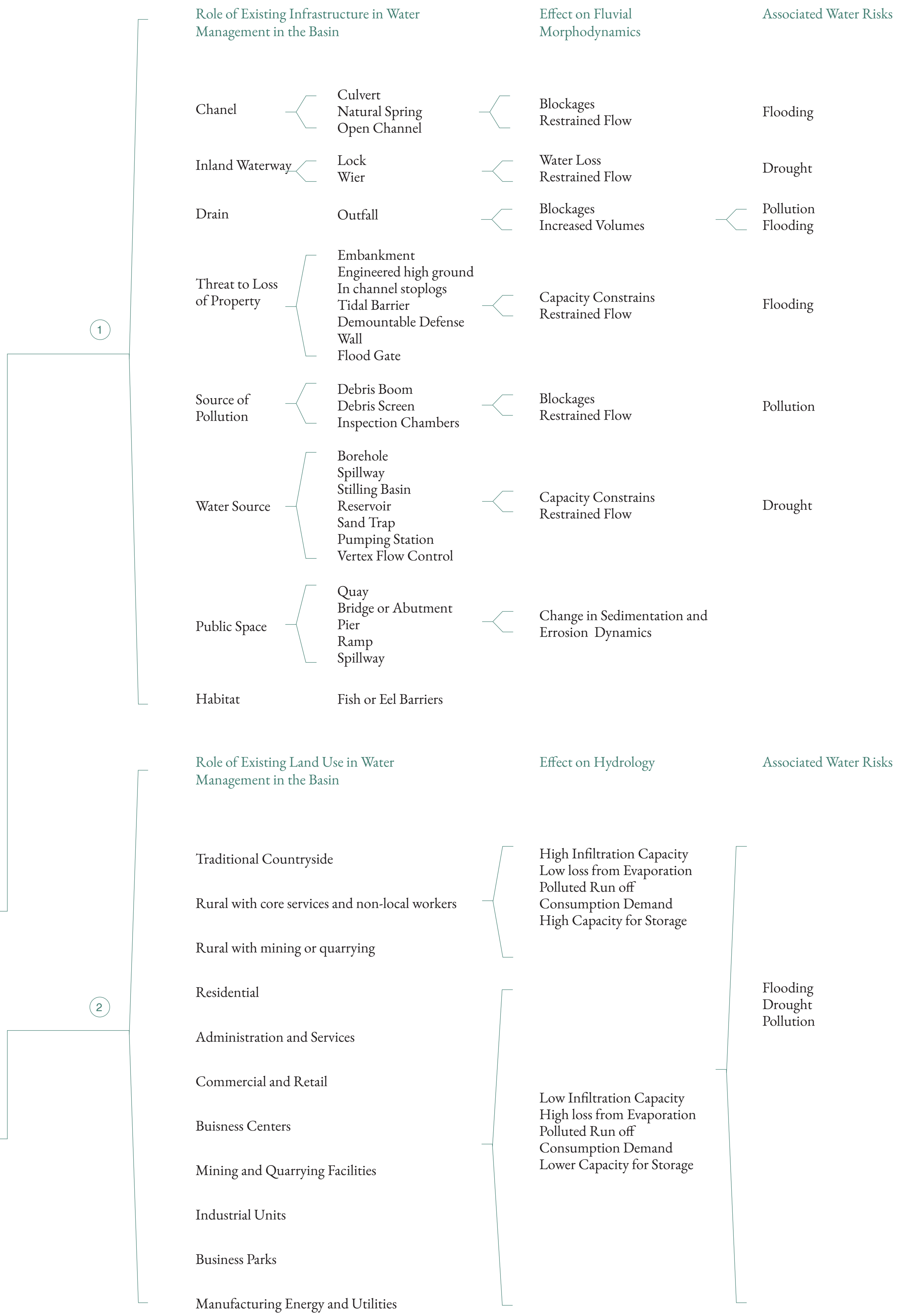


Table 5: Non-scalable Framework to Highlight the Hydrological Relevance of the Countryside

08 Photo Montage : Life along the Thames

[Description]

The aim of the photographic project was to capture the River Thames and its surroundings, highlighting the daily interactions between people and the waterway. One of the remarkable features of the River Thames and its tributaries is the changing nature of development and engineering along the river banks, which varies as you move downstream from its source in Gloucestershire to the bustling tidal limit at Teddington Lock in London.

Upon reviewing literature from the previous section, I came to understand that the urban-rural binary that I had expected to observe is subjective and has evolved over time. Upon analysis, it became evident that when attempting to move beyond the aesthetic dimension and focus solely on the degree of infrastructural control, the conditions of urban and rural areas are almost comparable, with the exception of the Thames, which defies such categorization.

My objective with the photo montage was to capture the contrasting development and engineering along the River Thames and its surroundings, and to create a compelling narrative that explores the ways in which people interact with different environments. Since I was unable to obtain a visa to travel to England directly and did not have firsthand experience with the English context, I relied on n the insights and perspectives of the photographer, Alex Starkey to inform my work

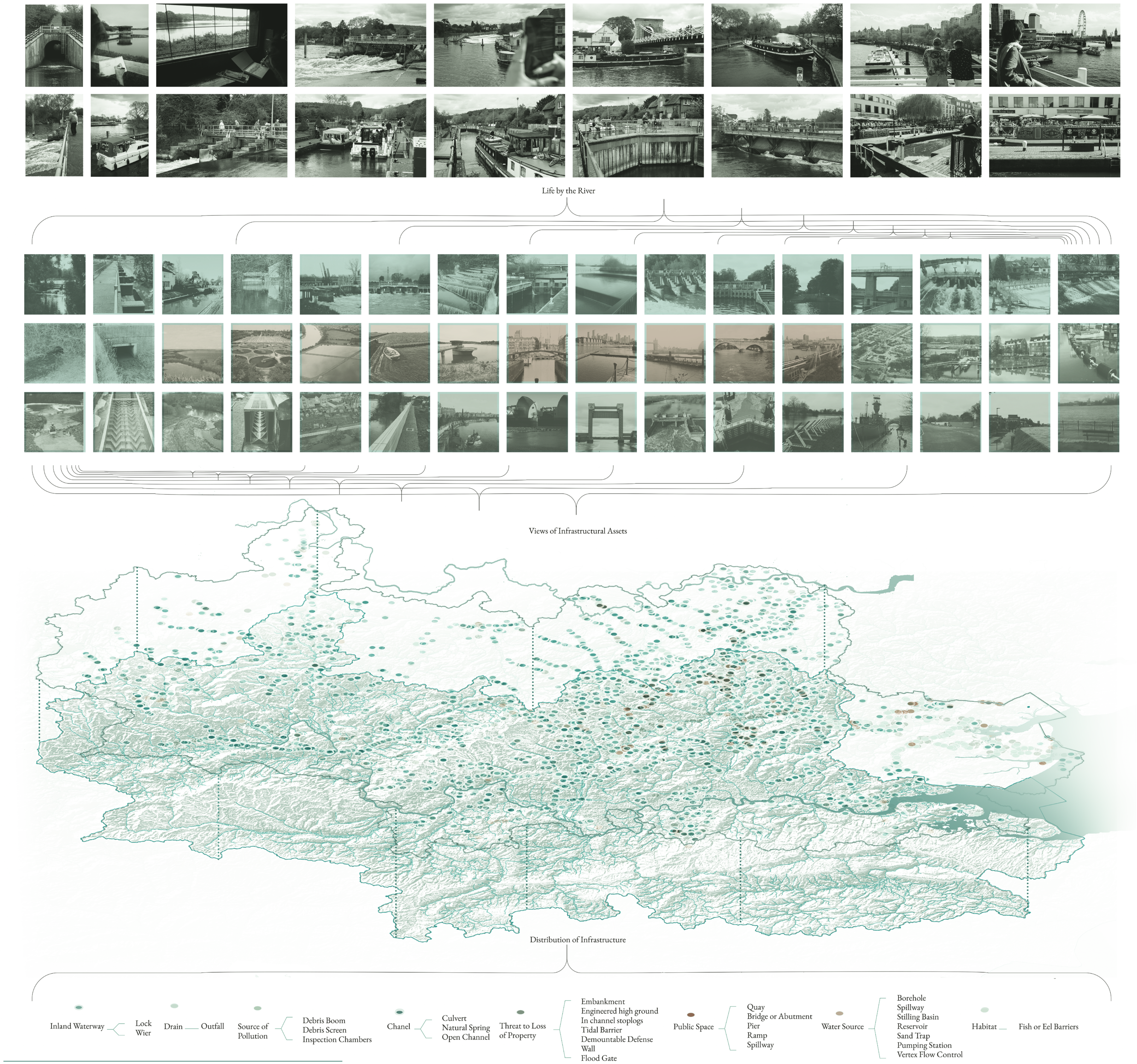


Fig 66: Photo Montage of Infrastructure in the Subcatchments (Source: Author)

Fig 67: Boating at Marlow, Buckinghamshire
Alex Starkey, 2023

Fig 68: Along Marlow Lock, Buckinghamshire
Alex Starkey, 2023

Fig 69: At Ardingly Reservoir, Sussex.
Alex Starkey, 2023

Fig 70: At Ardingly Reservoir, Sussex.
Alex Starkey, 2023

Fig 71: Weir Wood Reservoir (inside the birdwatching hut), Sussex
Alex Starkey, 2023

Fig 72: View from Royal Festival Pier, London
Alex Starkey, 2023

Fig 73: View from Victoria Embankment, London
Alex Starkey, 2023

Fig 74: Views of from Marlow and Hambledon, Buckinghamshire
Alex Starkey, 2023

Views of from Marlow, Buckinghamshire
Alex Starkey, 2023

09 Design

[Contents]

9.1 Design Scenario

Meteorological Outlook Projected by UKCP18

The project designs for a future susceptible to increasing instances of heatwaves, droughts, and flash floods and is based on the probable projections published by the UKCP18 Met Office in the United Kingdom, which predicts a stronger drying trend in south-eastern England in the scenario of higher greenhouse gas emissions. The Maps below shows different probable rainfall distribution along the basin in an RCP 6.0 scenario

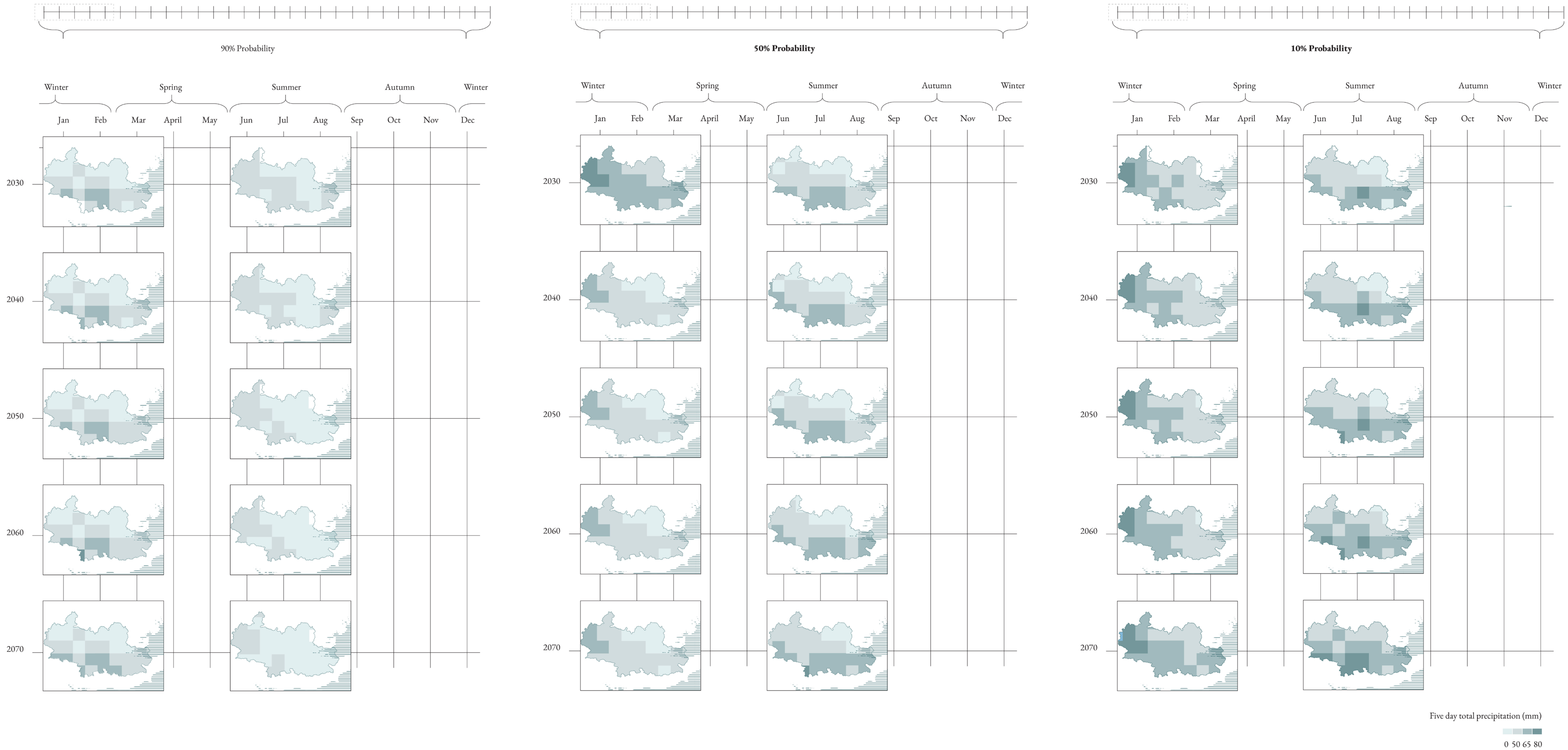


Table 6: Probable Rainfall Distribution according to UKCP 18

9.2 Design Framework

The Earth retains the imprints of natural shocks and forces that predate our direct experience within our limited human lifetimes. Furthermore, our actions persistently shape the Earth's memories through the lasting marks we leave upon the land.

'Whether we and our politicians know it or not,
Nature is party to all our deals and decisions,
and she has more votes, a longer memory, and a
sterner sense of justice than we do. '
(Wendell Berry, 1977)

We try to reconstruct the distant past by examining the physical remnants that are visible to us. However, our reconstructions are constrained by the information at hand, and our understanding is bound by its limitations. These reconstructions are inherently subjective and adaptable, giving rise to different narratives when viewed from different perspectives. I'm bringing back the idea of Anamnesis that I introduced in my Theoretical Framing to clarify by Design Framework on two levels here.

The first level of anamnesis involves geological reminiscence, where we observe the physical imprints within the landscape. When studying geology, we encounter layers that have accumulated over billions of years, a time scale beyond our comprehension. These layers are a result of immense floods and tectonic movements that have left lasting imprints beneath the surface we inhabit, influencing its ability to adapt to changing weather patterns.But these efforts to transform nature can still be traced in the lay of the land in the pathways water takes today, even though some objects from these efforts have either gone out of the use or been removed.

The second level of anamnesis is a political reminiscence. We have inherited numerous precedents that often go unnoticed or unexamined, yet they significantly contribute to the growing inequality in how risks are distributed. These precedents manifest in binary definitions such as natural versus man-made, urban versus rural, and so on. These categorizations shape our approach to maintaining and shaping land and water systems, ie. theway we care for them. To address this, we need to reconsider our practices and question the notions of agency.

Recollections of history (both political and geological) also hold answers for adapting to the future. The challenge of overcoming the inability of highly engineered modern projects to combat the uncertainties of extreme weather events lies in acknowledging their physical limits in dealing with these extremes. The alternative would be to accept a return to infrastructure that is more flexible in dealing with extremes and is also regenerative. Creating these flexible forms of infrastructure also entails designing practices of care or utilizing design to revive the idea of recognizing land and water as commons (just like the countryside was the original commons in England prior to the enclosure movement). This also requires us to be flexible enough to reframe our practices and consumption demands, in recognition of the extremities 'under the weather'.

Problem Today

Coping with Extreme Weather Events

1. Inability of Current Modes of Water Infrastructure to cope with pressures
2. Inability of Current Modes of Land Management to cope with pressures

Anamnesis in Design

Re-constructing Narratives — *Political Anamnesis*

Anamnesis in using being mindful of the power disparities in how the basin was engineered and its water redirected

Acknowledging precedents of modern infrastructural efforts that needs to be countered with locally managed approaches

Decentralised systems of management through partnerships between neighbours and species

Re-programming the Countryside — *Geological Anamnesis*

Compositions of the	Interventions of	Management through
Surface	Vegetation	Anamnesis in drawing inspiration from practices that predated the modern project since they didnt over ride natural processes
Subsurface Capacity	Soil	Maintenance focussed on seasonal changes
	Water	Focus on sub-surface infiltration ensure the water systems are replenished to sustain abstractions

Future Challenge

Fields in Flux

1. Flexible forms of infrastructure that respond to weather extremes
2. Management of soil, water and vegetation as the commons

Table 7: Design Framework

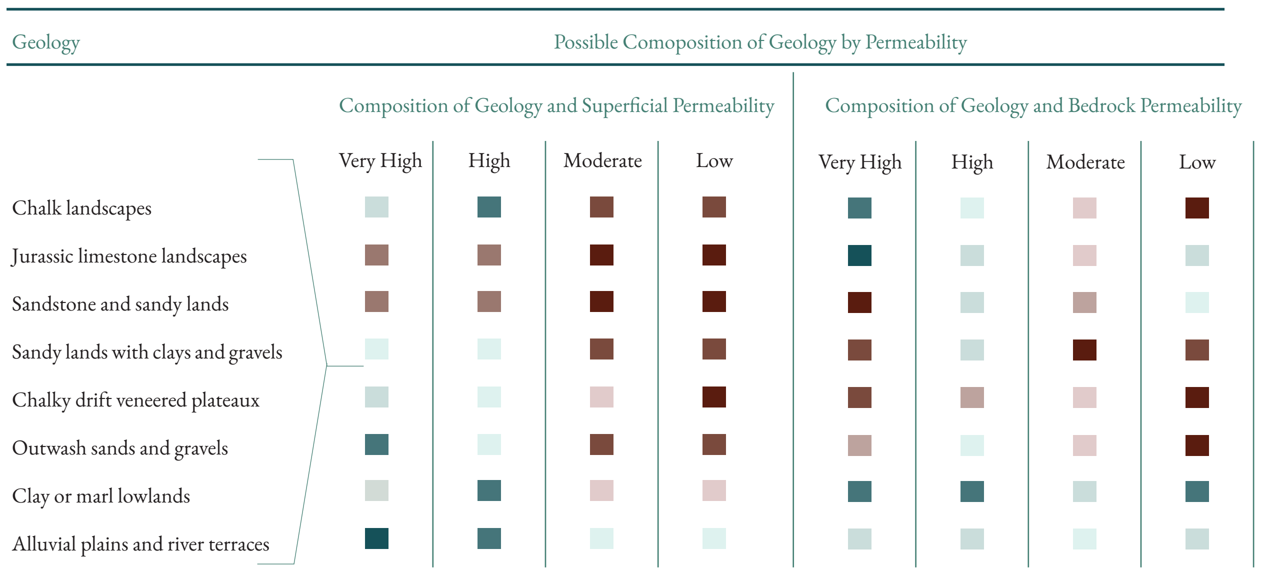
9.3 Composition of the Thames Basin

The Thames River Basin is a unit for hydrologic management encompassing diverse terrain characteristics that significantly influence the diversion, conveyance, and attenuation of water. The formation of this terrain is a result of geological processes spanning a considerable epochs of time, and the nature of the subsurface geology plays a crucial role in determining water infiltration and aquifer recharge. This recharge of groundwater is essential not only to meet water abstraction requirements but also to maintain river flows. By correlating and analyzing the diverse typologies of surface and subsurface conditions, a comprehensive understanding of how these factors interact and overlay within the Thames Basin has been shown below.

Surface

Terrain Classification	Topographic Wettness Index	Geology	Height above Sea Level
Mountain Tops, High Ridges	Dryer Regions	Chalk landscapes	Between 180-300m
Upper Slopes		Jurassic limestone landscapes	Between 180-300m
Local Ridges		Sandstone and sandy lands	Below 210m
Mid Slope Ridges		Sandy lands with some clays and gravels	Below 210m
Small Hills		Chalky drift veneered plateaux	Below 210m
Canyons, Deeply incised Stream	Increased Accumulated Run-off	Outwash sands and gravels	Below 210m
U shaped Valleys		Clay or marl lowlands	Below 210m
Plains		Alluvial plains and river terraces	Below 210m

Sub-surface



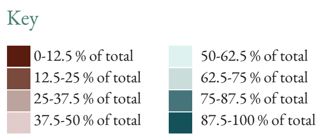


Table 8: Geological Composition of the Basin

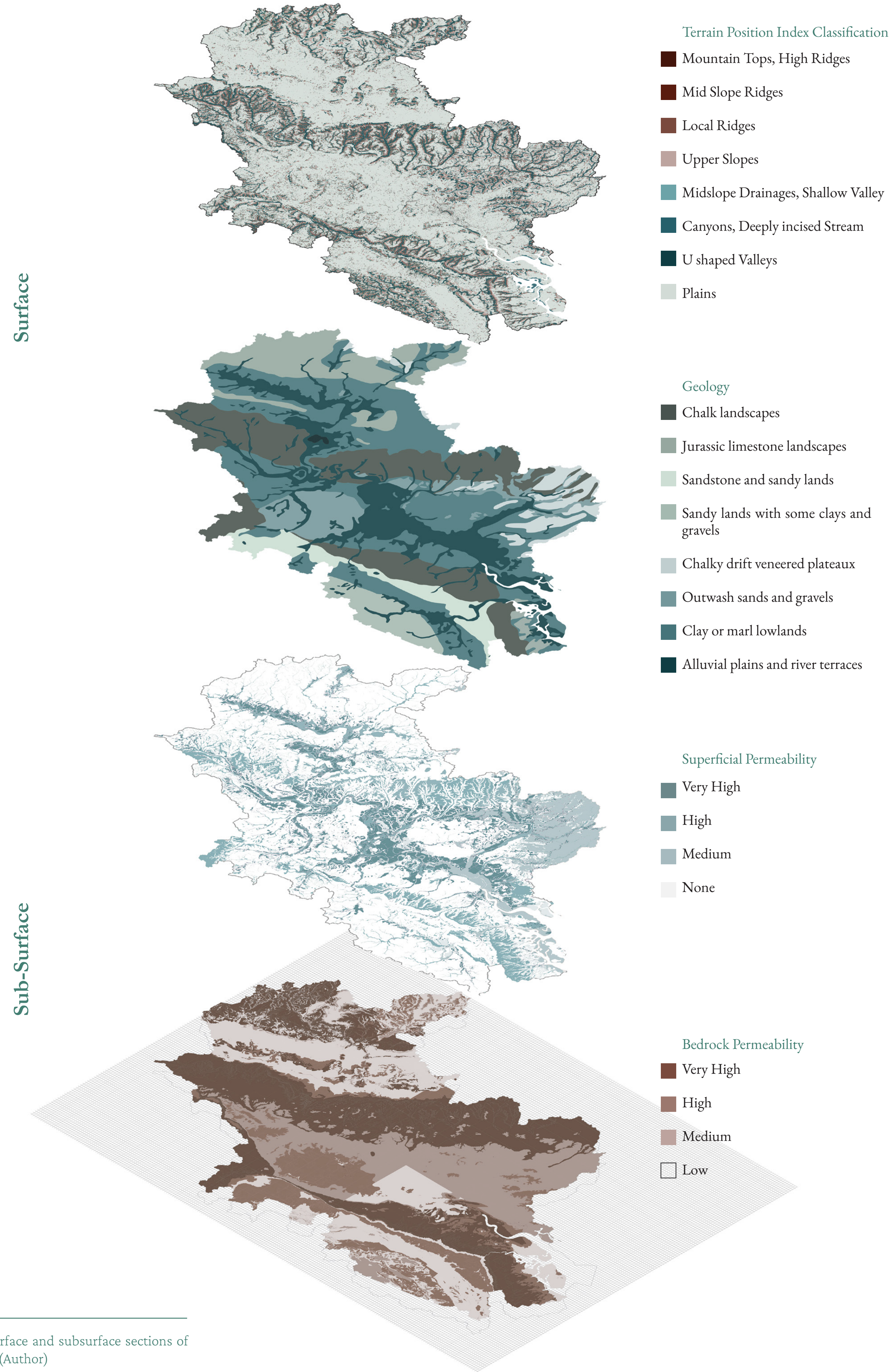


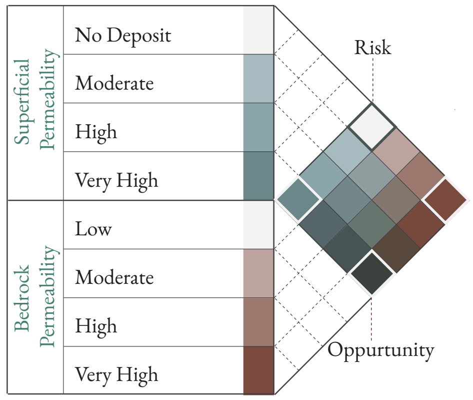
Fig 76: Surface and subsurface sections of the basin (Author)

Site Selection and Systemic Working

The site exhibits two layers of geological deposits: the overlying superficial geology and the underlying bedrock geology. The superficial geology, which is the more recent deposit from approximately 2.6 million years ago, comprises formations shaped by natural forces such as wind, water, and ice. It is important to note that these formations are not uniformly present throughout the entire basin, and in some areas, the bedrock geology is exposed at the surface. The presence of superficial geology provides insight into regions where fluvial activity is dynamic.

In the design process, one significant sub-surface property that I am considering is the permeability of these geological layers. Understanding the graded permeability performance of each layer is crucial for evaluating how water flows and infiltrates within the site. To illustrate this information, a bivariate choropleth map is presented below, overlaying the graded permeability performance of both geological layers.

The lowest grade of superficial permeability denotes the absence of that layer, which in turn alludes to the absence of a river body. Similarly, the lowest grade of bedrock permeability indicates a low infiltration capacity. When both of these conditions overlay or coincide, the sites are marked as flood risks. This is because, during periods of heavy rainfall, the subsurface is unable to contribute to the storage or absorption of the excess volume. The other overlays of extreme grades have been chosen as typologies for further design.



	Typology A	Typology B	Typology C
Geological Classifiction	Chalk Lanscapes Alluvial Terrace	Alluvial Terrace Clay or Marl Lowlands	Alluvial Terrace Clay or Marl Lowlands
Primary Terrain Category	Canyons Upper Slopes Local Ridges Shallow Drainages U Shaped Valleys	Plains U Shaped Valleys Upper Slopes	Plains U Shaped Valleys Upper Slopes
Proximity to River Body	Low	Near	Near
Infiltration Capacity	High	Low	High

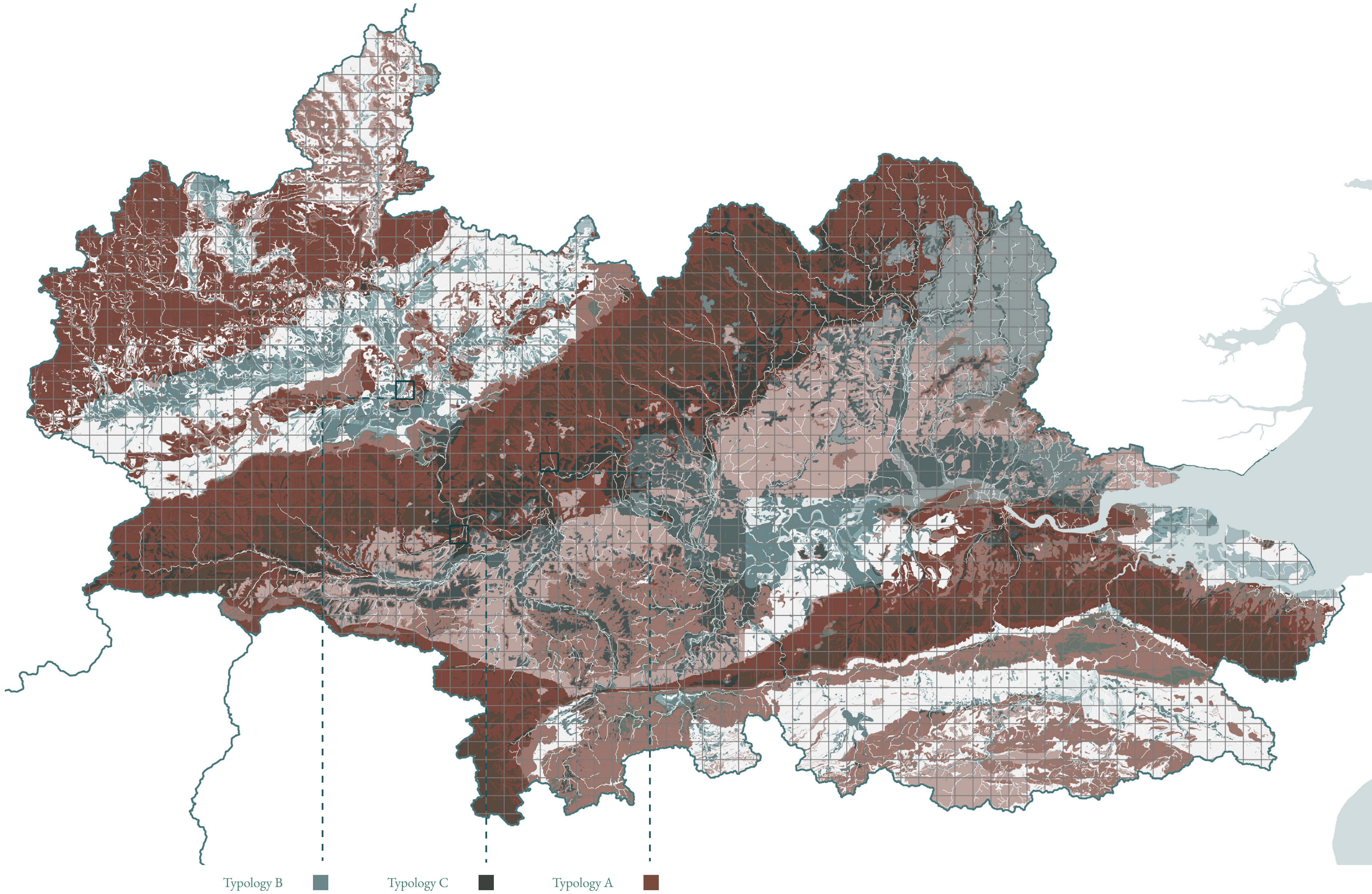
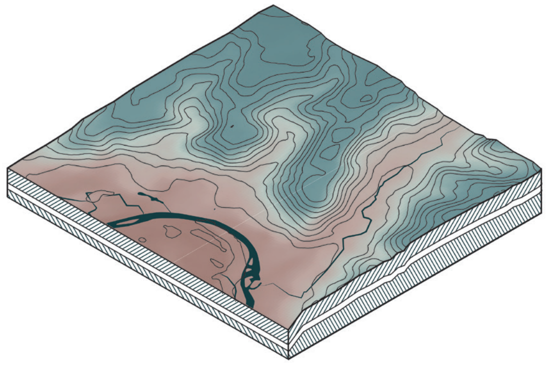
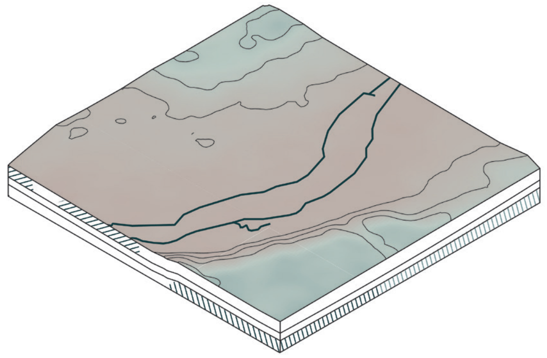
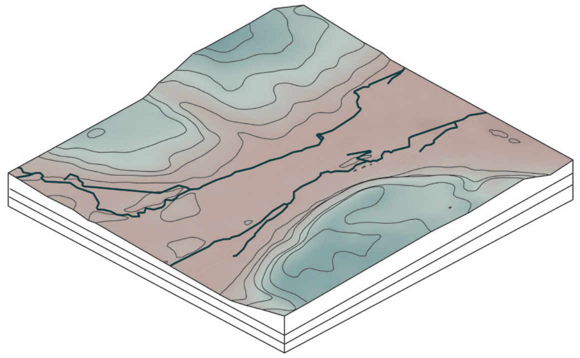


Fig 77: Bivariate Chloropeth Map of the Basins Permeability

Overview of Typologies of Design







Typology A

Superficial Permeability	No Deposit
Bedrock Permeability	Very High

Potential Productive Aquifer System

Design Goal in Typology

Infrastructure to Increase Sub Surface Infiltration

Reduce Erossion

Reduce Loss of water to run-off

Typology B

Superficial Permeability	Very High
Bedrock Permeability	Low

Potential Renaturalising the river to harvest flood water and establish water meadows

Design Goal in Typology

Improving Biodiversity

Reducing Silt being carried to the lower catchments

- Imporoves local soil fertility
- Reducing sediment deposition in lower catchments

Reduces volume of water being carried downstream

Typology C

Superficial Permeability	Very High
Bedrock Permeability	Very High

Potential Creating a Wetland Food Forest

Design Goal in Typology

Improving Biodiversity

Restoring Dynamic flooding-disturbance-succession systems

Infrastructure to Increase Sub Surface Infiltration

Reduces volume of water being carried downstream

Table 9: Overview of Design Typologies

9.4 Typology A

The site is situated on the Chiltern Hills, characterized by a mostly steep terrain. However, the lower portion of the site transitions into foothills where it meets the River Thames. The area surrounding Hambledon Brook, which runs through Hambledson village, consists of farms and grassland that are extensively used for grazing. The brook itself is a chalk stream, known for its shallow yet fast-moving water, and is highly cherished by the local residents (Henley Standard, 2018).

A significant portion of the woodlands, situated away from the brook, has been designated for the countryside stewardship program. This program aims to support sustainable management practices for both the woodland areas and the farms.

The main design objective for the site is to develop infrastructure that promotes increased sub-surface infiltration, reduces erosion, and minimizes water loss through runoff. This is particularly important as the site features a steep hill leading into the floodplain of the Thames and is characterized by highly permeable bedrock. To address these challenges while considering the existing land use, key strategies have been implemented, including the creation of a keyline system of ponds and a shift towards regenerative agro-pastoral management.

