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Yallah*

a path to climate resilience and spatial justice in Nouakchott

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Design of the Urban Fabrics
Embracing plurality / growing porosity

PV Report
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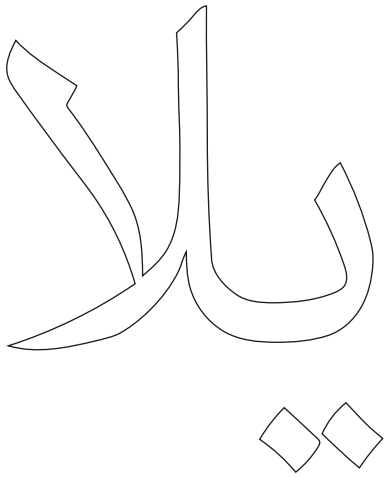

* Yallah : come on / lets go / hurry up

arab word used when you want something to happen or to get moving, expressing urgency

ABSTRACT

This research explores the relationship between socio-ecological resilience and spatial justice in Nouakchott, Mauritania, a city shaped by opposing climatic forces altering the landscape, rapid urbanization, deeply rooted social inequality and political uncertainty. The problematization emphasizes how climate impacts amplify existing social inequalities, both threatening the city's existence as a habitable place and posing a challenge to the survival of especially vulnerable communities.

The study critically examines the concepts of resilience, spatial justice and indigenous knowledge through the local context, highlighting the adaptive capacity embedded within local practices. Through a diachronic spatial analysis of Nouakchott's development, it identifies territories of persistent informality and displacement, revealing how past interventions have disrupted rather than supported vulnerable communities. In this context, resilience and vulnerability coexist, emphasizing the importance to strengthen local knowledge and to learn from the community.

Using the pattern language methodology, this research develops tools to design context-sensitive spatial strategies that combine socio-ecological resilience and spatial justice across scales. It advocates for adaptive, community-driven interventions that empower vulnerable communities, addressing environmental, social and spatial challenges in a contextually grounded design. This study demonstrates how addressing social and environmental challenges simultaneously can create unforeseen opportunities for both social equity and climate adaptability.

EX ANTE

Motivation

My motivation for this research is born from personal experience. Having lived in Nouakchott, Mauritania for several years, the country and people have shaped me as an individual, making me more aware of my own privilege and the disparities across the globe.

The climate crisis is a global concern that urbanists worldwide are beginning to address more urgently, especially as its impacts are increasingly felt in European cities. Yet, this crisis, undeniably anthropogenic and caused by the western world, affects the most often overlooked vulnerable communities disproportionately.

As an undeniable anthropogenic issue, the vulnerable communities most affected by climate change are not the ones causing it; nevertheless, they are the ones most often overlooked.

This project attempts to raise awareness for a country many people are not familiar with, a place extremely exposed, sensitive and affected by the effects of the climate crisis in the past, present and more severely in the future.

Aim

The aim of this thesis is to explore the interconnected nature of socio-ecological resilience and spatial justice within a complex environment of climatic and political of uncertainty. My main objective is to propose urban and climate-resilient solutions that respond to the needs of Nouakchott's most vulnerable residents.

By examining the context of Nouakchott, where opposing impacts of the climate crisis amplify social sensitivity, this project focuses on adaptive approaches to design. Cross-scale design principles that seek to improve the city's urban and climate resilience while enhancing spatial justice will be presented in a pattern language, aiming for solutions that are flexible, inclusive, and transferable to other contexts.

Ethical consideration

The ethical considerations plays a vital role in this research, particularly as it pertains to the long-term implications of design principles and interventions I aim to propose. This evaluation is essential in the context of spatial justice and resilience, as each decision may have lasting effects on the community's social and ecological well-being.

As an outsider, I recognize the importance of not imposing my own believes, but instead learn the cultural context. I am well aware of the existing privilege imbalance, and even as a well-intentioned outsider, I do not want to impose my ideas without understanding of the community's needs and perspectives. Therefore, the proposed pattern language and spatial design merely attempt to give inspiration and guide a conscious and effective co-creation process.

I acknowledge that my perspective is inherently subjective, shaped by my own background, upbringing, and experiences. However, I am committed to broaden my perspective to ensure a more comprehensive understanding of the issues at hand. By doing so, I hope to contribute a thoughtful, community-informed approach to resilience and spatial justice, grounded in both local realities and ethical integrity.

ACKNOWLEDGMENTS

Creating this project has been a challenge. However, many people have helped and guided me throughout this journey. I want to thank my mentor Claudiu Forgaci for guiding me through this at times chaotic process, for always seeing potential in my ideas, helping me navigate in the right direction, bringing to light what I didn't see, while always staying critical and honest. I want to thank my mentor Roberto Rocco for our mind-opening conversations that enriched this project in countless ways, for staying calm and confident when I wasn't. Thank you to my parents - my mom, for teaching me to look beyond myself and question what isn't right, and my dad, for encouraging me to always reach for the stars. Thank you, Josh, for the endless encouragement and for always grounding me. My gratitude goes to all my friends for supporting and inspiring me, for the collective wisdom they shared, and for listening to every thought and doubt throughout this process.

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I Introduction

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I . 1 CONTEXT



1.1 World map and Climate zone shift (OECD, 2014)

Sahara desert
Islamic Republic of Mauritania

Isohyet average 200mm / year
1940 - 1967
1968 - 2000

800 km



With many opposing qualities, the Islamic Republic of Mauritania can be described as a place of extremes. Located along the Atlantic coast of Africa, it is larger than any country in Europe with a surface area of 1.025.520 km^2, equivalent to 24.5 times the Netherlands. Around 90% of its landscape is covered by the Sahara Desert, (Johnson, 2017) making it one of the driest ecosystems in the world. This harsh landscape presents both profound challenges and unique ways of life for its inhabitants.

Historically, Mauritania's inhabitants have adapted to this desert environment through a nomadic lifestyle, moving with the rhythm of the seasons and depending on scarce natural resources. However, this way of life is increasingly threatened by irregular rainfall. From the 1970's to 1990's, extreme droughts and declining average rainfall caused the isohyet lines, zones of equal rainfall, to shift about one hundred kilometers south, expanding the desert landscape (PIK & UNHCR, 2021, p.5). Year to year differences make predictions about the future climate and rainfall difficult. Median projections for the Sahel region indicate an initial increase in rainfall followed by a harsh decrease until 2080 (OECD/SWAC, 2014, p.204). While exact models vary, all suggest that rainfall will become more irregular, leading to more extremes in both droughts and heavy rains.

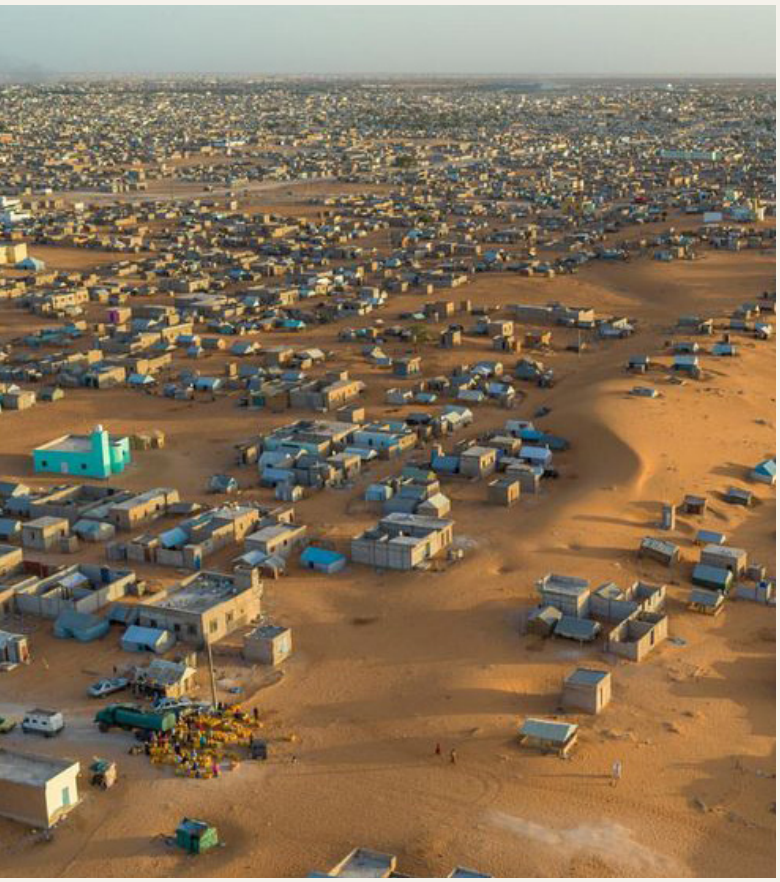
Mauritania has a complex cultural background. It is one of the rare places where the Arab-Maghreb and Black-African worlds meet; a place where they come together but still not become one. Culturally very different, what does bring them together is a strong religious believe. As the name reveals, the Islamic Republic of Mauritania is a deeply Muslim country, with 99% of the population being Sunni Muslim (US DOS, 2022). Therefore, religious traditions and family have a strong standing in society.

I . 1 . I Cities and their Character

Mauritania is ranked as the 20th most vulnerable country to negative impacts of climate change, measuring exposure, sensitivity and its capacity to adapt (ND-GAIN-Index, 2022). After severe droughts in the 1970's most of the population moved to cities near the coast. However, these areas are especially vulnerable to sea level rise. The map on the right shows the different identities of Mauritania's main cities. Nouadhibou in the north is famous for its tradition in fishery and its maritime reservoir Banc d'Arguin. It is one of the world's most important habitats for over two million migratory birds (UNEP-WCMC, 2017). The reservoir connects marshes, swamps, sand dunes and small islands, creating a biodiverse ecosystem for many bird species.

Chinguetti, known as one of the seven holy Islamic cities, is a former trade center for caravans traveling through the desert, dating back to the 12th century. It has specific religious importance for Muslims with its archive of ancient manuscripts. UNESCO heritage since 1996 and famous for its clay and stone architecture, they constructed a narrow urban fabric that would protect urban life from the desert. Chinguetti is prove for a long-lasting tradition of adapting to extreme climate conditions and harsh environments (UNESCO & Sao, 2023).

Although both cities have a richer cultural and historic background the focus of this project will be on Nouakchott. Founded in 1958 as the capital, it is the largest city in Mauritania with an estimated 1.6 million inhabitants (UN & Department of Economic and Social Affairs, 2018). Characterized by its astonishing urban growth of more than 4% annually, it has grown from a military post to a metropolitan city (UN DESA, 2018). Threatened on one side by the ocean, on the other by the desert, it is a place torn between longing for progress while trapped in tradition, injustice and vulnerability.



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1.2 Aerial view of Nouakchott

1.3 Eco-regions and main cities in Mauritania



I . 1 . II Historic Biography

For over 700 years different influences from the African, Arab world as well as its colonial background have influenced the culture and history of Mauritania. These influences, shaped by conflict and migration, created a complex and layered identity still visible today.



1442: Portuguese reach Cap Blanc

Around the 8th century different Berber groups formed the Sanhadscha bond, controlling the routes of trans-Saharan caravan trade connected to the Kingdom of Ghana. The Sanhadscha seperated, partially forming an alliance known as the Almoraviden going from southern Spain to the Senegal river. Their influence is still seen today as they were the alliance spreading Islam throughout the Maghreb and Western Africa (BBC, 2024).

Kingdom of Ghana

Kingdom of Mali

Arab invasion

8th century

2500 BC

1442

14th century

16th century

B.C.
More than 2500 years B.C. Mauritania's landscape was not a desert. The indigenous populations of the Barfur cultivated land and lived as fishers and hunters. Next to them the indigenous population of the Wolof and Tukulors lived in the valley as cattle farmers (BBC, 2024).

Drier periods transformed the landscape into a desert. The nomadic Berber warriors migrated from the north towards Mauritania. Back then still on horses, they only managed to claim the territory by domesticating the camel, an animal able to survive weeks without water. The camel made it possible for them to trade throughout the Sahara, fighting off the indigenous population that fled south (BBC, 2024).

At the end of the 13th century the Mali kingdom claimed most of Mauritania's territory that before was owned by the Ghana empire.

Starting in the 14th century a slow Arab invasion of Mauritania caused Berber as well as Africans to flee south. In the 16th century this ended 700 years of Black African dominance throughout the territory. The black population that stayed North was enslaved and forced to maintain the oasis essential for trade (BBC, 2024).
In this time Chinguetti won its religious importance, prominent until today.


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1885

Berlin Conference

The Berlin Conference saw European powers divide Africa into colonies with little regard for existing ethnic, cultural or territorial boundaries. Mauritania was claimed by France and became part of French West Africa, an arrangement that would influence its political and social structures for decades (BBC, 2024).

1904

French colony

This time brought waves of independence movements across Africa, sparking violent clashes in French West Africa, ultimately leading to independence in 1960 (BBC, 2024).

1946

Fight for Independence

1958

Autonomy
Nouakchott becomes capital

Through autonomy from the Frenchin 1958, Nouakchott, originally a small fishing village with 1,800 inhabitants, was chosen as the capital (BBC, 2024). Nouakchott's history begins with initial modernist plans for the city by French colonial architect Lainville.

1960

Independence

In the 1970's severe drought quickly led to the rapid transformation of Nouakchott from a village into a metropolitan.

1970

This graphic highlights profound moments in history that left lasting impacts on Mauritania's culture, politics and society, visible to this day.

I . 1 . III Demography and Social Structure



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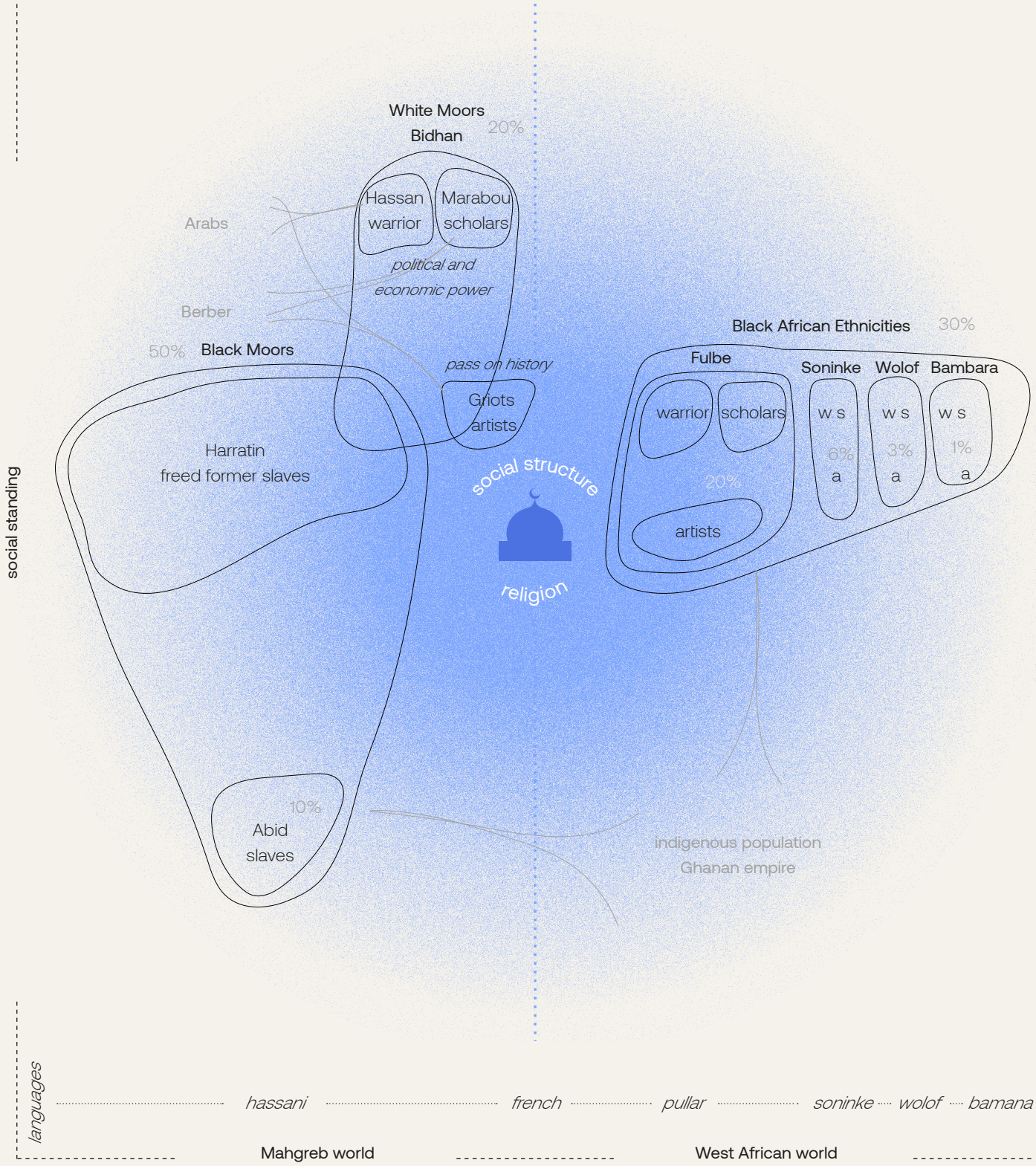
Mauritania's society and complex social structure have been shaped by its history of wars, invasions, and waves of migration. This history has resulted in a deeply divided culture. On one side are the Moors, descended from Berber and Arab ancestors. On the other side Black African ethnic groups, whose roots can be traced back to the strong, centralized black African Ghana Empire or the indigenous population that cultivated the land over 4.000 years ago. Population censuses in Mauritania are highly politicized, and cause of riots, death and instability (OFPRA, 2012). Accurate numbers about this are difficult to acquire. Therefore, the following numbers reflect an estimate of the population's demographics but may not fully capture the reality.

