PARCHED PARADISE

A Deconstruction of the Mexican Water Crisis

Fig. 1: *El Caracol ,* an evaporation field for salt extraction from the vanshing *Lake Texcoco.*

As, Through, Without

Tasteless, odorless, and transparent. Water is this seemingly unexceptional molecule. A chemical compound which is abundantly scattered around the planet; as ice covering our poles and mountains, as steam in clouds and geysers, and as a liquid in our lakes, seas, and rivers. It cycles through all these forms, in a perpetual planetary cycle.

Life would not exist without water. Organic compounds first formed within it. Water forms the most significant component of any life form as it streams through every body. Through the bacteria and fungi that inhabit every niche of the planet, through the plants which cover most surfaces, and through us. It connects everything.

Yet, this is not where the story ends. Our collective actions are warming the atmosphere, destabilizing the finely balanced water cycle. Its consequences can be felt with every drought, with every failed harvest, and with every hurricane. Without aquatic balance, we risk the foundation of 10.000 years of human history.

And for what?

PARCHED PARADISE

A Hydrological Deconstruction of the Mexican Water Crisis

"Separating land from water on the Earth's surface is one of the most fundamental and enduring acts in the understanding and design of human habitation. The line with which this separation is imaged on maps, etched in the imagination and enforced on the ground with regulations and constructions has not only survived centuries of rains and storms to become a taken-for-granted presence; it has also been naturalized in the coastline, the river bank, and the water's edge [...] When people see flood, [...], they see water transgressing this line."

Dilip aa Cuhna, Introduction to The Invention of Rivers

When the first humans settled in what is today the Valley of Mexico, their surroundings must have been breathtaking. The surface of the basin was covered by a system of five great lakes which would swell with the torrential rainfalls and contract in the dry season. These diverse aquatic niches laid the foundation for early human settlements, as people lived in an ecosystem balanced with the waters. The development of Tenochtitlan (1325) marked a marginal, yet transformative departure from this balance. Through the construction of dikes, levees, aqueducts, and innovative water-centric agricultural practices, inhabitants intervened in the natural hydrological order. Nevertheless, their imperative to „preserve the fragile hydrological balance" of the lake system (Sosa-Rodriguez, 2010), attests to a nuanced awareness of the ecological intricacies inherent in their interventions.

The Fall of Tenochtitlan (1519) at the hands of the Spaniards would change this. As a series of floods ravaged the capital of New Spain, the Colonizers perceived the waters to be at odds with the future of the city. They looked with ambition to change the water territories. Technological advancements following the Industrial Revolution made these longstanding ambitions feasible as the intersection between land and water became drastically redrawn. Rivers were channeled, sources exhausted and most notably, the lake system was drained. These actions reinforced the belief that water could be subdued and expanded under the new Mexican state's aspirations toward modernity. Contrary to their intentions, many interventions had, and still have, drastic consequences. The once complex lake system faded from the Valley and left a parched landscape.

The newly exposed lakebeds provided land for Mexico City to expand, most of which was covered in the explosive population growth of the twentieth century. The existential question shifted from combating the floods to quenching the thirst of its 22 million inhabitants. To that end, the city built an extensive infrastructural network. The system relies mainly on aquifer extraction from the former lakes and interbasin water transfers from the neighboring Lerma & Cutzamala basins. Critically, both sources experience critical overexploitation of up to 230% of annual recharge (Palma Nava et al., 2022).