The Role of Terrain in Water Storage : Mapping Zones of Flow Accumulation

Fig 78: River and Historic Extend of Flooding

River — Historic Flood Zones

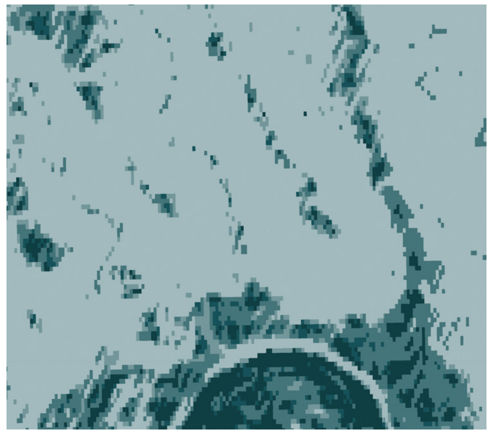


Fig 79: Topographic Wetness Index

Wetter Regions — Drier Regions

The Role of Terrain in Conveyance: Mapping Natural Water Pathways

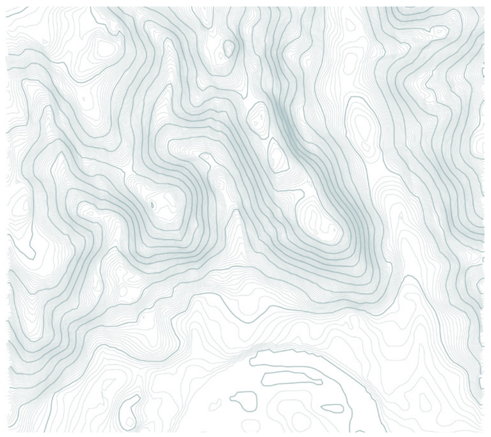


Fig 80: Natural Contours

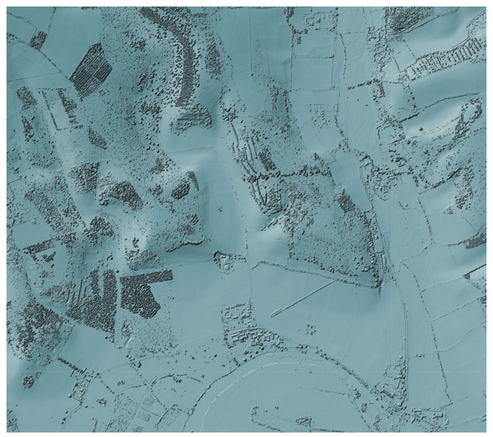
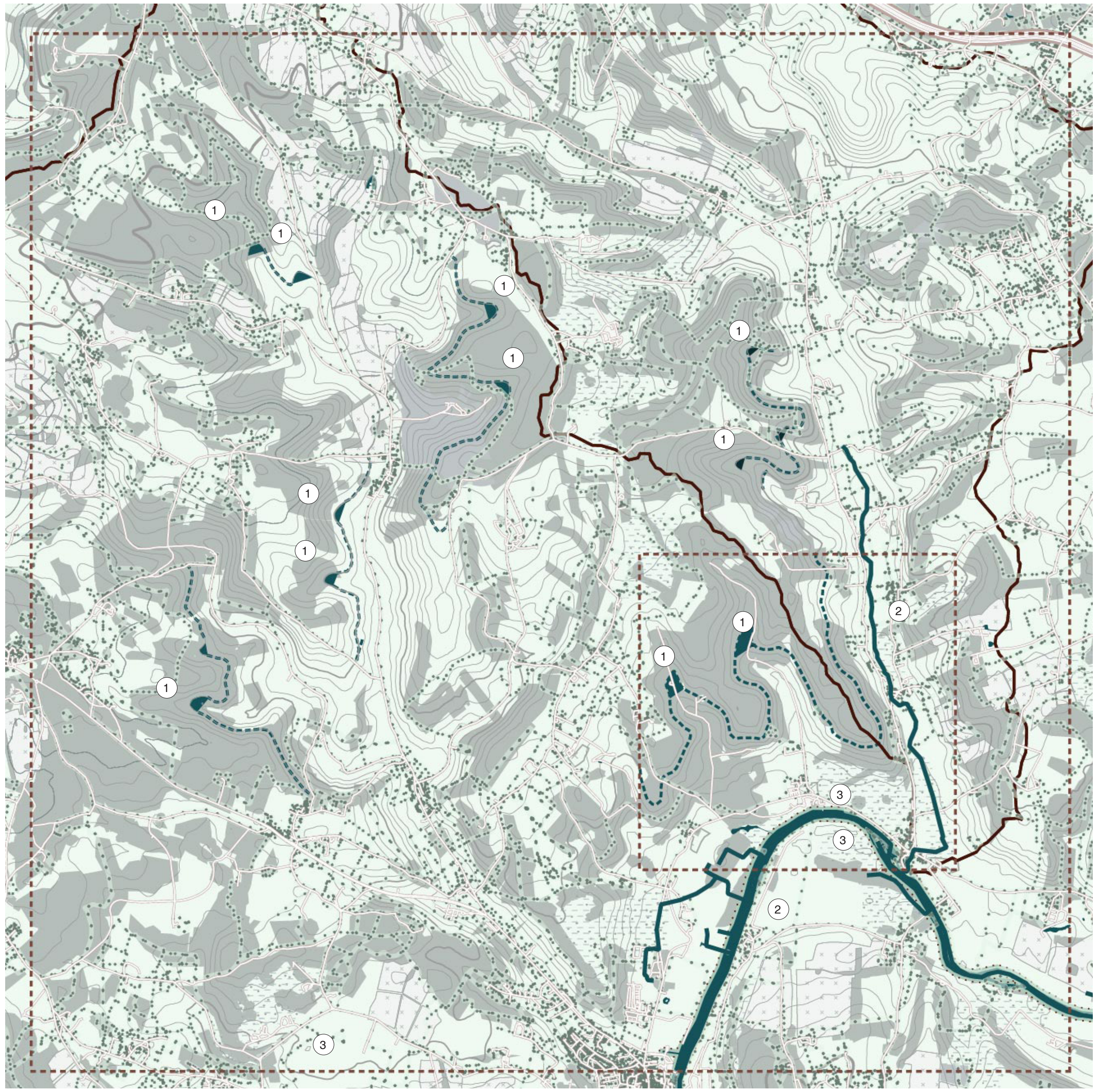


Fig 81: LIDAR Data for higher precision



Recreational
Farmland
Meadow
Natural Grassland
Woodland

(A) (1) Keyline Storage Ponds
(A) (1.1) Keyline Contour in Plot
(C) (2) Riparian Woodland
(C) (3) Storm Water Bio filtration throught floating wetlands
(B) (4) Replant fragmented Hedge Networks as biodiverse corridors and to control run off

Fig 82: Positioning Typology A within the larger context, and connecting strategies to larger networkd

Design Framework for Typology A

Key	Scale	(S) System	(P) Patch	(C) Corridor
1	Macro	River Basin	Sub Catchments	River Thames
2	Meso	Micro Basin	Land Use in Parcels	Streams and Tributaries
3	Micro	3km x 3km site (Typology)	Property Divison	Pathways of Water in the Terrain

Criteria for Transferability of the Project into other parts of the Site

Enhancing the Larger Basin System: The Replenishing Effects of Design Application

	Primary Classification	Secondary Classification	Effect on Hydrology: Natural	Effect on Hydrology: Altered by Design	Strategy	Interscalarity of Approach: Intervention In Micro Scale	Interscalarity of Approach: Effect on Macro Scale	Design Goals from Typology Classification
Natural Terrain	Corridors	Shallow Valley Deeply incised Stream U shaped Valleys	Conveyance - Natural Pathways for Water	Water attenuation at keyline location	Key Line Pond System	C3 Intervention redirects water along contours leading to better soil moisture distri-bution	C1 Reduced nutrient ruck run off in to the River Thames and its tributaries	Reduced Loss of Water to Run-off and Evaporation
	Patches	Plains	Attenuation - Water Accumulates					
	Edges	High Ridges Mid Slope Ridges Local Ridges Upper Slopes	Conveyance - Diverts Water Flow	Water redirected along the same contour				
Geology	Superficial Layer		None			S3 Water storage at the surface for local use	S1 Un-compacted base of the pond system allows sub-sur-face recharge for common abstraction needs	Increased Sub Surface Infiltration
	Bedrock Layer		High Bedrock Permeability					
Riverine System	Effect on Fluvial Morphodynamics			Forced Flooding on Stream banks during high flow events	Off contour channels Spillway Brush Dams Hedgerows Wetland water Treatment Keyline Pond Hedgerows	P3 Localised control of water conveyance by virtue of plots position in the terrain	P1 Sub-catchment level partner-ship for run off control	Reduced Loss of Water to Run-off and Evaporation
	Role of Existing Infrastructure in Water Management in the Basin	Chanel Drain Threat to Loss of Property Source of Pollution Water Source Habitat						
Urban System	Transportation Networks	Transportation Networks Parking Sidewalks Paths	Conveyance- Diverts Water Flow		Agro-Silvi Pastoral System	S3 Improved soil management means better soil health and local productivity	S1 Improved overall soil bio-diversity	Reduced Erossion
	Land Use	Traditional Countryside Rural with core services Residential Commercial and Retail		Water Attenuation Systems for Local Use				

Strategy 1: Agro silvo Pastural System

Traditional agricultural practices such as tilling, decrease soil organic matter by compacting soil and in turn inhibiting its ability to absorb and retain water. In contrast, Regenerative Agriculture can play a key role in restoring the water cycle as it has the potential to use water more efficiently while keeping the water cleaner than conventional farming. Additionally, it can reduce excess evaporation and increase the water-holding capacity of soil by increasing the soil organic matter, which has a positive correlation with the water-holding capacity of the soil. Research shows that increasing soil organic matter from 1.5 percent to 3 percent more than doubles the water holding capacity of soil, regardless of the soil type (Hudson, 1994). Cover crops in healthy organic soil perform better in managing both heavy runoff and developing deep roots that show better drought tolerance (Funders for Regenerative Agriculture, 2022).

Agro-Silvi-Pastoral Systems,

An example of a regenerative farming practice that is suited to the land use of the current site is the Agro-Silvi-Pastoral systems, It involves the integrated management of cattle and woody components, aiming to establish symbiotic relationships between livestock management, forestry, and agriculture for ecological and economic benefits. This approach diversifies production activities, thereby reducing economic risks for small-scale farming practices. The benefits of these interactions have been summarized (Russo, 1996).

> The periodic decay of leaves, branches, and fruits from trees contributes to an increase in soil organic content. Furthermore, deep tree roots are capable of absorbing nutrients from deeper soil layers and transporting them to the surface, benefiting the growth of crops and pasture cover.
>
> Moreover, trees provide shade, improving the microclimate and influencing the thermal balance of animals. This, in turn, promotes better cattle health and reduces food consumption.
>
> The presence of cattle droppings in both the pasture land and forest land acts as organic manure, enhancing soil health.

Despite the evident benefits of combined management practices, competition among species for light and water can arise, requiring additional labor in maintenance activities to sustain the system. It is crucial to prevent one species from thriving at the expense of another. For instance, the presence of wide tree canopies and deep roots may restrict adequate light, nutrient, and water transfers to the crops and pasture cover. To address this issue, it becomes necessary to annually prune the branches and roots of large trees. Furthermore, excessive and repeated grazing in specific locations over an extended period can lead to soil compaction and negatively impact crop and pasture growth. Additionally, the cattle themselves can trample on young tree seedlings (Russo, 1996).

Norfolk Four-Course System

Diverse planting patterns are essential for maintaining soil productivity without relying on chemical fertilizers and highly mechanized land management practices. The inclusion of various plant species promotes the development of diverse microbial communities, which contribute to the accumulation of rich organic matter and enhance soil moisture levels (Funders for Regenerative Agriculture, 2022). One system of cropping that could achieve this is the Norfolk four-course system, which is a practice that existed in England since the 17th Century.

In this system, a specific crop rotation pattern is followed. Wheat is cultivated in the first year, followed by root crops such as turnips in the second year, and then barley in the third year. Simultaneously, clover and rye grass are undersown during the third year. By the fourth year, the land can be grazed or the pasture can be harvested. The animals grazing in the fourth year contribute to the soil through their manure, replenishing lost nutrients from previous crops. Each crop serves a specific purpose in the rotation: turnips act as a cleaning crop to control weeds, while clover aids in nitrogen fixation. This rotation system ensures continuous land productivity without the need for fallowing. Traditionally, the four crops were grown in separate sections of a plot, and the crop type was rotated annually following the rules of the system.

In the present-day application of this system, farmers who are contractually obligated or find it financially beneficial to grow a single crop type for extended periods may face challenges. However, an alternative approach could be for landowners within a site to collaborate and reach agreements to exchange equal quantities of land for the production of specific crop types. This interdependency among landowners reframes the land as a shared commons that requires joint management to ensure its sustainability, as opposed to intensive practices that deplete its resources. By adopting this cooperative approach, farmers can maintain the integrity of the land and promote sustainable agricultural practices.

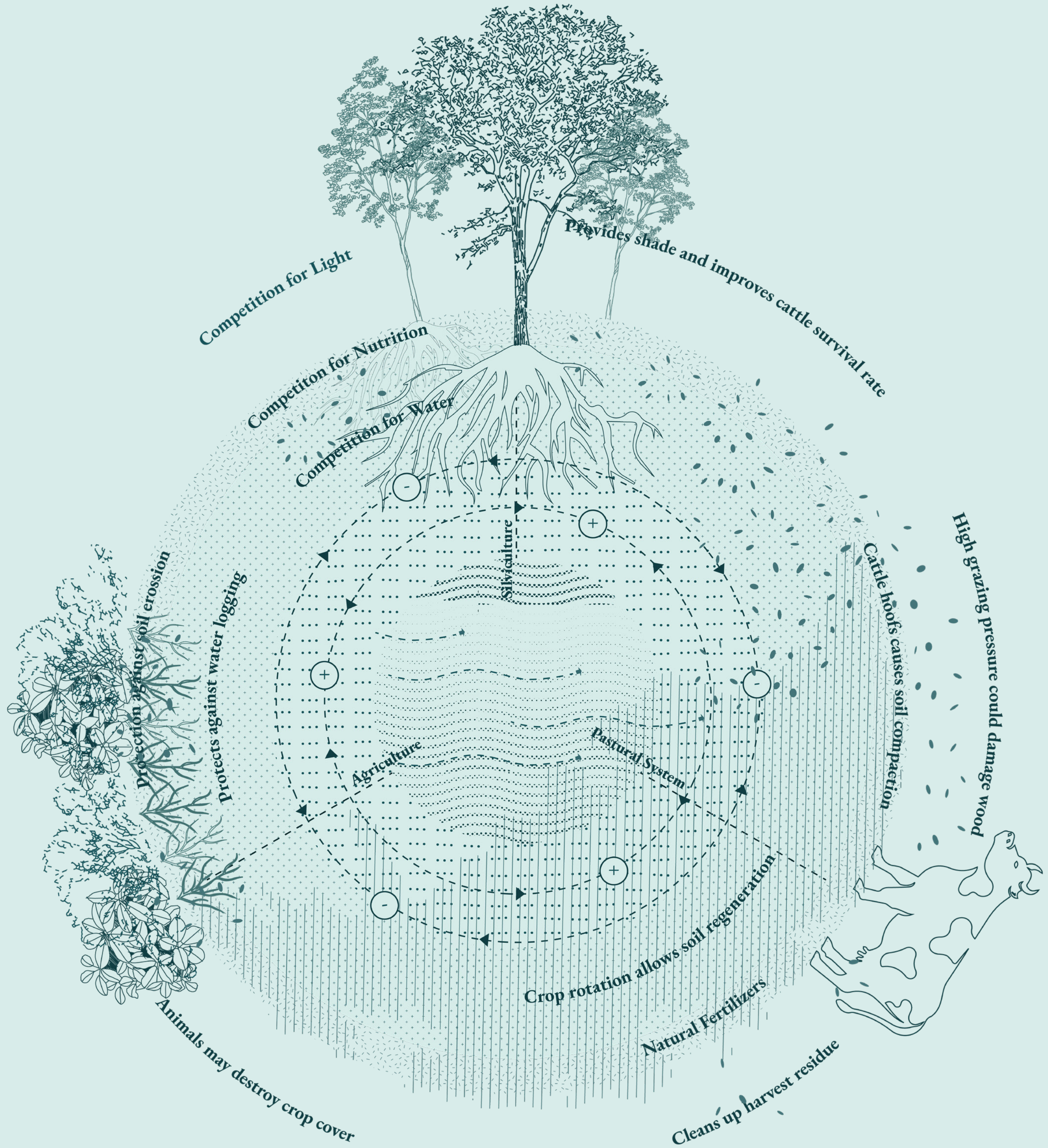
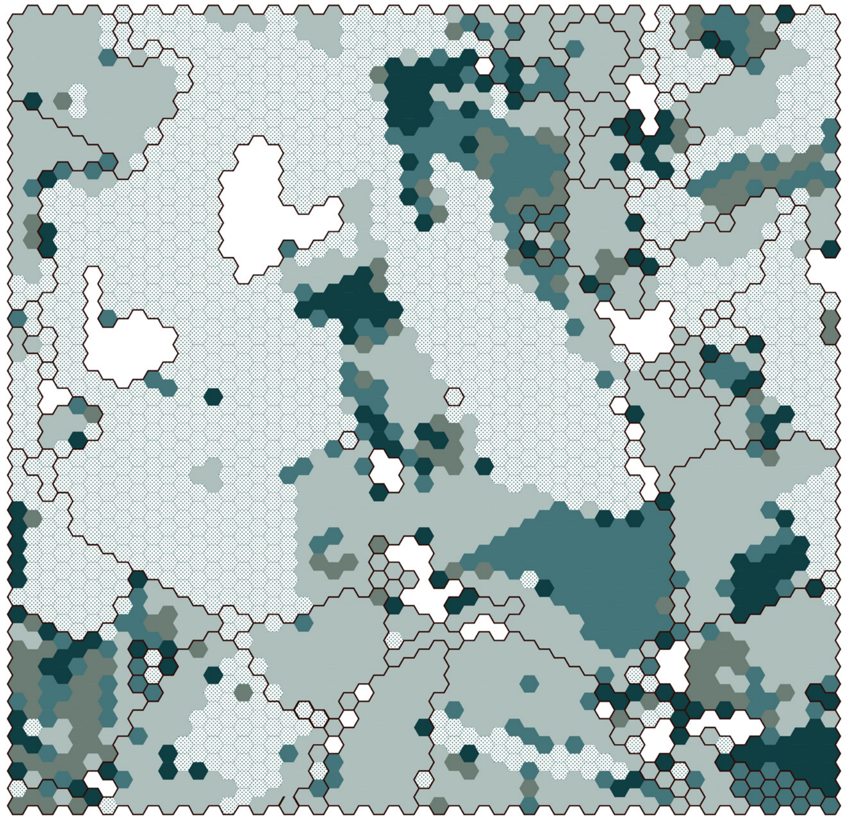
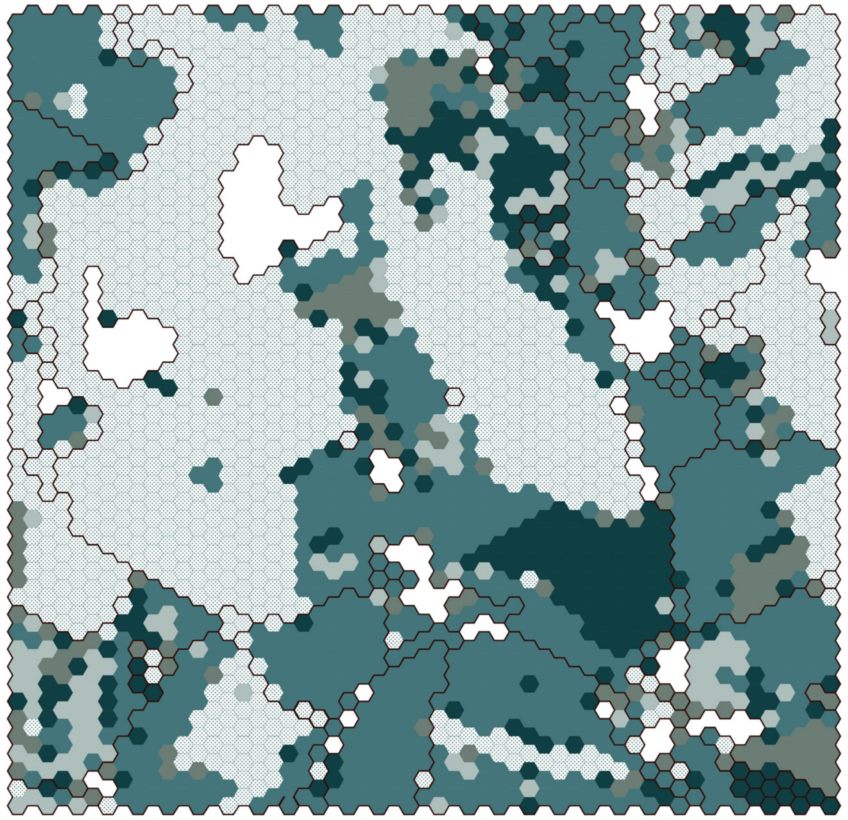


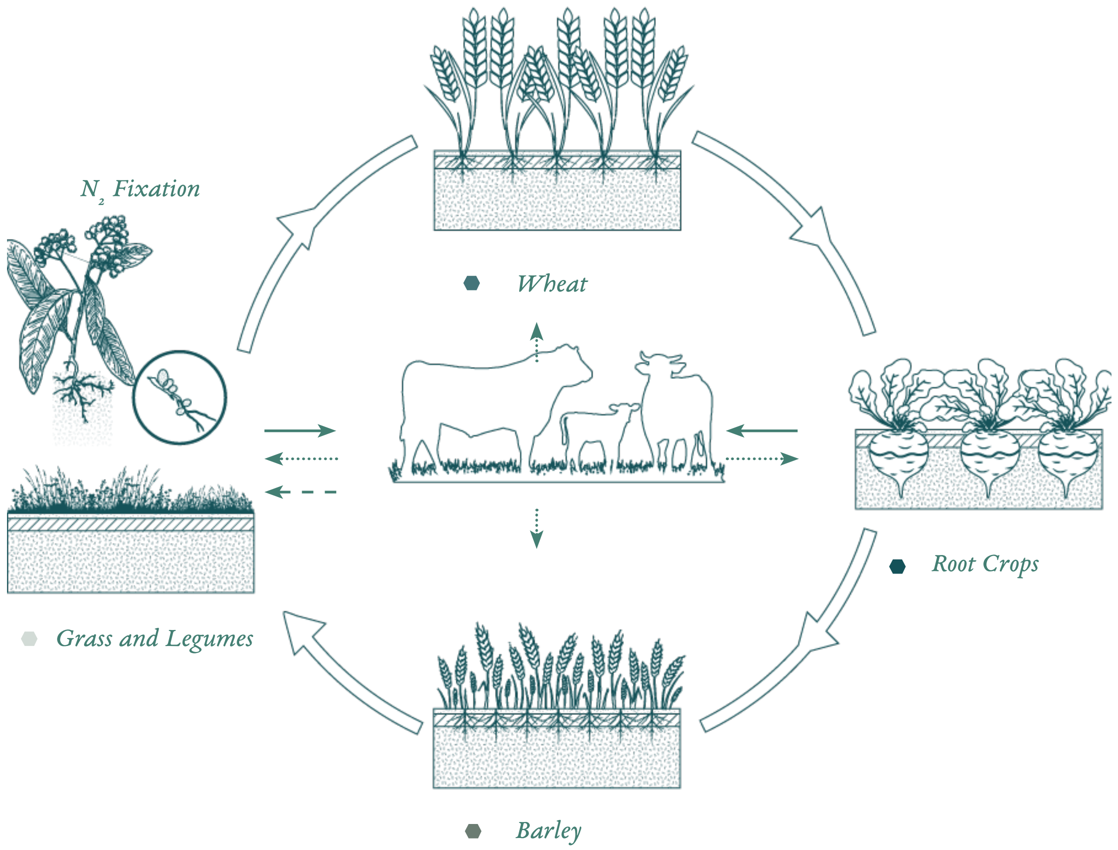
Fig 83: Interdependencies and competing demands from each practice in the Agro-Silvi-Pastoral system

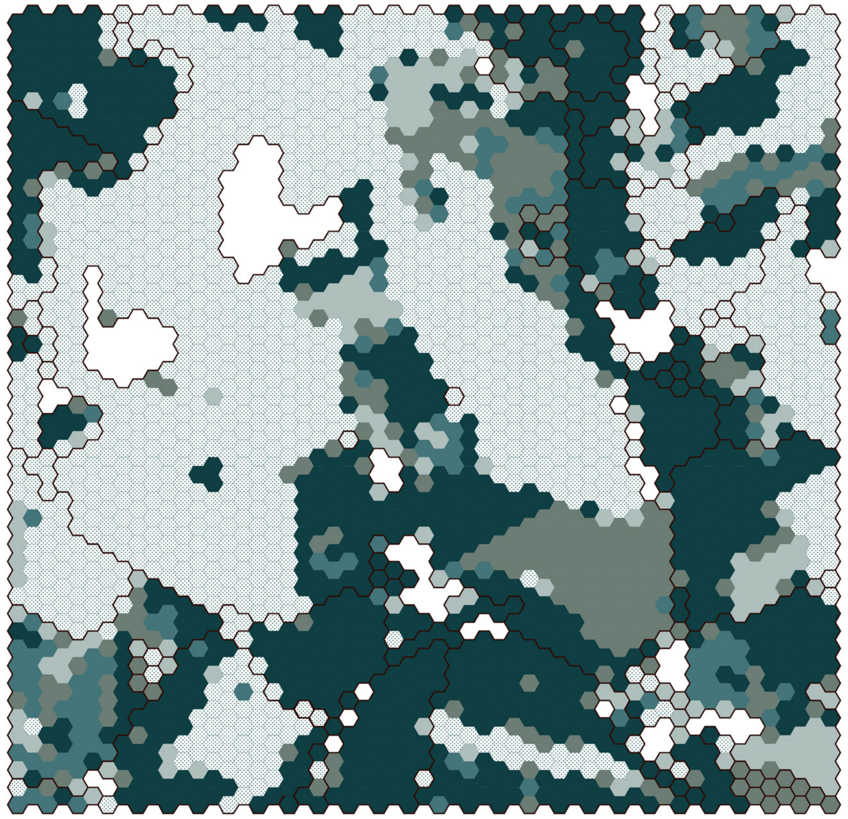


Year 1

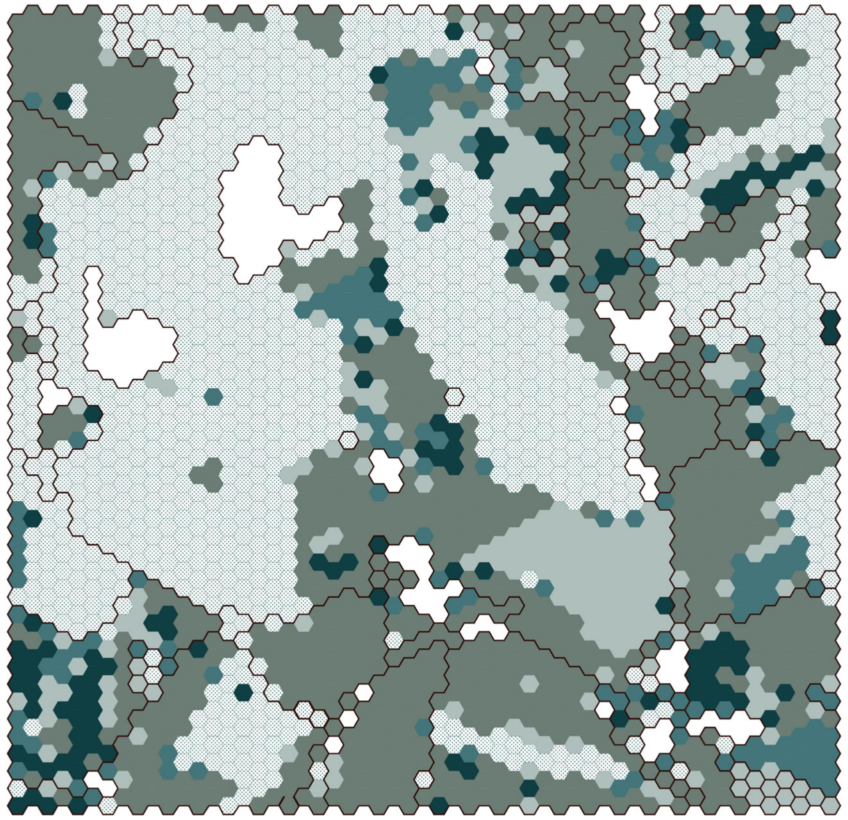


Year 2





Year 3



Year 4

Legend

Tree Cover · Wheat · Root Crops · Barley · Clove and Grass Cover · Property Division Lines

Manure from animals · Crops harvested for animal feed · Direct grazing of animals on fields

Fig 84: Norfolk Four-Course System

Strategy 2: Key Line System of Farming

The Keyline Method is a system of farmland management proposed by engineer P.A Yeoman in the 1940's and 1950's. It was conceived as a practical response to the unpredictable rainfall regime in Australia (Doherty, 2009). This system is popular among permaculture enthusiasts and was specifically developed for the efficient irrigation and even distribution of soil moisture and runoff by following the natural elevation levels of the site and through light engineering works. The main earthwork here is to control the flow of water through channels and drains and to construct embankments for the storage dams.

Siting the Ponds

Valleys naturally serve as pathways for rivers and runoff to traverse the terrain. In steep landscapes, water movement can cause significant erosion of the top layer of soil. The concept of Keyline refers to identifying the key point in the valley where the steepness of the slope begins to flatten. By constructing a pond at this key point, water can be accumulated and stored before being directed to other locations.

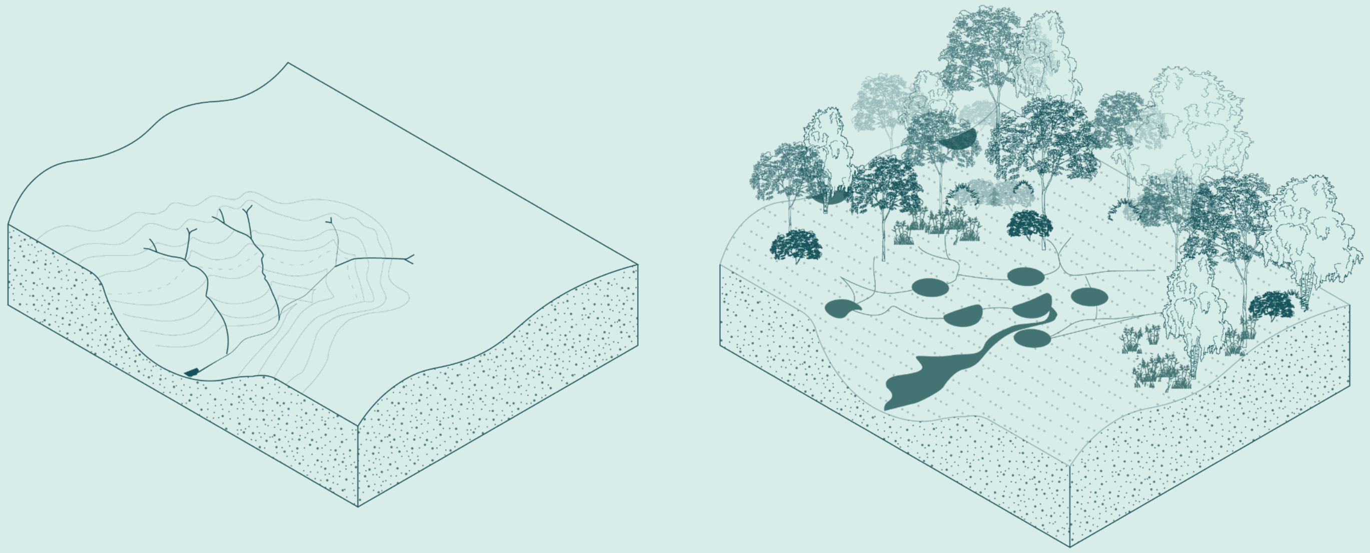
Instead of allowing water to flow directly down the valley, an off-contour channel system is created to guide the water along the contours of the land. This system works against the slope, preventing erosion and promoting even distribution of water across the entire site. Through a gravity-fed system, the water can be spread throughout the area. Utilizing this method, crops can be strategically planted along these channels, ensuring uniform irrigation and optimizing water usage.

Designing the Ponds

The pond serves a dual purpose by storing rainwater and runoff while also recharging the groundwater. It plays a crucial role in the overall system as it allows for the in-situ usage of rainwater for irrigation while simultaneously replenishing the groundwater reserves. This interconnectedness between the pond system and the channel system ensures that water usage for irrigation is balanced with the recharge of groundwater, rather than depleting it (Hügel, 2017).

Water losses from evaporation in earthen ponds can be effectively mitigated by implementing tree plantations as windbreakers around the pond. This practice, known as silviculture, has demonstrated a significant reduction in evaporation rates, ranging from 17% to 34% according to Pachpute et al. (2009). Furthermore, the implementation of a floating plant cover, such as water fern, can serve a dual purpose of minimizing water loss and acting as a natural deterrent against insects that are attracted to water bodies (Hügel, 2017).

The level sill, positioned at the lowest elevation near the river, serves as an additional pond that comes into play during periods of heavy rainfall when the capacity of the primary pond and carrier system is exceeded. Apart from storing excess water, the level sill has the added benefit of capturing nutrients. Aquatic plants cultivated in this pond can effectively utilize these nutrients and contribute to the remediation of pollutants.