The Moorish population in Mauritania is split into two groups. The Bidhan, or "white Moors," make up about 20% of the population and form the country's elite. The "black Moors," around 50% of the population, have a lower social standing due to their slave ancestry. The Bidhan are further divided into two symbolic groups based on their ancestral roles: the warriors (Hassan) and the Islamic scholars (Marabou). The Hassan, with Arab roots, and the Marabou, with Berber roots, hold the highest social standing. Both groups have Griots, artists forming a distinct circle, with lower status. However, their artistry is vital for spreading historic knowledge through songs and poems, a common practice used upon nomadic groups to share their oral history. Most of the political and economic power in the country is concentrated among elite Hassan and Marabou families; every president so far has come from an elite Marabou family. (Cheikh, 2010, p.6)

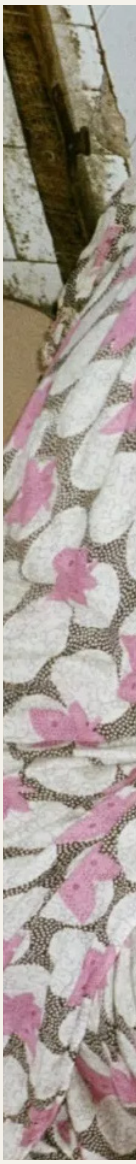


1.4 Societal Structure and Demography

The black Moors consist of two groups: the Haratin (freed former slaves) and the Abid (slaves). Both groups are culturally connected to the Arab and Berber worlds and speak Hassaniya, an Arab dialect also spoken by the elite. Despite their cultural proximity to the elite, they have the lowest status in the country. Especially the Abid are not well recognized, with some still living with their former masters' families. This dynamic makes it hard for people to break out of societies constrains. (Melly, 2019, p.12).
The other side of Mauritania's population consists of various Black African ethnicities, known collectively as the Soudans, making up about 30% of the population. They speak the language of their respective ethnic groups and French. These groups have strong ties to the African world and less connection to the Arab and Berber realm. Their social structures are similar to the Moors, with divisions into warriors, and scholars. The largest ethnic group among them are the Pulaar-speaking Fula or Fulbe, who make up about 20% of the population. Traditionally, they are semi-sedentary farmers or nomadic pastoralists with territory extending from north of Nouakchott to south of the Senegal River. Cattle domestication is crucial to their culture, symbolizing wealth and status. Although there are extremely wealthy and influential Pulaar families in Mauritania, they are not always socially accepted by Moors. The other ethnic groups, the Soninke, Wolof, and Bambara, comprise the remaining 10%, each speaking their own language (Rebstock, 2007, p.58) (Cheikh, 2014).

Connection

Mauritania represents a unique intersection of the Maghreb and Black African cultures, blending diverse cultures, traditions, languages and identities. Despite their cultural differences and clear social hierarchy, making marriages between groups socially unacceptable, they share the importance of Islam in their daily lives. Daily prayers structure the rhythm of life, providing a common thread that unites these otherwise parallel societies.





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I . 1 . IV Governance

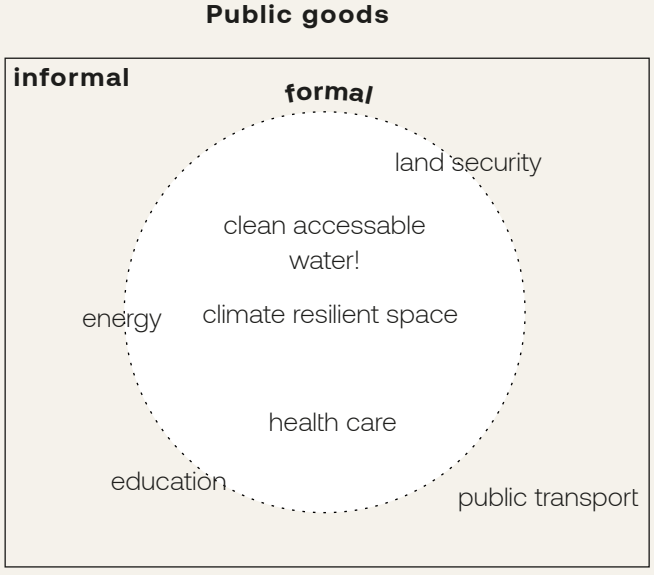
Mauritania's governance faces inherent issues of corruption and inefficiency, particularly in urban centers like Nouakchott. Although improvements have been achieved, they remain minimal and localized to urban centers. Mauritania is praised a model of stability within the Sahel region. However, the last coup d'état only dates back to 2008 and the governing president since 2019, Mohamed Ould Ghazouani, participated in at least two of the country's nine coups (The Economist, 2024).

Mauritania follows a French-style presidential government system and is recognized as a moderate autocracy. (Cheeseman, 2020). Formal rules and informal practices contribute to the president's concentration of power, which is referred to as hyper-presidentialism. Through this immense power and persistent majority in seats, the president overshadows elected assemblies like the National Assembly, regional councils and municipal councils. The military is considered a veto power in Mauritania. Since 1978, all presidents, with one exception, have been active or retired Bidhan military officers. These autocratic structures and frequent merging of administrative and political roles foster corruption, embezzlement and clientelism. Debates on Mauritanian identity have shaped politics, reinforcing narratives of exclusion that prioritize the nation's "Arabness". This stance affects marginalized groups like the Haratin and Black African communities, who face systemic barriers and lack power in government, military, and crucial ministries (BTI, 2024b, p.41).

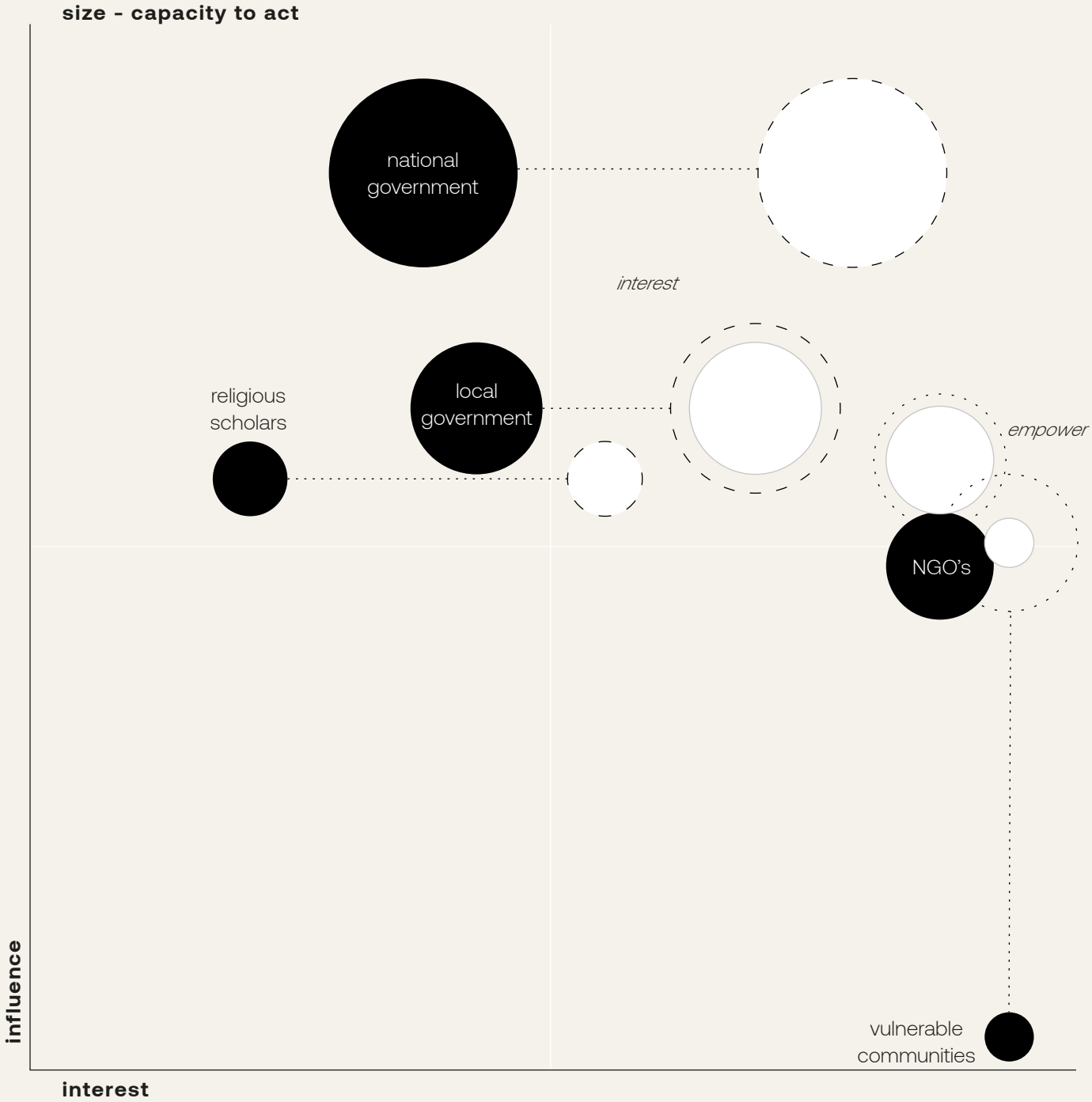
Mauritania consistently scores low on governance and anti-corruption indices. According to Bertelsmann's Transformation Index (BTI) 2024, Mauritania scores a 4.1 out of 10 for governance quality and state legitimacy, and a 3.0 for anti-corruption efforts and stability of democratic institutions. These scores have shown little to no improvement over the past decade (BTI, 2024a). The Corruption Perception Index (CPI) 2023 ranks Mauritania 130th out of 180 countries globally (Transparency International, 2024).

While decentralization is constitutionally enshrined, Mauritania's attempts to disperse political and administrative systems remains unsuccessful. A 2017 reform created regional councils; however they remain financially dependent on the central government and lack autonomy (BTI, 2024b, p.12). Every region, or wilaya, has its own regional council, except Nouakchott, which has a single council merging three wilayas. The council president, currently Fatimetou Mint Abdel Malick, serves as the de facto mayor of Nouakchott and aligns with the president's party (Saleh, 2022). Despite efforts to transfer responsibilities to municipalities, the government does not pass on necessary funds; a system where mayors and local administrations are not equal partners. The lack of coordination among local, regional, and national authorities further weakens an already limited problem-solving capacity (BTI, 2024b, p.34) (Melly, 2019, p.10f).

Mauritania's governance structures are impeded by the concentration of presidential power, widespread corruption, and ineffective decentralization, leaving vulnerable populations exposed to systemic inequalities. These issues require an approach that enhances transparency and the distribution of power by considering stakeholders, their interest, influence and capacity to act. Local governments need support to increase their autonomy, while religious scholars, who hold significant influence across all social classes, play a vital role in bridging different societal groups and stakeholders. Most importantly, a focus on empowering vulnerable communities through participation, education, and co-creation shapes their sense of belonging. These steps are essential to move towards an equitable society in Mauritania and Nouakchott. (GAN Integrity 2020)



1.5 Public good analysis



1.6 Stakeholder analysis

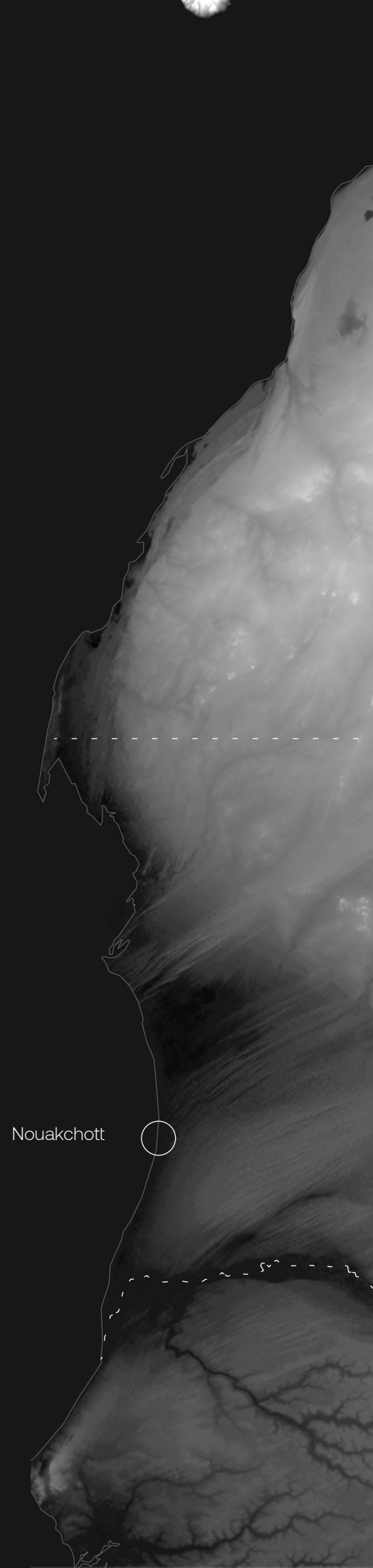
I . 2 PROBLEMATIZATION

The areas of the world most overlooked when considering the climate crisis paradoxically suffer its harshest impacts. In Mauritania, the opposing forces of the climate crisis intersect with existing social injustice and extreme poverty. The climate crisis acts as a threat multiplier to vulnerable communities, driving migration, displacement, and loss of livelihoods. Vulnerability is defined as "the propensity or predisposition to be adversely affected" (IPCC, 2014, p.5). Literature on urban vulnerability incorporates three dimensions; exposure, sensitivity and adaptive capacity (Romero Lankao & Qin, 2011). These factors, and their intersection, are highly visible in Nouakchott, where climate impacts intensify social inequities. This problematization explores why Mauritania and particularly Nouakchott is especially exposed to climate change and how social injustice amplifies its vulnerability.