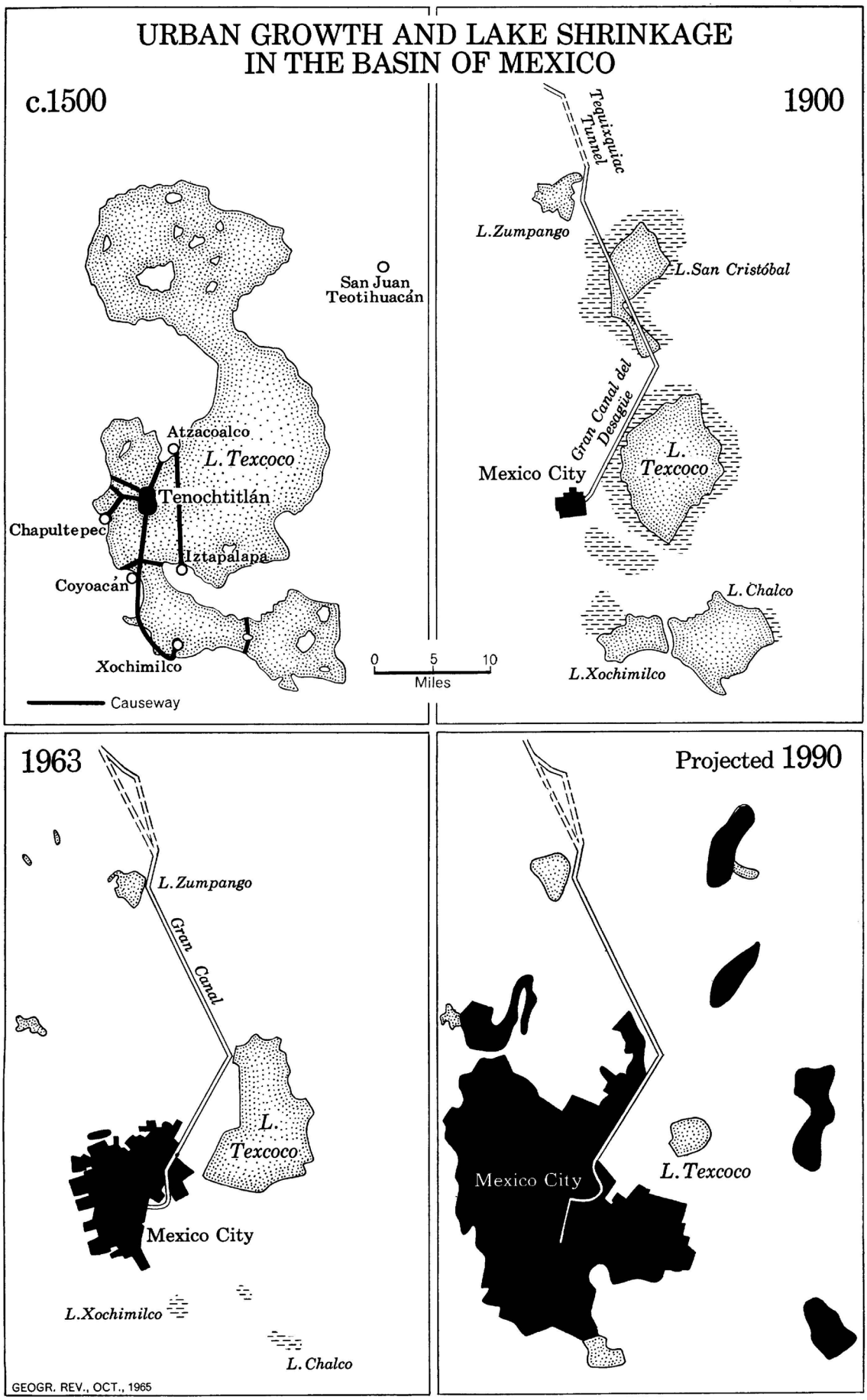


Fig. 2: Urban growth and lake shrinkage in the basin of Mexico.

Fig. 3: The urban expansion *Mexico City* (left) drained and covered the old *Tenochtitlan* (right) and the lake system.

Despite the severe over-exploitation of the water sources, current needs of the population are not met. Many inhabitants lack proper access to water, both in quantity and quality. Some marginalized regions are forced to buy water as private deliveries, spending up to 20% of their income on the resource. Furthermore, the heavy exploitation of aquifers leads to subsidence further damaging an already ailing infrastructure. Significant volumes of water are lost due to leakages. Paradoxically this enhances the risk of summer floods in some low-lying areas, as drainage infrastructure is ill-equipped to address accumulation in the rainy season. Climate Change threatens to amplify many of the existing challenges. It is likely that new ones will emerge in the process (Romero Lankao, 2010). Mexico City is under pressure to adapt. Failure to confront these challenges will undoubtedly place the livelihoods of its 22 million citizens at risk.

Despite past mismanagement, water is the exclusive domain of city authorities. Residents are considered "passive" consumers. The current asymmetrical power dynamic of top-down decision makers "choos[ing] what environmental signal or threat to respond to, when it matters and for whom, and how to respond," makes change hard to imagine (Eriksen et al., 2015 and Tellman et al., 2018). However, the emergence of Decentralized water practices, like Rainwater Harvesting by NGO Isla Urbana and the ejido system, challenge the state's supremacy in matters of water. These enable partial self-sufficiency, counter the top-down approach, and foster democratic water management.