Without Intervention	Through Intervention
High Run off and erosion	Low Run Off
Uneven distribution	Even Distribution of Soil Moisture
High Evaporation	Low Evaporation
Low Infiltration and Groundwater Recharge	High Infiltration and Groundwater Recharge
	Soil Conservation

Fig 85: Overview of how the strategy effect the hydrology of the site

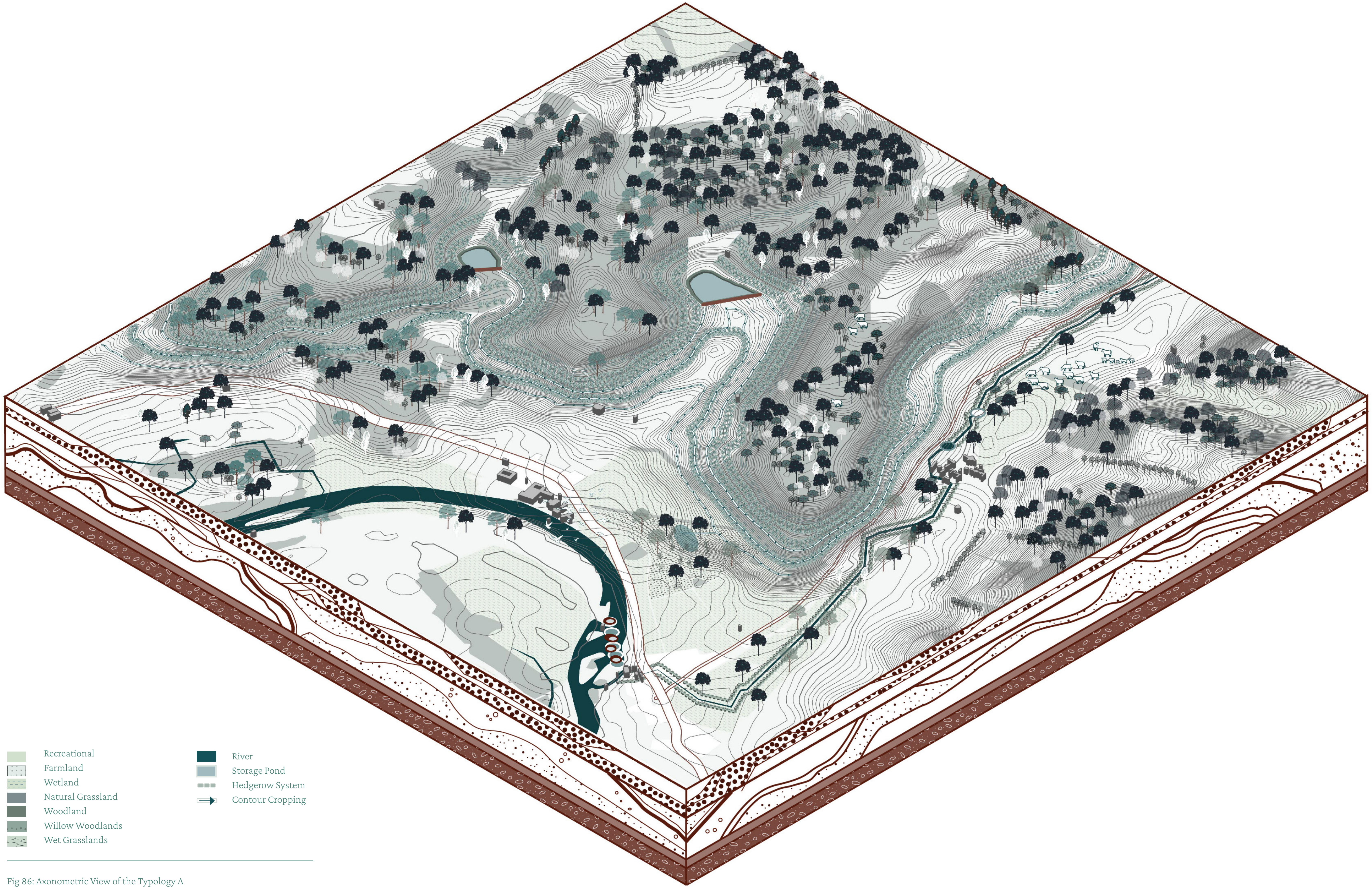
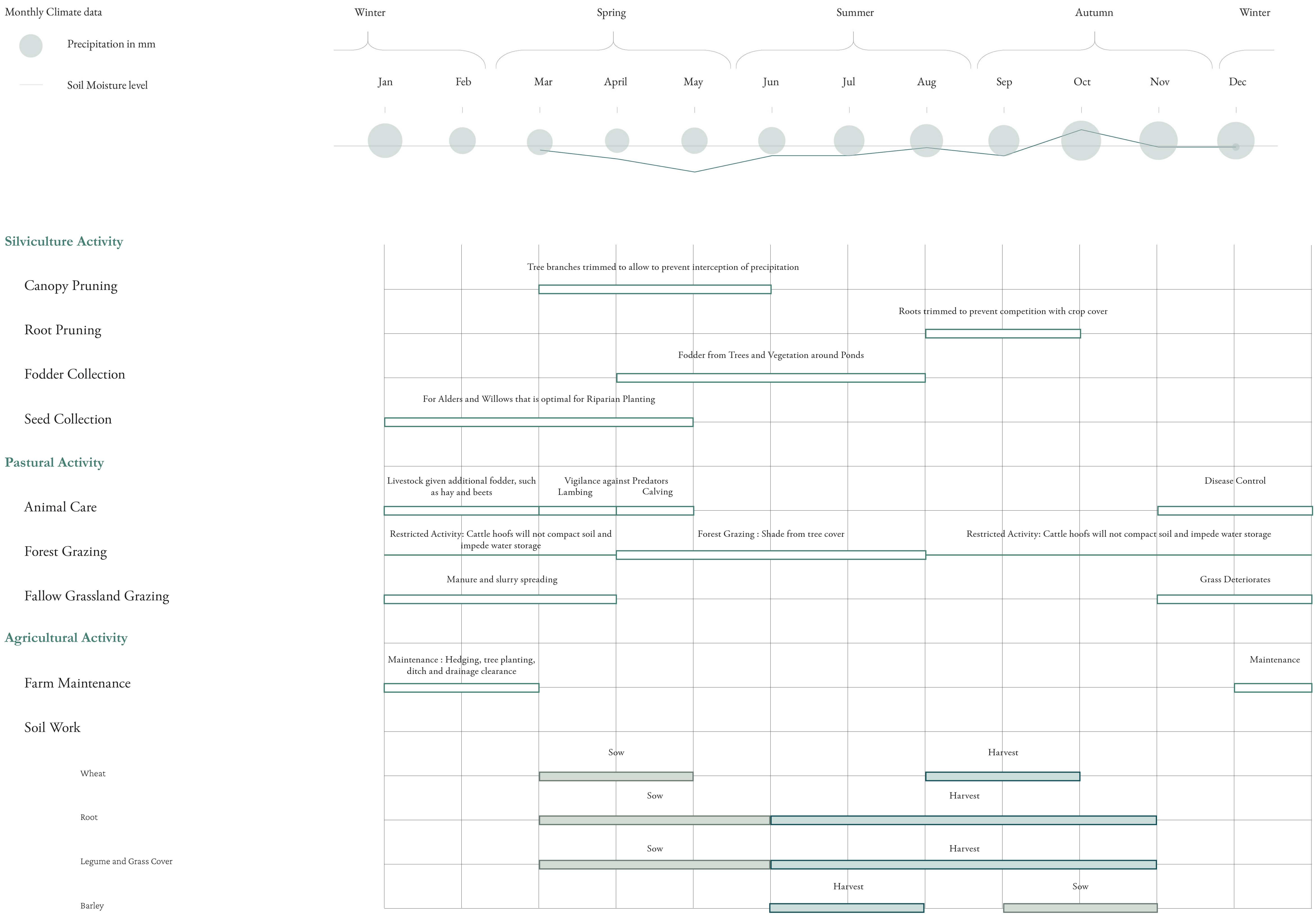


Fig 86: Axonometric View of the Typology A



Monthly Climate data
Precipitation in mm
Soil Moisture level
Winter
Spring
Summer
Autumn
Winter
Jan
Feb
Mar
April
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Silviculture Activity
Canopy Pruning
Tree branches trimmed to allow to prevent interception of precipitation
Root Pruning
Roots trimmed to prevent competition with crop cover
Fodder Collection
Fodder from Trees and Vegetation around Ponds
Seed Collection
For Alders and Willows that is optimal for Riparian Planting
Pastural Activity
Animal Care
Livestock given additional fodder, such as hay and beets
Vigilance against Predators
Lambing
Calving
Disease Control
Forest Grazing
Restricted Activity: Cattle hoofs will not compact soil and impede water storage
Forest Grazing : Shade from tree cover
Restricted Activity: Cattle hoofs will not compact soil and impede water storage
Fallow Grassland Grazing
Manure and slurry spreading
Grass Deteriorates
Agricultural Activity
Farm Maintenance
Maintenance : Hedging, tree planting, ditch and drainage clearance
Maintenance
Soil Work
Wheat
Sow
Harvest
Root
Sow
Harvest
Legume and Grass Cover
Sow
Harvest
Barley
Harvest
Sow

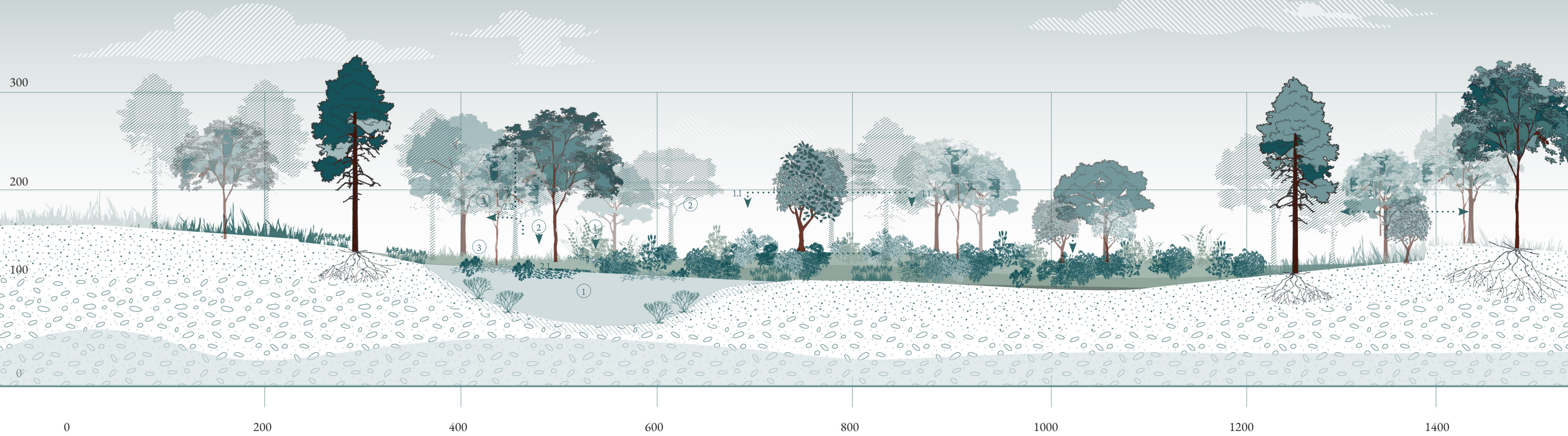


Fig 87: Section of Keyline Ponds

Legend

① Key Line Dam	1.1 they store greater sums of water for little earth moved	② Water Ferns	2.1 to reduce loss of water by evaporation can be used as fodder	③ Silvicultural Practices	3.1 Improved micro-climate for grazing animals and better animal health
	1.2 off contour Cropping		2.2 Can be used to feed grazing animals		
	1.3 Incision channels to irrigate crops				

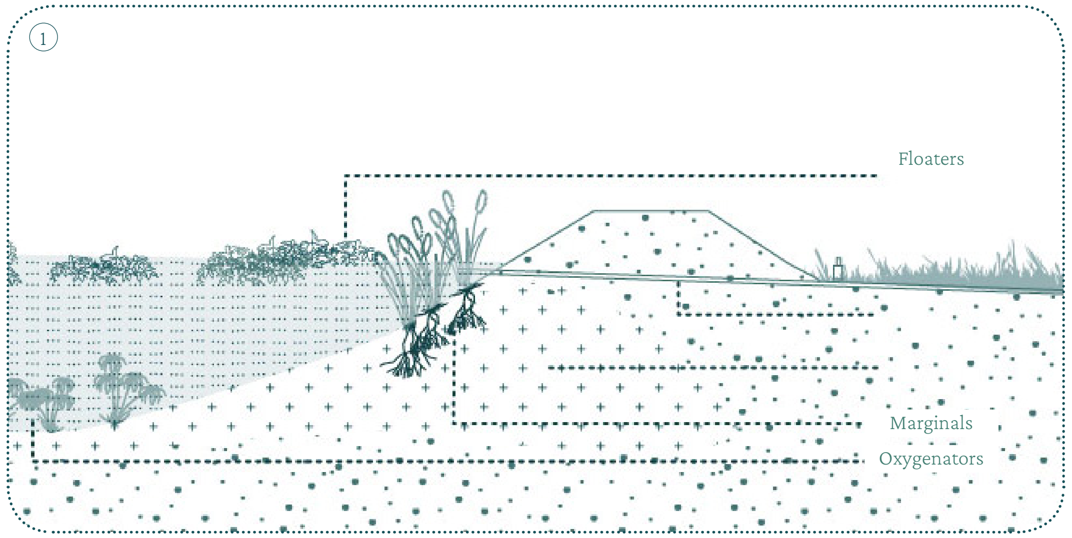


Fig 88: Detals of Keyline Pond

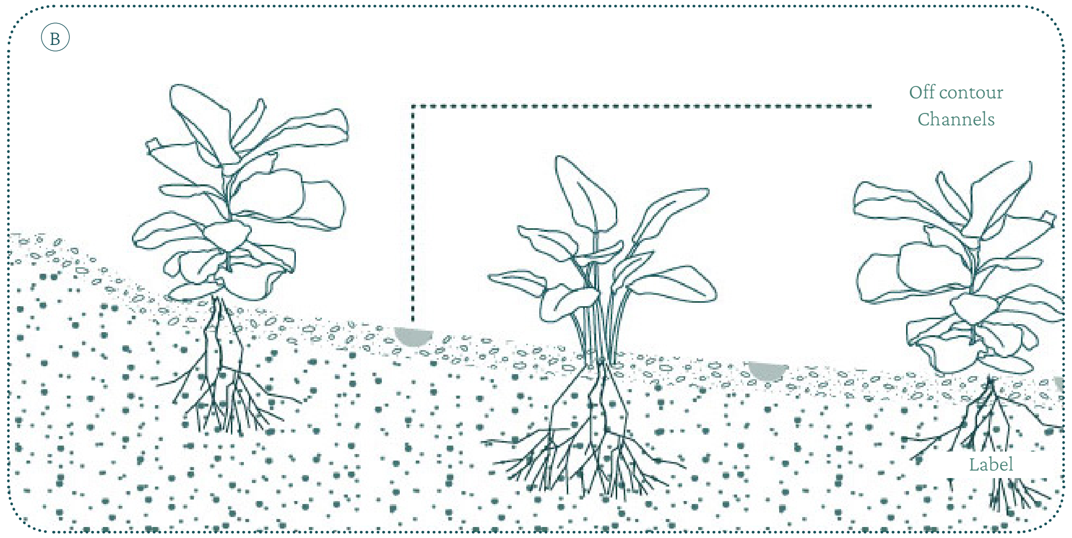


Fig 89: Details of Off Contour Channel

Permaculture ponds are created by cut-and-fill measures from within the site, using the excavated soil as embankments to contain water. The base of the pond is lightly compacted to allow infiltration through seepage at the base and is planted with a selection of aquatic plants to both remediate pollutants, and produce bio-mass for the productive activities of the Agro-Silvo-Pastoral system.

Off contour Channels are constructed along the same contour levels to convey water from the ponds and across the field rather than along natural valleys that eventually feed the River Thames. These slower and more winding pathway for water irrigates the field evenly and conserves fertile topsoil by reducing runoff. The entire system of channels across the height of the cropland is circuitous and gravity fed.

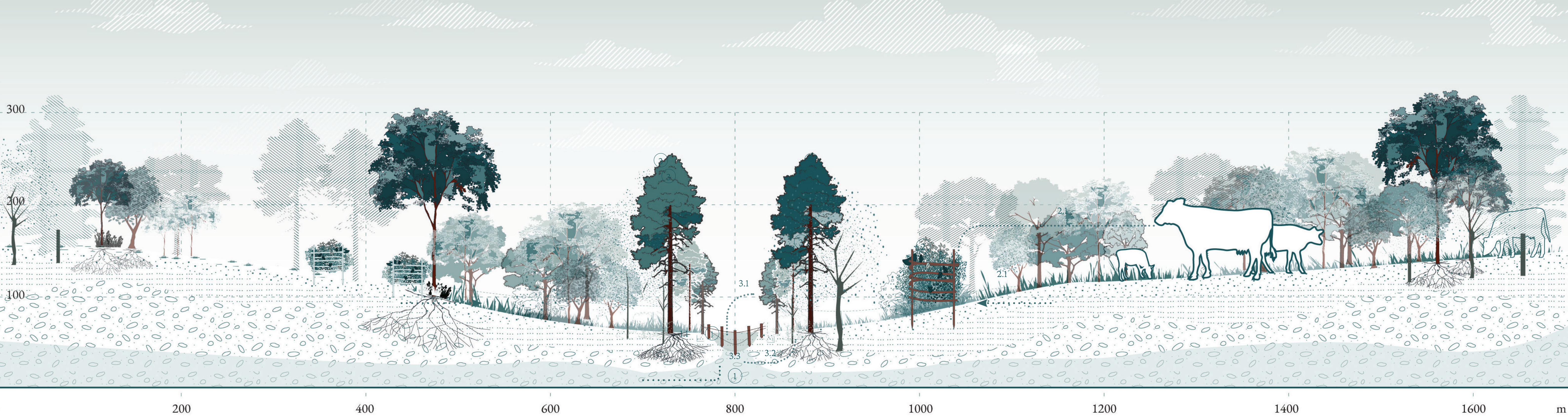


Fig 90: Section of Riparian Landscape along Hambledon Brook

Legend

(1) Brush Dam
1.1 Avoids excessive erossion, and allows soil to accumulate to support vegetative growth

(2) Hedgerow system
2.1 Aborbs run off and reduces standing water which affects animal health
2.2 Reduced Silt reaching the River

(3) Riparian Woodlands
3.1 prevent the banks from eroding away
3.2 trees alter the chemical balance of the water by taking up minerals from the soil and releasing them into the water.
3.2 Enhances biological value of the aquatic habitat

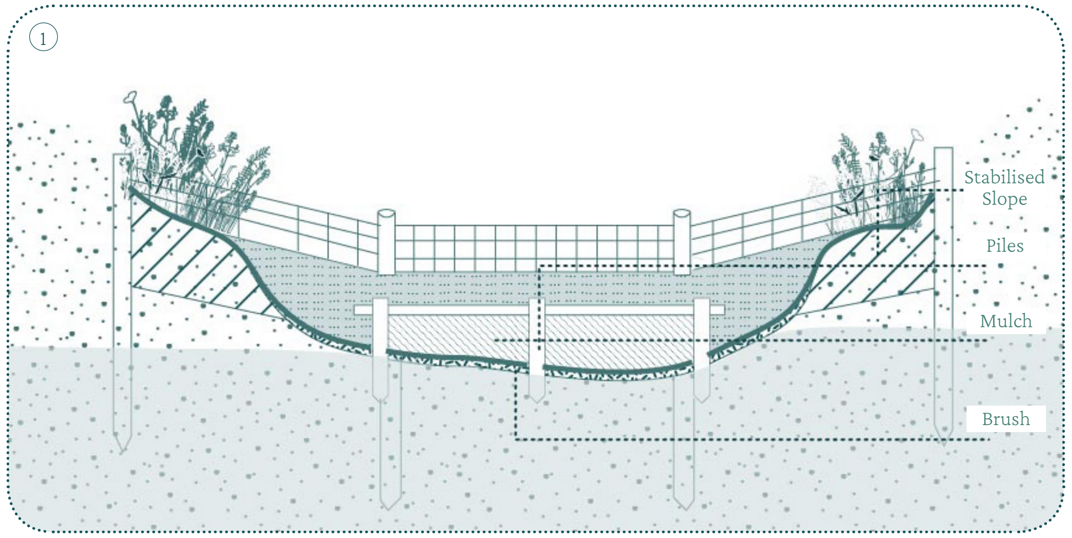


Fig 91: Details of Brush Dam

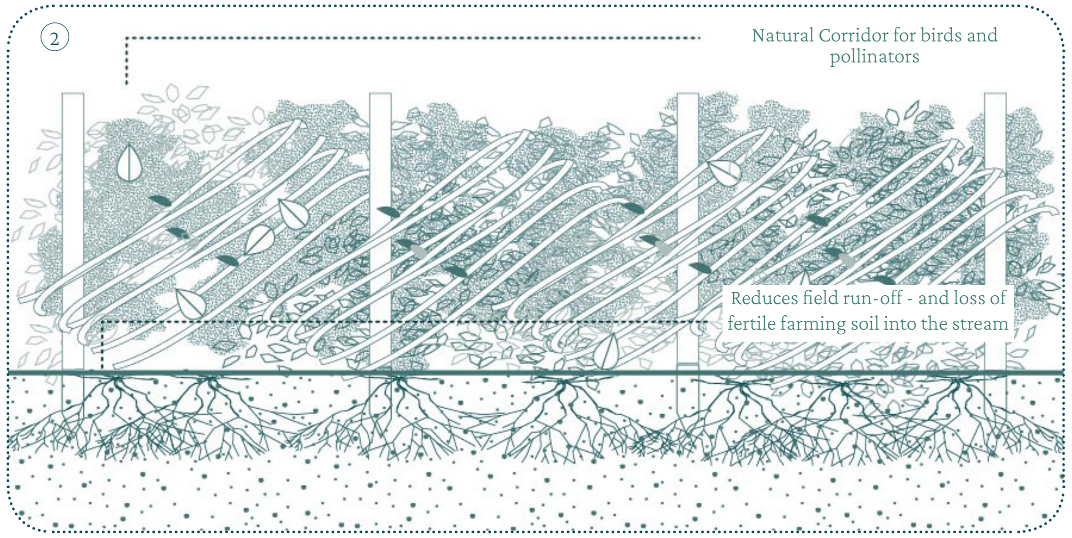


Fig 92: Details of Hedgerow

It's a light engineering work that involved placing natural woody materials within water channels such that normal base flows of water pass through it easily. During heavy rainfall events, large volumes of water are likely to pass through the channel with high erosive force. By placing a brush dam, the speed of the stream's flow is slowed down, and the volume that exceeds the channel's capacity spills over and infiltrates the soil near the banks of the stream.

Hedgerow are rows of low-lying shrubs that are planted to demarcate boundaries between private properties. In addition to acting as a green corridor that supports diverse species, like pollinators, bats, birds, hedgehogs, and dormice, they offer warmth to grazing cattle in the cold winter months. Un-interrupted patchworks of hedge rows offer a huge potential to boost biodiversity. The practice of setting up and maintaining these hedge rows requires skilled labor.

Micro Scale: Interventions on Landscape

Earth Movements + Light Infrastructural Work : Directing Water Flows

Forms of Water in the Terrain

	Conveyance	Attenuation
Terrestrial Storage	Identifying Keyline points in the terrain to impede fast moving run-off	(-) Siting Permaculture Storage Ponds at the Keypoint of the site (+) Creating earthern embankments for storage ponds
River Discharge	*Weir removal to restore natural riparian landscape* *Brush Dams addition to slow fast flowing brook*	Brush Dams spread out stream flows and slows it along channel widths
Run Off	(-) Channel incisions to connect system of storage ponds (-) Off contour swales between croplines (+) Redirecting water flows from valleys to ridges	(-) Level Sill to collect excess run off in the scenario of heavy rainfall. (+) Creating earthern embankments to contain / slow down heavy volumes of run off
Ground water		(-) Protected recharge zones along channels and streams
Soil Moisture	Expanding water pathways along vegetated cover	

(-) Excavation

(+) Fill

Vegetation Works : Filteration and Effect on

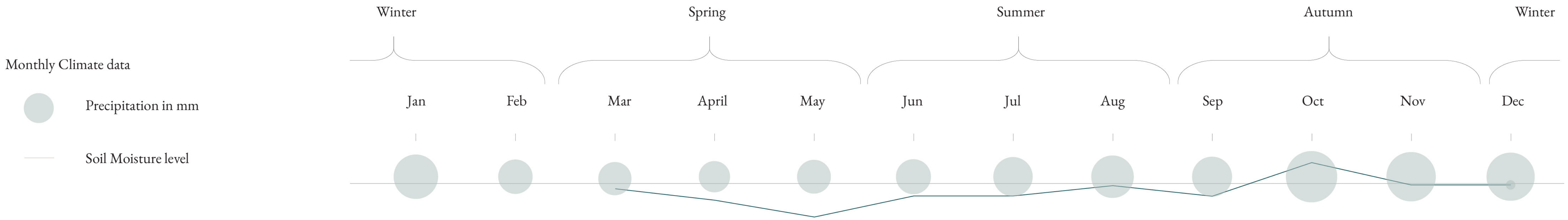
Forms of Water in the Terrain

	Crop Cover	Tree Cover	Pasture Cover
Terrestrial Storage		(-) Wide Canopies Intercepts rainfall (-) Increased leaf litter amount reduces surface water run-off or contribution to stream depth	
River Discharge		Stabilises river banks, reduces erossion Greater amount of carbon carried by the rivers	(-) Reduces silt in stream and reduces flood risks downstremes Vegetation strips reduce the transfer of sediment, nutrients, and pesticides into freshwater ecosystems.
Run Off	(-) Crop cover with with high organic matter can reduce runoff in flood years by nearly one-fifth and cut flood frequency	(-) Reduces Runoff	
Ground water			
Soil Moisture	(+) Increases water holding capacity of soil by increasing soil organic matter	(+) Increases rate of soil infiltration (+) Effect of shade may act to reduce water loss from soil by limiting evapotranspiration rates from plants. (+) Decomposing leaf litter amount improved soil moisture	(+) Manure Increases water holding capacity of soil by increasing soil organic matter (+) Planting Forage improves soil organic matter

Effect on (-) Decrease

(+) Increase

Filteration (*) Cleaning Pollution



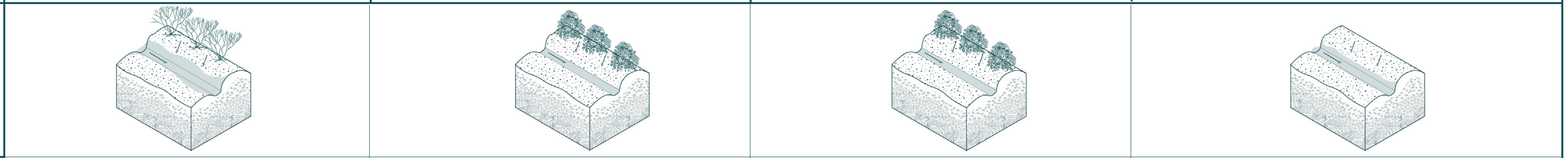
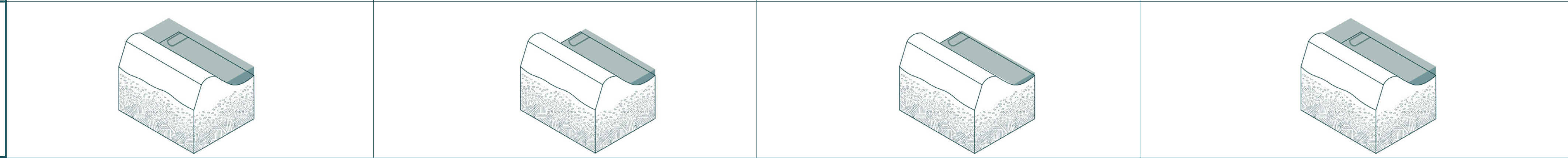
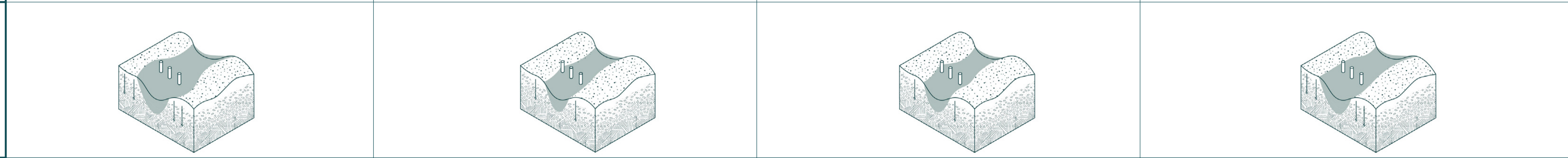
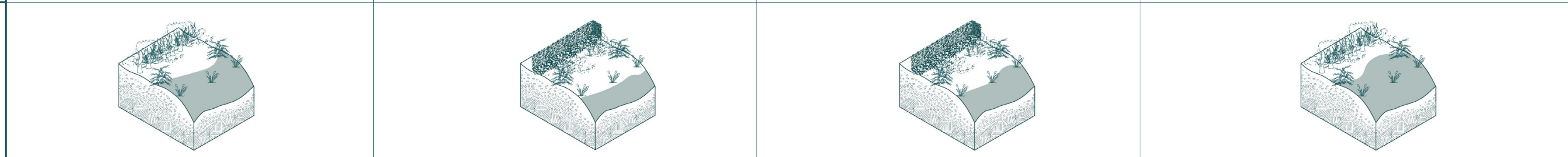
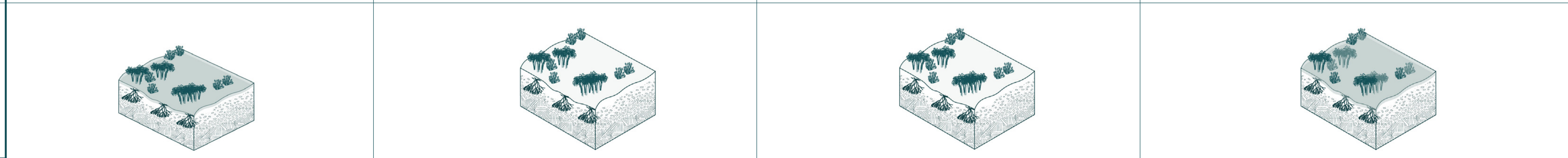
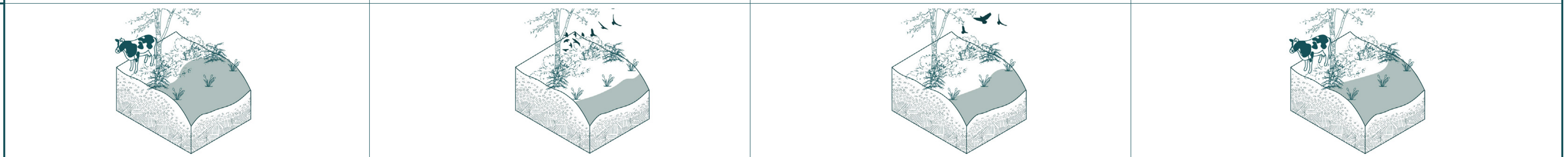
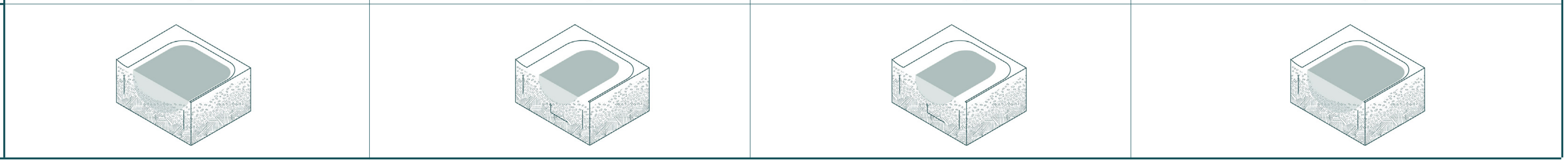
Landscape as Infrastructure			Winter	Spring	Summer	Autumn
Chanel	:	Off contour channels				
Drain	:	Spillway				
Threat to Loss of Property	:	Brush Dams to Flood Stream Banks				
Source of Pollution	:	Hedgerows				
Source of Pollution	:	Wetland water treatment at level sill				
Habitat	:	Hedgerows for cattle				
Water Source	:	Keyline Ponds				

Fig 93: Regenerative Water Storage and Land Management : Design for Typology A

Engineered Elements in the Landscape

Legend

1. Key-line Pond
2. Embankments to contain run off and precipitation
3. Floaters
4. Marginal Planting
5. Off Contour Channels
6. Contour Cropping
7. Silviculture

Altered Ecology

Legend

(1) ***Effect of Silviculture***

(1.1) Micro-climate modification for cattle health

(1.2) Attracts birds who aid in biological pest control

(2) ***Effect of Pastoral Activity***

(2.1) Cattle activity increases soil nutrients and organic content

(2.2) Increased nutrient uptake by crop roots

(3) ***Phytoremediation***

(3.1) Rhizodegradation : contaminant breakdown by soil organisms

(3.2) Rhizofiltration : filtering contaminated groundwater, surface water, and wastewater through a mass of roots to remove toxic substances or excess nutrients

Altered Hydrology

Legend

(I) Interception

(C) Conveyance

(R) Surface Run off

(SM) Soil Moisture

(P) Percolation

(G) Ground Water Storage

(SS) Surface Storage

(SF) Stream Flow

(E) Evapotranspiration

(P) Precipitation

(EV) Evaporation

Fig 94: Revitalizing Riparian Landscape : Design for Typology A

Engineered Elements in the Landscape

Legend

1. Piles
2. Brush Dam
3. Marginal Planting
4. Stabilized Slope
5. Hedgerow System
6. Riparian Landscape

Altered Ecology

Legend

① *Effect of Hedgerow Restoration*

(1.1) Promotion of Plant Diversity

(1.2) Provides warmth to cattle in the winters

(1.3) Movement corridors for mammals

(1.4) Pest Control by attracting insects away from crops

(1.5) Perennial home for hundreds of species animals, birds and fungi

(1.6) Carbon Sinks

(1.7) Uninterrupted corridors for pollinators who can pollinate crops in the vicinity

(1.8) Spatial cue for bats and Moths to navigate the landscape

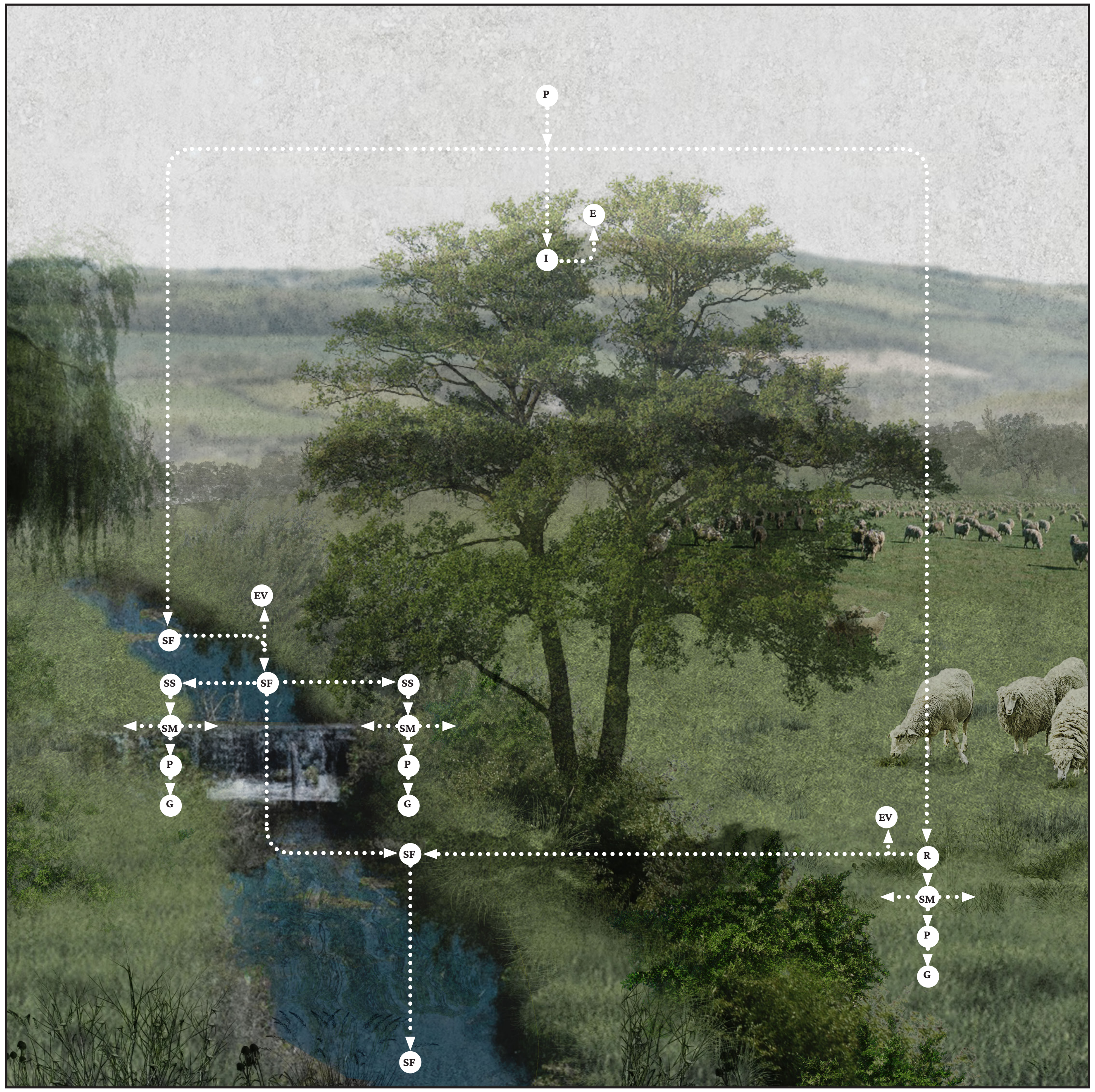
② *Effect of Norfolk Four Crop Rotation*

(2.1) Wheat Plantation

(2.2) Root crop like turnip as a cleansing crop that allowed hoeing to kill weed

(2.3) Barley Plantation

(2.4) Nitrogen fixation by legume plants like clover



Altered Hydrology

Legend

(I) Interception

(C) Conveyance

(R) Surface Run off

(SM) Soil Moisture

(P) Percolation

(G) Ground Water Storage

(SS) Surface Storage

(SF) Stream Flow

(E) Evapotranspiration

(P) Precipitation

(EV) Evaporation

9.5 Typlogy B

The site is located in the alluvial terrace zone in southern Oxfordshire. From a meso scale perspective, the rivers Thames and Cherwell form a braided system, which is a unique characteristic in the Thames Basin region.At a micro site level, extensive dredging has been carried out to maintain a consistent form of the river, even though most parts of the site are not embanked. This dredging serves the purpose of accommodating boating activities and increasing the channel's capacity to cope with frequent flooding.