Exposure

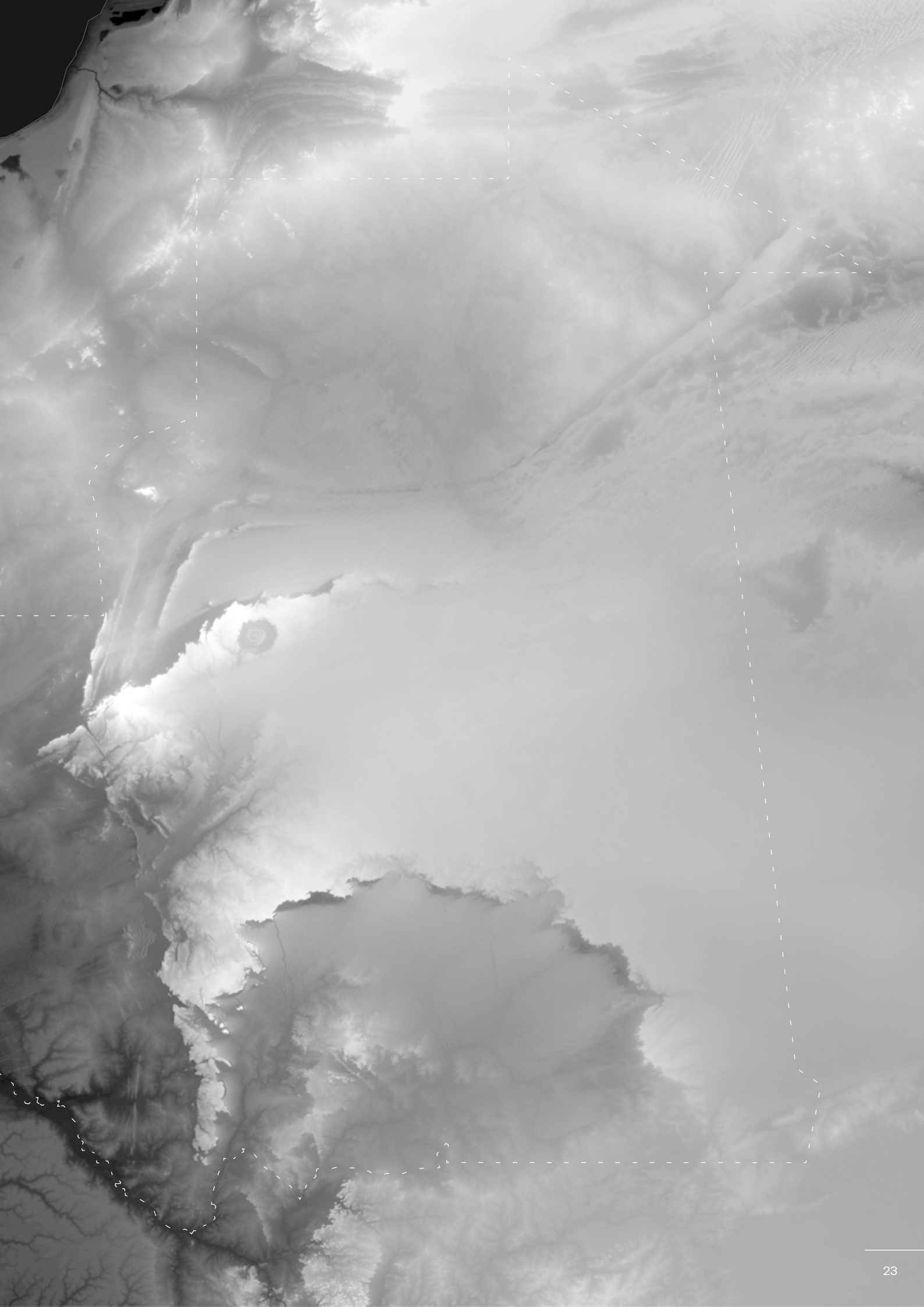
Exposure describes the likelihood and extend to which environmental conditions pose risk to a system (Romero Lankao & Qin, 2011). Nouakchott's geographical location exposes it to opposing natural forces, including persistent stress as well as sudden shocks. The low-lying terrain along the west coast exposes the city's urban fabric to rising sea levels, resulting in pounding groundwater salinization and frequent flooding. In the future these forces will impact local groundwater resources (Mohamed et al., 2017). The only protection, a narrow strip of coastal sand dunes, is threatened by erosion due to natural but mainly anthropogenic activity including sand extraction, harbor construction, and intense traffic (Mohamed et al., 2017). This persistent pressure will be intensified by more frequent shocks such as storm surges and flash floodings caused by erratic rainfall (PIK & UNHCR, 2021, p.4).

At the same time, Nouakchott's proximity to the Sahara Desert exposes it to severe desertification. Over the 20th century the Sahara Desert expanded by 10% globally (Liu & Xue, 2020). This gradual dynamic process, driven by droughts and wind erosion, threatens the already fragile ecosystem and its inhabitants. By 2080 Mauritania is projected to experience temperature increases of 2 to 4.5°C above pre-industrial levels, with more extreme periods of droughts and up to 300 very hot days per year. Nouakchott will face increased shocks including heatwaves, projected to affect 34% of the population, increasing heat related mortality and challenging livelihoods. Sandstorms and the intensified Harmattan winds will drive further sand encroachment and air pollution posing a serious health hazard (PIK & UNHCR, 2021, p.16).



1.7 Topography of West Africa

- 5 m 915 m



National

multi-dimensional poverty vulnerable to mdp (UNDP, 2023)

Urban population (CAHF, 2023)

in informal settlements 2018 (CAHF, 2023)

lacking electricity (World Bank, 2019)

lacking improved water sources (World Bank, 2019)

Projected impact of sea level rise on urban extend (World Bank, 2007)

Projected air temperature increase (IPCC, 2023)

Sensitivity

Sensitivity reflects the extent to which a system is affected by climate exposures (Romero Lankao & Qin, 2011). This is particularly relevant in Nouakchott's vulnerable communities, where social, economic, and infrastructural conditions increase sensitivity. In 2019, around 40% of Mauritania's population was under 15 years (Jobarteh, 2024), making a large proportion of residents particularly sensitive to climate stresses. Nouakchott houses around one third of the national population, most of which live in informal settlements, known to be more sensitive to extreme weather events. 42% of urban households lack access to improved water sources, relying on truck water, retailers, tanks, and wells without pump (World Bank, 2019, p.4) reinforcing sensitivity to droughts, heatwaves and water contamination. Additionally, 58.4% of Mauritanians live in multidimensional poverty, lacking access to crucial resources like healthcare and education (UNDP, 2023) (MPPN, 2023). This lack of essential infrastructure increases residents' sensitivity to climate shocks and undermines their capacity to adapt.

Adaptive capacity

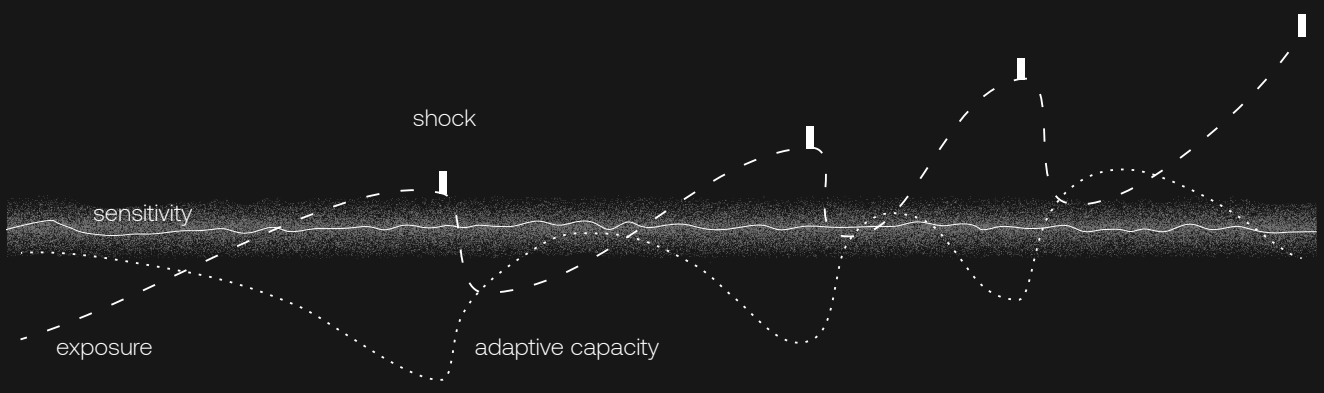
Adaptive capacity refers to the ability of a system to respond, adjust, and adapt to change. Political stability plays a vital role in a country's capacity to address crises effectively. Compared to other countries in West Africa, shaped by conflict and unrest, Mauritania prides itself on a politically stable democratic government. However, this political stability may be challenged as climate change exacerbates existing social inequalities, amplifying the risks of social unrest and organized violence (Muggah, 2021). As resources diminish and inequality intensifies, the nation's risk to instability will grow, limiting the political ability to effectively respond.

Communities across the world prove their adaptive capacities by thriving in extremely hostile environments. Mauritania's nomadic communities demonstrate their resilience by coping with extreme exposure to sun, heat, and dust while having little water. However, they may struggle to adapt to a future with rising sea levels, flooding and downpour. High illiterate rates of 33% (World Bank, 2021) may complicate effective adaptation, especially as the landscape and ecosystem they have known for centuries radically transforms.

Conclusion

Nouakchott's vulnerability to impacts of the climate crisis reveals a complex interplay of environmental exposures, social sensitivities, and limited individual and political adaptive capacity. In this context, the climate crisis poses a challenge to the survival of particularly vulnerable communities while amplifying conflict among growing segregated communities. Establishing urban and climate resilience while strengthening spatial justice in Nouakchott is critical to its existence as a habitable place. This highlights the need to examine how climate exposure and social sensitivities manifest spatially and focus on identifying vulnerable communities with low adaptive capacity in Nouakchott. A meaningful design decreases the community's sensitivity while increasing their adaptive capacity above the uncertain but inevitably increasing exposure of the climate crisis.

Nouakchott's existence as a habitable place is threatened by climate stresses such as pounding groundwater flooding and desertification altering the landscape and spatial injustice shaped by extreme poverty and displacement, posing a challenge to the survival of vulnerable communities.





II Approach

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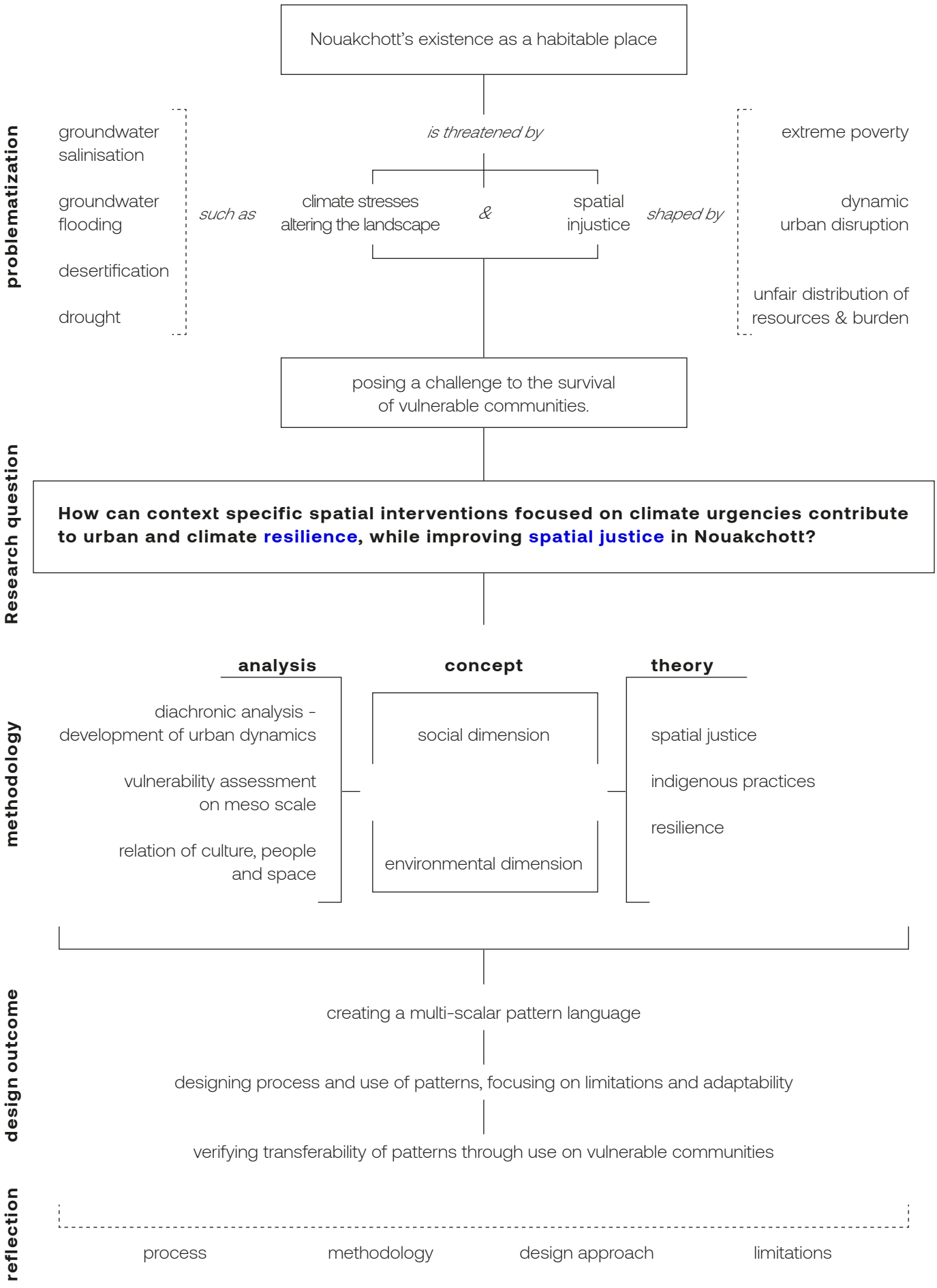
II . 1 RESEARCH APPROACH

II . 1 . I Research Framework

Focusing on the process of research through design, this thesis synthesizes theoretical research, as well as qualitative and quantitative analysis, resulting in the development and testing of a pattern language.
Starting from the overarching issue of vulnerability and its spatial implications analyzed in the problem statement, a main research question framing the scope of this thesis was identified. In this context the focus will be on interventions contributing to urban and climate resilience while improving spatial justice. Therefore, the theoretical research includes literature reviews and discussions on the notions of resilience, spatial justice and indigenous practices, developing critical maps explaining the relation of territory and injustice in space. Case studies on indigenous practices will be analyzed to understand the notion of time and the cycle of seasons relevant for each practice and identify their applicability in a new context.

The analytical framework is divided by sub research questions, each with focus on a different scale. The overarching theme of the analysis focuses on a deeper understanding of vulnerability – how it develops in the first place, how it can be identified and assessed, and how it impacts peoples use of territory. The outcome of the analysis will include a diachronic analysis of urban dynamics on a metropolitan scale, an assessment and evaluation of vulnerability on a neighborhood scale, and a deeper understanding of culture, tradition and nostalgia in the daily life of Mauritanians.

The synthesis of the theoretical and analytical framework will lead me to my final design proposal, containing a pattern language that will be used in a design process on two vulnerable locations in Nouakchott with different climate exposure. Although represented here as a linear process, it is important to note that the approach of research through design encourages the exploration of space and design ideas throughout the analysis and research phase.


problematization
Nouakchott's existence as a habitable place
groundwater salinisation
groundwater flooding
desertification
drought
such as
is threatened by
climate stresses altering the landscape
&
spatial injustice
shaped by
extreme poverty
dynamic urban disruption
unfair distribution of resources & burden
posing a challenge to the survival of vulnerable communities.
Research question
How can context specific spatial interventions focused on climate urgencies contribute to urban and climate resilience, while improving spatial justice in Nouakchott?
methodology
analysis
concept
theory
diachronic analysis - development of urban dynamics
vulnerability assessment on meso scale
relation of culture, people and space
social dimension
environmental dimension
spatial justice
indigenous practices
resilience
design outcome
creating a multi-scalar pattern language
designing process and use of patterns, focusing on limitations and adaptability
verifying transferability of patterns through use on vulnerable communities
reflection
process
methodology
design approach
limitations

II . 1 . II Research Questions

As mentioned before, the main research question focuses on a design assignment combining the concepts of resilience and spatial justice. The sub research questions come from the preliminary problem analysis and identify notions that need further investment.

Nouakchott is drastically impacted by negative effects of the climate crisis in the past and present. Understanding what this means for the future spatially and why the city is particularly vulnerable to these threats is critical to design sensible solutions. Understanding the cities dynamics through time is part of the analysis to understand persistence, transformation and disruption of the urban fabric on a smaller scale.
Assessing vulnerability and obtaining a deeper understanding of the life and culture is especially important to create a pattern language that is adaptable to various conditions but sensible to the specific context.