Can decentralized practices challenge the paradigm of hydrological overexploitation in Mexico City, both practically and in their conception of water?

The centralized water system has created a water crisis in Mexico City. As authorities plan its expansion to address resulting challenges, they risk perpetuating a dangerous cycle. This research aims to determine avenues of hydrological transition through the analysis of existing decentralized water practices.
To accomplish this, the research will begin with a summarization of the relevant changes which shaped the modern hydrological system. This draws on the political science concept of historical institutionalism, which emphasizes the importance of historical factors and the development of institutions over time in shaping political and social outcomes. Central to this is the role of path dependency (North, 1990). After establishing these dynamics, both infrastructural interventions and organizational structures of the current water system will be identified to understand their connection with the hydrological challenges of the Crisis. This will also enable an expanded examination of how path dependencies could hinder adaptation to a changing climate. Finally, the research aims to explore decentralized water practices, shedding light on the adaptations people have created to address the limitations of the existing system. As many of the systems are nascent, the generated knowledge will lastly allow an extrapolation to future systems.

The case of Mexico City is a relevant one to consider. Not unlike many examples from the Global South the city faces a dual challenge. It is in dire need of providing water to satisfy the needs of its growing number of inhabitants. Authorities therefore rely on tried and tested approaches which mostly materialize in centralized infrastructure. Simultaneously, resilience will be built into the system to address the changing climate. The implementation of new systems will have to overtake the expansion of conventional solutions in parallel. The success or failure of the City will define the lives of its 22 million people, yet it also has the opportunity to establish a framework for other cities in the Global South. This is not a reduction to the pure function of these systems, but rather a framework for deriving new ones within their respective context.

2 Conceptual Frameworks

The research will engage with diverse knowledge fields due to the multi-dimensional nature of the Water Crisis. These include Hydrological paradigms, Socio-hydrology, Sustainable water management, Resilience thinking, and sociological and behavioral aspects. Specific concepts are used to assess and evaluate the Crisis landscape of Mexico City. These are detailed in the following categories:

2.1 Assessment

Social Construction of Water Landscapes

To understand the hydrological landscape of Mexico City it is paramount to look beyond its materiality. Greider and Garkovich (1994) introduced the concept of 'nature as a social construction' into the environmental discourse. Environments possess their own materiality. But humans attach different meanings to the physical environment and transform them into what the authors define as "landscapes." These meanings define the "proper and improper relationships among themselves and between themselves and the physical environment." In turn, this shapes management practices and thereby the physical configuration of the environment. Confronted with change, these meanings experience a process of negotiation which is shaped by the physical space. The research will have to analyze the importance of social constructions in shaping the landscapes of the competing systems but also how these have developed.

Sociospatial Analysis and Water

To attend to both the spatial and social dimensions of Mexico City's hydrological landscape the research uses a Sociospatial Analysis. The approach attends to the diverse, polymorphic nature of the topic. Generally, authors have referred to a variety of individual frameworks in accordance with their specific case. Jessop et. al (2008) criticize the scatteredness of conceptual frameworks as they 'overextend' applicability or fall into the trap of "one-dimensionalism." They propose a more systematic approach to represent polymorphy through the TPSN framework, composed of four concepts: Territory, Place, Scale, and Network. The research will built on this framework.

Visibility of Water

As the lakes in Mexico City vanished water became physically less visible. Stedman (2003) demonstrated how material qualities constrain social constructions of the environment. Brown (2017) differentiates this relation through a series of case studies in which this is and is not the case. To assess these discrepancies, she proposes the concept of "visibility." Where water is physically visible, its material qualities can predict attached meanings. In the absence of visible water, cultural mechanisms define if material and meaning coincide. Sociospatial visibility defines a society's will for conservation and management strategies. This is also the case in the different cases the research will examine. Therefore it will be invaluable to understand the mechanism of how water is or is not made visible in Mexico City.