The flood plains of the site are currently utilized for agricultural purposes, and analysis of LIDAR data suggests the possible existence of a water meadow in the past (zoom into A). However, there is a lack of historical records to substantiate this claim. The design objective for the site, considering its low bedrock permeability and high superficial permeability, is focused on enhancing biodiversity and reducing silt transport to the lower catchments. This involves improving local soil fertility, minimizing sediment deposition in downstream areas, and utilizing floodwater harvesting to decrease the volume of water carried downstream. Proposed strategies to achieve these goals include restoring the meandering pattern of the river along the active floodplain and establishing a water meadow in the extended section of the alluvial terrace.

The Role of Terrain in Water Storage : Mapping Zones of Flow Accumulation

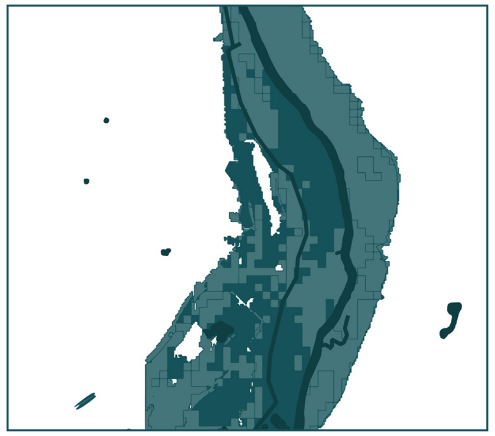


Fig 95: River and Historic Extend of Flooding

River · Historic Flood Zones

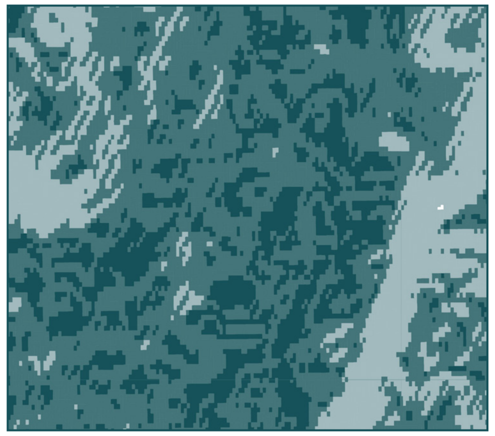


Fig 96: Topographic Wetness Index

Wetter Regions · Drier Regions

The Role of Terrain in Conveyance: Mapping Natural Water Pathways

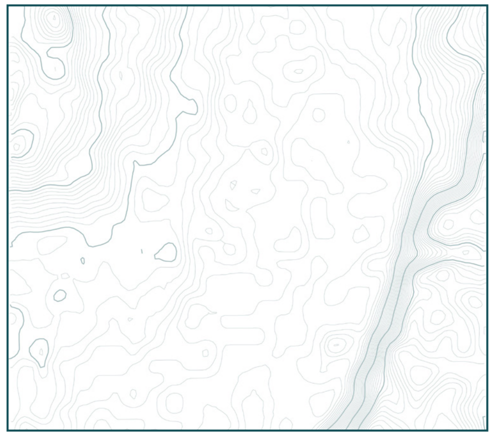


Fig 97: Natural Contours

Fig 98: LIDAR Data for higher precision

- Recreational
- Farmland
- Meadow
- Natural Grassland
- Woodland
- Low mounds for livestock refuge
- Renaturalised Floodplain to Harvest Flood Water
- Water Meadow to Harvest Flood Water
- Main Carriers
- Two Step Ditch
- Blue Network
- Green Network
- Retrofitting Road Network for Green Infrastructure
- Retrofitting Road Network for Blue Infrastructure

Fig 99: Positioning Typology B within the larger context, and connecting strategies to larger networkd

Design Framework for Typology B

Key	Scale	(S) System	(P) Patch	(C) Corridor
1	Macro	River Basin	Sub Catchments	River Thames
2	Meso	Micro Basin	Land Use in Parcels	Streams and Tributaries
3	Micro	3km x 3km site (Typology)	Property Divison	Pathways of Water in the Terrain

Criteria for Transferability of the Project into other parts of the Site

Enhancing the Larger Basin System: The Replenishing Effects of Design Application

	Primary Classification	Secondary Classification	Effect on Hydrology: Natural	Effect on Hydrology: Altered by Design	Strategy	Interscalarity of Approach: Intervention In Micro Scale	Interscalarity of Approach: Effect on Macro Scale	Design Goals from Typology Classification
Natural Terrain	Corridors	Shallow Valley Deeply Incised Stream U shaped Valleys	Conveyance - Natural Pathways for Water	Preserving Pathways carrying Run off into the Flood plains		C3 Intervention redirects flood water and run off along floodplain leading to better soil moisture distribution	C1 Reduced nutrient run off in to the River Thames and its tributaries	Reduced volume of water being carried downstream
	Patches	Plains	Attenuation - Water Accumulates	Conveyance Pathways in the Plains				
	Edges	High Ridges Mid Slope Ridges Local Ridges Upper Slopes	Conveyance - Diverts Water Flow					
Geology	Superficial Layer		High Superficial Permeability			S3 Water harevsting at the surface for local use	S1 Flooding at active plain increases sub-surface recharge	Reduced volume of water being carried downstream
	Bedrock Layer		Low Bedrock Permeability					
Riverine System	Effect on Fluvial Morphodynamics			Increased Localised Flooding Reduced Flood Peak Downstream	Field Carriers Seasonal Boating Controlled Flooding System Two Step Drain Riparian Sub-surface Recharge Livestock Earth Mounds Re-Meandering the River Water Meadow System	P3 Localised control of water conveyance by virtue of plots position in the terrain	P1 Sub-catchment level partnership along the flood plain. Reduced flood peak in catchments downstream	Reduced volume of water being carried downstream Improved Biodiversity
	Role of Existing Infrastructure in Water Management in the Basin	Chanel Inland Waterway Threat to Loss of Property Source of Pollution Water Source Habitat						
Urban System	Transportation Networks	Transportation Networks Parking Sidewalks Paths	Conveyance= Diverts Water Flow			S3 Improved soil management means and localised deposition of silt	S1 Reduced silt load carried downstream, alleviating the flood risk there	Imporoved local soil fertility and educing sediment deposition in lower catchments
	Land Use	Traditional Countryside Rural with core services		Water Harvesting for Local Use				

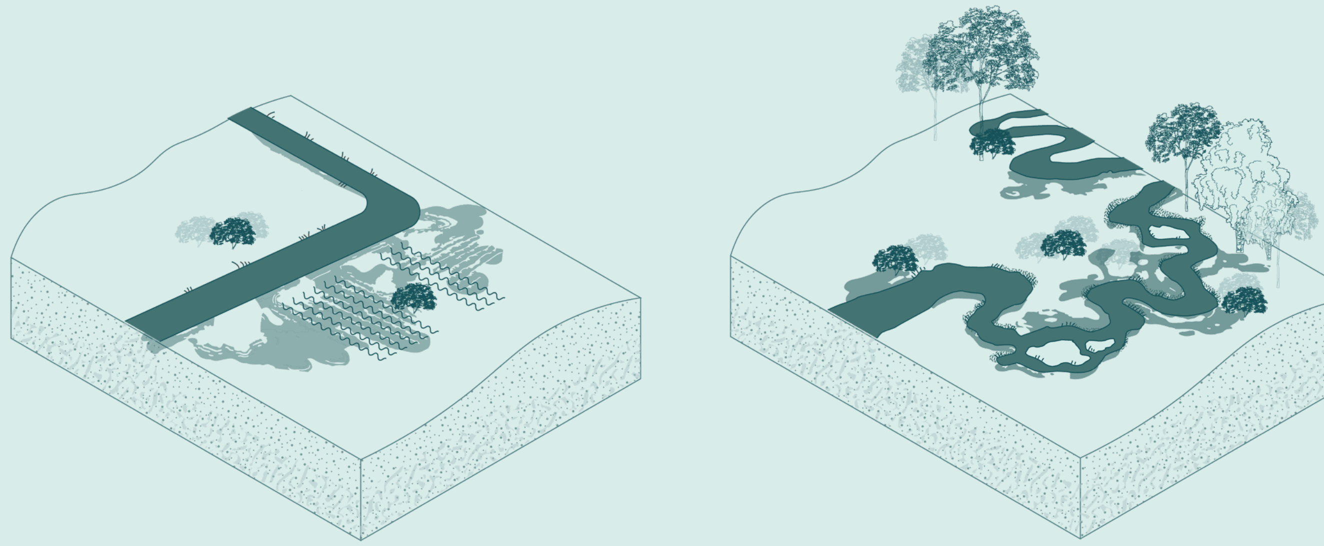
Strategy 1: Re-naturalising the River

River restoration aims to revert a river to its original state, undoing the effects of channelization and straightening, and giving the river more freedom to shape its morphology within the floodplain. Such efforts to straighten rivers have reduced the surrounding flood plains capacity to store floodwater.

The restoration process has the potential to reinstate natural processes and enhance riparian biodiversity. Various techniques are employed in river restoration, including restoring natural meanders, improving channel morphology, planting wetland species, and managing overland floodwater (The River Restoration Center, 2019).

In typology B, the site appears to have undergone extensive dredging to facilitate boating activities, as evidenced by the lack of deviation in the channel since the 18th century. The river's edges are not heavily embanked, but frequent flooding events have occurred in this area. These practices of consistently straightening and deepening channels contribute to increased flood risk downstream.

Restoring the natural meander involves reshaping the floodplain by filling in the existing channel and creating a new, relatively shallow pathway for the river. This allows the river to chart its own natural course, which stabilizes over time. Additionally, this area can serve as a flood storage zone during periods of heavy rainfall, helping to reduce discharge downstream and mitigate flood risks.



Without Intervention	Through Intervention
Accelerated flow	Meandering flow with delayed flood peak
Increased fragility of the river banks and riparian vegetation cannot survive	Improved biodiversity along river banks and dynamic river bank
Carries high volumes of water downstream to add to flood risk there	Increase in localised flooding reduces flood risk downstream
River bed requires constant maintenance	Rivers natural dynamic allows better exchange with ground water

Fig 100: Overview of how the strategy effect the hydrology of the site

Strategy 2: Reviving Water Meadows

During the 13th to 16th centuries, historical records mention the existence of waterleets and Le Flodgatemedewe, indicating early irrigation practices in England. Pre-17th century irrigation in England involved a simple technique known as "floating upwards." which included blocking a watercourse, causing it to overflow and flood the surrounding farmland (Historic England,2018).

In the 18th century, Dutch engineers introduced a technique called warping to address water-logging issues. This was modified to create more sophisticated form the water meadow, known as "floating downwards," facilitated a controlled flow of water through the grass sward, ensuring constant movement and improved water management on meadows (Historic England, 2018).

Bedworks seen in classic water meadows that are being preserved for its historic value became prominent from the 17th century onward, especially on the flat alluvial plains, serving as a means to enhance the local "sheep and corn" farming system prevalent in the chalklands of southern England . Water meadows eventually reached their peak popularity during the 18th and 19th centuries, particularly in the heartland of southern England (Historic England, 2017).

Flooding on water meadows required continuous human intervention. In the past, those responsible for managing the flooding were referred to as drowners, meadmen, or watermen. Cooperation among neighboring landowners was crucial, as water supply disputes, particularly with water mill owners, could be intense (Historic England, 2017).

The decline of water meadows was influenced by several factors, including the availability of alternative fodder and artificial fertilizers, leading to decreased demand for meadow grass and animal dung. Additionally, labor shortages and changes in agricultural practices contributed to their decline.In the 1960s, aggressive river straightening and the removal of weirs became common practices to accelerate river flow and prevent urban flooding. These modern interventions replaced traditional water meadow systems (Historic England, 2018).

Construction of the Water Meadows

The layout of water meadows varied depending on factors such as the time of construction, land ownership or tenancy patterns, and most importantly, the topography of the land. They were designed to be responsive to the natural contours of the terrain. The most notable features of water meadows were their parallel channels, which roughly followed the contour lines of the land.

One of the main challenges of water meadows was to distribute the fast-moving river water evenly across the meadows and efficiently drain it away. To achieve this, a system of channels, drains, and hatches was implemented. Additionally, a leat, which is an open watercourse, was used to transport water from higher elevations to the channels in the meadows.

Dams and weirs were strategically positioned to divert water from the river into the meadows, ensuring a controlled flow of water throughout the system. These structures played a crucial role in regulating the water supply to the meadows.

Grazing's Role in Managing Water Meadows

Water meadows are carefully flooded areas that were intentionally designed to control the growth of grass and enhance the hay crop during summer. The deliberate flooding served multiple purposes, including promoting early grass growth in spring and improving soil fertility through nutrient-rich floodwater (Historic England, 2017).

Due to the undulating nature of water meadows, machinery is unable to effectively maintain them, hence light grazing is considered essential. Grazing plays a crucial role in removing dead grass, leaf thatch, and invasive scrub from the ground, thus ensuring the health of the meadow ecosystem. Additionally, grazing helps improve biodiversity by periodically removing taller and coarser species, allowing for a more diverse range of plants to thrive (Historic England, 2017).

Maintenance of water meadows is highly responsive to weather conditions. Wet meadows are not grazed to avoid damaging the delicate ecosystem, highlighting the need for adaptive and weather-dependent management practices (Historic England, 2017).

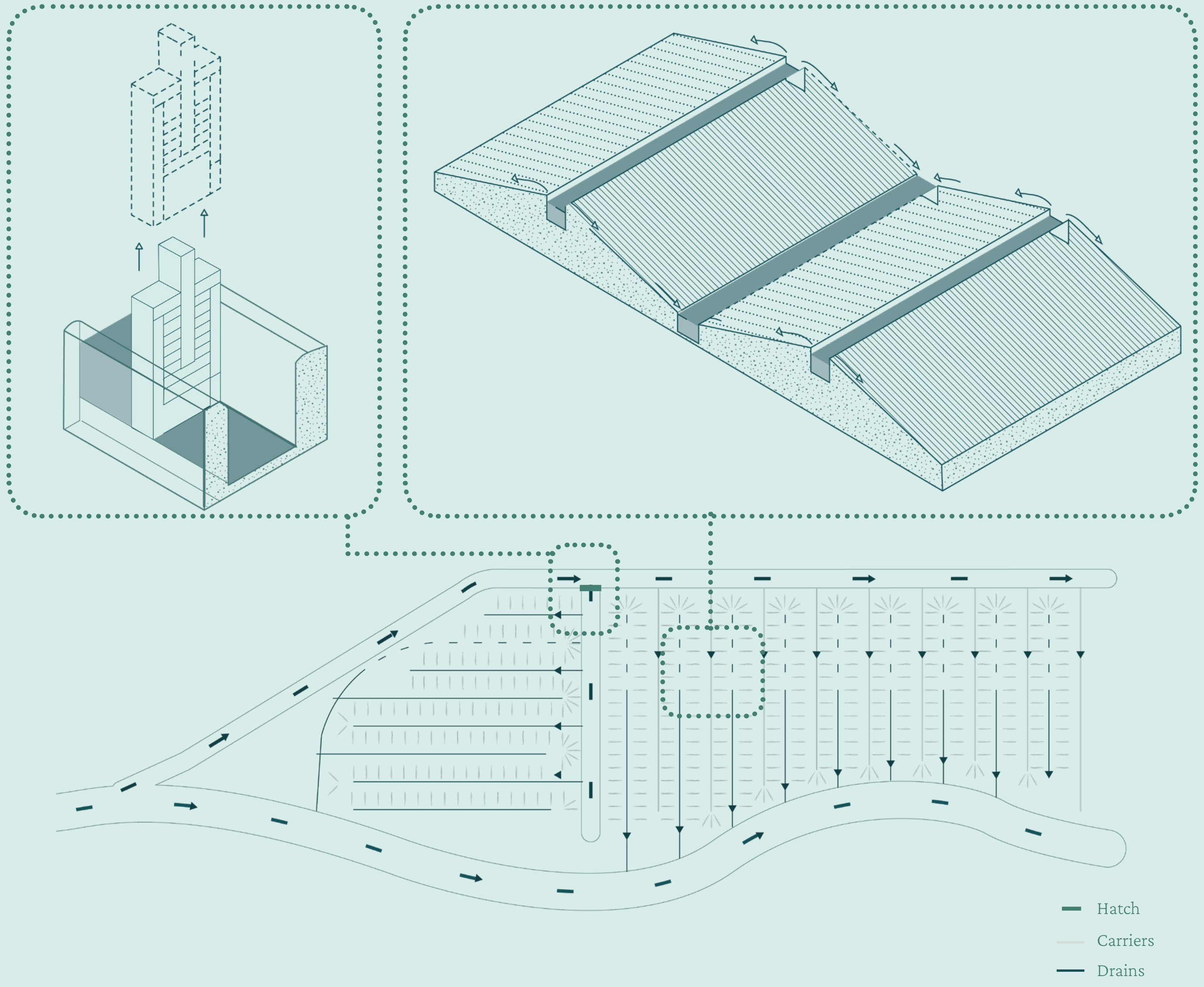


Fig 101: Overview of water meadow system with hatch, carrier and drain system

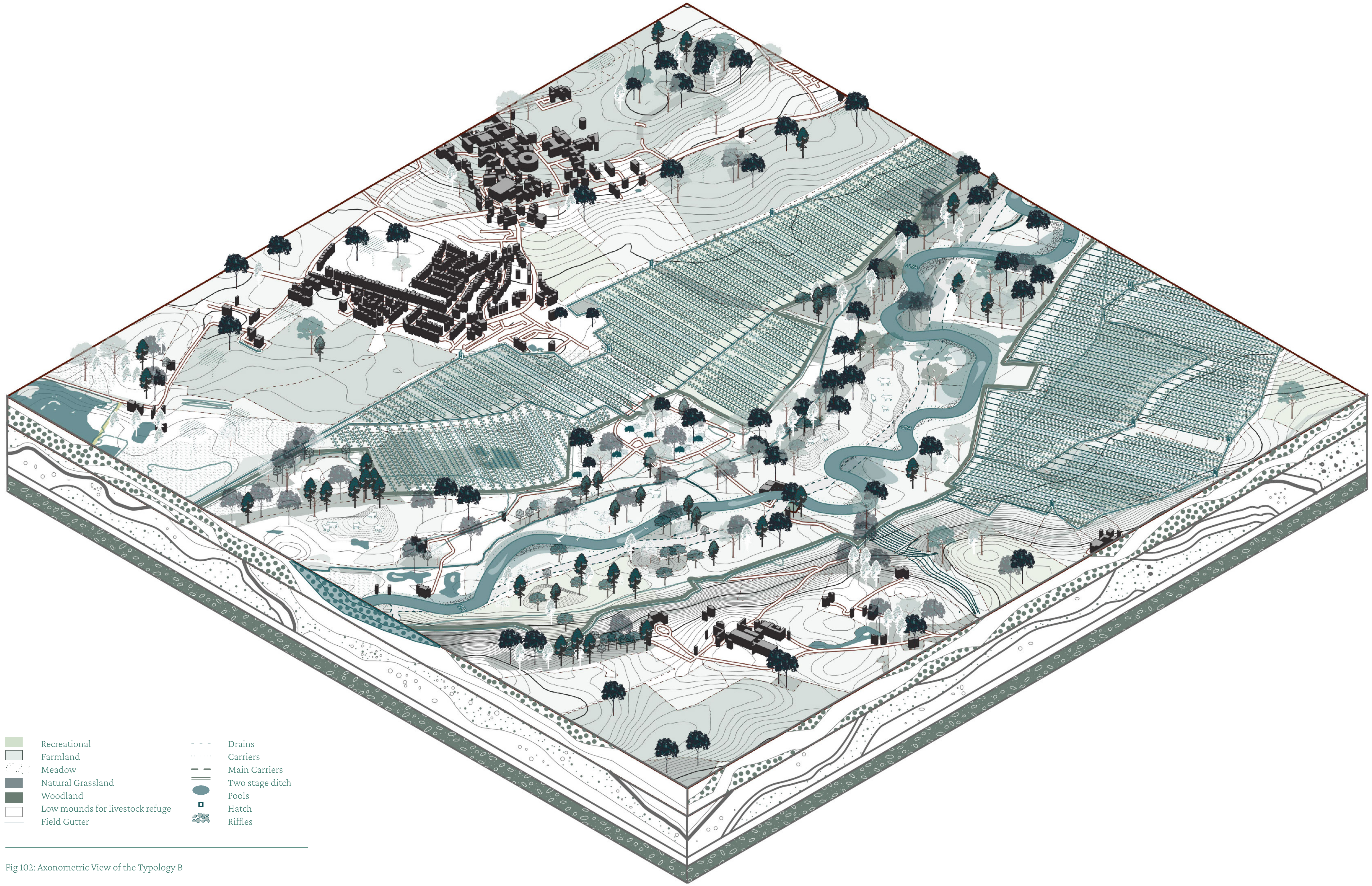
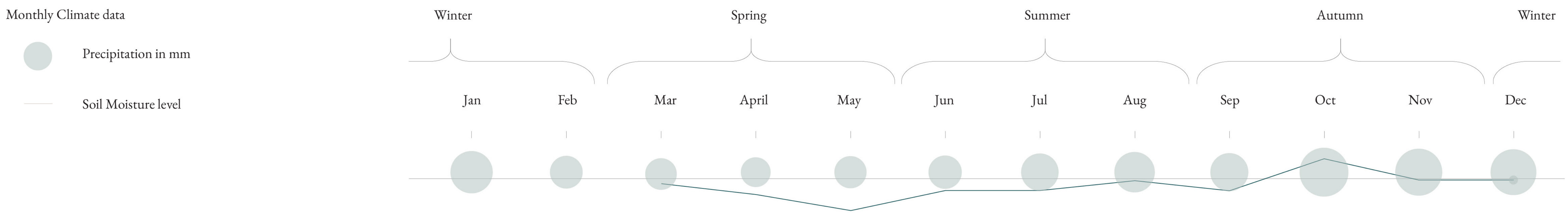


Fig 102: Axonometric View of the Typology B


Monthly Climate data
Precipitation in mm
Soil Moisture level
Winter
Spring
Summer
Autumn
Winter
Jan
Feb
Mar
April
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

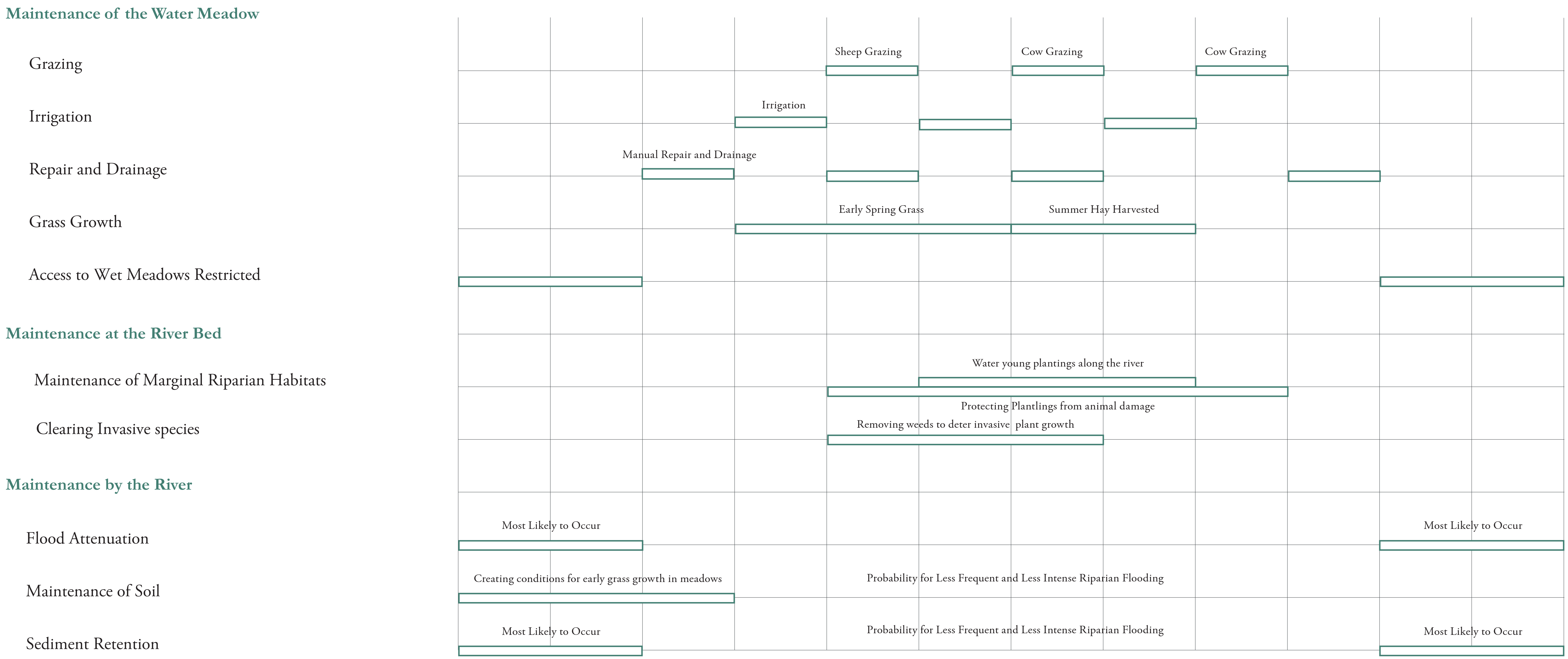

Maintenance of the Water Meadow
Grazing
Irrigation
Repair and Drainage
Grass Growth
Access to Wet Meadows Restricted
Maintenance at the River Bed
Maintenance of Marginal Riparian Habitats
Clearing Invasive species
Maintenance by the River
Flood Attenuation
Maintenance of Soil
Sediment Retention
Sheep Grazing
Cow Grazing
Cow Grazing
Irrigation
Manual Repair and Drainage
Early Spring Grass
Summer Hay Harvested
Water young plantings along the river
Protecting Plantlings from animal damage
Removing weeds to deter invasive plant growth
Most Likely to Occur
Most Likely to Occur
Creating conditions for early grass growth in meadows
Probability for Less Frequent and Less Intense Riparian Flooding
Probability for Less Frequent and Less Intense Riparian Flooding
Most Likely to Occur
Most Likely to Occur

Fig 103: Section of Remeandered Flood Plain

Legend

1 Reprofiled Banks
2 Filled in Channel
3 Earth mounds for livestock
4 Two step ditch
5 Cultivation
6 Reed Beds
7 Gravel Shoals
8 Lock
Low Flow Level
Flood Level

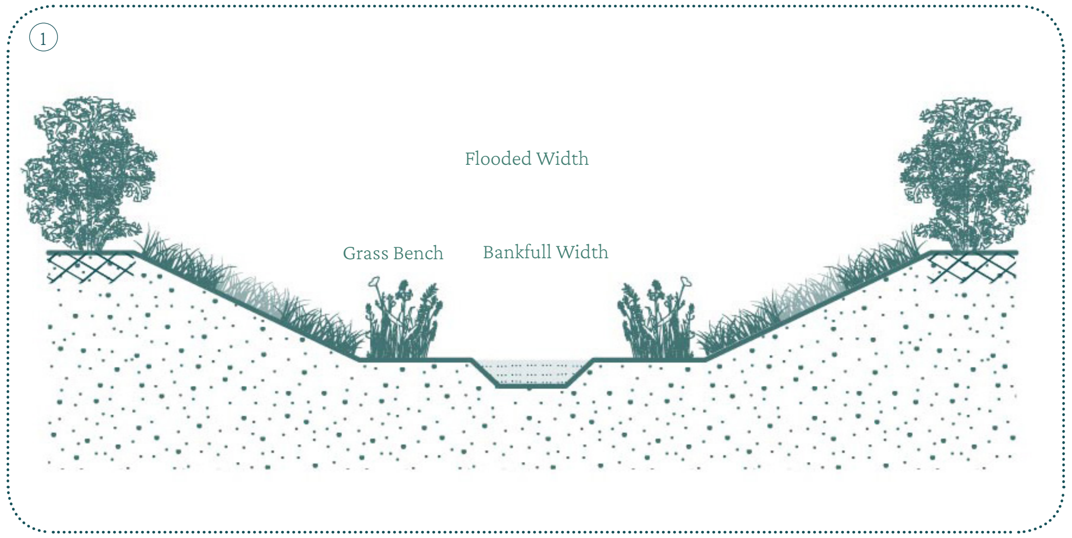


Fig 104: Details of Two Step Ditch

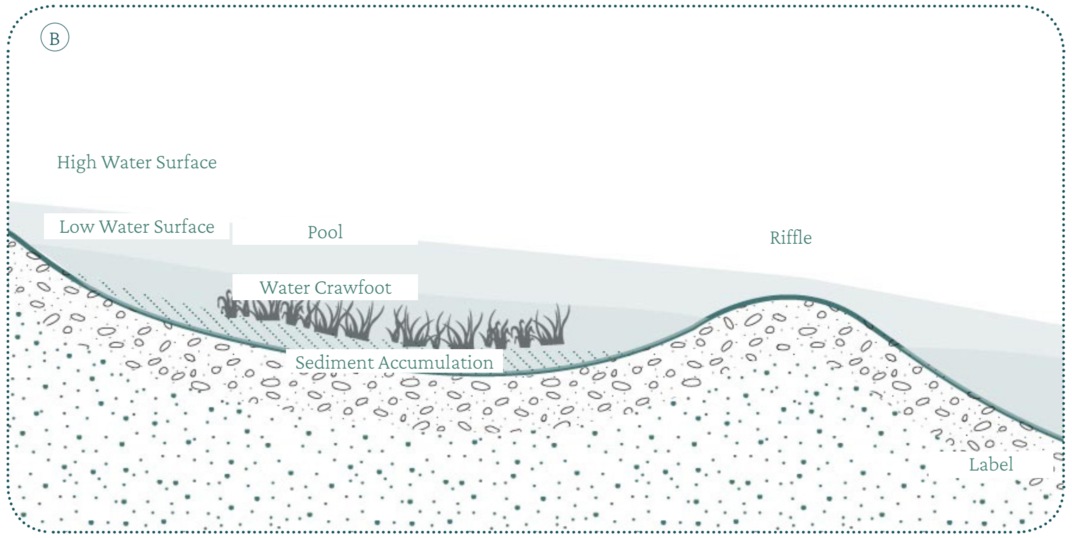


Fig 105: Contructing Riffle Pool at river bed

Traditional agricultural ditches are prone to erosion and are often unable to cope with peak flows. This degradation compromises the water quality and transforms the channel profile, which results in a need for active maintenance. A Two-Stage Drainage Ditch has a flexible conveyance capacity. The growth of grass on the inner surface of this channel improves the water quality by filtering nutrient flow and slows the runoff, thereby maintaining the channel's stability.

Riffle pool structures consists of alternating shallow and deep conditions along a river bed. The pools are areas where the river errodes the bed and this sediments are deposited at the riffle. Meandering streams are charachteristed by such formations.

This feature is an active habitat for diverse aquatic habitats. Eg. pools support trouts, mollustks and worms who prefer slow water whereas riffles support small algae and aquatic insects that can cling to rocky surfaces against fast moving water.

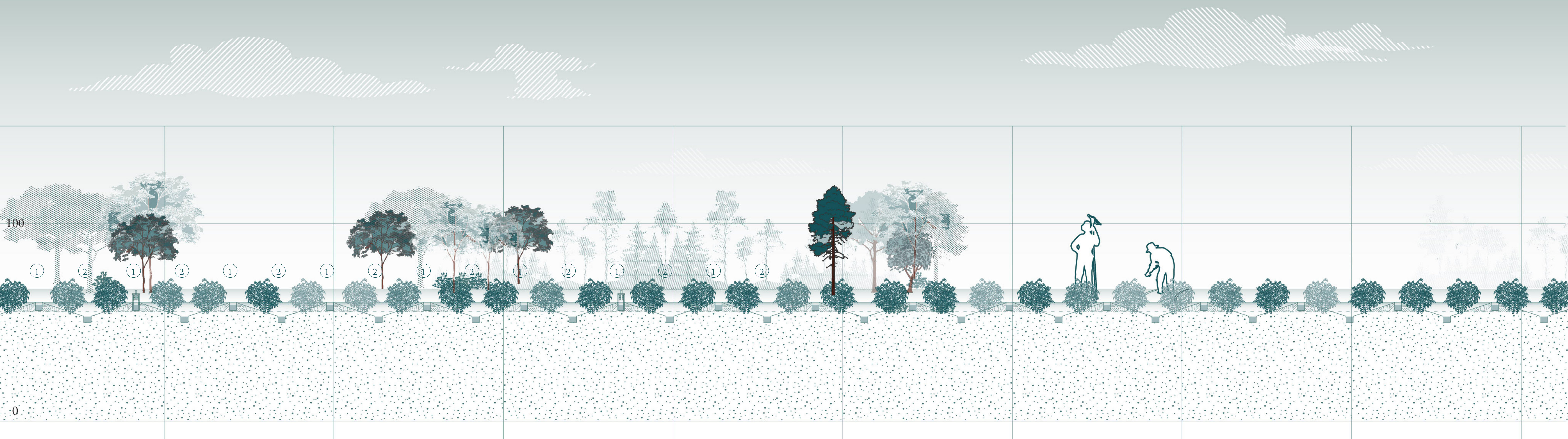


Fig 106: Section of Water Meadow

Legend

1 Carriers

2 Drains

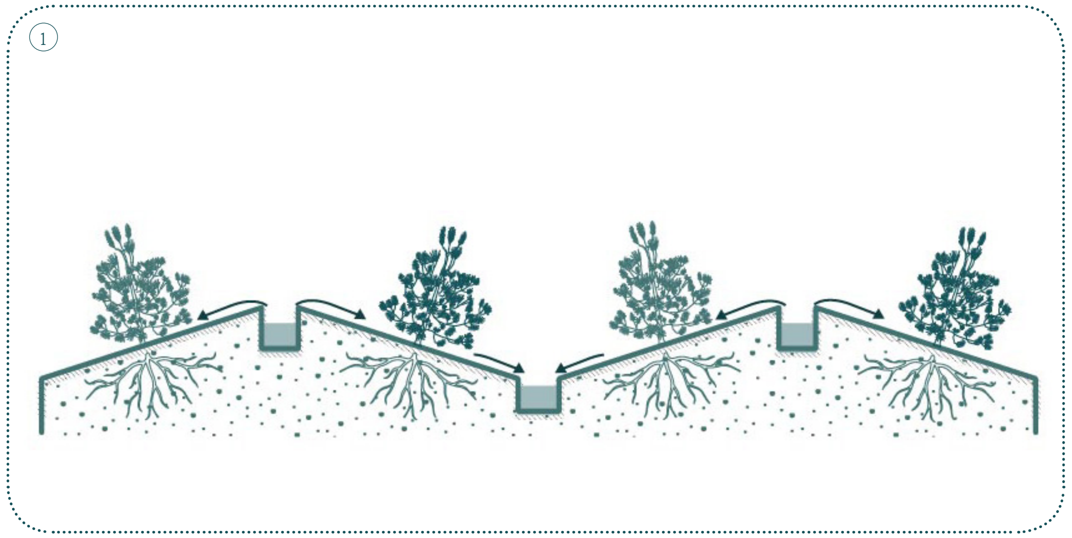


Fig 107: Details of Carriers and Drains

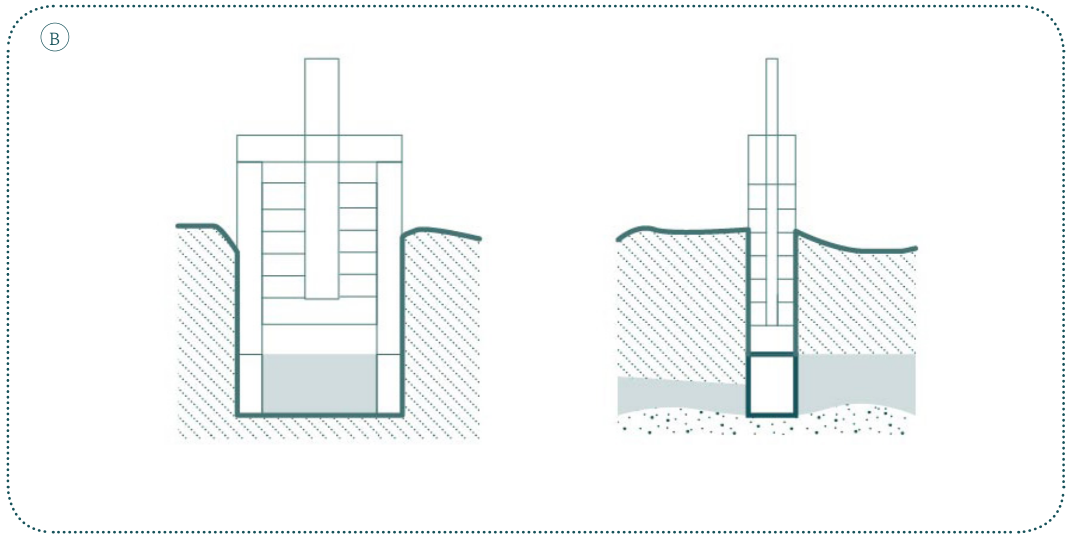


Fig 108: Details of Hatch System

Carriers and Drains are man-made channels in the bedwork of the meadow. Traditionally, water logging allows the grass to grow faster, whereas flooding kills it. The main carriers takes water from the river, and after this volume has circulated through the bed-work water returns to the river at a location further downstream through the drains

The flow of water in this system is controlled by a small hatch that when open allows the river to take an alternate path through the water meadows bedwork. It mainly consists of a 'Top Hatch' and a 'Stop Hatch'. When the goal is wet the meadow, the Top Hatch is raised and the Stop hatch is dropped. Conversely, when the meadow has to dry the Top Hatch is shut and Stop Hatch is left open.