Nouakchott's urban fabric has evolved informally throughout time. This in connection with corruption, ambiguity and a general lack of transparency makes finding accurate data challenging. Therefore, a balance between qualitative and quantitative methods is used to analyze the context of Nouakchott.
Existing spatial data must be compared to recent satellite imagery and in some cases be manually transformed. In this case, spatial data is based on OpenStreetView, added and transformed through comparison with Google Earth satellite images. Statistical data has been used with care, as certain numbers might not reflect the reality due to internal agendas of the publishing entity. When specific data is not available, measurable representative factors that are comparable will be used in a systematic approach, drawing strong relations between the analyzed and measurable factors.

4. What can we learn from the cultural identity and historic context of Mauritania?

1. What makes Nouakchott particularly vulnerable to present and future impacts of climate change?

How can context specific spatial interventions focused on climate urgencies contribute to urban and climate resilience, while improving spatial justice in Nouakchott?

2. How has Nouakchott grown and persisted over time in its vulnerable geographical context?

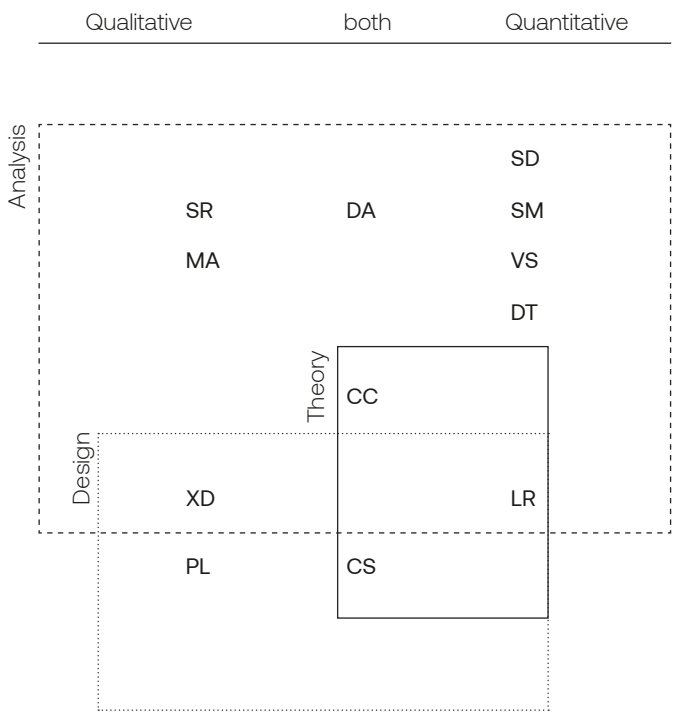
5. How can indigenous practices and technological solutions inform the design of an adaptive pattern language?

3. What spatial injustices, especially in vulnerable communities, arise in Nouakchott?

II . 1 . III Method

Method items	Acronym	Method	
		Qualitative	Quantitative
Site research through text, video, photography	**SR**	X	
Morphological analysis	**MA**	X	
Research through explorative design	**XD**	X	
Diachronic analysis	**DA**	X	X
Research and statistical data analysis	**SD**		X
Spatial Mapping with GIS	**SM**		X
Data comparison and transformation	**DT**		X
Literature review	**LR**		X
Case study analysis	**CS**	X	X
Vulnerability assessment	**VS**		X
Critical cartography	**CC**	X	X
Pattern language method	**PL**	X	

2.1 Qualitative and Quantitative Methods



2.2 Methods and their relation to the research questions

How can context specific (4.) spatial interventions focused on climate urgencies (1.) contribute to urban and climate resilience, (2.) while improving spatial justice (3.) in Nouakchott?

Sub-research question

1. What makes Nouakchott particularly vulnerable to present and future impacts of climate change?

2. How has Nouakchott grown and persisted over time in its vulnerable geographical context?

Why does Nouakchott experience this rapid growth?
Where does this happen spatially on a city scale?
What urban structures are persistent or transformed and how on a neighborhood scale?

3. What spatial injustices, especially in vulnerable communities, arise in Nouakchott?

4. What can we learn from the cultural identity and historic context of Mauritania?

5. How can indigenous practices and technological solutions inform the design of an adaptive pattern language?

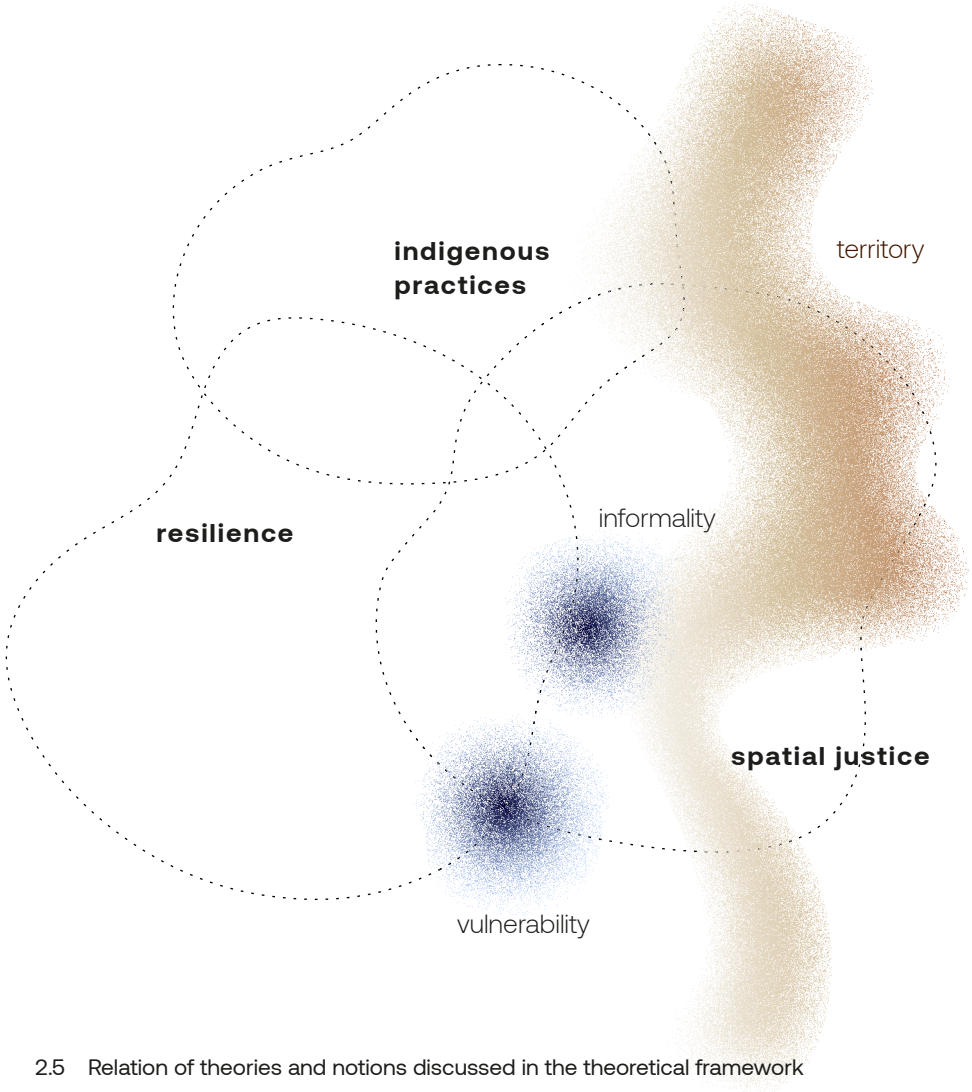
= Approach Research Approach

Analytical research question
Theoretical research question
Design assignment

Method	Acronym	Expected Outcome
(1) Morphological analysis, Research and statistical data analysis (2) Spatial Mapping with GIS	**MA** **SD** **SM**	**Maps projecting the spatial implications and landscape alterations caused by negative impacts of the climate crisis**
(1) Literature review and statistical data analysis (2) Morphological analysis, Spatial Mapping, Diachronic analysis (3) Data comparison and transformation, Spatial Mapping, Critical cartography	**LR SD** **MA SM** **DA** **DT SM** **CC**	**(1) Identifying drivers for urbanization dynamics. (2) Diachronic maps of urbanization , infastructure and landscape on a metropolitan scale. (3) Diachronic maps identifying persistent and transformative patterns on a neighborhood scale.**
(1) Literature review (2) Spatial Mapping (3) Research and statistical data analysis, Vulnerability assessment	**LR** **SD** **SM** **VS**	**An atlas on identifying and assessing vulnerability. (1) Summary of reviewed literature to identify the relation of vulnerability and scale. (2) A typology of urban patterns representative throughout the city, and map of their replication. (3) An assessment criteria and evaluation for spatial and social vulnerability, used on the identified typology**
(1) Site research through text, video, photography, Morphological analysis, Literature review (2) Research through exploration and design, statistical data analysis, Spatial Mapping,	**SR** **MA** **LR** **XD** **SD** **SM**	**(1) Identifying aspects of the culture, tradition and indigenous resilience in the daily life of Mauritanians through identity portraits. (2) Map of spatial implications and activity on a neighborhood to architectural scale.**
(1) Literature review, Case study analysis, Pattern language method, (2) Research through exploration and design	**LR** **CS PL** **XD**	**Pattern booklet with spatial interventions through all scales. Designing the process and use of patterns through pattern sets. Lastly verifying their transferability, adaptive qualities, and limitations of patterns by mapping transformative implications.**

II . 2 THEORY

The following theories are an extract of the existing literature to shape the theoretical underpinning of my thesis project. Attempting to connect social and ecological vulnerability to a spatial dimension with a focus on solution-oriented research, theories are grouped under the overarching topics of resilience, spatial justice, and indigenous practices. Although some vital notions, such as relate to several topics, they are here presented through one lens to avoid redundance. Therefore, the topic of vulnerability is discussed through theory on resilience, while the concepts of informality and territory are explained through their relation to spatial justice.



2.5 Relation of theories and notions discussed in the theoretical framework

II . 2 . I Resilience

The concept of resilience is used over multiple disciplines, including engineering, psychology, and ecology, leading to tension in its definition (Meerow et al., 2016). Often cited as the founder of modern resilience theory is the ecologist C.S. Holling. As Meerow et al. explain in their literature review, Holling defines resilience as "the ability of an ecological system to continue functioning—or to 'persist'—when changed, but not necessarily to remain the same." (Meerow et al., 2016, p. 40) This directly contradicts prior definitions of 'engineered resilience' which focus on reverting systems to their pre-disruption state. (Holling, 1996)

This fuzziness is amplified when we get to the term urban resilience, as neither urban nor resilience is clearly defined. Tensions within the definitions can be found between the notion of stability, the understanding of adaptability, and the way complex urban systems recover, either to persist, transition or transform. Criticized by Meerow et al.'s literature review, most definitions fail to address these tensions. As Klein et al. put it: "The problem with resilience is the multitude of different definitions and turning any of them into operational tools. … the definition of resilience has become so broad as to render it almost meaningless." (Klein et al., 2003, p. 42)

Similarities can be drawn in the discourse on climate resilience where the cause of disturbances is clearer. Climate resilience refers to a systems capacity to recover and adapt from disturbances caused by the climate crisis (Friend & Moench, 2013). These disturbances can be categorized as either shocks, extreme disturbances over a short time, or stresses, gradual long-term disturbances. A resilient system will both bounce back and adapt to better respond to future disturbances. For people, climatic stresses are often less relatable than shocks because they are more complex and less tangible. Shocks like flooding or wildfires are immediate and visible, while the gradual effects of heat stress are more difficult to assess. As a result, many administrations fail to address the impacts of climate stresses, leading to a lack of urban and climate resilience (IPCC, 2023).

What all definitions share is seeing urban and climate resilience as a desirable state, something positive we should strive to achieve. In this discourse social scientists tend to ask, "resilience of what and for and by whom?" (Friend & Moench, 2013) This question is central to my project, as I focus on more resilience for specifically vulnerable communities who are more exposed, sensitive and have lower adaptive capacity. This focus leads to the concept of socio-ecological resilience, which emphasizes not only the adaptability of natural systems, but also the well-being and adaptability of communities.

In this context it is important to note the relation of resilience and vulnerability. Existing research often describes resilience and vulnerability as "opposite sides of the same coin", seeing vulnerability as the tendency of damage to a system, and resilience as the ability to recover and resist this damage (SOPAC, 2023, p.1). This theory of two opposing forces is rejected by scholars such as de Boer arguing that vulnerable communities often prove the opposite. He argues that by continuously functioning in exposed contexts they prove that resilience and vulnerability are deeply interconnected and co-exist. (De Boer et al., 2016) Therefore, I see importance in looking at resilience and vulnerability simultaneously. Vulnerable communities prove they are extremely resilient by persisting and adapting in hostile environments.

Through an unpredictable combination of shocks and stress, the climate crisis creates a context of uncertainty that I will attempt to design for. In this context the concept of resilience is an important aspect to consider when designing for uncertain futures. It asks for flexibility but at the same time clarity and determinacy on who we want to design for.

II . 2 . II Spatial Justice

The lens of justice and its relation to space is an integral notion throughout this thesis in order to understand spatial vulnerability. Focusing on the concept of spatial justice, territory, and informality, this framework attempts to define spatial justice and interpret it for the context of Nouakchott.

A critical figure in the field of urban theory is Edward W. Soja, who emphasizes the spatial dimension of social inequality and thereby shaping the discourse on spatial justice. He describes spatial justice as "the fair and equitable distribution in space of socially valued resources and the opportunities to use them" (Soja, 2009, p. 2). Building on Henri Lefebvre's theories (Lefebvre, 1967), he argues space is socially produced and shaped and can therefore be socially challenged and transformed. Soja sees spatial injustice as both an outcome that is easier to identify, and a process with underlying causes that produce injustice, which are harder to identify (Soja, 2009). Therefore, identifying these underpinning notions that produce injustice is critical to understand unjust space and how to transform it. This distinction indicates that spatial justice involves investigating not only the physical location (where), but more also the social, racial and economic mechanisms (how). Soja identifies some of these mechanisms, including discriminatory biases and the political organization and uneven development of urban space in a capitalist-driven society (Soja, 2009).

In Nouakchott this underlying process can be traced back to early post-colonial times and the initial planning of the city. The city was planned with two separate centers for the wealthy and the 'common' population, respectively, and therefore based on the idea of inequality and segregation. In this context, the cornerstone of the city itself is the cornerstone for its spatial injustice and, with other factors, its vulnerability. However, the concept of the social production of space suggests that by challenging these power dynamics that shape the urban space, it can be contested and transformed. (CUN, 2013: pp 10-12)

This leads me to the concept of territory as the process and manner of claiming territory deeply impacts spatial justice. In its abstract concept territory is made of a central point, a base that a being comes back to, and a certain behavior leading to a range from this central point. This center is not permanent; especially when resources are scarce or linked to seasonal changes, the center and therefore the territory is more dynamic and adapts. A nomad's cosmos, moving from one place to the other, changes with time, therefore proving that their territory is intrinsically temporary, meaning multiple centers can be dispersed throughout space. Nomads claim their territory purely through their temporary use of the space (Habraken, 1998).

This contrasts with the concept of territory in settlements, where territory is more static and permanent. In dense cities territories of different types often overlap leading to competition and conflict. Territoriality, in this sense, is closely tied to spatial justice, as conflicting claims to space lead to power imbalances and historical inequalities. With little understanding and appreciation for these dynamic territories, lines were drawn with a ruler, cutting through space that before had no fixed borders. Through colonization, foreign powers decided about territory, movement, and cultural belonging of people, leading to conflicts of territorial claims until today. These power dynamics, favoring those with political and economic influence, have long shaped territorial boundaries across Africa. This imbalance extends beyond physical space, imposing ideas and norms around behavior and order.