2.2 Evaluation

From a Two-dimensional Line to a Three-dimensional Wetness

The history of Water in Mexico City is deeply shaped by a static conception of water that can be subjugated to the needs of authorities. In The Invention of Rivers (2018) Dilip da Cunha describes this understanding of water as a static line. This is documented in maps which depict land and water as mutually exclusive categories of space. The delineation of "dryness" is a prerequisite for habitation and was built into reality through infrastructural interventions facilitating the "subjugation of water."
Interventions drastically impact hydrological stability, which is exacerbated by the dynamics of climate change. Da Cunha advocates for a novel interpretation of water with his concept of "wetness." Contrary to the static line of the past, wetness acknowledges the dynamic nature of water as an ever present condition and negates the mutually excluding categorization of land and water. He proposes it as a design framework promoting novel spatial configurations (Mathur et al., 2014). While the static conception of water has shaped the History of Mexico City, wetness is a conceptual approach for the future. Therefore the research will have to analyze to what extent the different systems embody these conceptions, both in word and deed.

From Water Supply to Water Sensitivity: Heuristics of Hydro Social Contracts

The hydrological System of Mexico City has undergone dramatic changes. This will continue in the future as the city adapts to the pressures of Climate Change. Rebekah Brown et. al (2009) conceived developments of cities' water management paradigms (hydro-social contracts) as a six-stage model: the Water Supply City, the Sewered City, the Drained City, the Waterways City, the Water Cycle City, and the Water Sensitive City. Every stage is shaped by both external as well as internal pressures. The model is conceived as a heuristic tool to assess the developments towards more sustainable urban water practices and will be applied to the developments in the case of Mexico City. Most notably this will allow to map the trajectory of the centralized system but also the decentralized practices if adopted widely.

Water Sensitivity Communities, Commoning, and Citizen Participation

A complex interplay of private interests and state intervention has destroyed the lakescape in Mexico City. Citizens have not been entrusted to actively shape these developments. This is in line with Hardins (1961) destruction of the "commons" as a consequence of competing individual interests. But this was disproven by authors like Elinor Ostrom who argue for the opposite. In her book "Governing the Commons: The Evolution of Institutions for Collective Action" (1990) she substantiates self-organization as a viable alternative to State or Market-driven systems. The water sensitive discourse supports this with its concept of the water sensitive community. This is more relevant in the Global South, where sustainability discourse has often not reached governmental bodies. In these cases, the importance of "water-sensitive communities" as an impulse generator can not be understated. This is in line with the observations of decentralized water practices in Mexico City. The research will therefore analyze how these commoning dynamics create more sustainable outcomes.

3 Methodological Reflections

The research will examine the hydrological landscape of the Water Crisis in Mexico City. The centralized water system will be contrasted with competing decentralized practices, primarily the ejido system and rainwater-harvesting systems championed by Isla Urbana. These decentralized examples were strategically picked in the fraught field of the water crisis, as they share a political and material context. These systems can not be understood solely in their materiality. Hughes (1987) notes these systems are a sociotechnical and material hybrid which consists of a multiplicity of spatial and social components. Therefore, a material analysis would not comprehensively depict their systemic functions. The research should "not [...] determine where social constructions end and materialities begin, [... but] see how completely they are intertwined" (Orlove and Canton 2010: 403).

However, different sociospatial dimensions require an assessment of fundamentally different sources. Therefore, a mixed methods approach will be used, combining both quantitative and qualitative avenues. This may include GIS, statistics, reports, or paper analysis for the quantitative portion, as well as archives, newspaper reports, or interviews for the qualitative part.