Micro Scale : Interventions on Landscape

Earth Movements + Light Infrastructural Work : Directing Water Flows

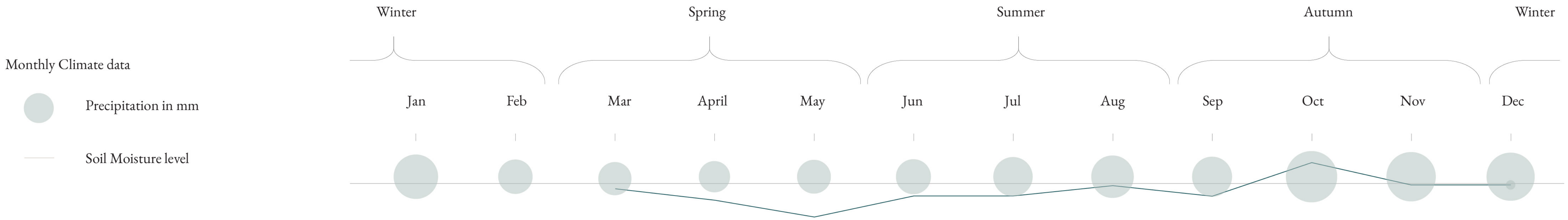
Forms of Water in the Terrain	Conveyance: Dynamic	Conveyance: Engineer	Attenuation
Terrestrial Storage		(-) Flood Water Carrier Channels (+) Constructed Slopes (-) Flood Water Drain Channels (+) Light Earthen Embankments around Settlements	(-) Flood Water Storage in Water Meadows
River Discharge	(+) Sediment Accumulation	(+) River Bed Modification (-) Reprofiling Banks with gentle slopes (+) Gravel Shoals on inner beds of meander (+) Filling in Channelised River (+) Earth Mounds for Animals (-) Sediment Traps - Trench (-) Sediment Trap - Sump	
Run Off		(+) Gravel Infill for planting	
Ground water			(-) Flood Water Seepage in Aquifers near Rivers Edges
Soil Moisture			(+) Crops in alluvial terrace zones (+) Riparian Tree Planting

(-) Excavation
(+) Fill

Vegetation Works : Filteration

Forms of Water in the Terrain	Crop Cover	Tree Cover	Pasture Cover
Terrestrial Storage		Shade from trees helps maintain river temperature	(+) Flooding of pasture cover causes early growth of summer fodder in spring
River Discharge	(-) Flood peaks flattened as flood waters are redirected and harvested by crops during heavy rainfall	Roots stabilise river banks High carbon torage in deadwood, and bio-mass in habitats along the river	
Run Off			(-) Vegetated Two stage ditch filters agricultural run off before reaching the river
Ground water		(-) Deep Roots increase infiltration capacity of the soil	
Soil Moisture	(-) Flood Waters diverted to evenly irri-gate fields in the wider flood plain		

Effect on (-) Decrease
(+) Increase
Filteration (*) Cleaning Pollution



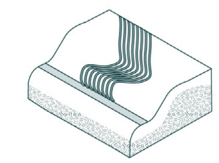
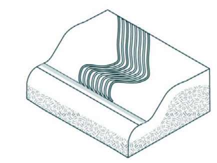
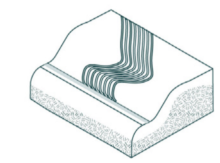
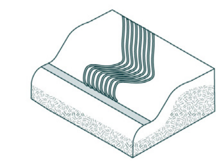
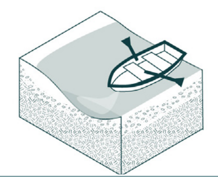
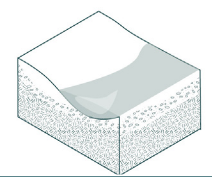
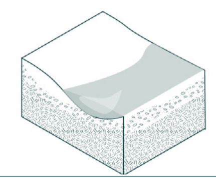
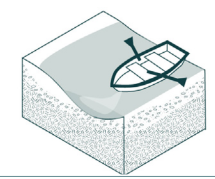
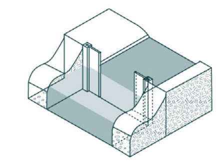
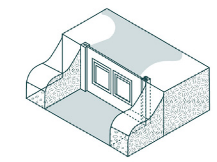
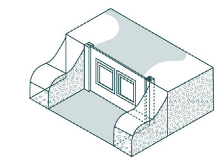
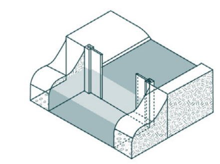
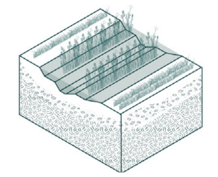
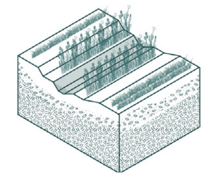
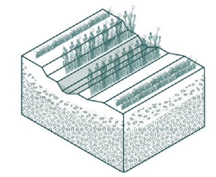
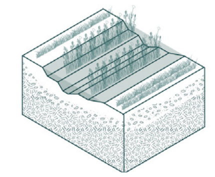
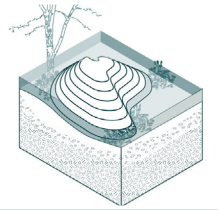
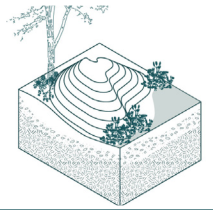
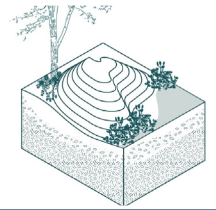
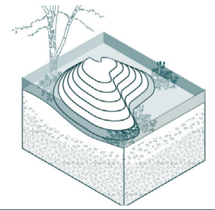
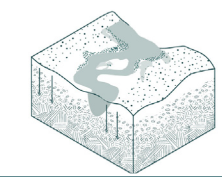
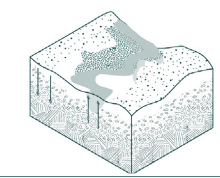
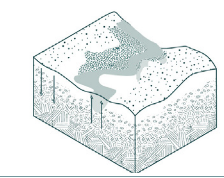
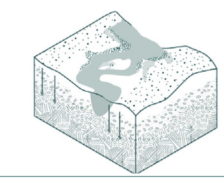
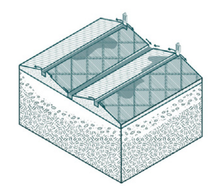
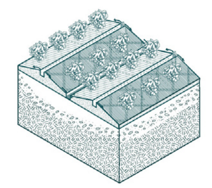
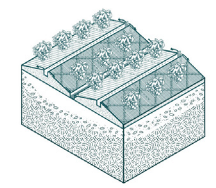
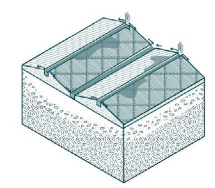
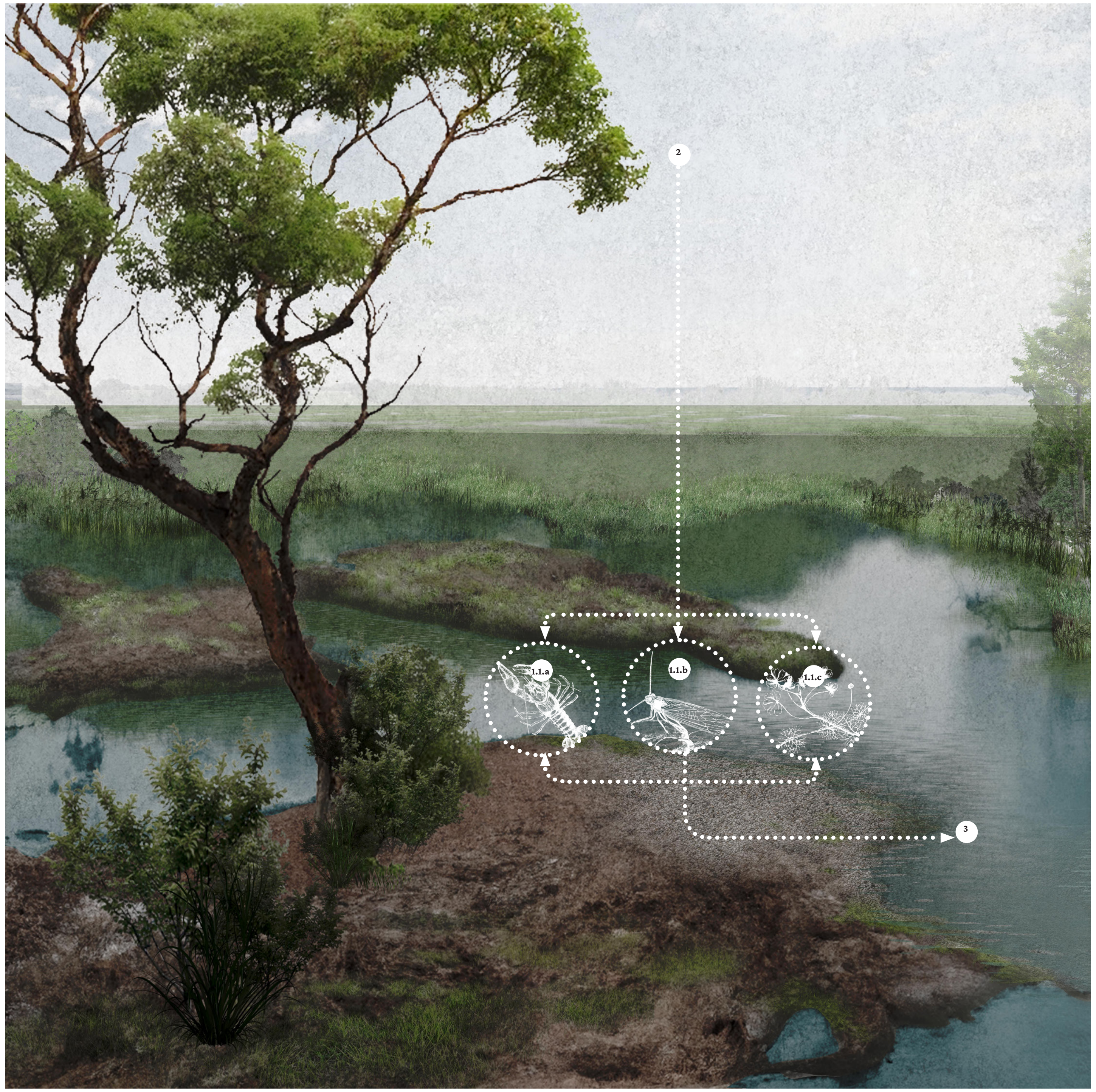
Landscape as Infrastructure		Winter	Spring	Summer	Autumn
Chanel	: Field Carriers				
Navigable Waterway	: Seasonal Flooding				
Threat to Loss of Property	: Lock and Floodable Landscape				
Source of Pollution	: Two Step Drain				
Habitat	: Livestock Earth Mounds				
Water Source	: Riparian Subsurface Recharge				
Water Source	: Water Meadow System to harvest flood water				

Fig 109: Restoring River Meander : Design for Typology B

Engineered Elements in the Landscape

Legend

1. Gravel Shoals
2. Re-profiled Banks
3. Active Flood Plain
4. Two Step Ditch
5. Reed Beds
6. Earth Mounds for Livestock
7. Riparian Trees



Altered Ecology

Legend

1 ***Biodiversity Restoration***

1.1 Threatened species that depend on chalk stream habitats are restored

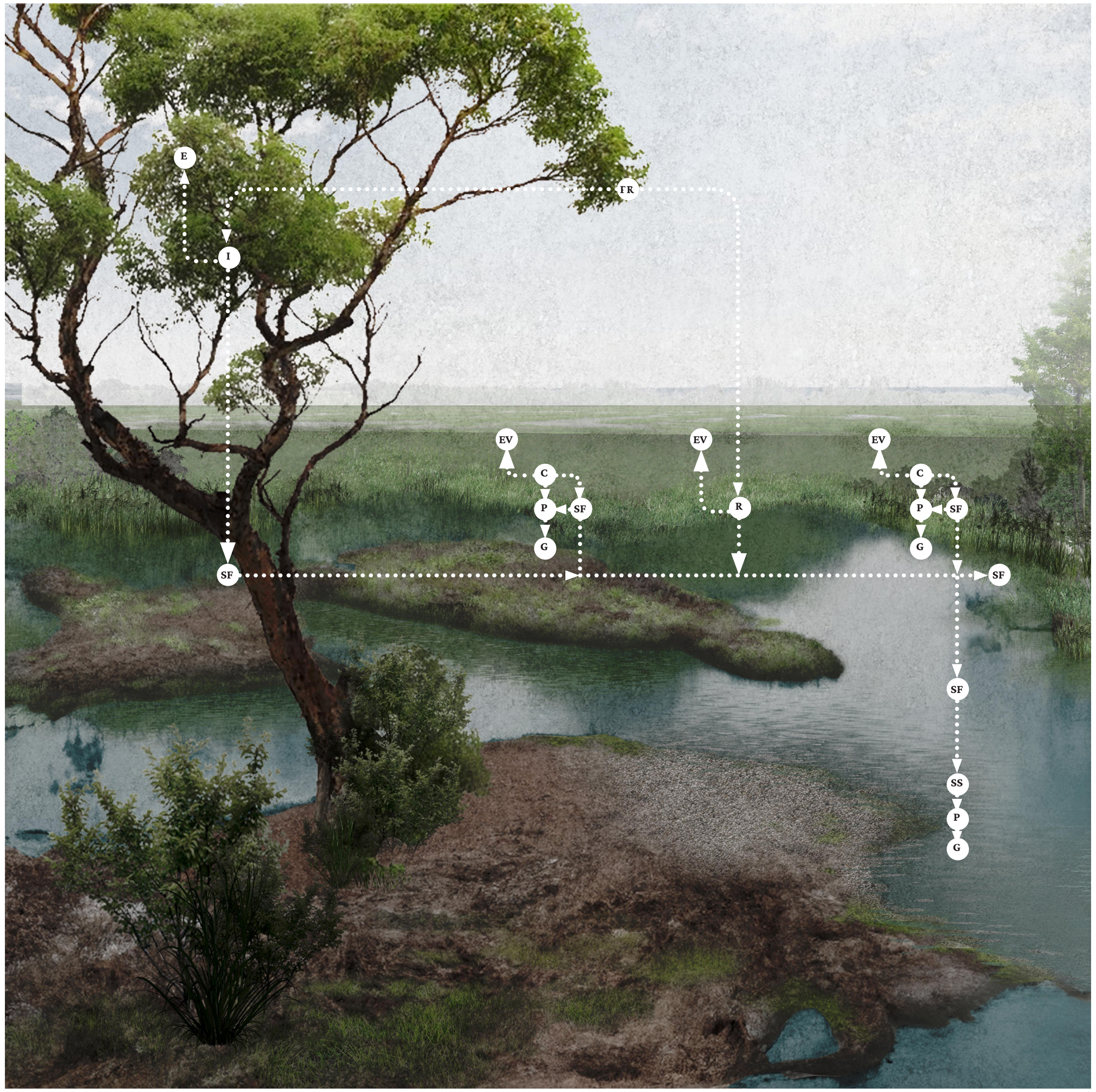
1.1.a White-Clawed Crayfish

1.1.b Winterbourne Stonefly

1.1.c Stream Water Crowfoot

2 Shade decreases water temperature and provides more time for species to adapt to changing weather conditions

3 Irregular river beds and banks allow for the thriving of aquatic biodiversity, providing hiding spots for fish, amphibians, and insects to seek refuge from predators.



Altered Hydrology

Legend

I Interception

C Conveyance

R Surface Run off

SM Soil Moisture

P Percolation

G Ground Water Storage

SS Surface Storage

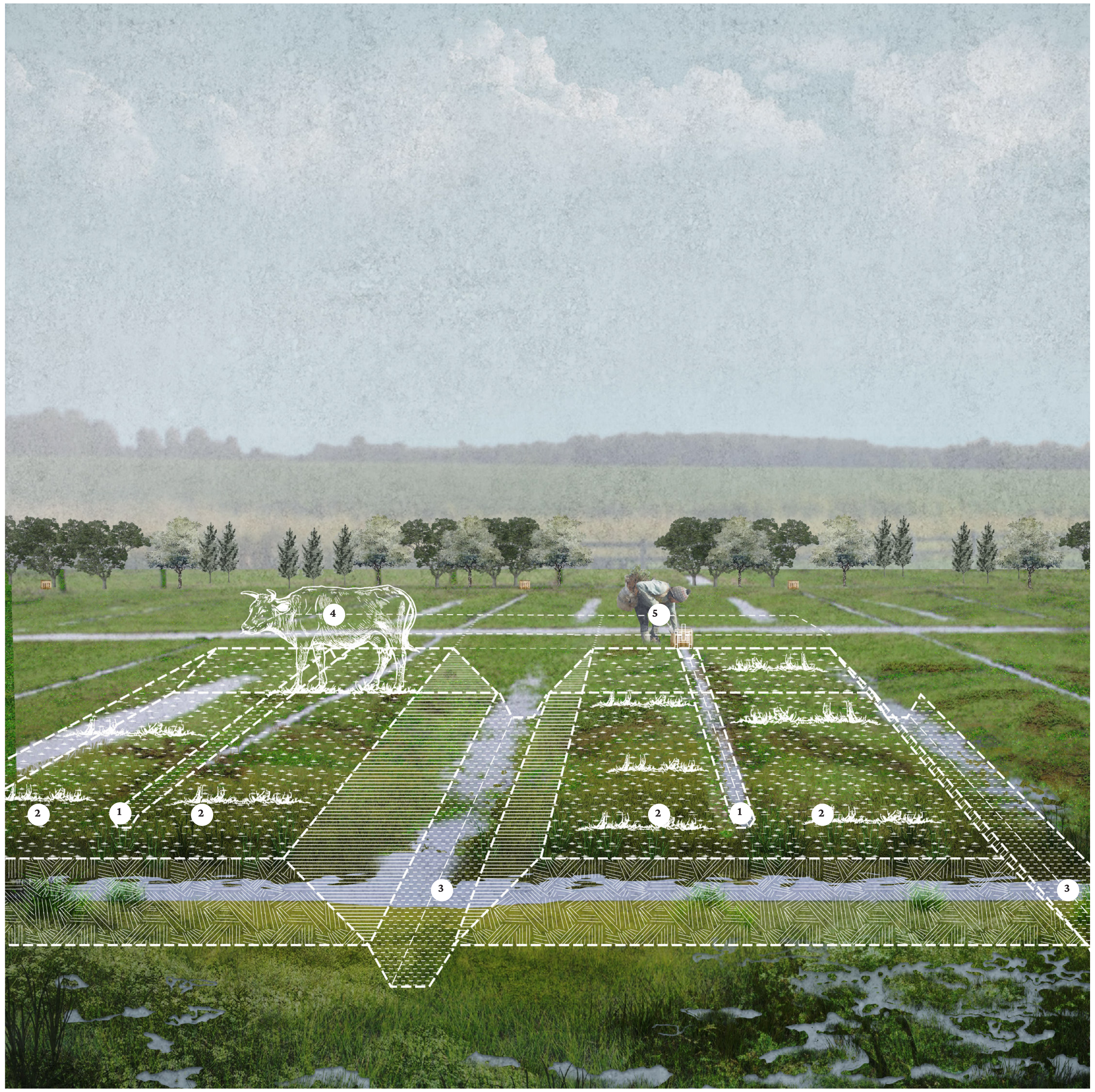
SF Stream Flow

E Evapotranspiration

P Precipitation

EV Evaporation

Fig 110: Reintroduction of Water Meadow: Design for Typology B



Engineered Elements in the Landscape

Legend

- (1) Drain Channels
- (2) Bed-work with gentle slopes
- (3) Carrier Channels
- (4) Grazing to limit weed growth
- (5) Hatch to control Conveyance

Altered Ecology

Legend

1 *Effect on Biodiversity*

1.1 Ideal breeding for wading birds and waterfowl

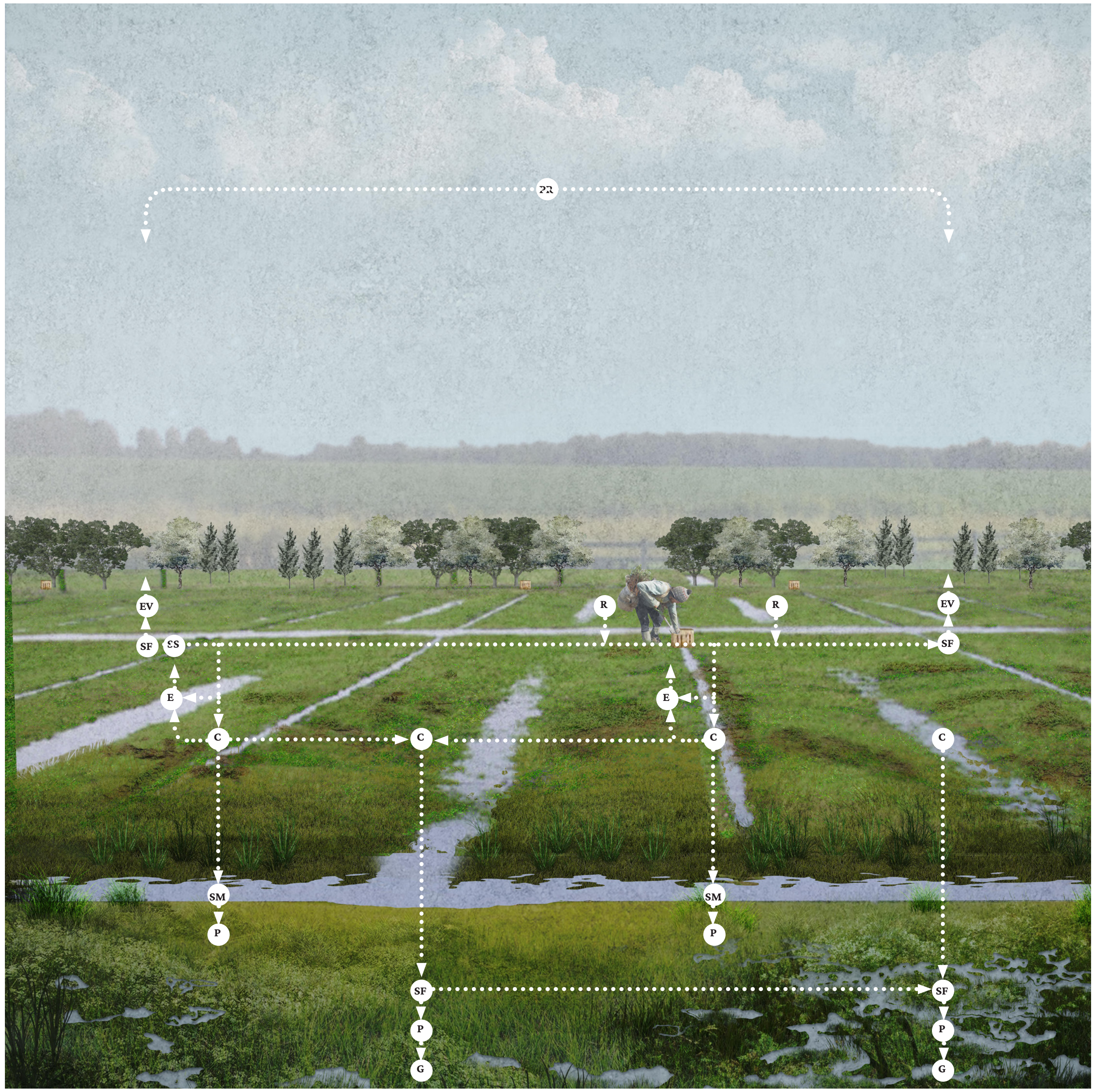
1.2 Light grazing with stock as a mode of vegetation control which benefits biodiversity

2 *Effect on Soil*

2.1 Well-maintained ditches and drains prevent soil loss erosion from uncontrolled run-off

2.2 Deposition of silt and nutrient by flowing water fertilises grass swards

2.3 Reduced eutrophication of the river water by nutrient pollution since the soil absorbs silt and nutrients



Altered Hydrology

Legend

I Interception

C Conveyance

R Surface Run off

SM Soil Moisture

P Percolation

G Ground Water Storage

SS Surface Storage

SF Stream Flow

E Evapotranspiration

PR Precipitation

EV Evaporation

9.6 Typology C

The site is characterized by the presence of the River Pang and a canal, both of which flow into the Thames. It experiences regular instances of flooding, and the water flows from the site contribute to downstream flooding along the Thames. Currently, the area is primarily grassland without any agricultural or noticeable pastoral activities taking place. In land use classification maps, the site has been designated as "Traditional Countryside."

The main design objective for the site, considering its high bedrock permeability and superficial permeability, is to improve biodiversity and restore dynamic flooding-disturbance-succession systems. Additionally, the goal is to develop infrastructure that promotes increased sub-surface infiltration and reduces the volume of water carried downstream. To achieve these objectives, the proposed strategy involves creating a floodable wetland forest.

The Role of Terrain in Water Storage : Mapping Zones of Flow Accumulation

Fig 111: River and Historic Extend of Flooding

River | Historic Flood Zones

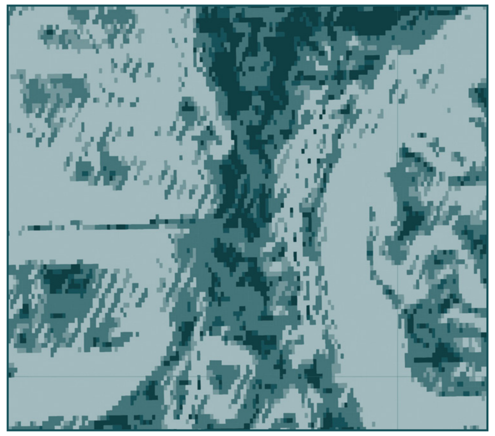


Fig 112: Topographic Wetness Index

Wetter Regions | Drier Regions

The Role of Terrain in Conveyance: Mapping Natural Water Pathways

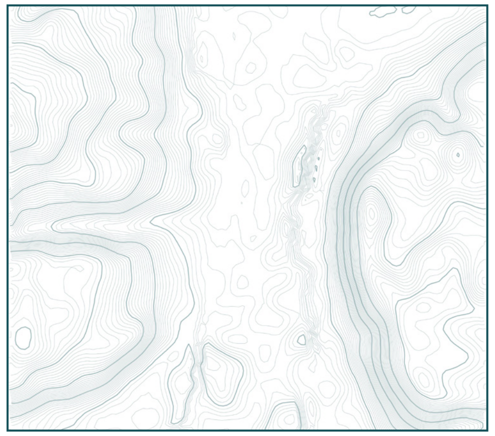


Fig 113: Natural Contours

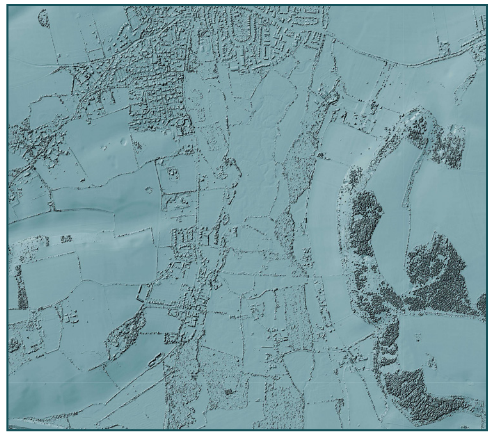
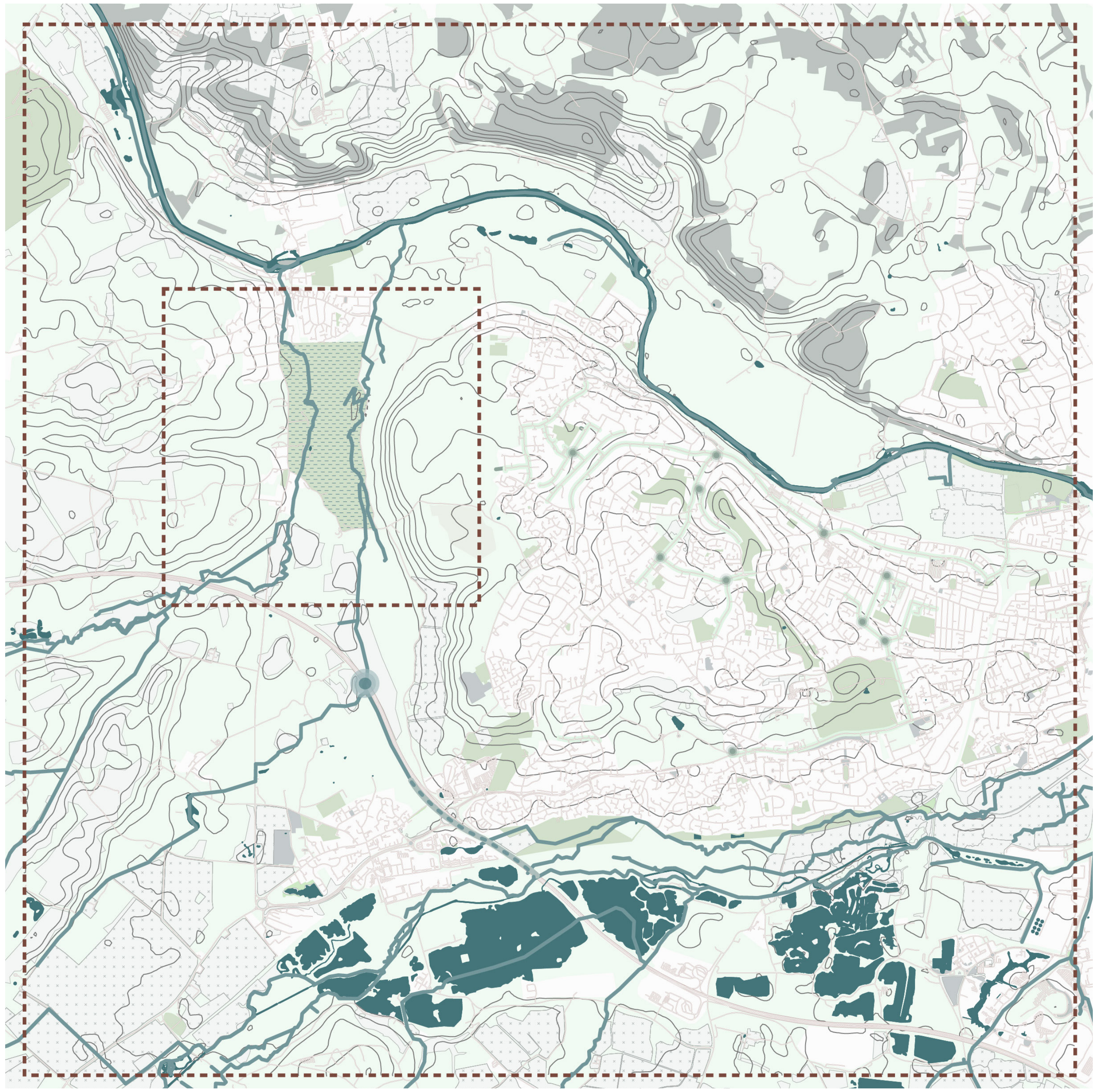


Fig 114: LIDAR Data for higher precision



Recreational
Farmland
Constructed Wetland Forest (former grassland)
Natural Grassland
Woodland

Green Network
Retrofitting Road Network for Green Infrastructure

Fig 115: Positioning Typology C within the larger context, and connecting strategies to larger networkd

Design Framework for Typology C

Key

Scale	S System	P Patch	C Corridor
1 Macro	River Basin	Sub Catchments	River Thames
2 Meso	Micro Basin	Land Use in Parcels	Streams and Tributaries
3 Micro	3km x 3km site (Typology)	Property Divison	Pathways of Water in the Terrain

Criteria for Transferability of the Project into other parts of the Site

Enhancing the Larger Basin System: The Replenishing Effects of Design Application

Primary Classification		Secondary Classification	Effect on Hydrology: Natural	Effect on Hydrology: Altered by Design	Strategy		Interscalarity of Approach: Intervention In Micro Scale	Interscalarity of Approach: Effect on Macro Scale	Design Goals from Typology Classification
Natural Terrain	Corridors	Shallow Valley Deeply incised Stream U shaped Valleys	Conveyance - Natural Pathways for Water	Preserving Pathways carrying Run off into the Flood plains			C3 Intervention redirects flood water and run off along floodplain	C1 Phytoremediation of urban run o	Restoring Dynamic flooding-disturbance-succession systems
	Patches	Plains	Attenuation - Water Accumulates						
	Edges	High Ridges Mid Slope Ridges Local Ridges Upper Slopes	Conveyance - Diverts Water Flow	Emankments along plains to prevent flooding					
Geology	Superficial Layer		High Superficial Permeability				S3 Diverse wetland habitat created at the suface	S1 Flooding at active plain increases sub-surface recharge	Infrastructure to Increase Sub Surface Infiltration
	Bedrock Layer		High Bedrock Permeability						
Riverine System	Effect on Fluvial Morphodynamics			Increased Localised Flooding Reduced Flood Peak Downstream					
	Role of Existing Infrastructure in Water Management in the Basin	Chanel Water Source Habitat			Bioturbation Pathways Wetland Aquifer Recharge Increased Evapotranspiration in Forest Earth Mounds for Trees Preservation of Hyporheic Zone	Re-Meandering the River	P3 Imropoved local biodiversity and wetland ecology with changing flooding cycles	P1 Multi-specie partnership for water control	Improving Biodiversity
Urban System	Transportation Networks	Transportation Networks Parking Sidewalks Paths	Conveyance= Diverts Water Flow			Constructing a Wetland Forest	S3 Flood water and run off redirected from adjacent sites	S1 Reduced flood peak downstream Contributes to active carbon sequestration	Reduces volume of water being carried downstream
	Land Use	Traditional Countryside		Wetland Ecosystem Creation					

Strategy : Wetland Forest

Forest Hydrology

The interactions between floodplain woodlands and the fresh-water environment have important implications for habitat restoration and hydrology. Floodplain woodlands serve as valuable habitats and play a role in flood and pollution control. By utilizing natural materials like fallen trees, these woodlands create lightly engineered features that temporarily store floodwater, slowing down the downstream flow of flood peaks. Restoring these lost habitats aligns with the goals of the UK Biodiversity Action Plan.