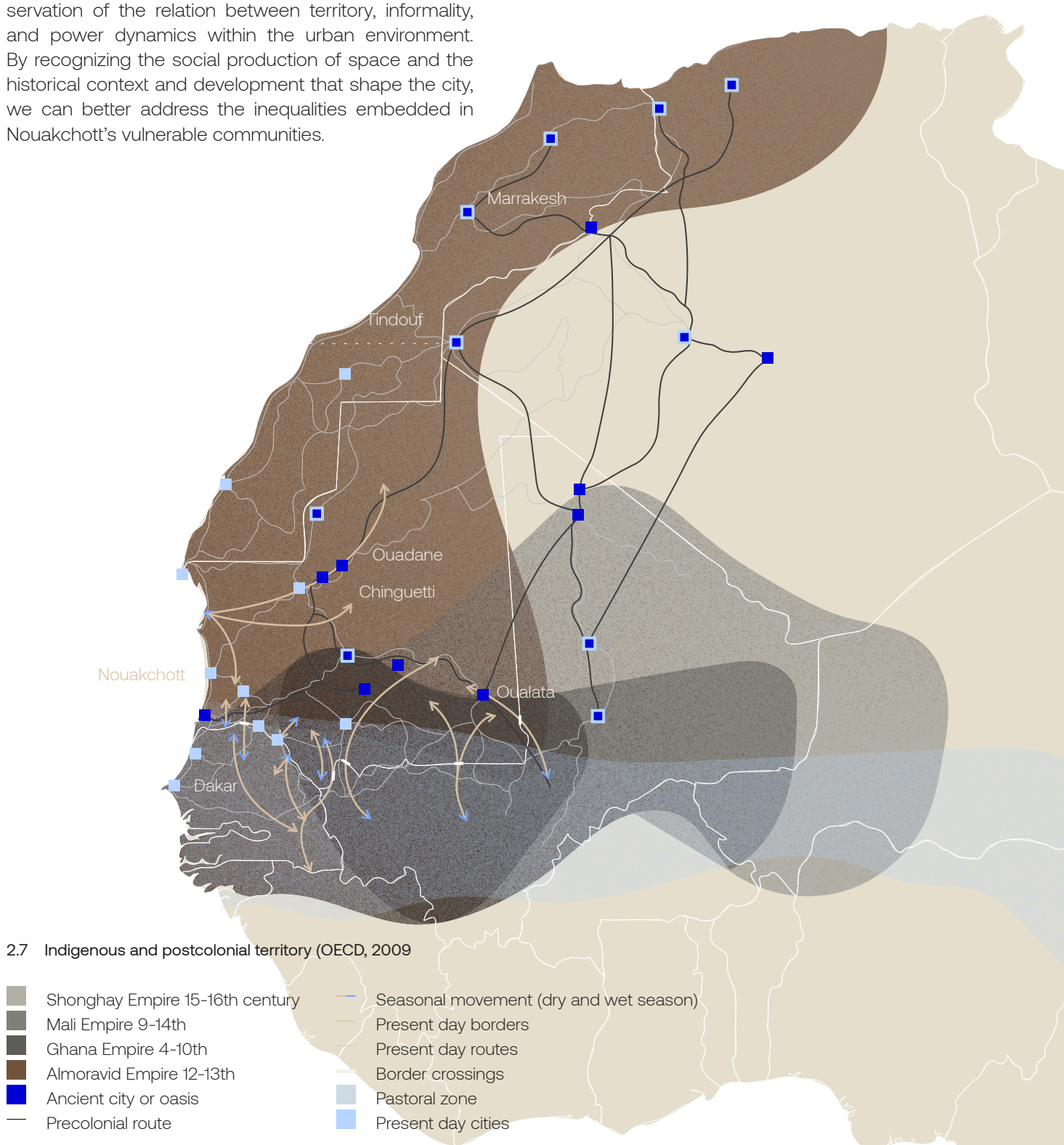
In this context, the meaning and reality of informality must be mentioned. Informality is a product of the 'formal' system clashing with reality. It refers to a parallel system that collides with the 'normality' and order of governance – a network that develops outside of state regulations (Watson, 2011). The term informality is used in relation to economy, ownership, urban planning, and architecture. In nomadic lifestyle the formal, and therefore the informal, does not exist, proving that both are concepts mainly present in urban spaces, created by and for society.

In Nouakchott this informality can be found everywhere – from informal settlements in the outskirts, to the informal economy making up 84% of employment nationwide (World Bank, 2022), to informal political processes. This unregulated reality can have enormous effects on people's lives. On the one hand it can give them economic power and a place to settle; on the other hand, it can lead to exploitation and displacement. People's rights cannot be properly protected when everyday informality happens outside of the cosmos of the law.

In this context, the goal should not be to move away from the informal and to the formal. Informality can be seen as an expression of resistance against oppressive structures that should be infused with the notion of power (Bayat, 2000). Therefore, the question should not be how to end informality, but how planners can break the stigmatization against informality to make it a tool of empowerment. In Mona Fawaz's interpretation, Lefebvre's 'right to the city' (Lefebvre, 1967) "rests in actualizing people's presence in the city through direct occupation" (Fawaz et al., 2021, p. 44). Part of the power of

self-determination includes the power to shape people's living environment to their wishes. This suggests that the right to the city is about more than physical access but about giving communities the agency to co-create urban spaces that reflect their values and needs, particularly in the context of historically marginalized groups.

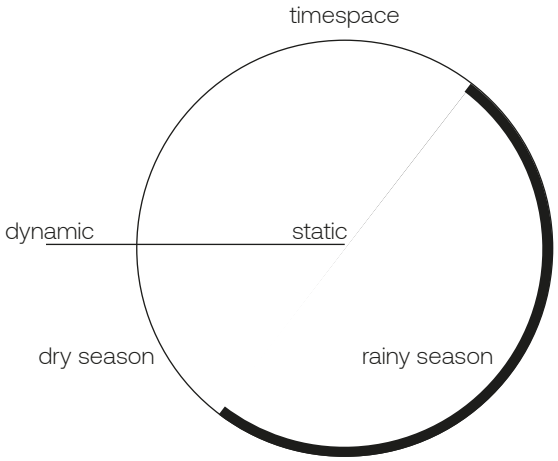
Understanding spatial justice requires thoughtful observation of the relation between territory, informality, and power dynamics within the urban environment. By recognizing the social production of space and the historical context and development that shape the city, we can better address the inequalities embedded in Nouakchott's vulnerable communities.



2.7 Indigenous and postcolonial territory (OECD, 2009

II . 2 . III Indigenous Practices

All over the world traditional ecological knowledge proves the resilience and strength of indigenous practices. Guided by the cycle of the seasons, and a fundamental understanding of the ecosystem they inhabit, they exemplify how humans can live in symbiosis with nature, benefiting both. They prove resilience by working with nature to flourish in hostile environments without causing harm. For this research I investigate two types of landscapes that flourish through indigenous practices, focusing on desert environments and wetlands. Surrounding each practice is a keystone species, a specific element or condition provided by the landscape, transforming their everyday life. (Watson & Davis, 2020)



2.8 Diagrammatic explanation of indigenous cycles



Underwater Aqueducts

The Qanat (literary meaning to dig) aqueducts in Iran, are one of the oldest and largest underground water networks in the world. Dating back to the Persian kingdom 550 – 330 BCE, this vernacular construction is an ecologically conscious practice to filter, harvest and distribute water (Watson & Davis, 2020). Starting from an aquifer in the mountains it connects through a gently sloped channel to wells, retention ponds, settlements, and agricultural fields, build around the concept of sharing the sacred resource. Water is only extracted at the rate it can recharge, and released back into the aquifer at the end, passing it back into the system. The Qanat aqueducts were spread 170.000km^2; making arid parts of the country accessible and shaping urban settlements by integrating water sources, passive cooling, and irrigation systems (Watson & Davis, 2020).
Today groundwater sources are depleted by non-sustainable water retention practices, focusing on profit and high extraction instead of conscious use. The Qanat show how sustainable water infrastructure through vernacular construction and community frameworks for fair distribution can bring water to people in a circular system, without depleting resources. Although the topography of Nouakchott is quite different, what inspires is the spiritual and conscious relationship the Qanat fostered. Water is an essential resource for life; it should be distributed fair for all residents today, while at the same time preserved for future generations.

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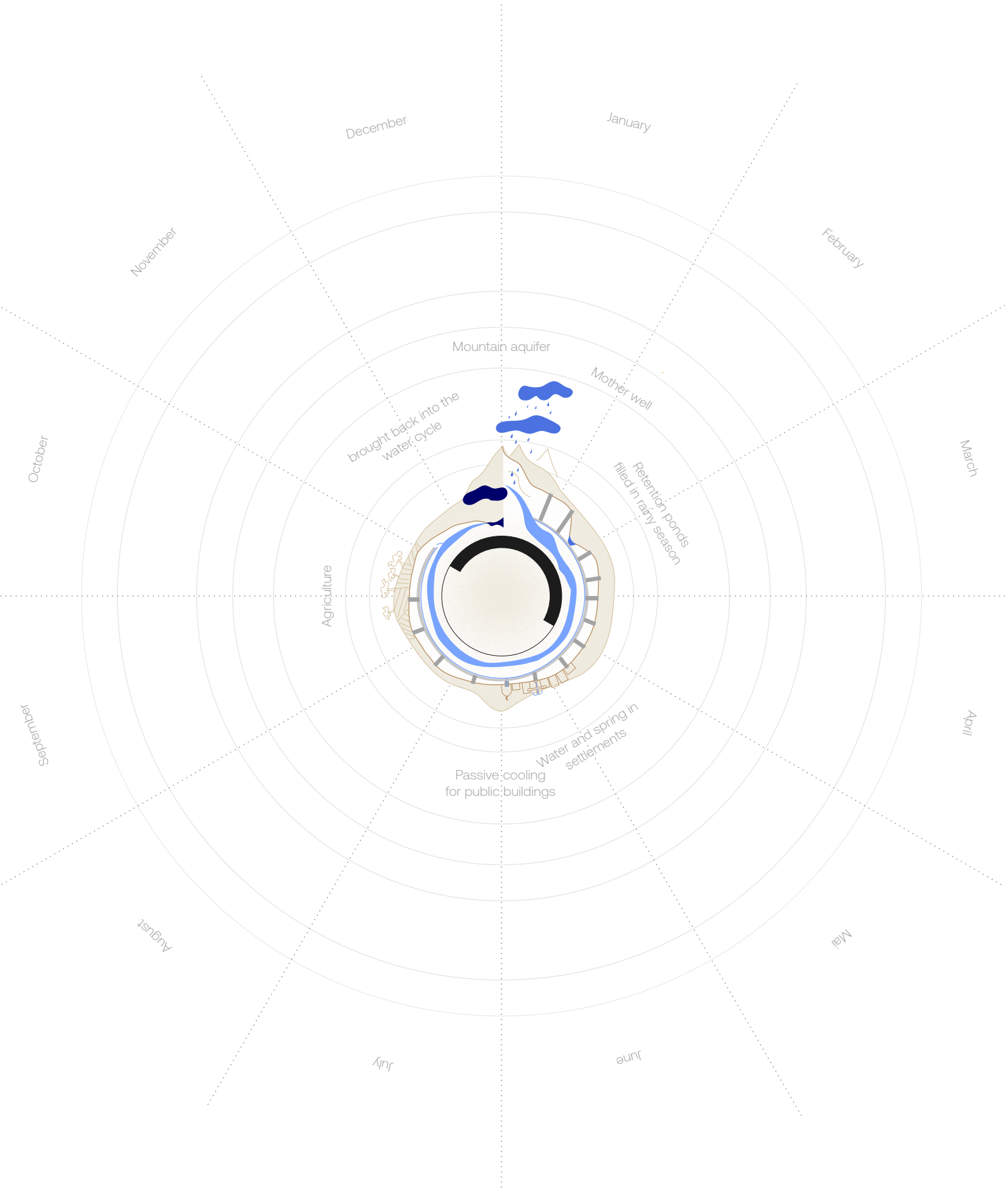

2.9 Seasonal cycle of the Qanat (Watson & Davis, 2020)



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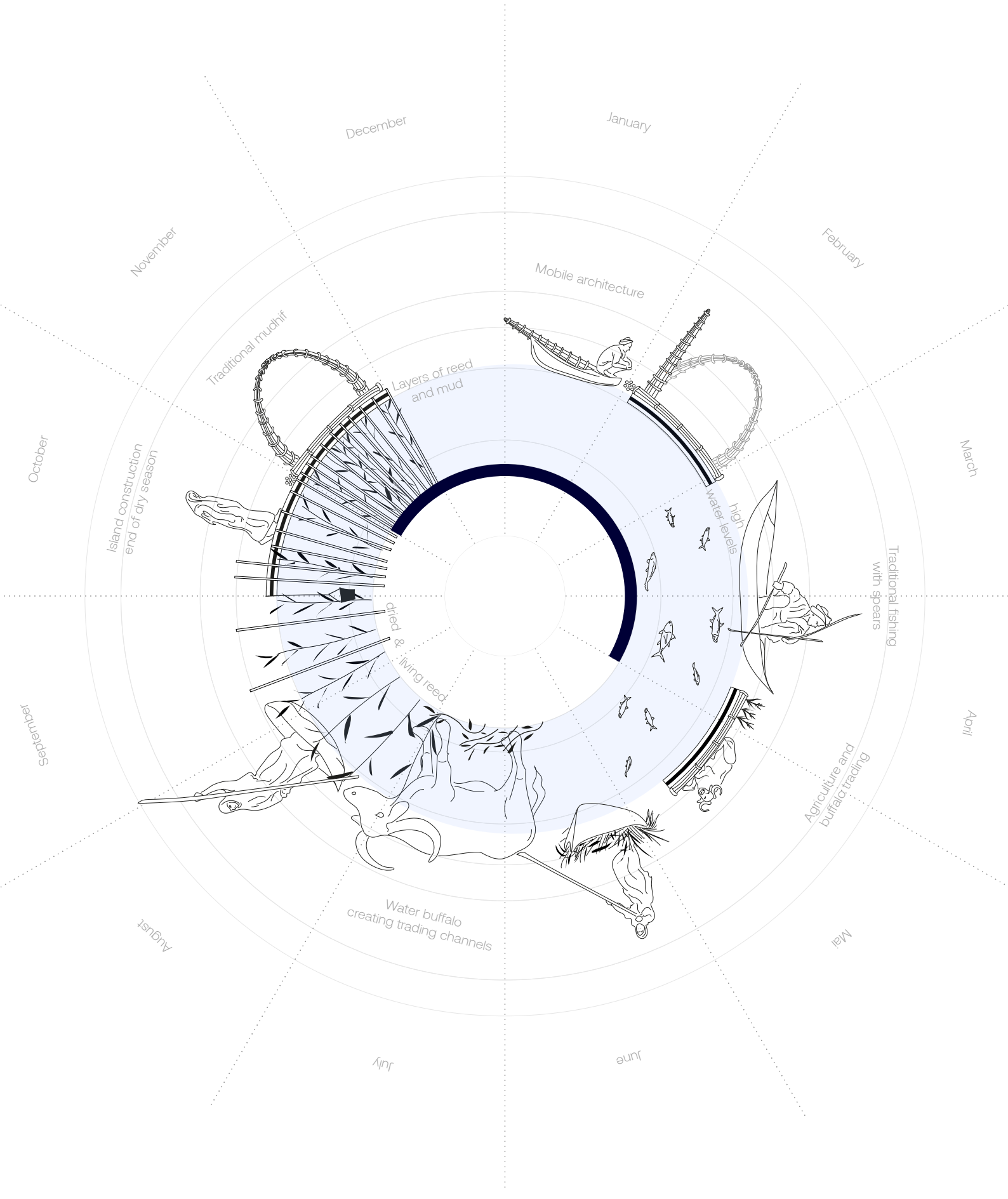
Floating islands

The Ma'dan, also known as Marsh Arabs and the Uros, located in Peru, are two indigenous communities living in extremely harsh wetlands. With their keystone species, two types of reeds, they construct floating islands in an otherwise hostile environment. Unlike the Uros, the Ma'dan are more limited as their construction of islands depends on the changing water levels of the seasons. They build their floating islands on living reed fields in autumn when water is lowest with a base construction made of a dried reed and several layers of reed and mud (Watson & Davis, 2020). The Uros on the other hand use the large blocks of roots, that through decomposing create a buoyant effect. What both have in common is the resilience to thrive in an exceptionally harsh environment, where without their floating islands they would not be able to survive. In both cultures reed is used in every aspect of life; to construct the land they inhabit, the architecture that protects them and the boats they use to move. Reed is even used as feed for their animals and to produce flour. These cultures prove that a single material when used consciously can generate inventive ideas.