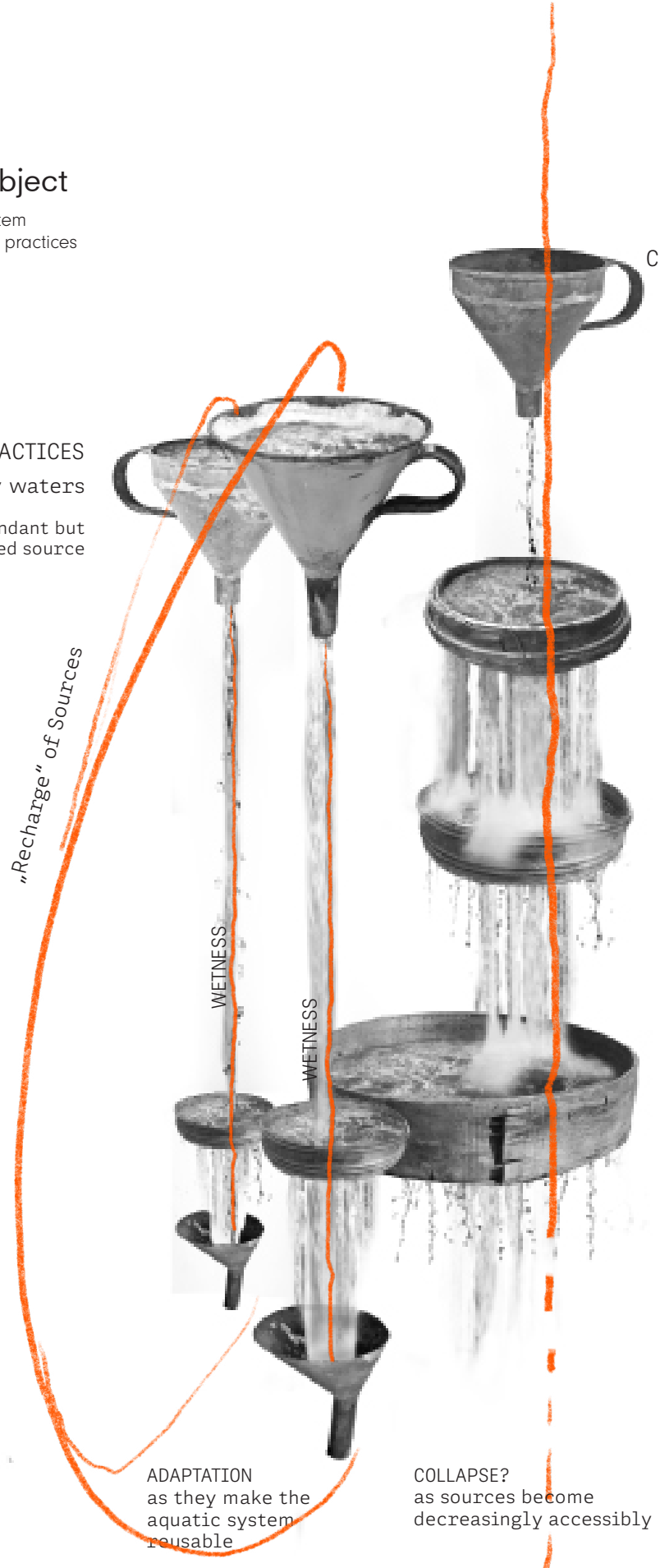
The output will be organized into three broad categories; the social, the spatial, and the sociospatial relations. The two former establish a contextual framework. The latter describes the overlap of the social and the spatial, as established by Jessop et al. (2008). However, it should be mentioned that the transitions between the categories could be fluid in some cases. The research will use the TPSN framework (Jessop et al., 2008) to organize the relational category. This structure was proposed to recognize the polymorphic nature of sociospatial relations while avoiding the 'one-dimensionalism' of some papers. The framework proposes Territory (T), Place (P), Scale (s), and Network (N) as the central sociospatial dimensions. Additional categories, such as "Visibility," could be added if the research deems them necessary. Most sociospatial analyses rely on text to state their findings. This disregards the opportunity to represent the spatial dimension comprehensively, to a certain degree.

The research will synthesize the collected information in text and through the process of "sociospatial mapping". Both approaches possess their merits. Text allows for an accurate and structured analysis or argumentation. It lends itself well to deconstructing the complexities of the hydrological landscape and its socio-cultural components. But it also establishes a certain hierarchical sequence. Complementarily, the medium of mapping represents the complexity of the information spatially (on one page). It does not create a hierarchy between the dimensions. Instead, it depicts their functionality more accurately as many of them work in parallel with and against one another. The approach relies on the long tradition of social cartography. It must therefore also address the inherent weaknesses. Furthermore, it expands the traditional notions of the field by not only depicting social outcomes but also showing the organizational power structures at their roots. To that end, the maps will use both traditional and novel techniques.

The sociospatial assessment, comprising both text and maps, illustrates the distinctions between the ejido system and rainwater harvesting compared to the existing system. Utilizing the concept of "wetness" and Brown's "water sensitivity," the analysis aims to assess their sustainability improvements and limitations in terms of widespread adoption. Ultimately, the objective is to evaluate the role of these systems in addressing the Water Crisis and the possibility of hydrological adaptation.