Forests, including floodplain woodlands, have a significant impact on the hydrological cycle and contribute to the natural supply of fresh water. Research indicates that around one-third of the world's largest cities rely on forested protected areas as a major source of drinking water. When considering distant protected forested watersheds and other forests managed for their water-providing functions, this proportion increases to approximately 44%. This highlights the crucial role forests play in maintaining water resources (Stolton and Dudley, 2007).

Intersection of Ecology and Hydrology

Floodplain woodlands are dynamic habitats that undergo constant changes. They typically consist of 30-70% tree cover and include open floodplain areas, as well as diverse dry and wet habitats such as scrub, reedbeds, and ponds. Wet woodlands, in particular, are rare in Britain and face the risk of extinction. They are important for supporting a wide range of species, both generalist and specialist, as they combine elements of different habitats into a functioning ecosystem (Water for Wildlife, UK).

The process of rewilding, which involves restoring natural habitats and promoting species diversity, has visible impacts on landscapes and appeals to our romantic notions of a well-functioning world. However, the benefits of rewilding go beyond aesthetics. Rewilded areas can contribute significantly to carbon sequestration, reducing stress on groundwater resources, and enhancing recharge (La Touche, 2021).

Bio Turbation

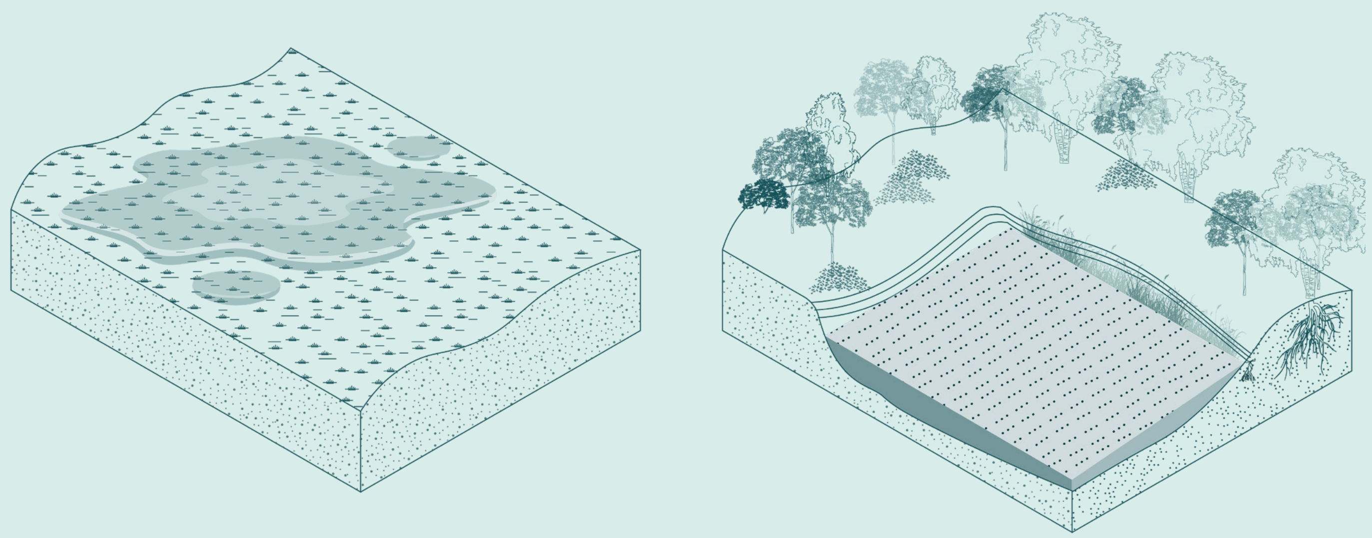
One of the physical role of the organisms as 'ecosystem engineers' (Jones, Lawton & Shachak, 1994), is called bioturbation when their activities contribute to the redistribution and reworking of soil and sedimaents. The exact extent of these effects has not yet been quantified and parametrized but this is a growing area of study among ecologists and hydrologists alike.

An example of these growing hypothesizes was in a study that looked into the effect that red deer in England had on the hydrology of reedbeds. Water samples were taken from zones that showed dense deer tracks connected wet woodlands and ponds to the reedbed system. It is hypothesized that the bioturbation of sediments along these tracks may show higher concentrations of nitrate, phosphate, and ammonia. These nutrients increase the growth of aquatic plants like macrophytes wahich are vital to maintaining wetland conditions (Tugwell, 2023).

The Hyporheic Zone

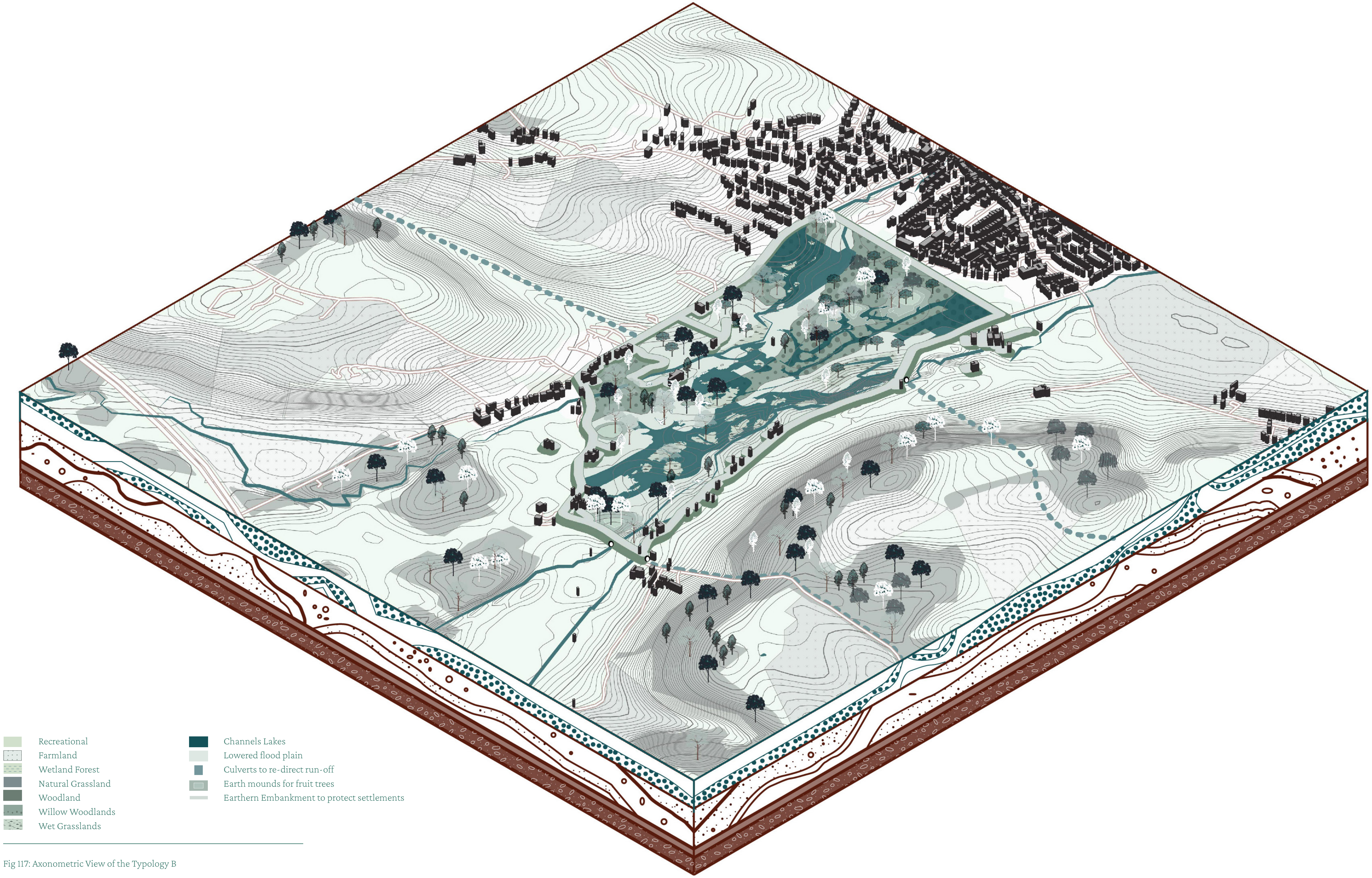
The Hyporheic Zone is an ecotone (a transitional zone between different ecosystems) that bridges the river with the subsurface. The Hyporheic zone is also a region of intense material and energy and transfer. It is here that the shallow groundwater intermixes with the river and anthropogenic modifications of the river bed have led to it being the "lost vertical linkages with groundwater".This zone is often not considered in river rehabilitation strategies, which are focused on floodplain features (Boulton, 2007) but it plays an important role in freshwater recharge.

Research on restoring vertical connectivity at this zone (Boulton, 2007) highlights the importance of acknowledging even the tiniest species that contribute to its maintenance. These species include hyporheic invertebrates that have an impact on the proliferation of microbial activity and the decomposition of organic matter in steam ecosystems. Small benthic invertebrates like Meifauna even contribute to the breakdown of leaf litter. What sets these species apart is their ability to substantially move vertically, laterally, and downstream and this movement facilitates the transfer of matter and energy in the hyporheic zone. In addition to energy and nutrient transfer, they are also an important food source for predators in the surface water.



Without Intervention	Through Intervention
Altered hydrology affects ability to sequester carbon and may even emit green house gasses.	Wetland Eco-systems have accelerated plant growth and slower decomposition rates thus improving carbon storage. Improved nutrient cycling and water quality Flood regulation through recharging groundwater Distribution of aquatic and terrestrial floodplain habitats from changing hydrological regimes, sustains diverse habitats.

Fig 116: Overview of how the strategy effect the hydrology of the site



Recreational	Channels Lakes
Farmland	Lowered flood plain
Wetland Forest	Culverts to re-direct run-off
Natural Grassland	Earth mounds for fruit trees
Woodland	Earthern Embankment to protect settlements
Willow Woodlands	
Wet Grasslands	

Fig 117: Axonometric View of the Typology B

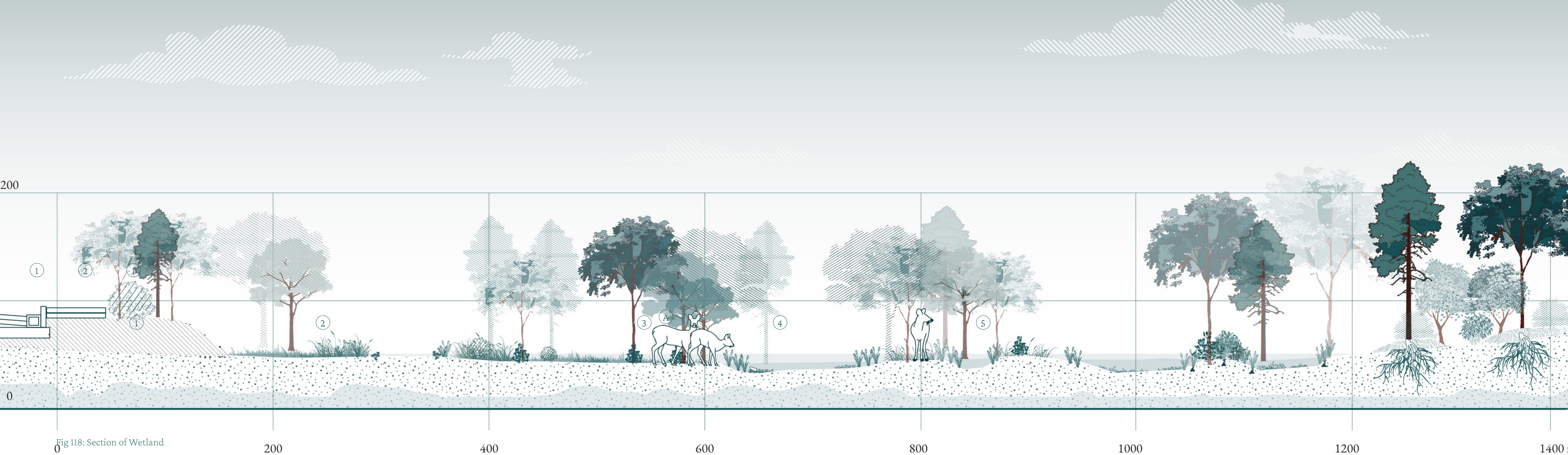


Fig 118: Section of Wetland

Legend

Low Flow Level
Flood Level
(1) Embankments
(2) Flood Meadow grassland
(3) Re-introduction of species for Bio-turbation
(4) Deep Channels with shallow margin
(5) Lake with shallow and aquatic vegetation

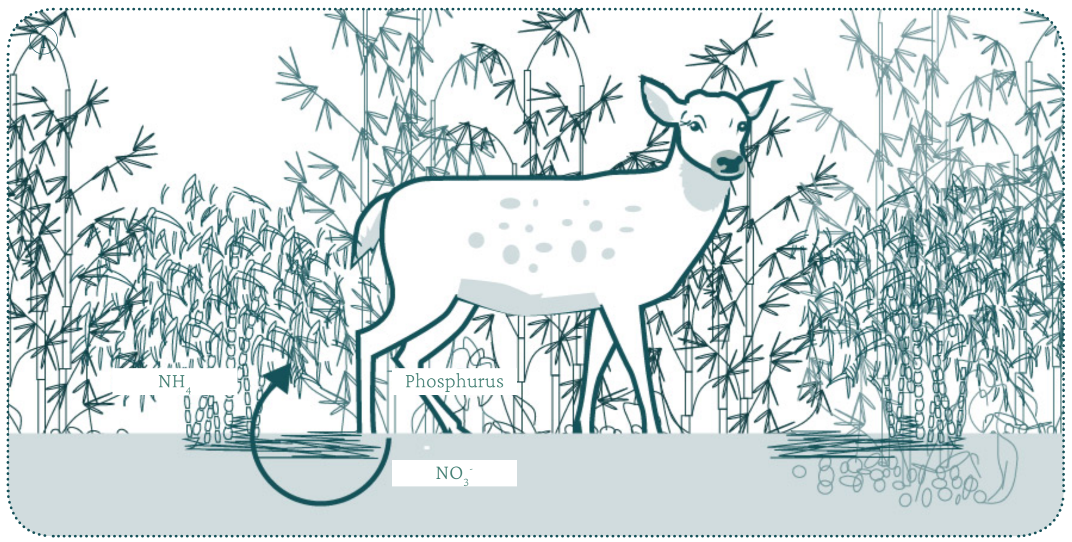


Fig 119: Effect of Bio turbation

The creation of deer tracks provides a pathway that connects different habitats on the site. Their activity is a form of bio-turbation that increases nutrient transfers like ammonia, phosphorus, and nitrates between wetland plants and animals which is vital to sustaining the wet woodland ecosystem.

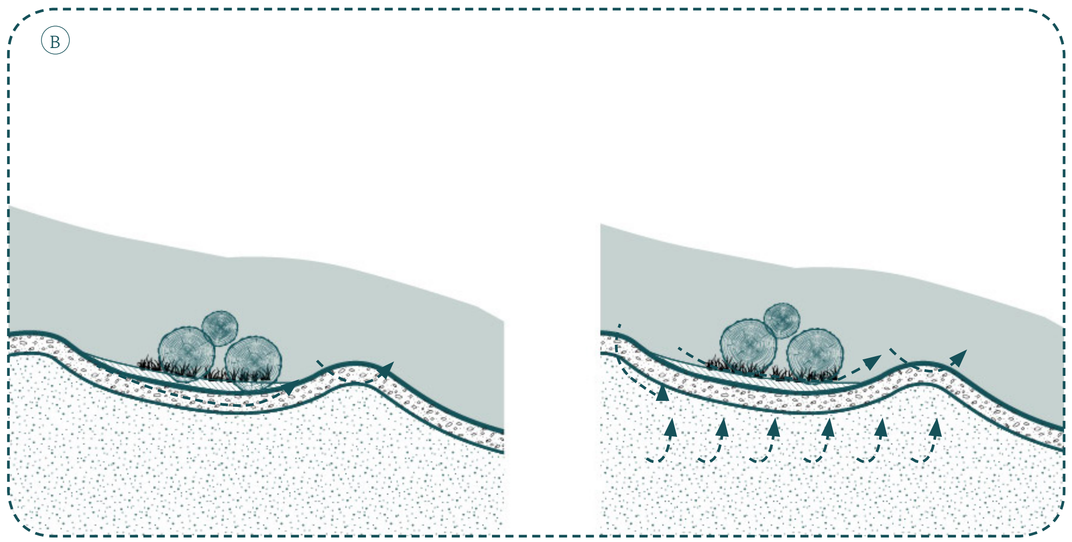
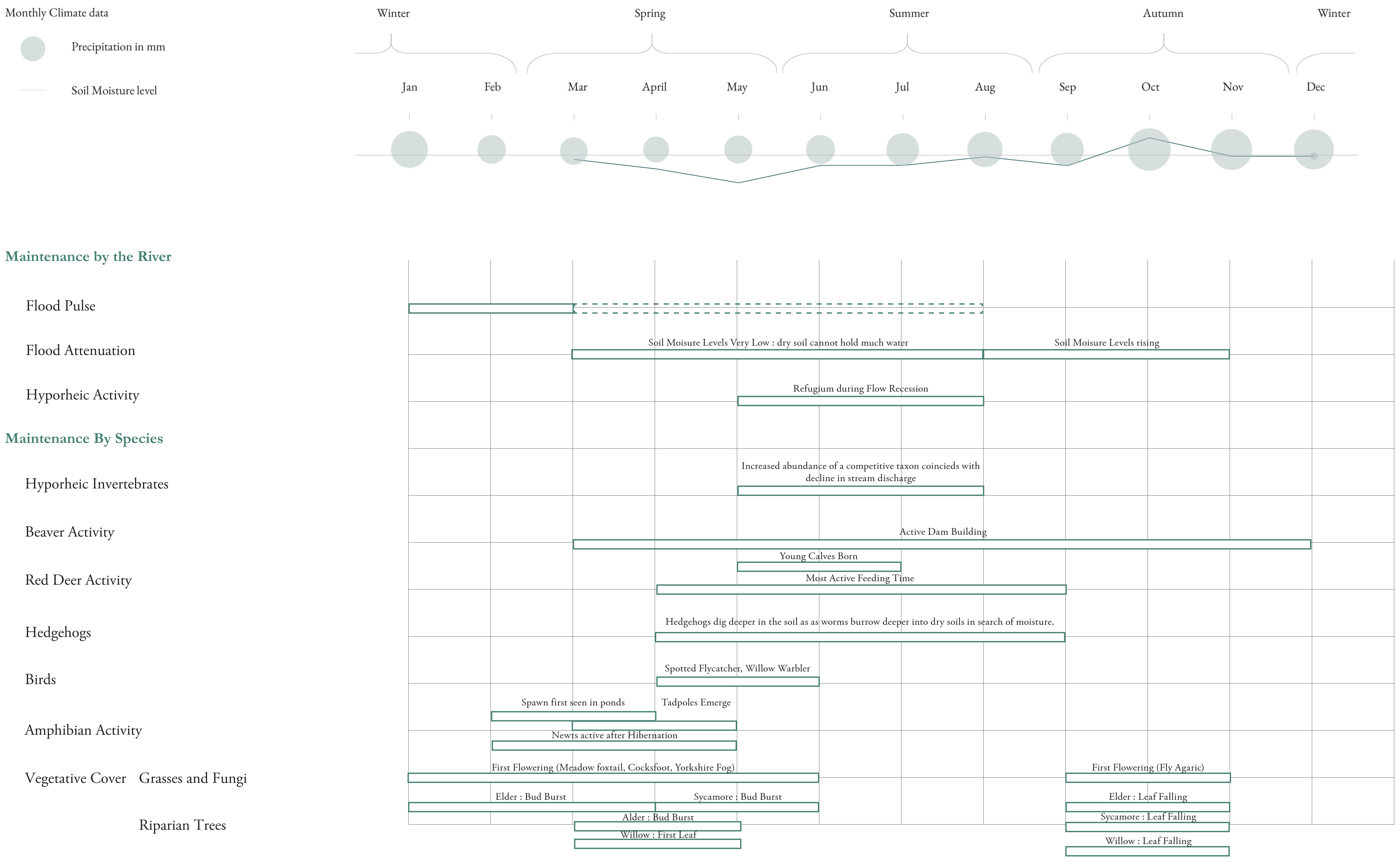


Fig120: Effects on Hyporheic Zone

Large wood that falls on the flood plain has an effect on hyporheic exchange flows which varies in upland and lowland rivers. Since the site is on a low-lying alluvial terrace, the natural fall of trees and braches in this floodable zone would improve subsurface exchanges (Adapted from Krause et al., 2014).


Monthly Climate data
Precipitation in mm
Soil Moisture level
Winter
Spring
Summer
Autumn
Winter
Jan
Feb
Mar
April
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Maintenance by the River
Flood Pulse
Flood Attenuation
Soil Moisture Levels Very Low : dry soil cannot hold much water
Soil Moisture Levels rising
Hyporheic Activity
Refugium during Flow Recession
Maintenance By Species
Hyporheic Invertebrates
Increased abundance of a competitive taxon coincieds with decline in stream discharge
Beaver Activity
Active Dam Building
Red Deer Activity
Young Calves Born
Most Active Feeding Time
Hedgehogs
Hedgehogs dig deeper in the soil as as worms burrow deeper into dry soils in search of moisture.
Birds
Spotted Flycatcher, Willow Warbler
Amphibian Activity
Spawn first seen in ponds
Tadpoles Emerge
Newts active after Hibernation
Vegetative Cover
Grasses and Fungi
First Flowering (Meadow foxtail, Cocksfoot, Yorkshire Fog)
First Flowering (Fly Agaric)
Riparian Trees
Elder : Bud Burst
Sycamore : Bud Burst
Alder : Bud Burst
Willow : First Leaf
Elder : Leaf Falling
Sycamore : Leaf Falling
Willow : Leaf Falling

Micro Scale : Interventions on Landscape

Earth Movements + Light Infrastructural Work : Directing Water Flows

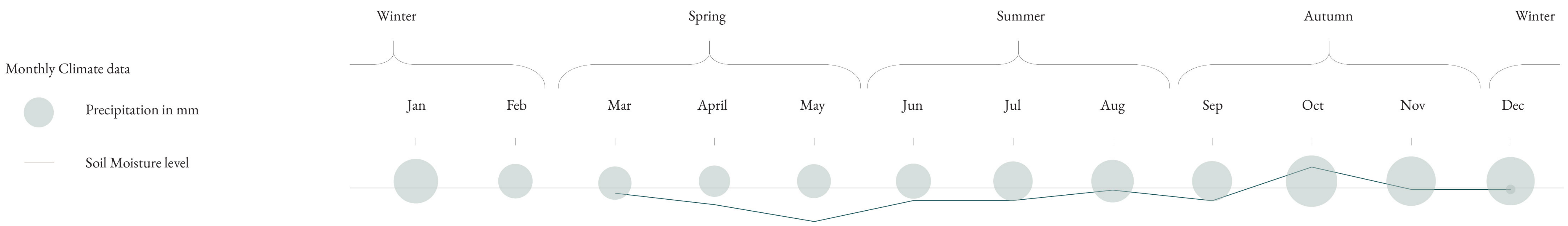
Forms of Water in the Terrain	Conveyance: Dynamic	Conveyance: Engineer	Attenuation
Terrestrial Storage		(-) Shallow Channels (+) Constructed Slopes (+) Light Earthen Embankments around Settlements	(-) Flood Water Storage in Floodable ponds and channels
River Discharge	(+) Sediment Accumulation	(+) River Bed Modification (-) Reprofiling Banks with gentle slopes (+) Earth Mounds for Animals	(-) Flood peaks flattened as flood waters are redirected around the site and infiltrated
Run Off		(+) Channels to redirect run off	
Ground water			(*) Flood Water Seepage in Aquifers near Rivers Edges
Soil Moisture			

(-) Excavation
(+) Fill

Vegetation Works : Filteration

Forms of Water in the Terrain	Crop Cover	Tree Cover	Pasture Cover
Terrestrial Storage		Shade from trees helps maintain river temperature	(+) Seasonal flooding patterns allows different species to thrive
River Discharge		Roots stabilise river banks High carbon torage in deadwood, and bio-mass in habitats along the river	
Run Off			(*) Wetland plants to filter run off feeding into the sites
Ground water		(-) Deep Roots increase infiltration capacity of the soil	
Soil Moisture	(+) Flood Waters diverted across wood-land forest		

Effect on (-) Decrease
(+) Increase
Filteration (*) Cleaning Pollution



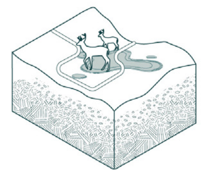
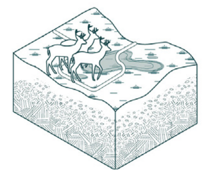
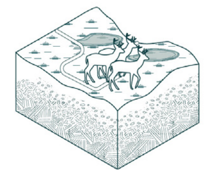
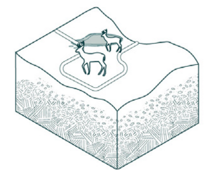
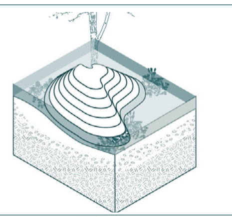
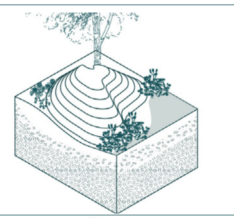
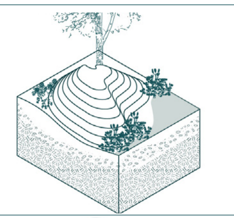
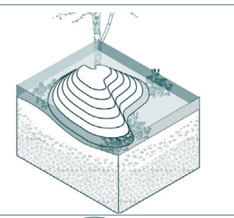
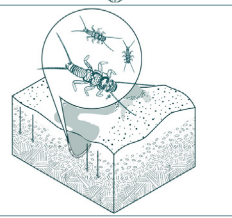
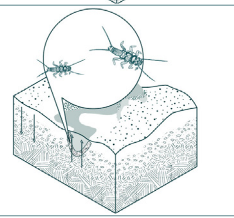
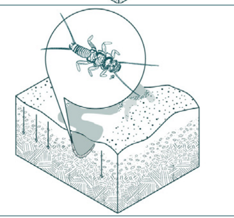
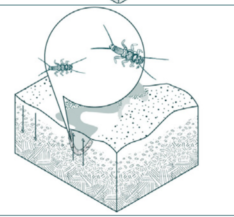
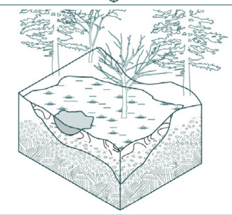
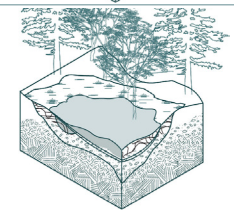
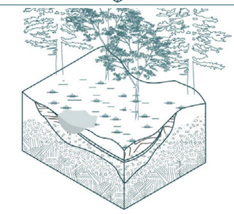
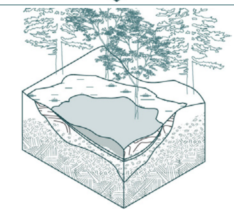
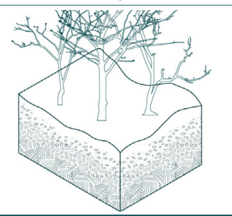
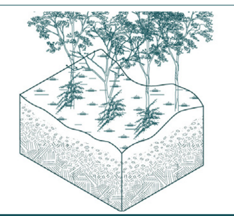
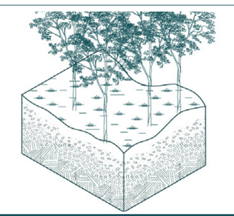
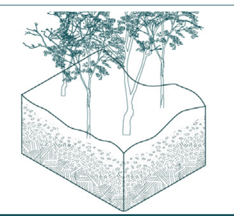
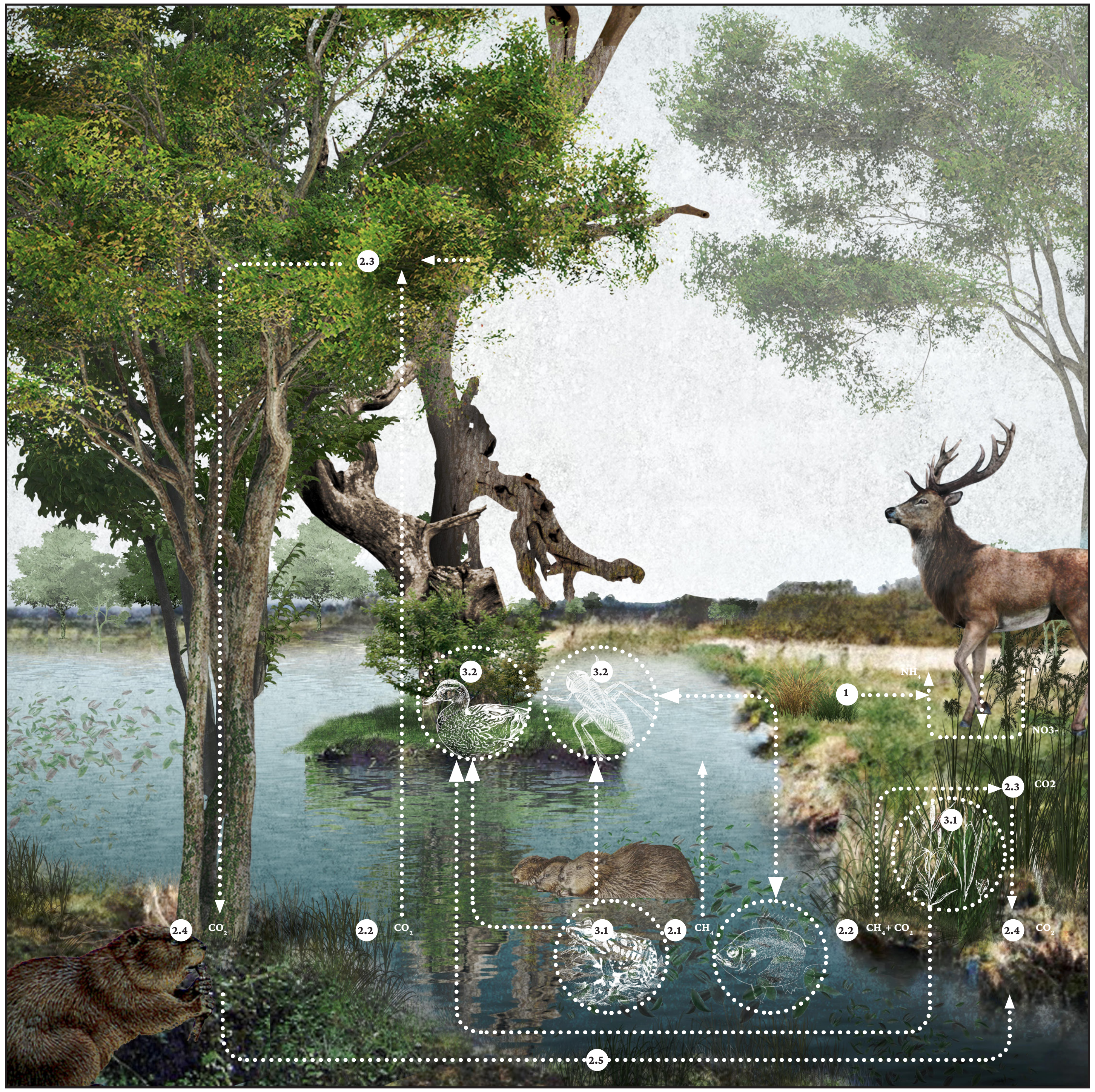
Landscape as Infrastructure		Winter	Spring	Summer	Autumn
Chanel	: Bioturbation Pathways				
Habitat	: Earth Mounds for Trees				
Habitat	: The Hyporheic Zone				
Water Source	: Wetland Ecosystem as aquifer recharge zones				
Water Source	: Woodland in driving evapotranspiration				

Fig 121: Rewilding the Floodplain : Design for Typology C

Engineered Elements in the Landscape

Legend

1. Reed Beds
2. Re-profiled Banks
3. Re-introduction of Beavers
4. Re-profiled Banks along floodplain to harvest flood water
5. Control of Red Deer Population
6. Mounds for Wetland Trees
7. Riparian Trees
8. Seasonal Wetland



Altered Ecology

Legend

1 Bioturbation

2 ***Carbon Cycling***

2.1 Decomposition of organic matter

2.2 Disturbance of wetland soil hydrology releases carbon

2.3 Photosynthesis

2.4 Sequestration into the soil

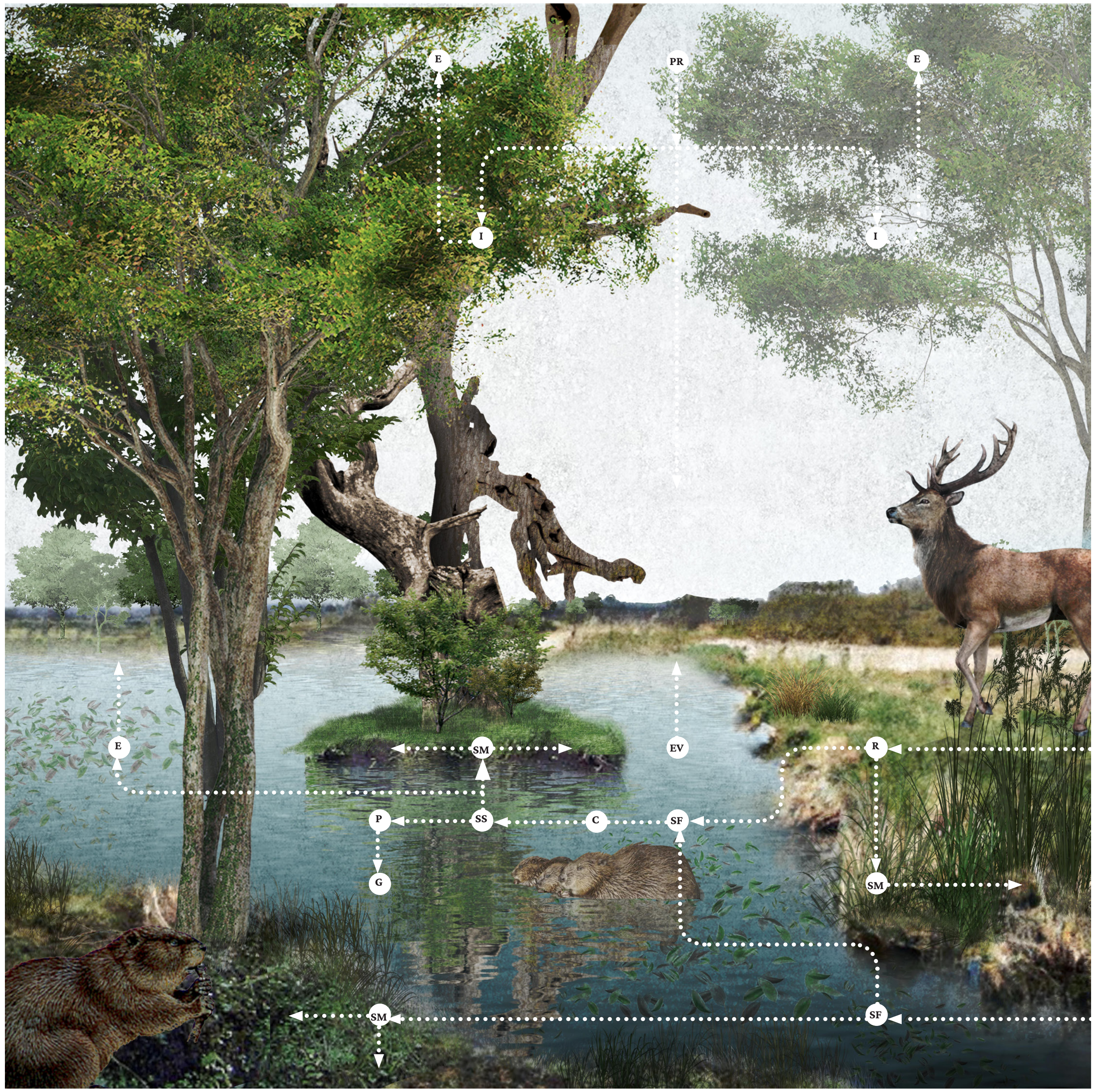
2.5 Carbon Storage

3 ***Trophic Interactions***

3.1 Gentle slope along wetland margins promotes amphibian abundance

3.2 Water level fluctuations facilitates species coexistence and promotes high biodiversity.

3.3 Trophic Interactions showing direction of energy flow



Altered Hydrology

Legend

I Interception

C Conveyance

R Surface Run off

SM Soil Moisture Distribution

P Percolation

G Ground Water Storage

SS Surface Storage

SF Stream Flow

E Evapotranspiration

PR Precipitation

EV Evaporation

9.7 Terra Fluxus: Indeterminacy in Design

James Corners definition of landscapes in his essay Terra Fluxus (Waldheim & Corner, 2006) challenges the notion of 'pristine wilderness' and emphasizes that human occupation has played a reciprocal role in shaping the land and its natural processes. This perspective acknowledges the interplay between human activities and the environment. he identifies the essence of landscape urbanism as the development of an ecology that unfolds over space and time and one thaat that integrates all forces and agents operating within the urban realm as interconnected networks. It perceives the surface as an ecology composed of various systems and elements, which interact in diverse ways.