In the south of Mauritania, along the Senegal river, native species of reed are part of the landscape. With Nouakchott's landscape transforming the practices of the Ma'dan and Uros can guide as an inspiration for creativity. Reed has already started to grow in certain flooded areas in Nouakchott and could be used as an important material to sustain in otherwise unlivable areas.



2.10 Seasonal cycle of the Ma'dan

Nomadic pastors

In Kenya nomadic pastors such as the Maasai or the Ngisonyoka Turkana base their lifestyle on the cycle of the seasons. The temporary or permanent corrals, developed to protect their herds, become living acacia fences that regenerate desertified soils, forming a symbiosis with human, landscape and animals. By moving seven to fifteen times a year within the dry season, they never overburden the land they settle on, but fertilize and nourish the soil for the next rainy season (Watson & Davis, 2020). The Zebu, a specifically resilient type of cattle, is their keystone species, making a nomadic lifestyle possible by providing milk and blood in critical dry seasons without water. The spiritual connection to the land is based on centuries of knowledge, providing guidance about the use and protection of the land.
Although these nomadic practices come from Kenya, the Fula making up the majority of Mauritania's Black African community, are related to the Maasai. Therefore, similar corrals for livestock can be found in Mauritania. The importance of the Acai tree for feed, building material and soil regenerator, can play a crucial role as this species of tree is extremely resilient and native in Mauritania.



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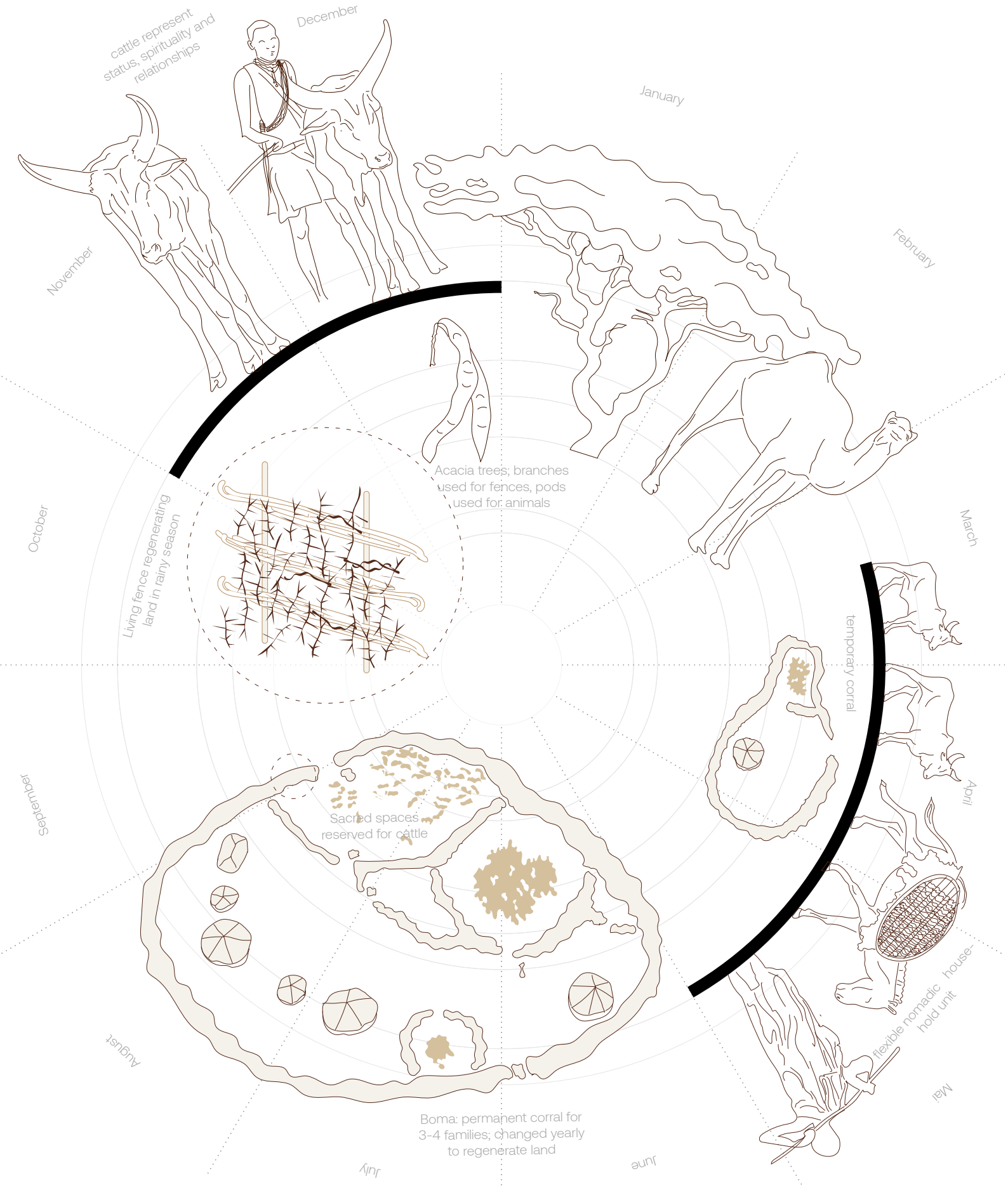
These and other practices prove the adaptive, strategic, and ecological intelligence hidden in traditional knowledge. However, these practices function in an intricate system with their environment that is easily disturbed. Therefore, they are threatened by environmental, territorial and political frictions, caused by focusing on what some see as 'progress' at the cost of our planet. In the past, certain indigenous practices have been blamed for the degradation of land, when in fact they regenerate their environments with long lasting benefits for the ecosystem. We need to question societies understanding of progress as only going forward, and instead try to learn from practices of the past.

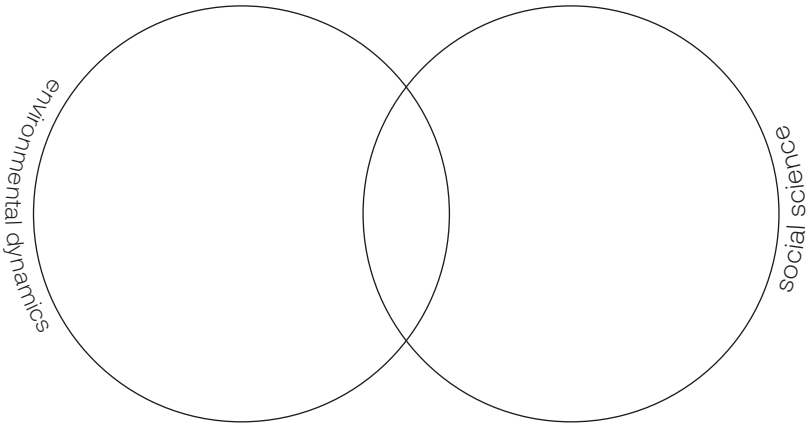


2.11 Seasonal cycle of the Maasai

II . 2 . IV Conceptual Framework

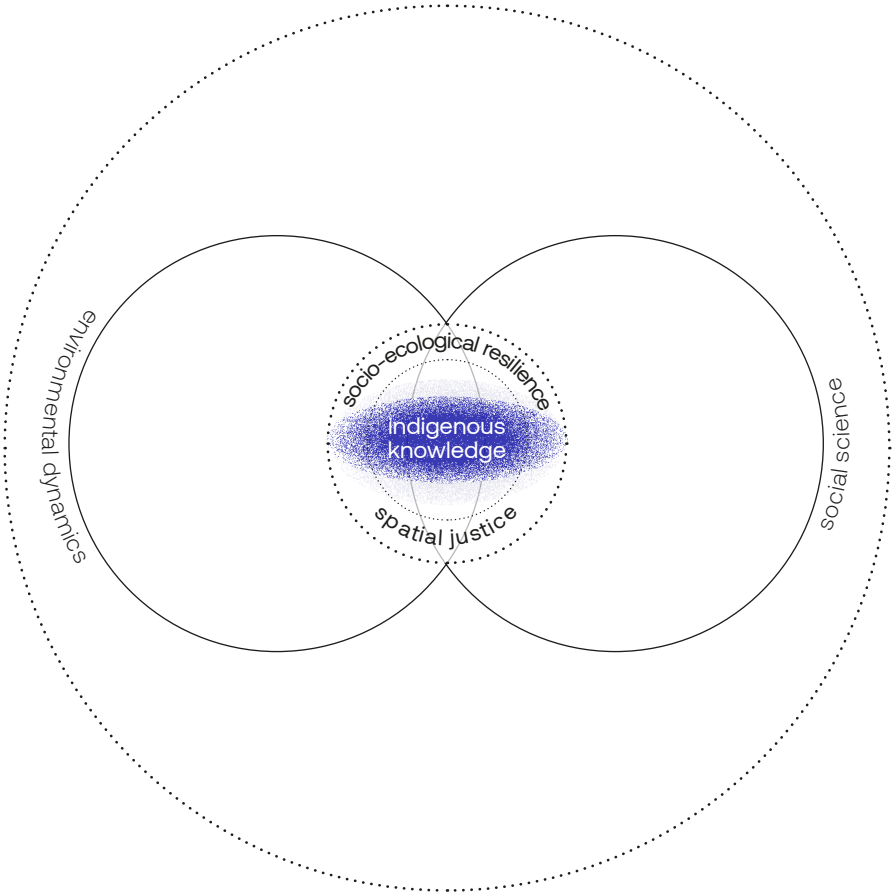
The concepts explained in the prior theoretical background create a solution-oriented framework that will guide my design decisions. Based on the preliminary problem analysis, it becomes clear that environmental exposure has a strong impact on the vulnerability of communities. Therefore, it is important to tackle the issues together by improving resilience of the city as a whole while improving accessibility, inclusivity and distribution. In this context urban and climate resilience can only be achieved through a just transition; therefore, incorporating the concept of spatial justice into adaptation strategies to create a just spatial design is equally important.

Therefore, the concept of socio-ecological resilience and spatial justice integrate into a conceptual diagram that will guide me in my design process. It is not just about finding interventions that cope with climate change and improve resilience, but about incorporating equity and social prosperity into inherently unjust communities.









2.12 Conceptual framework diagram



III Analysis

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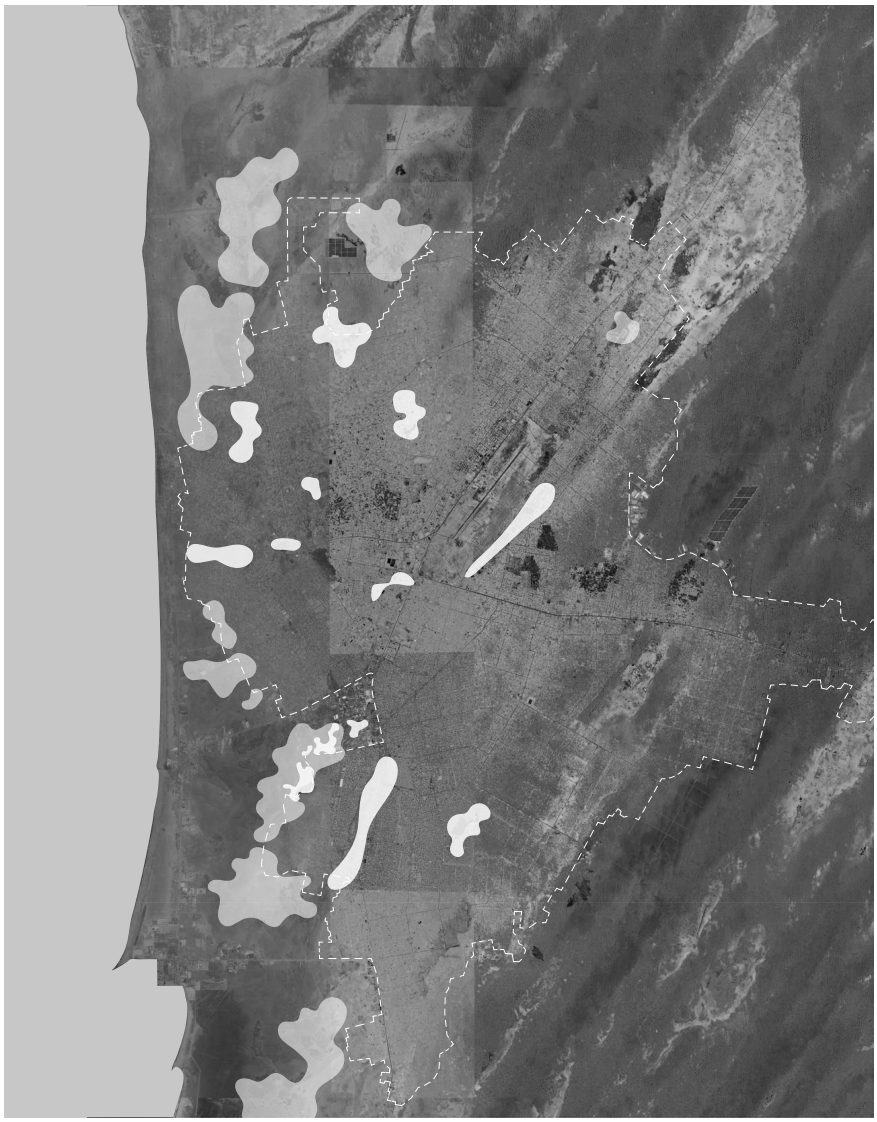
III . 1 CLIMATE OF UNCERTAINTY

The preliminary problem analysis established the interconnected dimensions of vulnerability through climate exposure, social sensitivity and low adaptive capacity. To gain a deeper understanding of these natural forces altering the landscape and social inequality, three main notions have been developed. Although it has been established that issues are inherently related and intertwined, this problem analysis addresses these topics separately to grasp their complexity. The following graphical cartography provides insights about the past, present, and projected spatial implications of natural forces and social despair. Nouakchott is a place where water, desertification and social injustice transform the current and future landscape of the city, physically and metaphorically.