3.1 Research Subject

Linear centralized System
Circular decentralized practices



CENTRALIZED SYSTEMS
lake and aquifer waters

limited but
concentrated source

DECENTRALIZED PRACTICES
blue and grey waters

abundant but
scattered source

INDIGENOUS

protected hydrological
balance

COLONIAL

suffered floods
drained lakes

MODERN

overexploits aquifers
subsidence
contaminates waters

ADAPTATION
as they make the
aquatic system
reusable

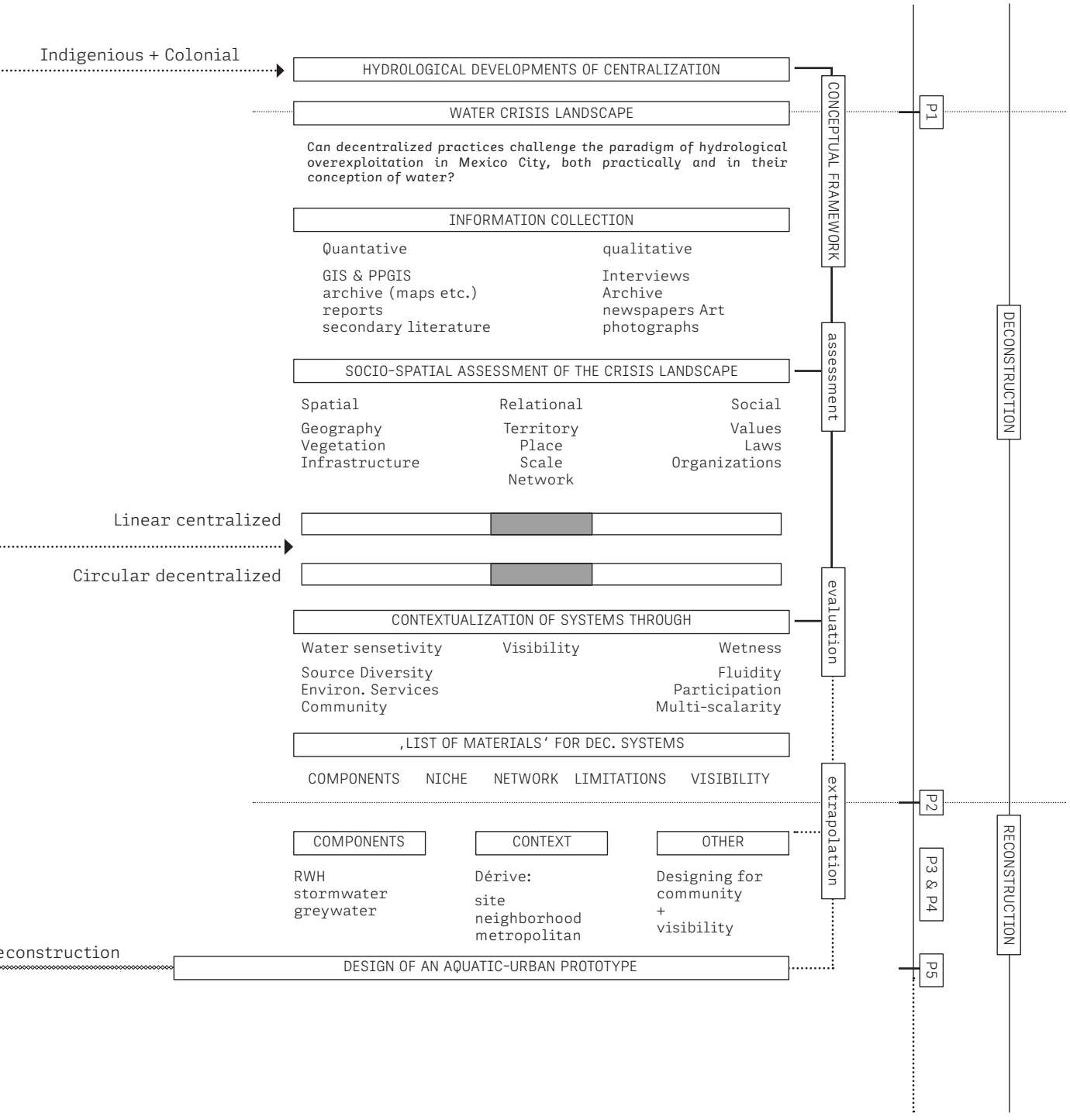
COLLAPSE?
as sources become
decreasingly accessibly

COMPETING FUTURES

both systems imply a
radically different
outcome in the context of
Climate Change

Systemic Deconstruction

into sociospatial components



4 Preliminary Findings & Relation to Design

The hydrological system of the Valley of Mexico has undergone significant change. The former City on a Lake has been turned into a parched landscape with over 22 million inhabitants. To quench their immense thirst, authorities have relied on a centralized system. Despite its enormous size, it lacks thoughtful complexity. It loses enormous amounts of water during transport, wastes rainwater and grey water, and does not use the human capital at its disposal. Instead, it critically over-relies on a supply-side approach. As the primary sources threaten to run dry, authorities plan to expand on these large sources of water or tap additional ones. They seem unable to imagine a different system from the one they already use. In it, the system functions as an agent of the static conception of water and land.