Corner identified four provisional themes in landscape urbanism. Firstly, 'processes over time' draws inspiration from ecology, highlighting the importance of our relationship with the environment in shaping urban spaces. Secondly, 'the staging of surfaces' prioritizes horizontal elements over vertical structures. Thirdly, 'the operational or working method' encourages designers to adapt their respresentation techniques to the specific context they are working in. Finally, 'the imaginary' promotes the creation of spaces that extend new possibilities and sets the stage for indeterminacy.

The primary goal of my project is to utilize the landscapes of the countryside as active elements in engaging with the hydrology of the basin. To accomplish this, my interventions specifically target the flood plains and valleys, which serve as the primary staging ground for various processes. Alongside adapting to seasonal changes, it is crucial for this area to anticipate and adapt to future transformations in the surrounding landscapes and urban settlements.

The second set of maps serves as an alternative representation, focusing on the staging of surfaces to emphasize the horizontal relationships between different elements within the design. This approach highlights how these surfaces contribute to effective hydrological management and demonstrates the site's capacity to adapt to the dynamic nature of floodscapes.

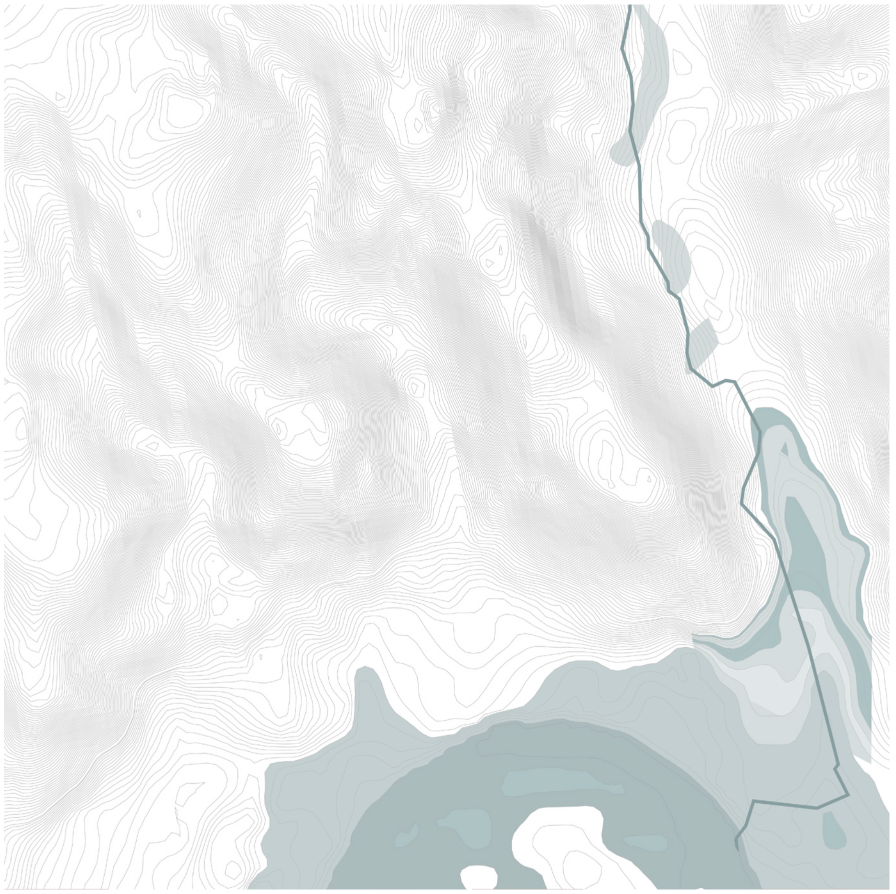


Fig 122: Floodscapes in Typology A : Seasonal Indeterminacy

Fig 123: Floodscapes in Typology B : Seasonal Indeterminacy

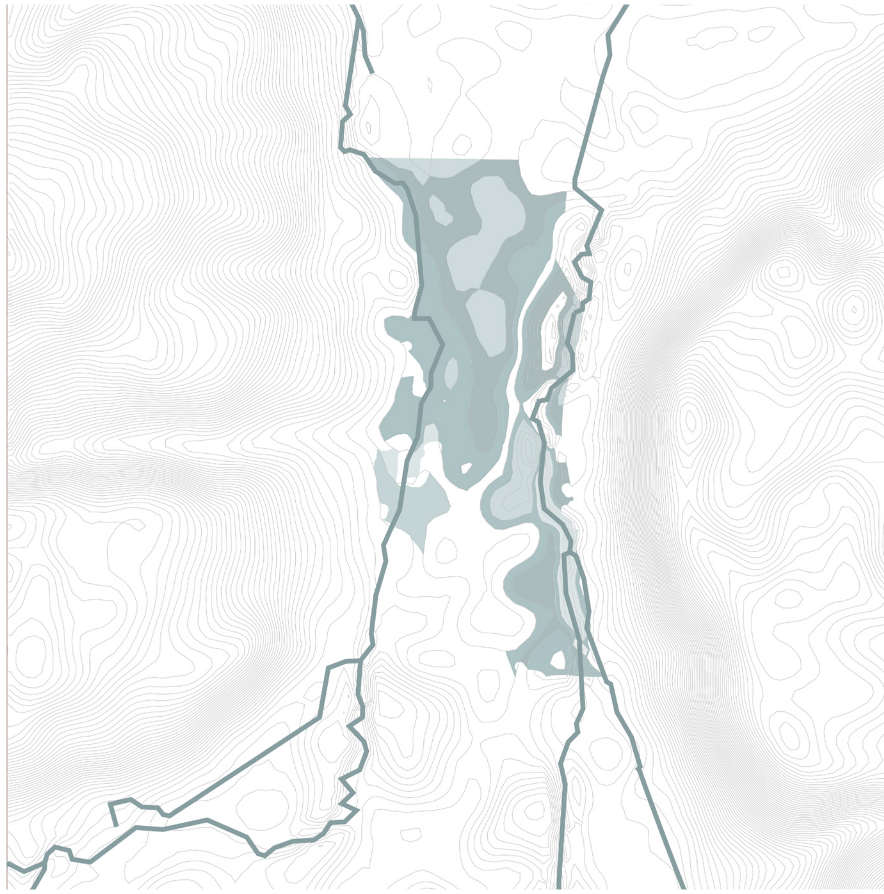


Fig 124: Floodscapes in Typology C : Seasonal Indeterminacy

Legend : The Staging of Surfaces

Process Unfolding

- Surface Storage
- Seepage
- Flood water Harvesting
- Conveyance
- Filterations
- Soil Conservation

Stage for Uncertainity

- Existing Urban Footprint
- Open Soil Cover

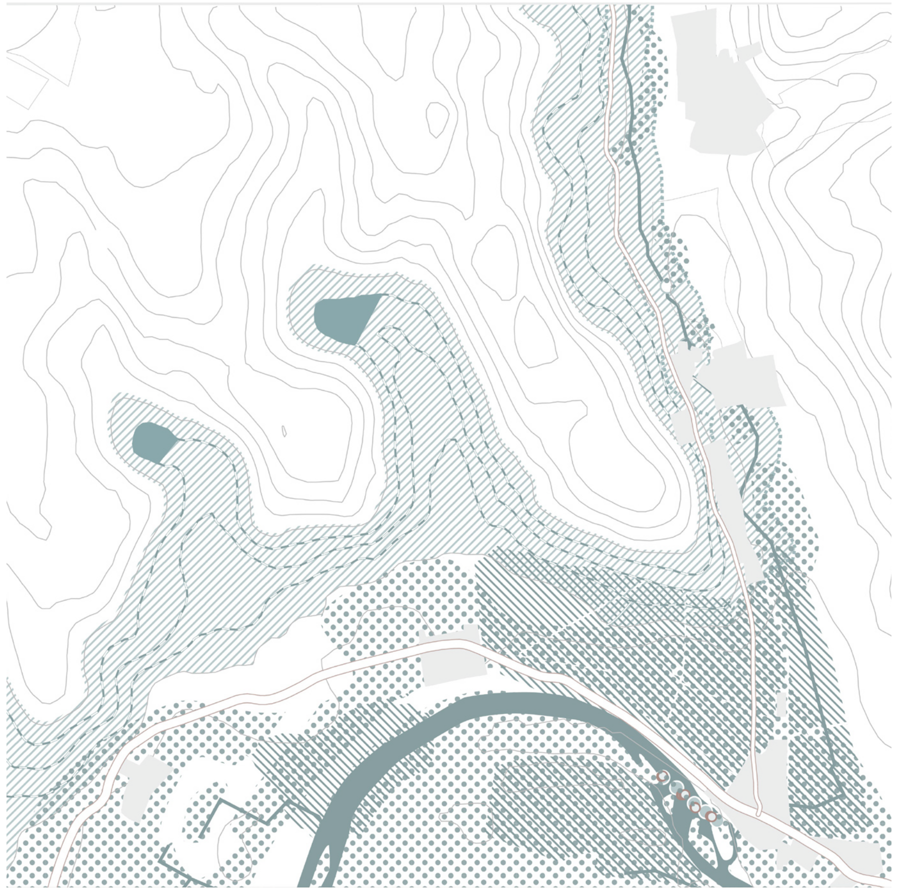


Fig 125: Staging of Surfaces in Typology A

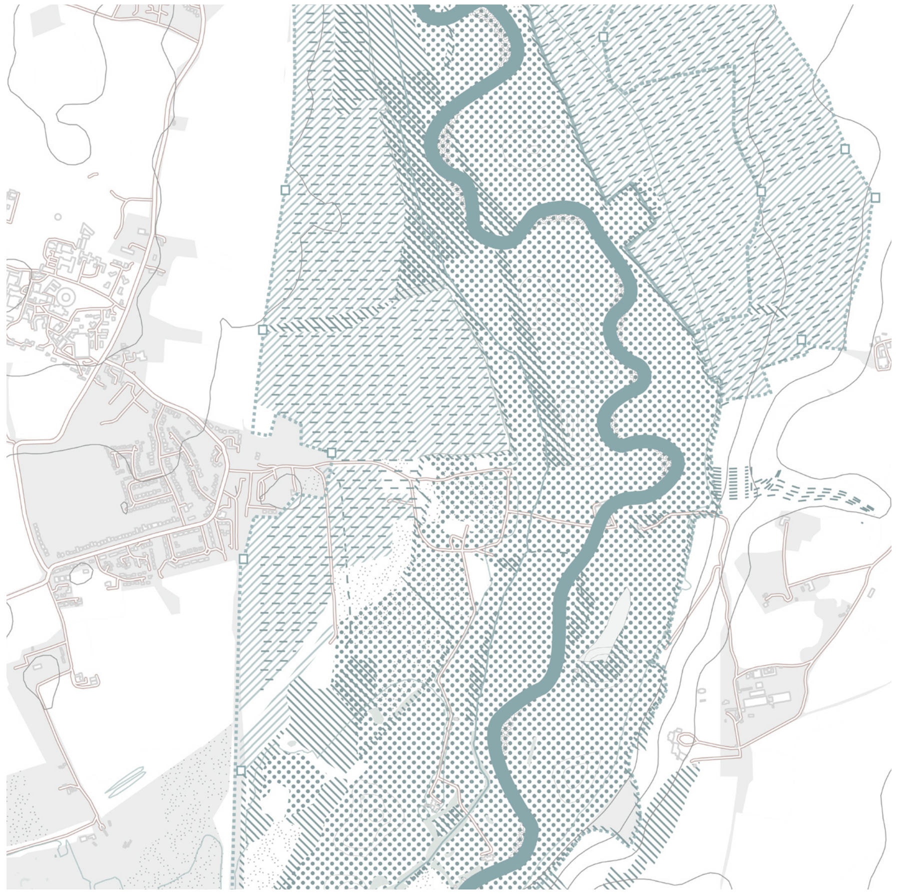


Fig 126: Staging of Surfaces in Typology B

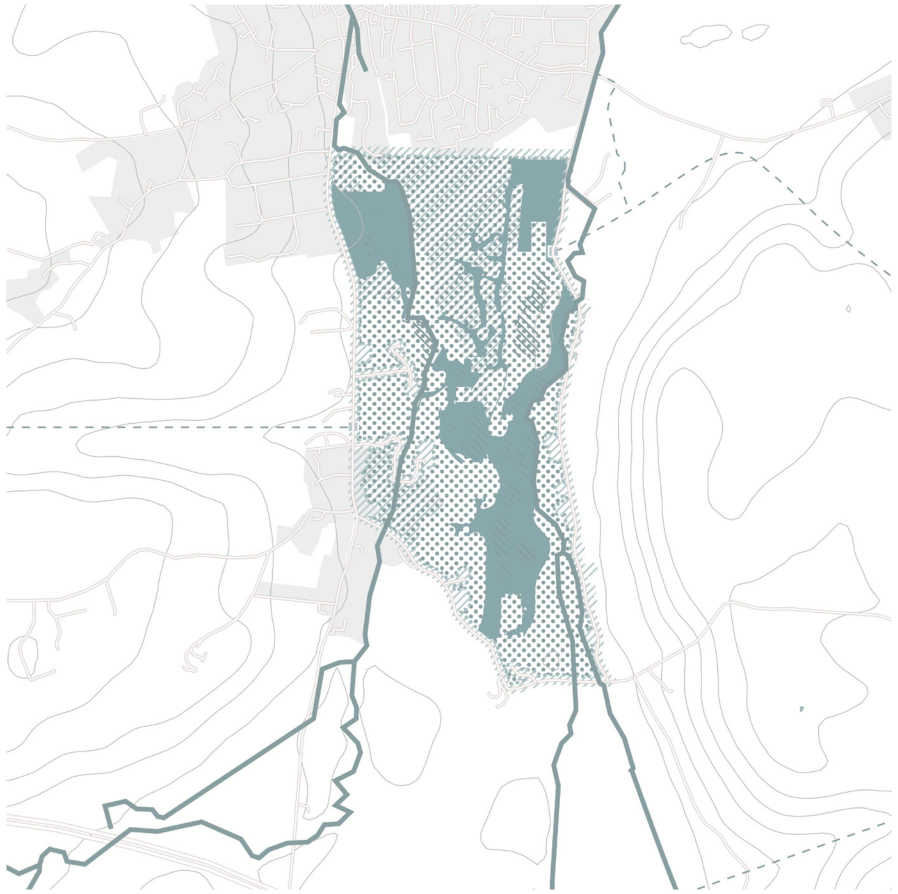


Fig 127: Staging of Surfaces in Typology C

10 Reviving the Commons

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10.1 Reviving the Commons

Introduction to the Commons

In England, the rural areas served as the original commons until the enclosure movement was implemented, a topic extensively discussed in the chapter "Many Meanings of the Countryside." While the notion of "commons" generally pertains to collective ownership, in Britain, commons typically exist as open land accessible to members of a community for activities such as grazing livestock, flying kites, or walking. This communal land provides a shared space for the local residents to engage in various recreational and pastoral activities .

In 1968, biologist Garrett Hardin presented his study on "The Tragedy of the Commons," which suggested that collective property was inevitably destined for failure due to its susceptibility to abuse by its users. According to Hardin, when a resource, such as a field, is not privately owned by any individual, people tend to take advantage of the generosity of others, neglect their responsibilities to maintain it, and ultimately cause its destruction. However, Elinor Ostrom, challenged this perspective and demonstrated that local communities can effectively manage shared resources without the need for regulation by central authorities or privatization. She advocated for democratic control as a means to conserve nature, opposing the top-down management approach and the idea of pure private ownership. Ostrom can be seen as an ecological thinker who promoted cooperation and challenged conventional economic notions of exclusive private ownership (Wall, 2017). In my project, I try to introduce her principles for the collective management of the commons as a framework to revive the commons and extend it to the management of riparian landscapes and conjunctive water management.

The Commons in the Context of the Thames

North Meadow in Wiltshire, serves as an example of a historic commons successfully maintained in the twenty-first century in the Thames Region. It serves as a successful example of a commons that has thrived for over a thousand years by adhering to design features outlined in "Governing the Commons." These features include a well-defined boundary, effective monitoring systems, and low-cost conflict resolution mechanisms. This meadow is renowned for its wild flowers, including the rare snake's head fritillary, making it one of the UK's most important wildlife sites. North Meadow has been maintained as a commons since 1066. The Court Leet, which still convenes in Cricklade, Wiltshire, is responsible for overseeing grazing activities on North Meadow (Wall, 2017).

While local cooperation has contributed to the conservation of this commons, climate change poses an external threats to its sustainable management. In 2016, an heavy rainfall caused the meadow to flood until April, leading to temporary closure and concerns about potential disruptions. In 2013, continuous flooding prevented the snake's head fritillaries from blooming altogether. North Meadow is situated between the Thames and Churn rivers and experiences seasonal flooding each year. However, during the summer of 2012, which recorded England's highest rainfall on record, the meadow remained flooded without drying out. This resulted in the inability to harvest the hay during July and August, leaving a densely packed mat that hindered the growth of delicate fritillary stems.(McCarthy 2013).

Common land in England can be owned by various entities, such as local councils, private individuals, or organizations like the National Trust. The different types of commons registered in England include pasture commons, arable and haymeadow commons, and Lammas rights. Lammas rights provide a seasonal right to pasture, typically observed from Lammas day on August 12th to April 6th.

North Meadow in Wiltshire serves as an example of common land with Lammas rights. It is legally owned by Natural England, which is sponsored by Department for Environment, Food and Rural Affairs (DEFRA). However, the management of North Meadow is conducted in close cooperation with the local residents and the local council. This collaborative approach demonstrates that there are legal systems in place to recognize land management as a commons, particularly in response to seasonal fluctuations.

In relation to water management, it is important to consider conjunctive management and water diversion rights. Conjunctive management involves the integrated management of surface water and groundwater resources. Additionally, water diversion rights ensure that the first person to divert water from a stream does not possess rights that take precedence over subsequent appropriators. These mechanisms help establish a fair and balanced approach to water allocation and usage within a given context (Wall, 2017).

Agriculture in england would run at a loss if it wasnt for the subsidies offered, and there is a lot of funding offered to regenerate agricultural through programmes like Countryside Stewardship Agreement, Environmental Stewardship Agreemenet, and Greening Payments. If the question of water management was introduced into the mix, there is potential to manage the water risks of the entire basin through the efforts in reviving a dying countryside.

The Commons in the Project

In England there are about 8,000 registered common land, that is mainly used for grazing activity. However, the concept of the commons in land management can also be extended to the management of streams and underground aquifers as shared resources. This approach, known as Conjunctive Management, recognizes the interconnectedness of surface water and groundwater and aims to govern them in a coordinated manner. In the Thames Basin, the local water provider Thames Water plays a significant role in the development, monitoring, and enforcement of water rights, with limited involvement from central government authorities (Burger et al., 2001).

Potable water exhibits subtractability, meaning that when one user consumes or abstracts water, it becomes temporarily unavailable to others until it is replenished through the water cycle. Water can be stored, measured, and even treated as a commodity. Furthermore, the degradation of water quality reduces the availability of water for other users, as it may become unsuitable for certain purposes.

Conjunctive management serves several purposes, including:
- Mitigating vulnerability to drought by diversifying water sources
- Supplementing surface water flows with pumped groundwater
- Addressing overuse of groundwater by replenishing aquifers with surface water

This project emphasizes the methods and approaches for communally run effective conjunctive management. In British systems, the determination of rights of access and use to natural resources places significant importance on land ownership. However, it is important to recognize that the water system extends beyond real property boundaries. Nonetheless, the primary challenges to implementing conjunctive management lie in the complex web of property rights and administrative systems that states have established to allocate and manage water resources (Burger et al., 2001).

The framework presented below demonstrates how the intersection of water and land management can be effectively addressed through the application of the eight rules for the management of collectives proposed by Elinor Ostrom. Drawing insights from the successful management practices observed at North Meadow, this framework for managing the commons serves as a guide for the development of the phasing diagram on the following page. The phasing diagram builds upon the actions proposed in the previous chapter and provides a structured approach to implementing the principles of collective management in the context of water and land resources.

Framework for Managing the Commons

Regulation of Land and Water Management

RL Riparian Land Owners

FO Farm Owners

Identifying Common Goals and Targets at a community level for Landscape recovery

Sharing of Tools and Knowledge

C County Council

Plays a role in appointing representatives of the Commons

Legal Owners of the Commons Land

L Local Rivers Trust

Provides Funding

Monitors Riparian Zones

D Department for Environment, Food & Rural Affairs

Natural England

Provides Funding through Environmental Stewardship Programme

Provides Funding through Countryside Stewardship Programme

Provides Funding through Basic Payments Scheme

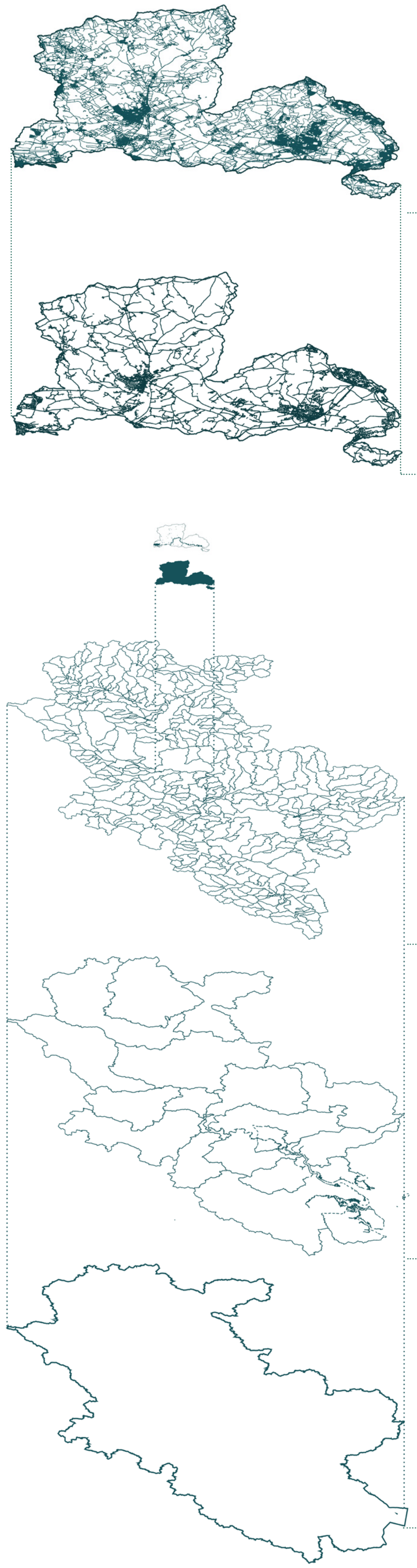
TW Thames Water

Regulates Public Water Useage Limits

EA Environmental Agency

Grants Ground Water Abstraction Licenses

Scales of Management



Adapting Ostroms 8 Rules for the Management the Commons

1 Commons need to have clearly defined boundaries.

In this context, the term "commons" pertains to the management of land, with a specific emphasis on implementing appropriate water management measures that are tailored to the site's unique geology and land use. The goal is to establish a nested system of commons that operates at a micro catchment level.

2 Rules should fit local circumstances. (RL) (FO)

The project presents three diverse translations of the countryside, accompanied by an evaluation of a fourth approach. Each translation serves as a compelling case for the necessity of a direct response to the specific terrain and existing land use systems in place.

3 Participatory decision-making (C)

Active community involvement in rule-making and decision-making processes increases compliance. n the case of North Meadows, the community of Cricklade elects a court, which in turn elects a High Bailiff. The court convenes multiple times a year in a public court that is open to all members of the community, allowing them to observe the proceedings.

4 Monitoring (EA) (C)

The community requires an accountable monitoring system, in line with Ostrom's rule. Given the challenge of climate change, it is crucial to improve the explicit communication of open data regarding meteorology, changing river levels in neighboring areas, and future predictions. Furthermore, the existing system by the Environmental Agency, which currently provides groundwater abstraction licenses, should be extended to include the management of flood, rain, and surface water harvesting through an integrated monitoring system.

5 Sanctions (C)

Ostrom noted that successful commons management systems did not solely rely on excluding individuals who violated the rules. This approach often led to resentment. Instead, effective systems incorporated warning mechanisms, fines, and informal reputational consequences within the community as means of enforcement.

6 Accessible Conflict Resolution (C) (EA) (D)

To address emerging issues, it is crucial to have a system that facilitates informal, cost-effective, and straightforward resolutions. The establishment of a locally elected court helps bridge this gap, as it can handle disputes within the micro-basin. This court can also be accountable to national agencies such as Natural England and DEFRA, providing a mechanism for resolving inter-micro basin conflicts in a collaborative manner.

7 Right to Organise (C) (EA) (D)

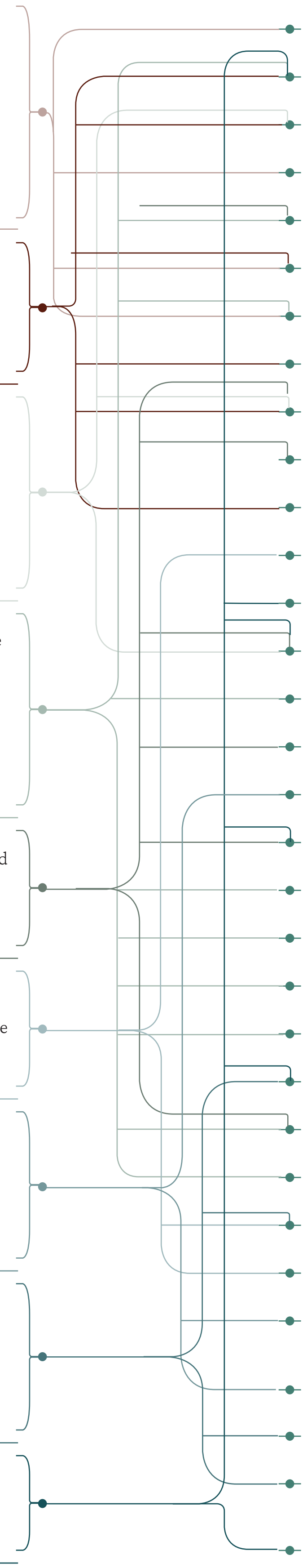
The effectiveness of commons rules relies on their recognition and legitimacy by higher local authorities. In the context of basin management, the smallest unit of this interscalar system is the individual property holding. It is important for neighbors at this scale to have the right to voice their concerns and make them valid.

8 Commons work best when nested within larger networks (L) (C) (EA) (TW)

While local management is important for certain aspects, there are issues that require broader regional cooperation, particularly along the floodplain between communities upstream and downstream. Therefore, establishing a council of commons management that regularly convenes with other relevant stakeholders would be ideal. This council would facilitate communication, coordination, and collaboration among different communitie

Phasing the Project

Action	2023 - 2030 Organisation and Initiation of Processes	2030-2035 Infrastructure Construction	2035 onwards Cyclic Maintenance and Inspection
Soil Management	Inspection of soil conditions Mechanically aerating soils Farmer Training Programmes Creating Systems for Temporary Land Swaps		Routine Inspections and management
Growing Winter Cover Crops	Integrating plan with crop rotation strategy	Selection of winter crops Leaving crop residues throughout winter	
Cross drains across Road Networks	Determining the size of drains depending on local conditions	Construction of cross drains across roads to channel water	Inspection and Routine Cleaning
Tree Planting Riparian Tree Planting Cross Slope Tree Planting Management of Existing Woodlands		Construction of small earts mounds along strip and planting native species Plant native species such as holly, blackthorn, hazel, hawthorn or woodrush.	
Planting and Managing Hedgerows		Constructing tree shelters for growing trees Preparing the ground Planting double staggered hedgerow with hawthrons and blackthorn mixed with hazel, geulder rose, rowan and holly. Growing oak, lime, aspen, alder every 10m Remove individual tree gaurds once fully grown	Newly planted hedgerows need high levels of maintenance
Bunds to store Temporary Run Off	Determining the size of drains depending on local conditions Consideration for where water should flow in case of exceedance	Construction of exceedance flow paths to avoid new flood risks	Regular inspection to make sure bund is intact and not filled with silt
Bush Dam / Leaky Barrier Construction	Determining the number and positions of brush dams at catchment levels	Constuction must allow fish passage underneath Use of locally sourced wood	Ensuring brush dams location is correct Periodic clearance of debris and sediment to prevent blockae and over flow of water
Storage Pond Construction	Test pits to see how well pond holds water Pond design according to site charchteristics	Construction of Pond Construction of spillway in relation to pond	Check for scouring in inlet and outlet drains Sediment removal Vegetation Management
River and Flood Plain Restoration	Re-meandering needs careful planning needs co-operations between landowners on both sides of the channel Dimensions are entirely site dependent and will need detailed specialist advice. Pre-work assessments and surveys will be required to ensure that works do not increase flood risk	Regrading flood plains Construction of Riffles and Pools in the river bed	
Wetland Creation		Regrading flood plains Stabilising and re-wetting Planting vegetative cover	



Cyclic Programmes

- Improved movement of air and nutrients through the soil profile
- Reduces soil and sediment in run off
- Reduces loss of soil and sediment into watercourses
- Little to no fertiliser input
- Increased leaf litter for soil quality
- Improved drought tolerance
- Increase in soil moisture retention
- Increases Infiltration
- Reduces soil loss
- Allows sediment settlement
- Reduces Nutrient Losses
- Traps Sediments, improving water quality
- Carbon Storage
- Diverts and reduces run off volume
- Slows run off
- Intercepts surface runoff
- Intercepts surface flow
- Filters run off
- Intercepts Rainfall
- Tree Roots stabilize water course
- Treed canopies keeps river cool for aquatic wildlife
- Provides habitat for polinaors and predators of pest
- Provides habitat for diverse species
- Shelter for livestock
- Reduced risk of water borne diseases to livestock
- Slow high flows, reducing maximum flood peak
- Flood water spillage for infiltration
- Slow drainge from the pond after flood period via infiltration or an outlet point.
- Retension of water for drought store
- Controlled discharge back into the river
- Allowing Natural lower energy flooding reduces risk of bank failure.
- Increases Infiltration

11 Conclusions

[Contents]

11.1 Transposing the Countryside in the City

The concept of considering the countryside as a potential solution arises from a process of inductive reasoning. This reasoning is based on several premises, including the shortcomings of modern water infrastructure, the influential position of London within the basin, and the recurring patterns observed in historical debates. Moreover, the inability of current infrastructure to effectively address extreme weather events reinforces the general conclusion that investing further in London or relying solely on technocratic interventions may not be the optimal approach. As a result, the design hypothesis contemplates an alternative scenario where interventions prioritize the ecological hinterlands or the concept of the countryside as a focal point.

The primary objective of typologies A, B, and C was to examine the potential of floodable landscapes within the agrarian landscapes of the Upper Thames region to mitigate downstream flood peaks. This would be achieved through the establishment of communal networks for water management. The concept of the countryside, as explored in this context, was always in relation to London, given its strategic position within the basin. The typologies in question concentrated on two specific land uses: rural areas with core services and traditional countryside. The key focus was on harnessing the hydrological relationships within these areas to revitalize land management practices, particularly in the context of adapting to flooding and drought. The intention was to explore how these perceived rural areas, when examined closely, could play a significant role in broader flood management endeavors and contribute to the establishment of a more resilient countryside.

In order to assess the applicability of reframing narratives and extending agency to non-human actors in the context of shared maintenance activities concerning land and water, I selected the lower Lee Valley as a location within London. Based on the approach adopted thus far, the ideal solution for addressing flooding in the lower Lee catchments would involve decentralized management interventions in the upper Lee catchment. This aligns with the proposed design typologies. However, by testing this approach within London itself, the limitations of the approach become apparent. The unique characteristics and complexities of the urban environment present challenges that differ from those encountered thus far.

The site is Hackney Marshes, which is part of the Lee Valley Regional Park. The park spans 26 miles, stretching from the Thames in the south to Ware in the north. It borders the River Lea along the Lee Valley and is often referred to as London's "unofficial countryside." The park comprises a diverse blend of countryside, heritage sites, country parks, nature reserves, lakes, and riverside trails.

Exploring the translation of the countryside within the context of the Lea River, which is London's second river, reveals significant differences compared to other sites:

1) The site represents a "third nature" and represents a higher intensity of human intervention and engineering in shaping the landscape.

2) It showcases the political economy of land use appropriation, specifically encroachments into the marshlands. The authorities have been unable to effectively address these issues, highlighting the challenges associated with land use management.

3) In relation to the non-scalable framework, the site is an open space but lacks the specific classification of being rural or traditional countryside due to its size. Instead, it is marked as commercial and industrial. This contrasts with other areas that have clear rural or traditional countryside designations. The site is currently being utilized as a sports field, and there have been rapid expansions into the Lea Valley despite local protests against such developments. The most recent example is the construction of an international ice rink and the proposed plans for densification in the marshlands. Protesting locals criticize authorities such as the Lee Valley Regional Park Authority (LVRPA) and Waltham Forest Council, who are responsible for protecting the city's green spaces. However, they are accused of collaborating in the destruction of these spaces for profit, ultimately leaving the community worse off (Save Lea Marshes, 2022).