3.1 Map of flooded areas (JICA, 2018 & google earth satellite images, 2023)







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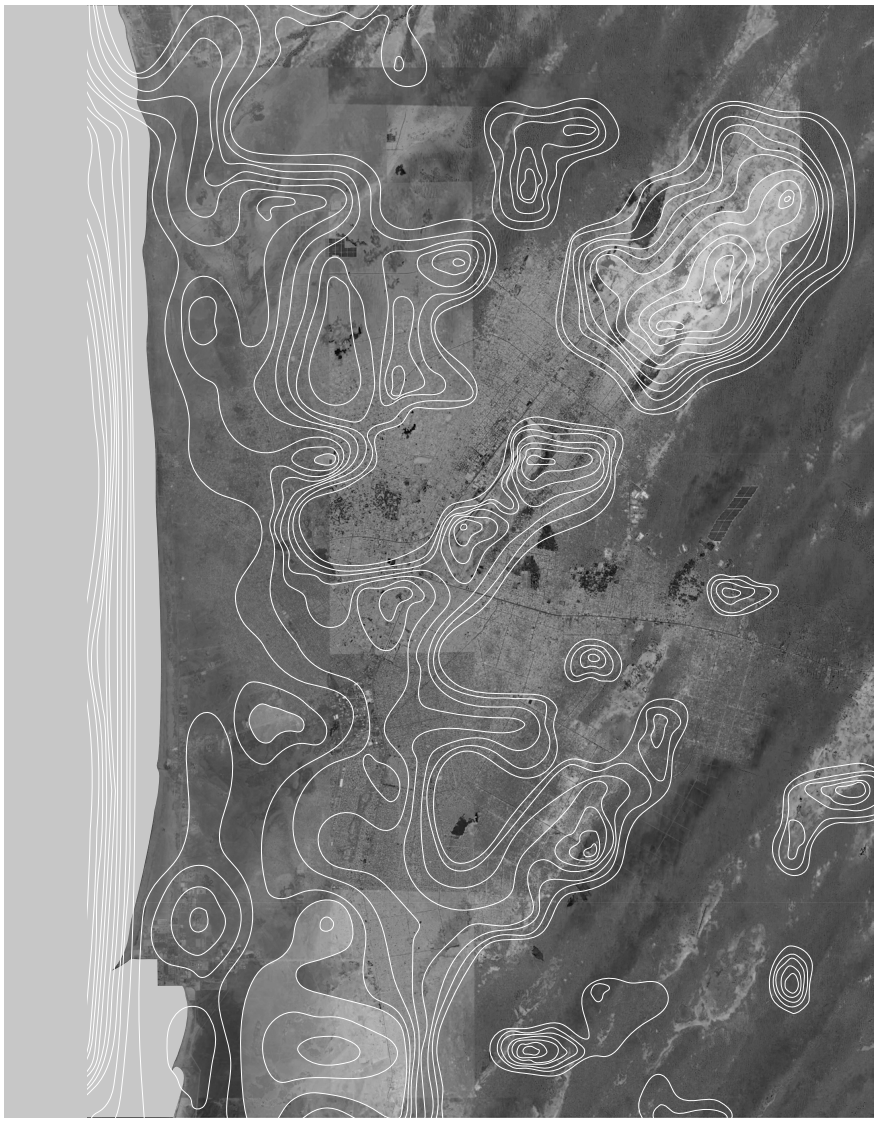
3.2 Photos of flooded areas

III . 1 . I Water

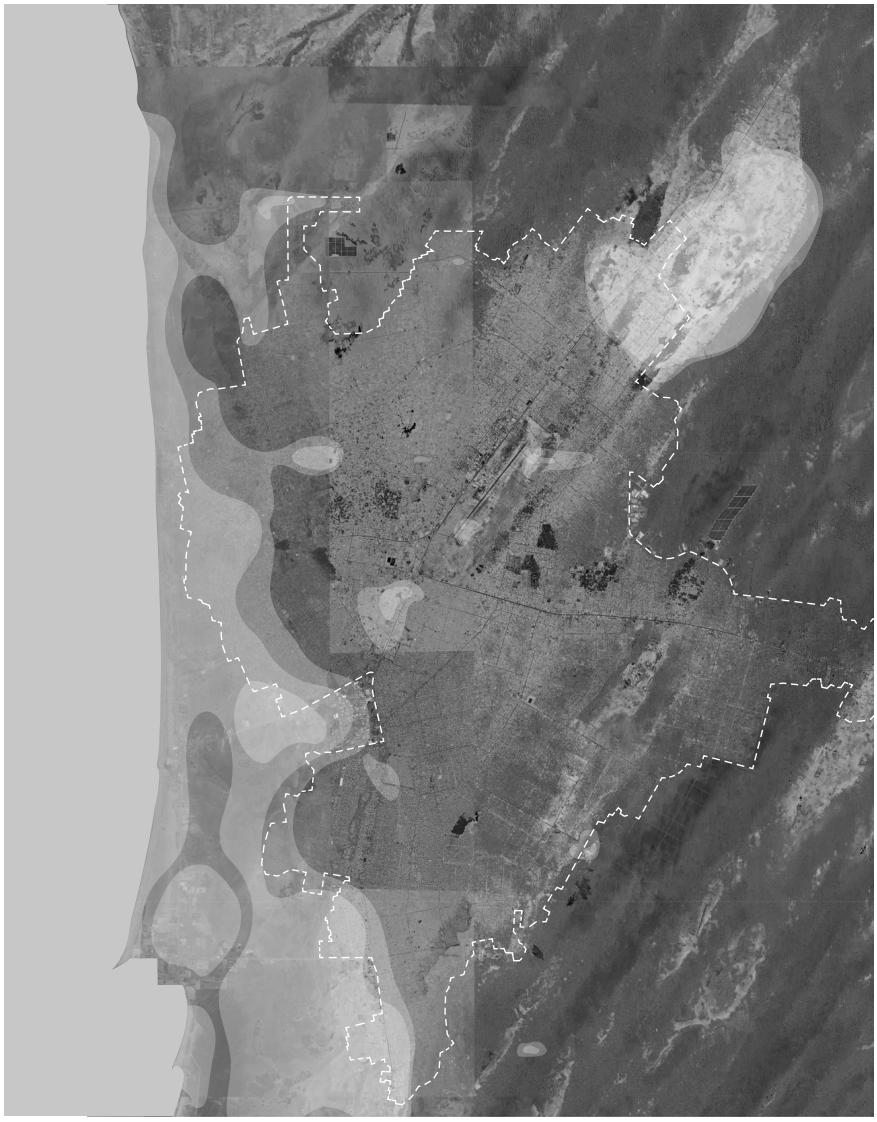


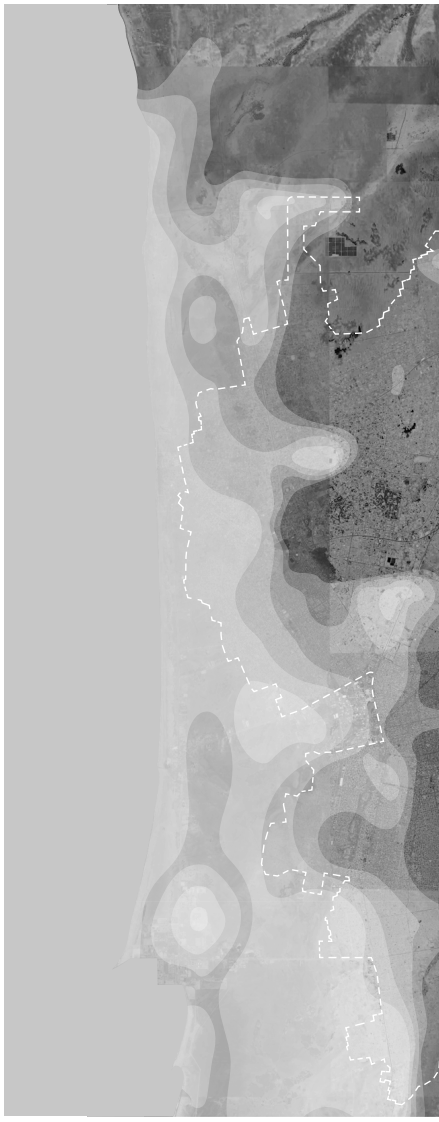
3.3 Topographic map with highlighted areas below sea level

In Nouakchott various interlinked issues concerning water will alter the future landscape. Currently the city is threatened mainly by groundwater flooding; in the future rising sea levels will intensify this issue while simultaneously threatening the low-laying terrain, fragile dune coastline and affect drinking water availability.

Ground water flooding

Nouakchott's rapid population growth over the past century, higher water usage and non-existent sewage system have caused an increase of 1-2 m in groundwater levels over the past 40 years (Mohamed et al., 2017). This occurs in combination with marine and groundwater pollution, as well as health issues caused by abandoned flooded districts. As more water is dumped into the ground than it can absorb these floodings increase with every year. Today's flooded areas are mainly located in ground below sea level, but with rising sea levels, these groundwater levels are at risk of reaching new highs. As sea and groundwater levels are connected and continue to increase, these flooded areas will become larger, extending further into the urban fabric.





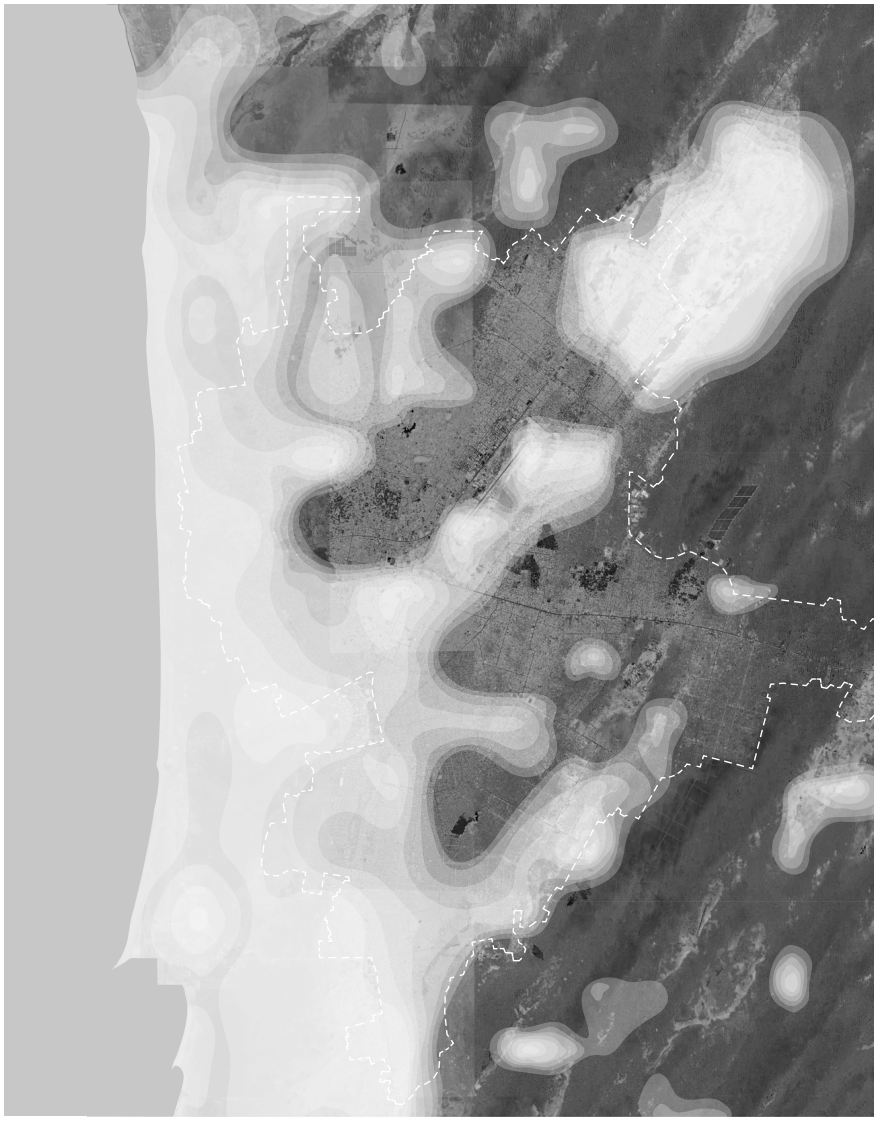
3.4 1, 2 and 3 meter sea-level rise, based on topography

Sea-level rise

Based on the topographic landscape of Nouakchott, the potential impact of sea level rise is severe. Predictions on sea level rise vary, becoming increasingly uncertain with higher emission scenarios. The IPCC report projects a rise of 1 meter by 2150 but acknowledges a myriad of influential factors that complicate forecasts. Among these is the potential destabilization of Antarctic ice sheets, which can lead to a rise of up to 6 meters by 2150 (IPCC, 2023).

Given the city's coastal location, limited dune landscape and no engineered protection, the lower terrain will be more vulnerable, affecting extensive parts of the city. Coastal erosion is mainly caused by anthropogenic factors, including sand extraction, heavy traffic, and the construction of the harbor, weaking the protective function of the dunes (Mohamed et al., 2017).





2 km

Conclusion

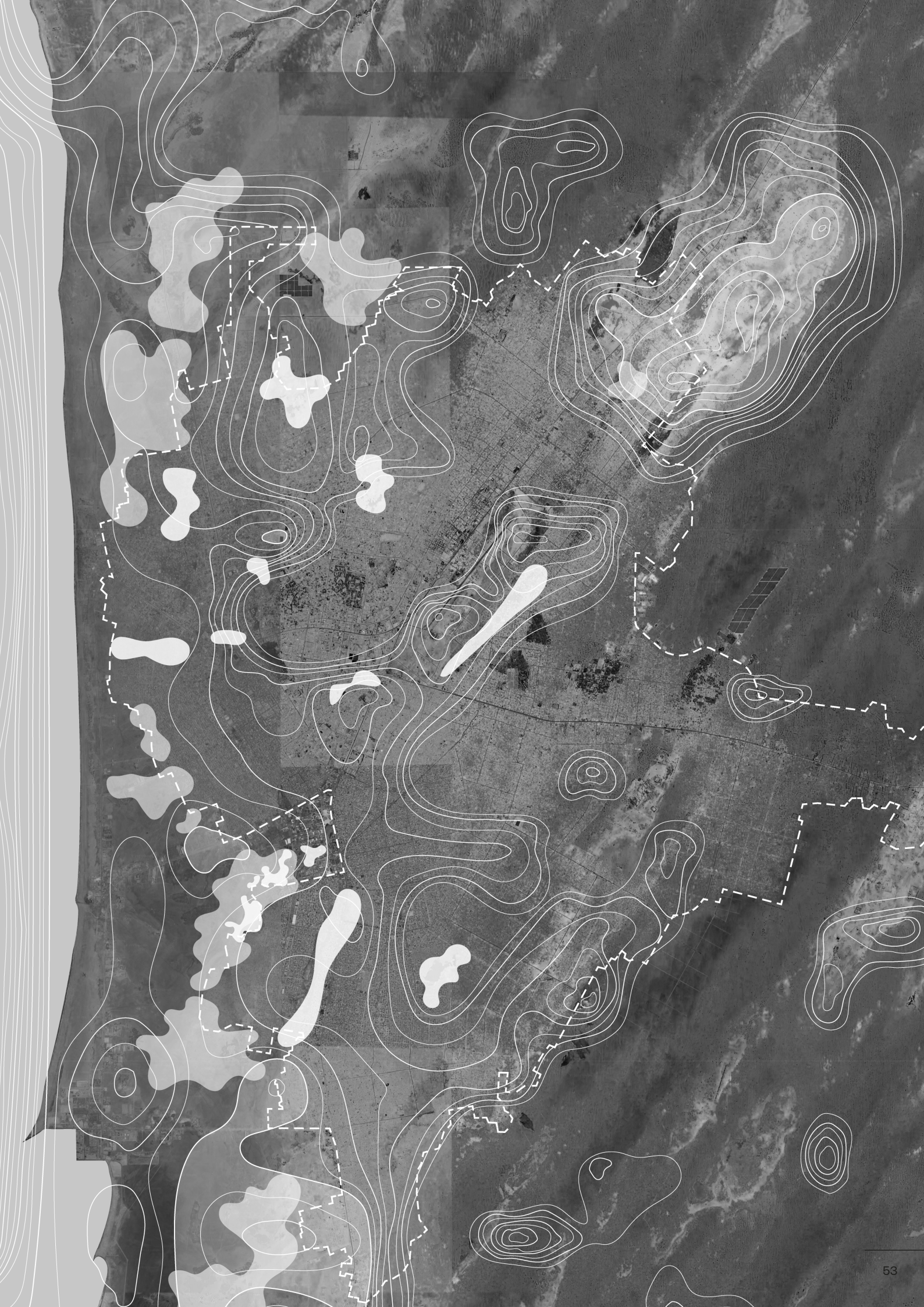
As global sea levels rise, groundwater is threatened to become brackish, impacting the availability of safe drinking water. The city's water supply system relies on two main sources; a surface water source from the Senegal River around 200 km away named Aftout project and a groundwater source called Iddini located 60 km to the north. Before 2018, Iddini used to provide 25% of Nouakchott's water supply. However, this has been reduced to 14% for conservation reasons (JICA, 2018). Although the Aftout project has positively impacted the accessibility to water, it has also caused further increase of ground water levels. The lack of a sewage system means that water, polluted or not, is discarded into the ground.

In conclusion, sea level rise will significantly alter the landscape of Nouakchott. Currently flooded areas will be more severely impacted in the future by very likely brackish water. The lack of proper coastal protection leaves no barrier between the Atlantic Ocean and the city's urban fabric. The spatial consequences of this vary depending on the scenario, with more land potentially flooded in extreme cases. Business as usual will lead to extreme flooding as well as groundwater and soil salinization and contamination, affecting the regions limited water resources and fragile landscapes.