The decentralized practices in Rainwater Harvesting or the ejido system, utilize the overlooked aspects of the centralized system. They constitute complexity by implementing new water sources, activating public interest in water sustainability, and acknowledging the need for a novel conception of water, both in word and action. Despite all their relative improvements, these systems are still in their infancy. They inherently exhibit limitations. The central one is their lack of widespread technical applicability alongside a still limited complexity necessitating reliance on the centralized system in extreme demand situations. Nevertheless, it cannot be denied that they will be an important tool in creating a sustainable future for Mexico City as they function as an agent of wetness.

The decentralized practices represent an alternative to the existing system as they "protect, maintain and enhance the 'multiple' benefits and services of the total urban water cycle" (Wong & Brown, 2009). Future systems will have to shift from a reliance on a centralized system to one of "decentralized systems within broader networks" (Howe & Mitchell, 2011). To that end, an analysis of contextual examples like the ejido system and the Rainwater harvesting practice is invaluable. They establish an initial knowledge foundation for subsequent systems to modify and adapt.

The design phase of the thesis aims to establish sociospatial prototype for a decentralized water system in Mexico City. It will build upon the knowledge established in the analysis of the decentralized precedents. Outcomes will be divided into three knowledge categories. Firstly, the case studies establish information about the spatial components which constitute the system. Secondly, they facilitate insight into the organizational functions of such networks and, critically, how communities are built around water. Lastly, they provide knowledge of the relative niches carved out within these systems and how novel solutions relate to these to create widespread appeal for application.

None of the individual precedents represent a complete basis for a resilient system, nor should they, as they are not " [...] only about being persistent or robust to disturbance, it also reflects how that system creates opportunities [...] for renewal and the pursuit of new trajectories" (Wong & Brown, 2009; Folke 2006). Nevertheless, it will be necessary to intertwine the different systemic components to overcome individual limitations during the design phase. Additional research through in-depth analysis of historical, natural, and international precedents from varying contexts will aggregate the gathered knowledge. The conceptual framework from the research phase will guide a knowledge transfer process from heterogeneous examples into the Mexican context, with a particular emphasis on wetness, water sensitivity, and visibility. These concepts also establish a benchmark for what this novel urban decentralized system will need to achieve as it overlays the aquatic and terrestrial realms.

The design aims to initially manifest as a neighborhood-scale concept tailored to the specific needs

of its context. By abstracting it into its prototypical function, the concept intends to be applied to a variety of conditions in the City. These individual systems should seamlessly interrelate with one another in a broader web of networks. This approach addresses the imperative for scale while recognizing the specificity of different regions within Mexico City.

Beyond the essential physical considerations of water sustainability, such as supply, efficient use, and reuse, the project aspires to redefine the social and communal dimensions of water. In contrast to the static conception of water, the prototype envisions a "wetter" conception of water which envelops daily life, fostering a sense of community engagement and stewardship. This encompasses not only human-aquatic connections but will inevitably need to incorporate non-human participants as a central component. The core ambition is to transcend the utilitarian approach of water management, with a provider and beneficiary. Water should rather be exchanged in a complex process of interconnected actors benefiting from one another.

The water cycle and its components have traditionally been regarded in Mexico City as a kind of storehouse which could be used and altered abundantly. This conception is faulty as it threatens water exploitation. Some sustainability initiatives now run the risk of falling into similar thought patterns, as water is set to be exploited through a non-destructive manner. The dual focus on the social and spatial components will seek to counteract this narrative both in the research and design thinking by considering the system holistically. I believe this to be the only feasible approach to foster a truly resilient and sustainable system for all participants.

„Every summer the City wants to become a Lake again.“
Renata Fulton, Isla Urbana

Fig. 4: 3D-Visualization of the Lake System in the Valley of Mexico before human habitation

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