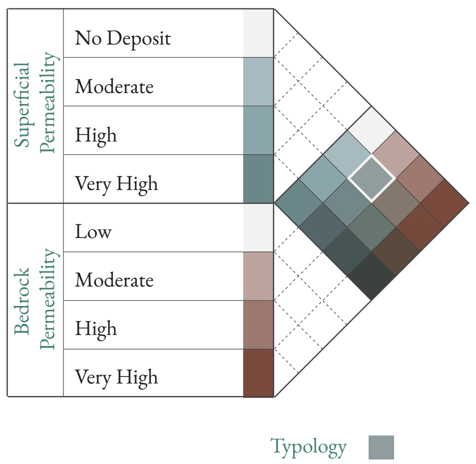
4) The site represents a highly engineered river system with a significant amount of redundant infrastructure.For example, the Middlesex filter beds and the Pond Lane Flood Gates, although no longer in use, still exist in the landscape. Despite

Fig 128: Existing Developments around Testing Site

the extensive engineering, the valley has experienced considerable flooding events. To address the flood risk, various channel alterations and defense measures have been implemented since the severe flooding in 1947. Man-made channels have increased conveyance capacity and provided flood relief in the area. However, the River Lee Flood Relief channel, constructed in the 1970s, is no longer sufficient to protect the surrounding area from floods of a similar magnitude.

Moreover, despite the aforementioned challenges, the Hackney Marshes hold significant potential as a valuable resource for enhancing the flood storage capacity within the River Lee catchment, as identified by the London Borough of Hackney. This recognition aligns with the design approach of this project, which seeks to evoke a sense of anamnesis, prompting an acknowledgement of London's wetlandscape that has been extensively built upon and engineered. Interestingly, even the name of London may encapsulate its wetland origins, with its possible Gaelic roots linking it to "lunnd," meaning "marsh." According to Ackroyd (2001), the repressed wetlandscape of the Thames' swamps and lagoons has not entirely faded but resurfaces through elements such as "mist, mud, monsters, and metaphors."

Considering the site's vulnerability to flooding and the significant pollution levels in the area, the restoration of the former



Geological Classifiction	Alluvial Terrace
Primary Terrain Category	Plains
Proximity to River Body	High
Infiltration Capacity	Low

Fig 129: Classification of Testing site in Terrains Geology

marshland is a valuable approach.The River Lea at Hackney Marshes is considered one of the most polluted locations in the country (Crisell, 2022), highlighting the urgent need for remedial action. Implementing wetland terraces is an effective method for restoring the marshland. These terraces can serve multiple functions, including providing recreational spaces for public use while also acting as natural filters.

The geology of the site indicates limited subsurface infiltration capacity, despite the presence of an active river. In such cases, it is more practical to focus on holding and filtering floodwater rather than relying heavily on infiltration. By employing wetland terraces, the site can effectively detain floodwater, allowing for the filtration and delayed release of the peak flow downstream. This approach not only addresses the flooding issue but also helps improve water quality by filtering out pollutants before they reach the river.

As the conclusion to the thesis, it is indeed essential to address both sides of the argument regarding the outcome of transposing the countryside into the city.

The con perspective presents valid concerns regarding the social conditions and restrictions that could impede the practicality of establishing a countryside within the city. It emphasizes the importance of considering the broader political economy associated with this undertaking, an aspect that may not have been fully addressed in the thesis. This perspective acknowledges the intricate socio-political complexities involved in integrating a countryside-like environment into an urban fabric, that is pressurized by development projects and increasing mobility demands. Furthermore, when considering the question of maintenance and providing space for non-human species to thrive, it becomes apparent that the site in question may be too contested by conflicting interests. This perspective is emblematic of the limitations of the thesis and is grounds for further research.

On the other hand, the pro perspective acknowledges that, ultimately, the thesis is an exercise in imagination, like all design projects. It recognizes the inherent value in contemplating the concept of the countryside and reflecting on the implications of its loss and the labor associated with it. The thesis invites consideration of alternative forms of management and encourages re-imagining the countryside within the context of the projects focus.

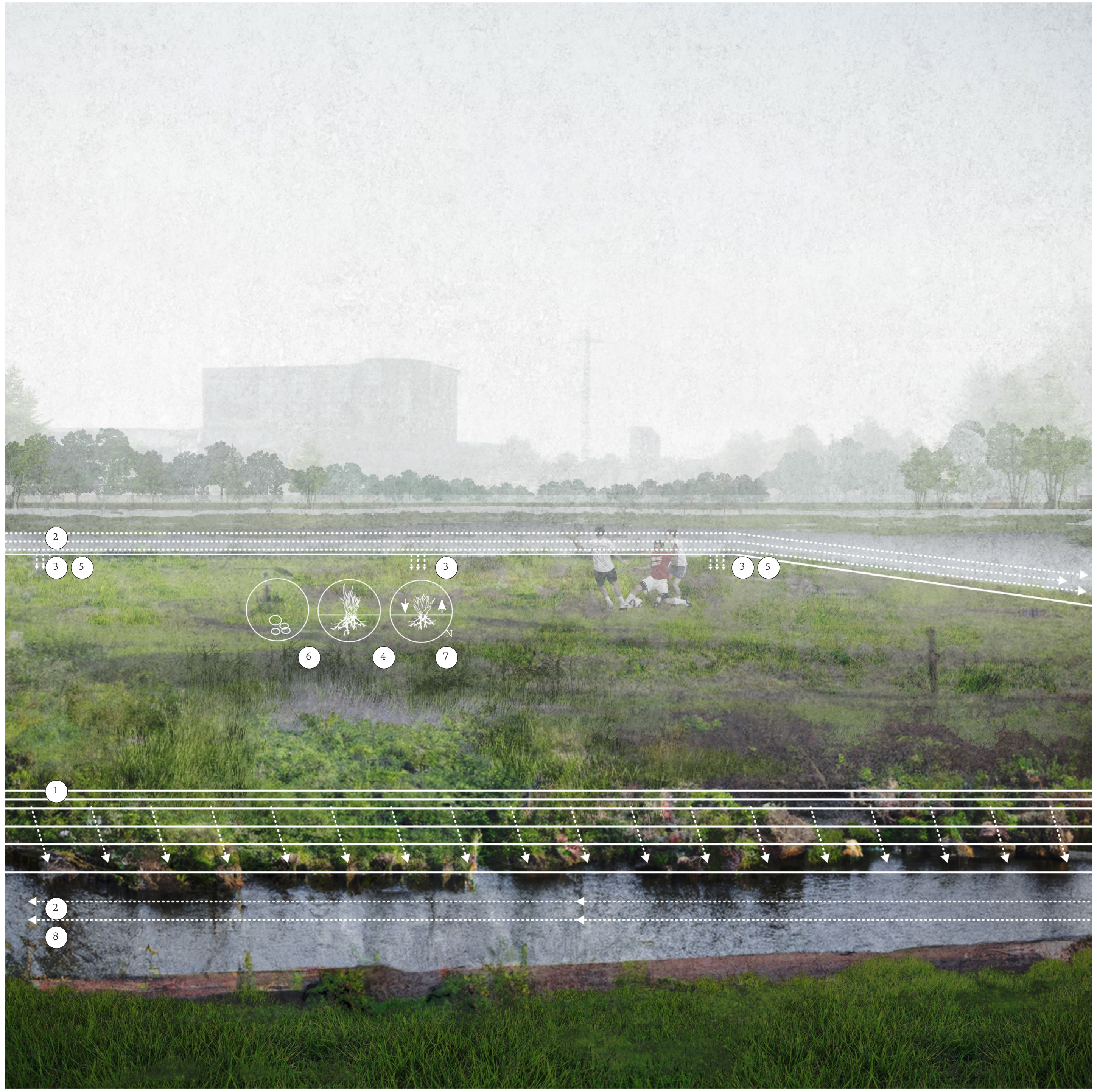


Fig 130: Restoring Marshlands in London - Engineered Elements in the Landscape

Legend

1. Wetland Terraces
2. Carriers and drains for high flow events
3. Macrophyte zone for aquatic species
4. Vegetation to filter run off and promotes even flow
5. Slowing Run off increases sediment deposition rates
6. Wetting and drying cycles leads to fixation of pollutants in sediments
7. Promotes conditions for nitrogen removal
8. Water leaves the wetland with reduced sediment, nutrient and pollutant loads.

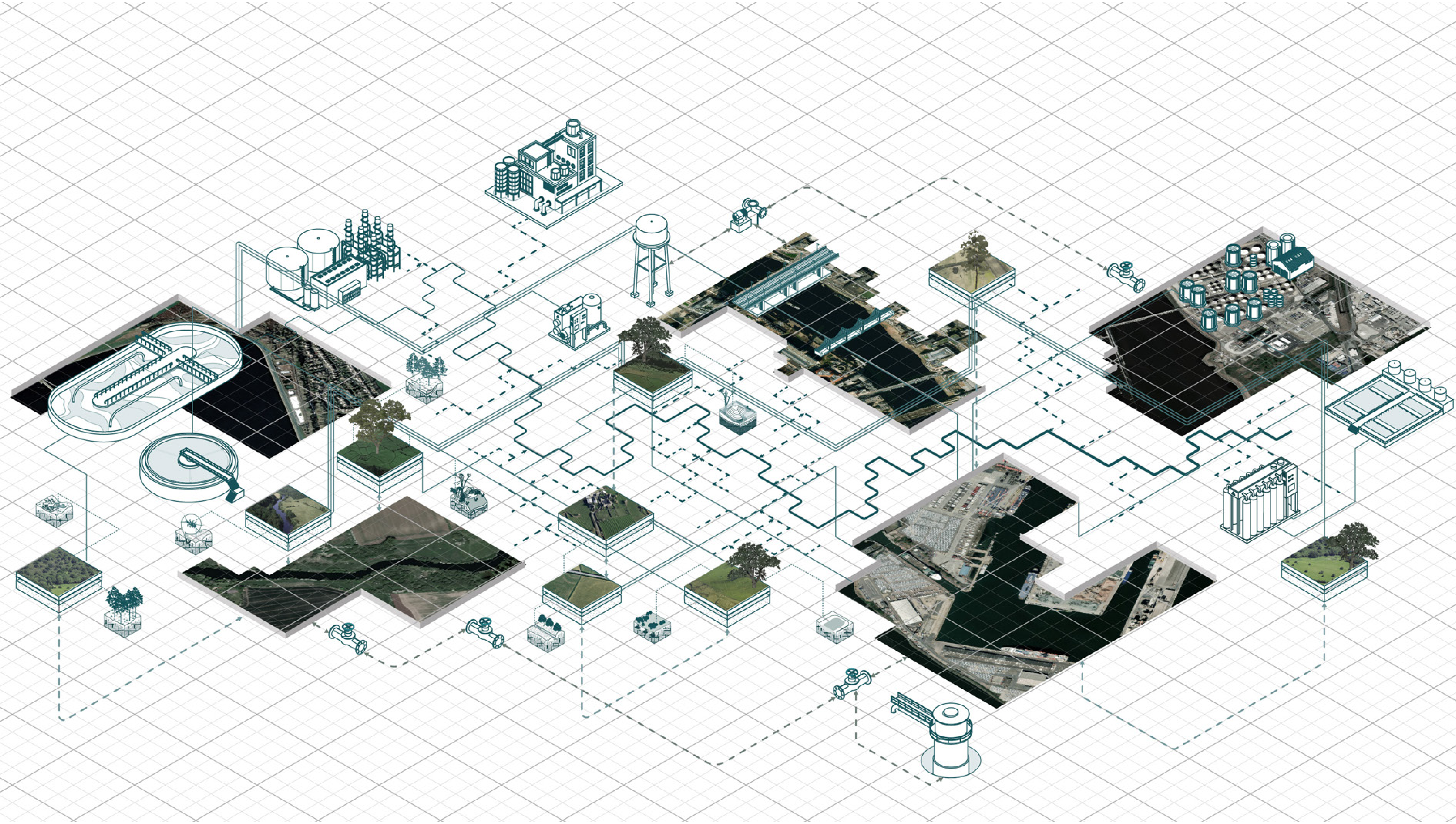


Fig 131: Water Machines in the Countryside

11.2 Conclusions

The thesis puts forward a view of using the notion of the countryside to create forms of land management that is both responsive to unprecedented extreme weather conditions and restorative in their capacity to reframe flooding as an opportunity to adapt to drought.

The Thames Basin in itself is a contested territory both in terms of how the river has been engineered and in how the land has been managed to support the interests of a few who could afford to do it at the expense of others. These efforts have culminated in degraded landscapes and a basin that seasonally fails to adapt to variable rainfall events. Since a dominant narrative that still surfaces is the tendency to invest heavily in techno-cratic projects oriented toward London's growing risks, the project instead looks at its ecological hinterlands specifically in upstream catchments to see how flooding events can be reframed as an opportunity for both locally and a measure to reduce the volume of river discharge that adds to the flood risk downstream.

The main design outcome is in creating almanacs for these seasonal practices of maintenance to allow these floodable landscapes to play a role in the current land use patterns and designing flexible forms of green-blue infrastructure that are more responsive to these seasonal shifts and decentralized in that it affords both local human and non-human actors more agency in adapting to extreme weather patterns.

11.3 Recommendations For Further Research

There are several avenues of research that I was unable to fully explore in my thesis but could be pursued by other projects. One important area is the intersection of water and the economy. Understanding the motives of private entities in profiting from providing water as a payable service and the government's inability to secure water as a public right is crucial. This issue has contributed to public discontent regarding climate adaptation in the Thames Basin. This form of water insecurity extends to reliance on intra-basin water transfers to replenish reservoirs and the increasing imports of food through virtual water transfers.

While my thesis delves into shaping different landscapes in the countryside, it is essential to consider the property value of land and the subsidies received by landowners. The current tax system grants higher subsidies to owners with larger areas of farmland, which can influence how the land is developed. Landowners may have less incentive to allow floodable landscapes for the collective good as it has few immediate incentives to offer them. The thesis cannot fully resolve 'the paradox of english environmentalism'(as mentioned in the chapter: The Many Meanings of the Countryside) in this regard.

Another area of research is the development of policy frameworks for recreating the commons. While the thesis itself serves as a case for how shared management can bring about change, it is important to acknowledge that people may still seek to capitalize on and profit from these systems, despite their necessity for our collective survival. Exploring policy approaches that strike a balance between incentivizing responsible management and ensuring equitable access to resources would be valuable.

Overall, these avenues of research would provide a deeper understanding of the complex dynamics between water, economy, land ownership, and policy frameworks. By addressing these factors, future projects can contribute to more comprehensive solutions for climate adaptation in the Thames Basin.

11.4 Reflections

1. What is the relation between your graduation project topic, your master track (Ar, Ur, BT, LA, MBE), and your master programme (MSc AUBS)?

As designers in M.Sc AUBS program, we work at the intersection of scientific and creative thinking. Urbanism specifically explores the challenge of designing for a collective future marred by the uncertainties of climate change, depleting resource reserves, and how they upset the complex systems that sustain the urban fabric. The track explores the various dimensions of this shift and encourages a re-imagination of modes of appropriation and operationalization.

The project proposed addresses a part of this larger problem, specifically the intersection of water with the changing paradigm of urbanity. Earlier paradigms are now collapsing under the weight of the climate crises, and a newer approach could be through a renewed sensitivity toward natural processes. The idea of climate resilience in the Thames Basin as it faces increasing threats of both flooding and drought is at present tied to either end of two extreme design ideals by contemporary designers and policymakers in the context. One imagined future involves retreating to a pre-modern archetype of letting nature reclaim its original path. The other involves imposing highly techno-cratic solutions of building walls and diverting the natural flow of rivers. While the proposal to reconstruct an idealized terrain that predates human intervention is criticized for not taking into account the influence and needs of the urban spaces, the infrastructural projects are prone to failure, when the growing demands can not be met by the structure's technical limits.

The Transitional Territories studio offered the necessary theoretical underpinning that helped me use urban design to reinforce water sensitivity in the context of the Thames basin. The studio takes a critical position regarding the paradigm of modernity and helps frame solutions that are conscious of the hybridity of the environmental crises today. This understanding helped me look past decoding water sensitivity through the lens of flows alone, but also in terms of control over infrastructure, and what continues to motivate decisions to invest in massive infrastructural solutions in the Thames Basin.

2. How did your research influence your design/recommendations and how did the design/recommendations influence your research?

Research played a crucial role in shaping my design approach by allowing me to take a position and focus on the challenge of climate adaptation within the context of landscape urbanism. It helped me recognize the limitations of highly engineered approaches and explore alternative perspectives. Through initial research and critical mapping exercises conducted during the Studio Essentials and Geographical Urbanism course, I was able to define the spatial units of my design and delve into extensive literature that challenged established design precedents and embraced post-humanist approaches.

This was furthered through the exercise of exploring the spatial composition, systemic relations, and limits using the lines of inquiry framework of analysis proposed by the studio. The framework categorized the analysis into Matter, Topos, Habitat, and Geopolitics, providing structure to the project's divergent exploration. This process helped me identify the project's limitations and served as a starting point for the design phase.

From that stage onwards, I was engaged in research through design, aiming to create a speculative design focused on reviving a hydrologically relevant countryside. Simultaneously, I delved into contemporary research on the concept of a 'dead countryside' and explored literary descriptions of an 'idyllic countryside'. To understand the material transformations necessary for the design, I referred to reports published by engineering consultants involved in re-naturalization and river restoration efforts in the UK. This research enriched my design framework and helped me visualize the design details.

The irony of using these engineering works, which involve large excavators to move earth, for the purpose of "re-naturalization" in response to the current climate crisis is not lost on me. However, it represents the hybridity of the approach and acknowledges that this design is not a return to an idealized past, but an effort to create a field that can operate and maintain itself in response to seasonal shifts, rather than in spite of them.

3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?

In addition to my broad reading of literature concerning the social and hydrological challenges of integrated river basin management, as well as the growing meteorological uncertainty, my methodology involved mixed media reviews. This approach initially included reading multiple newspaper reports and blog posts by local residents, focusing on their views on the Thames. The Thames holds great cultural significance to the identity of the cities and towns it passes through, providing valuable insights into the contemporary lived experiences of adapting to extreme weather events in this context. This was particularly important as I had limited personal experiences to draw upon. To compensate for my inability to personally travel to the site, I collaborated with a local photographer who possessed both regional familiarity and an understanding of the challenges associated with the infrastructural control of the basin. His firsthand experiences as a technician in flood control projects added valuable material perspectives to my work.

My curiosity about lived experiences was what drove me into a deep dive into history, tracing parallels between the present and the past. I explored works in eco-criticism, and environmental history, as well as artistic and popular depictions of loss associated with the river Thames since the 1800s. This exploration compelled me to focus on spaces and agents that I identified as either neglected or loosely integrated into today's narratives about building resilience. The agency of socially disadvantaged farmers, the river itself, the ecological hinterland outside of London, and both wild and domesticated species that intervene at minute process scales within the water cycle and the maintenance of the river were key areas of my focus.

This attempt to embrace the multiplicities embedded in notions of the 'countryside,' 'nature,' and 're-wilding' is, in itself, limited and susceptible to becoming entangled with other concerns in the wicked problem of designing for a future stressed with an affordable housing shortage and an energy crisis. These concerns, in turn, pose challenges to water sensitivity in the basin, particularly considering the ongoing construction of housing in floodplains and the legalization of hydraulic fracking in the UK in 2019. The latter could have detrimental effects on water quality in the aquifers that meet 40% of the Thames Basin's water abstraction demands.

Reflecting on my process as a whole, in the initial stages of the project, I attempted to parameterize my work and adopt a highly data-driven approach. The goal was to develop adaptive pathways that could somehow model responses to varying degrees of extreme weather events. However, as the project progressed, I found myself falling out of my depth as an urbanist and ironically at risk of furthering the modern project by somehow reframing the weather and the floodplains as something that can be efficiently operationalized (to meet human demands) if simply given access to enough data.

Throughout the cycles of research and design that followed, I made a conscious effort to shift my focus towards engaging with relationships rather than relying solely on scalable models. While I acknowledge that my design still operationalizes nature, I have tried to extend the notion of maintaining the countryside beyond human actors and create a framework that embraces the concept of "fields in flux" that I encountered in my reading of the work "Site Matters."

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

Academic Scope and Relevance

The goal of the project is to propose a design to cope with unpredictable weather extremes through a recognition of the patterns and time frames that nature operates in. Designing for water management in scenarios of drought and flooding would mean recognizing both the seasonal shifts of rainfall events and their duration and how this affects the daily variations in the river's discharge levels. Through acknowledging the time scales within which the hydrological system operates, the goal would be to work towards water cycle restoration and attempt to rehydrate the earth through rainwater retention and infiltration into the sub-surface while decreasing the socio-economic disruptions caused by flooding. The scientific literature surrounding the hydro-geological transformation of the basin historically, distribution of flooding risks, data on variable precipitation rates which are increasing vulnerabilities towards prolonged drought periods, and studies about the impact of private sector management of the sub-surface infrastructure seem separated by the domains of their disciplines. These understandings can be combined to understand seasonal water risks and the challenge of adapting to extreme weather events.

Social Scope and Relevance

The focus of most of the literature surrounding the history of the Thames River, or accounts for the growth of urban water systems, as driven by public health concerns, are all centered around the city of London, which occupies a very dominant position physically, and historically in the basin. The English countryside's role in this changing relationship with the riverine system is absent in most historical literature. Today debates surrounding water management infrastructure, continue to be centered around London's needs, given its high population density and role as a global financial hub. Addressing water needs, and adaptation strategies at a local scale through site-sensitive actions across the basin could help relieve the disproportionate concentration of extreme risks like pollution, or surface water flooding from reservoirs in some parts of the basins, to service the needs of others

5.How do you assess the value of the transferability of your project results?

The transferability of the project lies in the use of design frameworks. The design begins through a a typological reduction of the basin, considering its geological permeability, to redefine floodable landscapes as opportunities. At more tangible scales, the design framework details the material transformations in relation to the fundamental science of water movement, which is managed through landscape interventions and systemic thinking. This approach facilitates the development of situated translations of the broader design objective. These elements can be replicated and expands upon existing frameworks, thereby establishing a basis for further exploration and analysis.

However, the aspect that I consider non-transferable and specifically applicable within the UK (and possibly other parts of Europe) is the concept of how "the wild" is interconnected with agriculture and rurality. This idea influenced my design process when I encountered policy proposals aiming to reintroduce species like beavers for their role in woodland water management and birds that had become characteristic of English farmland. I found this notion intriguing, particularly when contrasting it with my own background in Kerala, India, where the romanticization of nature never grew as a counter-narrative to urbanization. In certain parts of Kerala, the wild remains relatively pristine, and agricultural practices are culturally viewed as separate from it.

Reflections on Geometries of Power

Initially, my project proposal revolved around the concept of "Geometries of Power" as discussed in the literature on urban political ecology. This concept explores the social power relationships inherent in the hydro-social cycle and the supply and distribution of water in the Thames Basin. I aimed to address the biases present in the current narrative by spatializing this concept and using it as a consistent framework throughout the project.

However, as I delved deeper into my research on the diverse interpretations of the river, the countryside, and resilience in the basin, I encountered increasing difficulty in continuing to build this concept. But sensitivity to this challenge was what drew me to focus on the counter pastoral and the areas, and species neglected in the current hydro-social narrative.

My project journey taught me the limitations of attempting to encapsulate the entire spectrum of power within the context of the Thames Basin. Instead, I shifted my focus towards understanding and nurturing the diverse expressions of agency embedded in the basin's socio-ecological system.

12 References

[Contents]

Literature Sources

Ashley, R., Gersonius, B., & Horton, B. (2020). Managing flooding: From a problem to an opportunity. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 378(2168), 20190214. https://doi.org/10.1098/rsta.2019.0214

BBC Public Service Broadcaster. (2022, September 27). Thames Water hosepipe ban to stay in force until 2023. BBC News . Retrieved January 17, 2023, from https://www.bbc.com/news/uk-england-berkshire-63049366.

BBC Public Service Broadcaster. (2022, December 27). Oxfordshire ongoing sewage release regrettable - Thames Water. BBC News. Retrieved January 17, 2023, from https://www.bbc.com/news/uk-england-oxfordshire-64102723.

BBC Public Service Broadcaster. (2023, January 6). Blackheath homes flooded after water main bursts. BBC. Retrieved January 17, 2023, from https://www.bbc.com/news/uk-england-london-64185485.

Bélanger Pierre. (2017). Landscape As Infrastructure: A base primer. Routledge.

Boulton, A. J. (2007). Hyporheic rehabilitation in rivers: Restoring vertical connectivity. Freshwater Biology, 52(4), 632–650. https://doi.org/10.1111/j.1365-2427.2006.01710.x

Burger, J., Ostrom, E., Norgaard, R. B., Policansky, D., Goldstein, B. D., Schlager, E., & Blomquist, W. (2001). Regional and Cross-Boundary Commons - Water Resources: The Southwestern United States. In Protecting the commons: A Framework for Resource Management in the Americas (pp. 133–161). essay, Island Press.

Burns, Fiona & Eaton, Mark & Gregory, Richard & Al-Fulaij, Nida & August, Tom & Biggs, J. & Bladwell, S. & Brereton, Tom & Brooks, David & Clubbe, Colin & Dawson, J. & Dunn, Euan & Edwards, B. & Falk, Steven & Gent, Tony & Gibbons, D.W. & Gurney, Mark & Haysom, Karen & Henshaw, S. & Wynde, Robin. (2013). The State of Nature report. 10.13140/RG.2.2.28049.02407.

Buse, K., & Bayliss, K. (2022). England's privatised water: Profits over people and planet. BMJ. https://doi.org/10.1136/bmj.o2076

Briggs, H. (2020, July 21). River Thames 'severely polluted with plastic'. BBC News. Retrieved January 25, 2023, from https://www.bbc.com/news/science-environment-53479635.

Burns, C., Kahn, A., & Sherman, W. (2005). Fields in Flux. In Site matters: Design concepts, histories, and strategies (pp. 311–314). essay, Routledge.

Cavalieri, C., & Vanin, F. (Eds.). (2019). The Language of Water. Tipografia Battagin slr, (Treviso), Italy.

Chakrabarty, D. (2020). "World-Making, "Mass" Poverty' and the Problem of Scale. E -Flux Journal, (114).

Cloke, H. (2019, June 12). Britain is in the middle of a drought – so how come there's flooding? The Conversation. Retrieved June 14, 2023, from https://theconversation.com/britain-is-in-the-middle-of-a-drought-so-how-come-theres-flooding-118710.

Committee on Climate Change Risk Assessment (2016). UK climate change risk assessment 2017. Synthesis report: priorities for the next five years. London, United Kingdom: Committee on Climate Change Risk Assessment.

Cocker, M. (2019). Our place: Can we save Britain's wildlife before it is too late? Vintage.

Crisell, H. (2022, July 14). The hackney riviera and london's wild swimming shame. Evening Standard. Retrieved June 16, 2023, from https://www.standard.co.uk/escapist/wild-swimming-hackney-riviera-marshes-polluted-b1012031.html.

Doherty , D. (2009, March 16). Permaculture news.

Donna Haraway, "Situated Knowledges: The science question in feminism and the privilege of partial perspective." (2016). Feminist Theory Reader, 452–463. https://doi.org/10.4324/9781315680675-68

Duggan, C., & Peeren, E. (2020). Making up the British countryside: A posthuman critique of Country Life's narratives of Rural Resilience and Conservation. Journal of Rural Studies, 80, 350–359. https://doi.org/10.1016/j.jrurstud.2020.10.011

Dunne, D. (2020, July 15). Siberia's 2020 heatwave made '600 times more likely' by climate change. Carbon Brief. Retrieved January 5, 2023, from https://www.carbonbrief.org/climate-change-made-2022s-uk-heatwave-at-least-10-times-more-likely/.

Environment Agecy. (2021). (rep.). Thames River Basin District Draft Flood Risk Management Plan 2021 to 2027 (pp. 1–408). Bristol.

Fencing off village brook will 'spoil' best views in country, says retired gp. (2018, July 30). Henley Standard. Retrieved June 16, 2023, from https://www.henleystandard.co.uk/news/environment/128826/fencing-off-village-brook-will-spoil-best-views-in-country-says-retired-gp.html.

Funders for Regenerative Agriculture. (2022). (publication). Regenerative Agriculture and Water.

Gandy, M. (2017). The Fabric of Space: Water, modernity, and the urban imagination. The MIT Press.

Gandy, M. (2004). Rethinking urban metabolism: Water, space and the modern city. City, 8(3), 363–379. https://doi.org/10.1080/1360481042000313509

Literature Sources

Garrard, G. (2020). Brexit ecocriticism. Green Letters, 24(2), 110–124. https://doi.org/10.1080/14688417.2020.1788409
Tsing, A. L. (2012). On nonscalability. Common Knowledge, 18(3), 505–524. https://doi.org/10.1215/0961754x-1630424

Haraway, D. J. (2016). Staying with the trouble: Making kin in the chthulucene. Duke University Press.

Historic England 2017 Conserving Historic Water Meadows. Swindon. Historic England

Historic England 2018 Water Meadows: Introductions to Heritage Assets. Historic England. Swindon

Hutchins, M. G., Abesser, C., Prudhomme, C., Elliott, J. A., Bloomfield, J. P., Mansour, M. M., & Hitt, O. E. (2018). Combined impacts of future land-use and climate stressors on water resources and quality in groundwater and surface waterbodies of the Upper Thames River Basin, UK. Science of The Total Environment, 631-632, 962–986. https://doi.org/10.1016/j.scitotenv.2018.03.052

Hudson, Berman D. "Soil Organic Matter and Available Water Capacity." Journalof Soil and Water Conservation, vol. 49, no. 2, 1994, https://www.jswconline.org/
content/49/2/189.abstract.

Hügel, S 2017, RUVIVAL Book Series: Productive Ponds as Part of Rainwater Harvesting Systems
in the Context of the Slope Farming Project Arba Minch, Ethiopia, TUHH Library Hamburg University of Technology, Hamburg, <http://nbnresolving.de/urn:nbn:de:gbv:830-88217935>

Inman, P. (2023, April 22). Lake or mistake? the row over water firms, drought and abingdon's new super-reservoir. The Guardian. Retrieved June 6, 2023, from https://www.theguardian.com/business/2023/apr/22/lake-or-mistake-the-row-over-water-firms-drought-and-abingdons-new-super-reservoir.

Jones, C. G., Lawton, J. H., & Shachak, M. (1994). Organisms as ecosystem engineers. Ecosystem Management, 130–147. https://doi.org/10.1007/978-1-4612-4018-1_14

La Touche, G. D. (2021, June 10). Groundwater and Rewilding. Retrieved May 18, 2023,.

Mass crop failures expected in England as farmers demand hosepipe bans. (2022, September). The Gaurdian. Retrieved January 17, 2023, from https://www.theguardian.com/environment/2022/aug/12/mass-crop-failures-expected-in-england-as-farmers-demand-hosepipe-bans.

Makarieva, A. M., & Gorshkov, V. G. (2007). Biotic pump of atmospheric moisture as driver of the hydrological cycle on land. Hydrology and Earth System Sciences, 11(2), 1013–1033. https://doi.org/10.5194/hess-11-1013-2007

McCarthy, M. (2013) 'Why Half a Million Fritillaries Didn't Make It This Year', http://www.independent.co.uk/environment/nature/
naturestudies/why-half-a-million-fritillaries-didn-t-make-it-thisyear-8586203.html, Independent, 24 April.

Merrett, S. (2007). The price of water: Studies in water resource economics and management. IWA Publishing.

O'Hara, G. (2017). The politics of water in post-war Britain. Palgrave Macmillan.

Oliver, S. (2000). The thames embankment and the disciplining of nature in modernity. The Geographical Journal, 166(3), 227–238. https://doi.org/10.1111/j.1475-4959.2000.tb00022.x

Osman, M. B., Coats, S., Das, S. B., McConnell, J. R., & Chellman, N. (2021). North Atlantic jet stream projections in the context of the past 1,250 years. Proceedings of the National Academy of Sciences, 118(38). https://doi.org/10.1073/pnas.2104105118

Parikka, J., & Dragona, D. (2022). Words of weather: A glossary. Onassis Foundation.

Rising J, Dietz S, Dumas M, Khurana R, Kikstra J, Lenton T, Linsenmeier M, Smith C, Taylor C, Ward B (2022) What will climate change cost the UK? Risks, impacts and mitigation for the net-zero transition. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

Russo, R. O. (1996). Agrosilvopastoral systems: A practical approach toward sustainable agriculture. Journal of Sustainable Agriculture, 7(4), 5–16. https://doi.org/10.1300/j064v07n04_03

Seneviratne, S.I., X. Zhang, M. Adnan, W. Badi, C. Dereczynski, A. Di Luca, S. Ghosh, I. Iskandar, J. Kossin, S. Lewis, F. Otto, I. Pinto, M. Satoh, S.M. Vicente-Serrano, M. Wehner, and B. Zhou, 2021: Weather and Climate Extreme Events in a Changing Climate. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change[Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1513–1766, doi: 10.1017/9781009157896.013.

Steensen, B. M., Marelle, L., Hodnebrog, Ø., & Myhre, G. (2022). Future urban heat island influence on precipitation. Climate Dynamics, 58(11-12), 3393–3403. https://doi.org/10.1007/s00382-021-06105-z

Literature Sources

Stolton, S., and Dudley, N. Managing forests for cleaner water for urban populations. Unasylva. FAO. 229. 40–1.

Swyngedouw, E. (2009). The political economy and political ecologyof the Hydro-Social Cycle. Journal of Contemporary Water Research & Education, 142(1), 56–60. https://doi.org/10.1111/j.1936-704x.2009.00054.
Swyngedouw, E., Kaïka, M., & Castro, E. (2002). Urban Water: A Political-Ecology Perspective. Built Environment, 28(2), 124–137.

Steensen, B. M., Marelle, L., Hodnebrog, Ø., & Myhre, G. (2022). Future urban heat island influence on precipitation. Climate Dynamics, 58(11-12), 3393–3403. https://doi.org/10.1007/s00382-021-06105-z

Taylor, V., Chappells, H., Medd, W., & Trentmann, F. (2009). Drought is normal: The socio-technical evolution of drought and water demand in England and Wales, 1893–2006. Journal of Historical Geography, 35(3), 568–591. https://doi.org/10.1016/j.jhg.2008.09.004

Taylor, V. (2015). Whose river? London and the Thames Estuary, 1960–2014. The London Journal, 40(3), 244–271. https://doi.org/10.1179/1749632215y.0000000006

Taylor, V. (2019). Watershed democracy or ecological hinterland? Rivers Lost, Rivers Regained, 63–82. https://doi.org/10.2307/j.ctt1qnw8gv.7

The River Restoration Center, 2019, The Manual of River Restoration Techniques, United Kingdom

Tugwell, E. (2023, March 23). The Deer in our Waters. Retrieved May 18, 2023, from https://www.mammal.org.uk/2023/03/the-deer-in-our-waters/.

Waldheim, C., & Corner, J. (2006). Terra Fluxus. In The Landscape Urbanism Reader (pp. 23–33). essay, Princeton Arch. Pr.

Waldheim, C. (2016). Landscape as urbanism Princeton University Press.

Wall, D. (2017). Elinor Ostrom's rules for radicals: Cooperative alternatives beyond markets and states. PlutoPress.

Water firms in England and Wales lost 1tn litres via leaky pipes in 2021. (2022, August). The Gaurdian. Re-trieved October 20, 2022

Wang-Erlandsson, L., Tobian, A., van der Ent, R. J., Fetzer, I., te Wierik, S., Porkka, M., Staal, A., Jaramillo, F., Dahlmann, H., Singh, C., Greve, P., Gerten, D., Keys, P. W., Gleeson, T., Cornell, S. E., Steffen, W., Bai, X., & Rockström, J. (2022). A planetary boundary for Green Water. Nature Reviews Earth & Environment, 3(6), 380–392. https://doi.org/10.1038/s43017-022-00287-8

Wenham, S. (2014). Pleasure boating on the thames: A history of Salter Bros. 1858-Present Day. The History Press.

Williams, R. (1973). Country and the City.

World Wide Fund . (2008, July 31). Climate change means more floods for a drying Thames basin. Retrieved January 17, 2023, from https://wwf.panda.org/wwf_news/?142541/Climate-change-means-more-floods-for-a-drying-Thames-basin.

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