3.5 Areas currently flooded or below sea level

Flooded areas (based on data)
Flooded areas (based on satellite)
Areas below sea-level

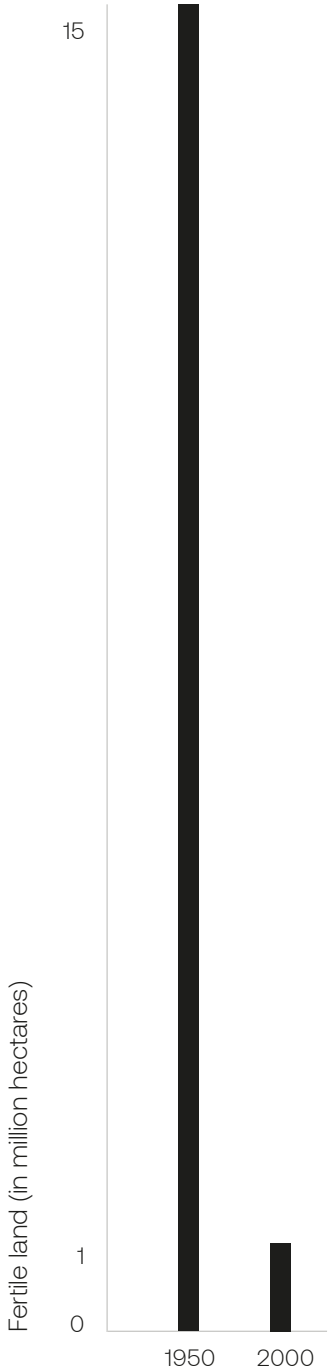
750 m



III . 1 . II Desert

The landscape of the desert is strongly connected to Mauritanian culture and tradition. As one of the former world's largest nomadic populations, people did not settle before the 1970's, when a period of droughts started to threaten nomadic livelihoods. Between 1950 and 2000 the nation-wide area of fertile land decreased from 15 to one million hectares and the area classified as desert increased from 65% to 90%. At the same time the population of the country more than tripled of which, many former nomads struggling to survive, moved to Nouakchott (Na et al., 2018).

Nowadays, people still feel connected to the desert, but the daily struggles it brings are evident. Desertification could potentially displace 50 million people globally within the next ten years, as degraded landscapes become unusable for farmers and livestock (UN, 2017). Nouakchott's proximity to the Sahara makes it especially vulnerable to the impacts of desertification, reinforced by strong wind dynamics and sandstorms (JICA, 2018). This is especially visible in the less dense outskirts of the city, where communities battle encroaching sand dunes.



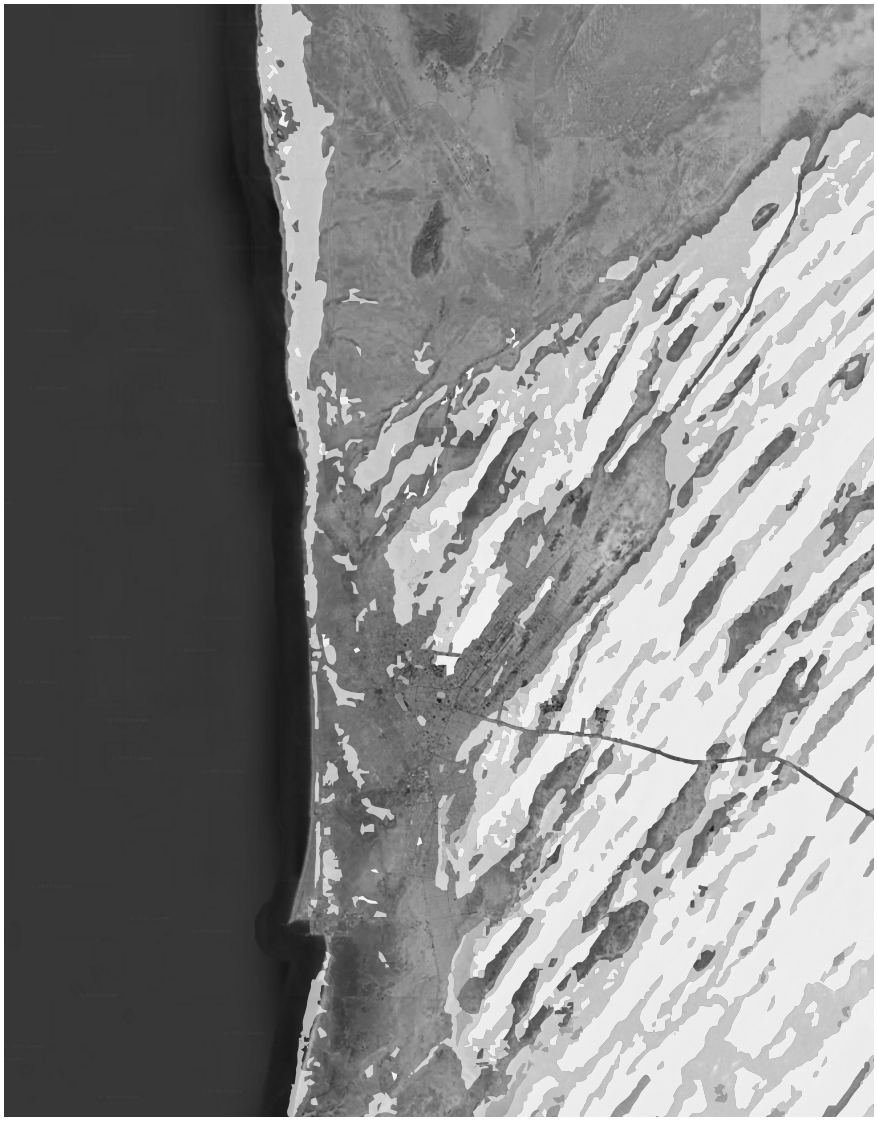


© En haut

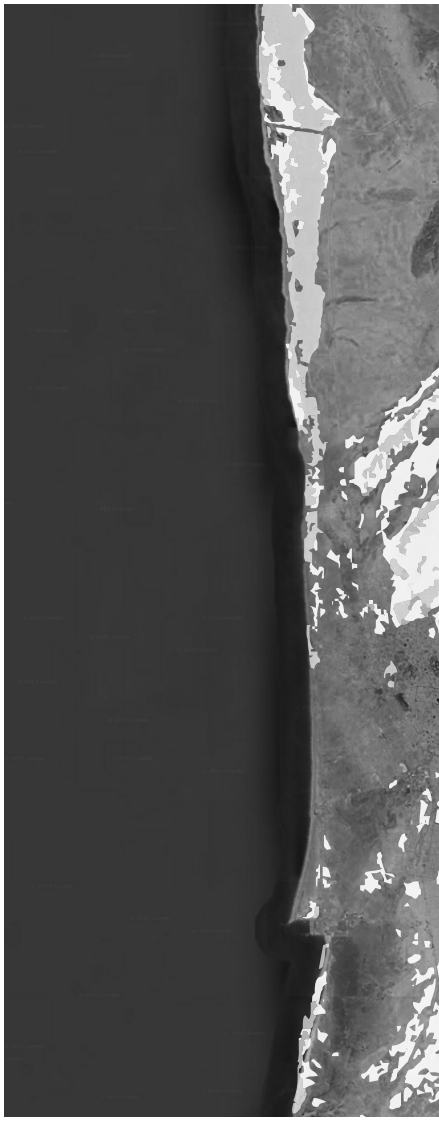
3.6 Photo of the d



esert meeting the outskirts of the city



3.7 Nouakchott, 1985 (Zhou Na, 2018)

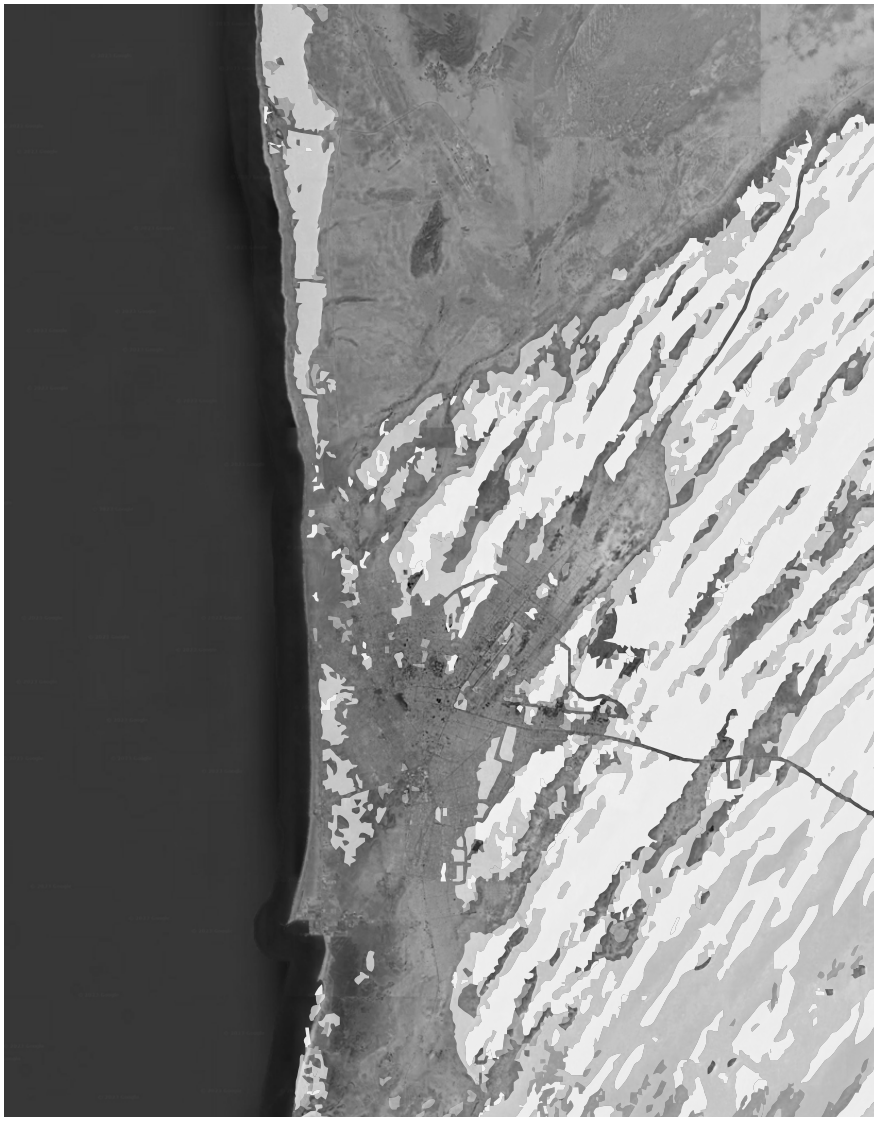


2000

History

Historical trends show that the largest area of very severe desertification around Nouakchott occurred around 2000. This trend gets reversed from 2000 to 2010, where areas of very severe desertification start decreasing again. However, comparably low levels of desertification from 1985 have not been reached ever since (Na et al., 2018). This local trend should be examined with care as global trends see a correlation of arid areas and higher rates of desertification, predicting 90% of the earth's land area to be degraded by 2050 (Cherlet et al., 2018).





2010

3 km

Desertification

Today Nouakchott's area of severe desertification is extremely high. Most affected are neighborhoods in the north and east due to their proximity to dunes and less dense urban fabric. The neighborhoods Toujounine, Teyarett, Dar Naim, and Ksar make up for 80% of area with severe desertification, equal to 267 km2 (Na et al., 2018). This not only causes destruction to the soil and urban fabric and displaces resident; The fine particles in the natural wind dusts lead to severe air pollution, causing chronical diseases and other health issues for many people living in the region (JICA, 2018).

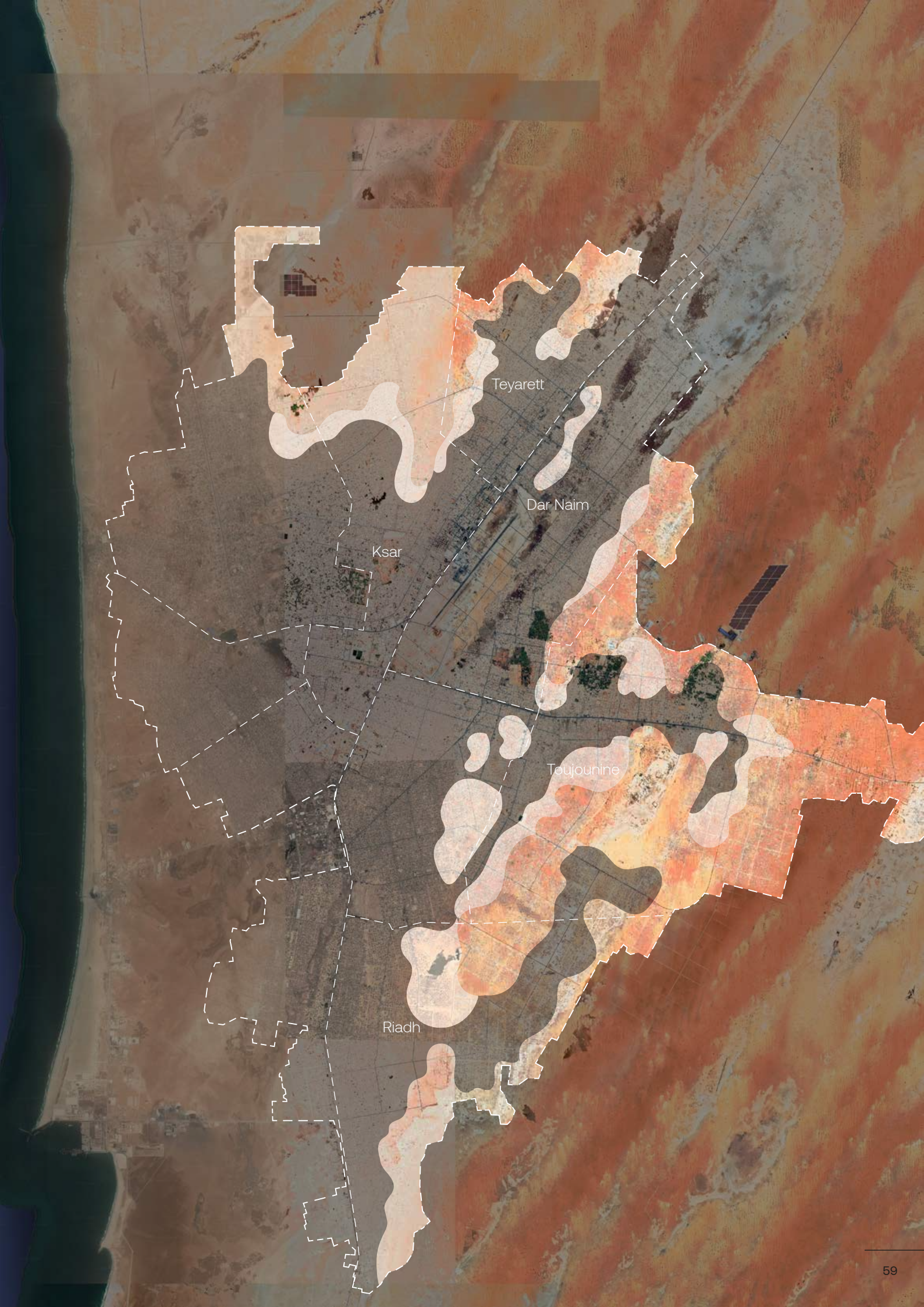
Conclusion

Desertification poses a significant threat to the livelihoods of residents, urban and therefore political stability of Nouakchott. As the Sahara Desert encroaches further into inhabited areas, it not only aggravates socio-economic sensitivity but also contributes to severe health issues. The rapid expansion of desert land has displaced communities and forced former nomads to settle in urban centers like Nouakchott. Here they face new challenges as their former way of life is destroyed.

3.8 Areas currently threatened by desertification (JICA, 2018 + google earth 2023)

Projected desertification
Severe desertification

750 m


Teyarett
Dar Naim
Ksar
Toujounine
Riadh

III . 1 . III Social Sensitivity

Mauritania is a country where 2.3 million people, equal to 58,4% of the population, live in multidimensional poverty (UNDP, 2023). Multidimensional poverty is measured in four equal categories: health, education, living standard and employment. The index shows that financial poverty is only part of the story. Poverty is a trap with natural and anthropogenic causes; it is amplified by the climate crisis, but also by corruption and ineffective governance hindering development.

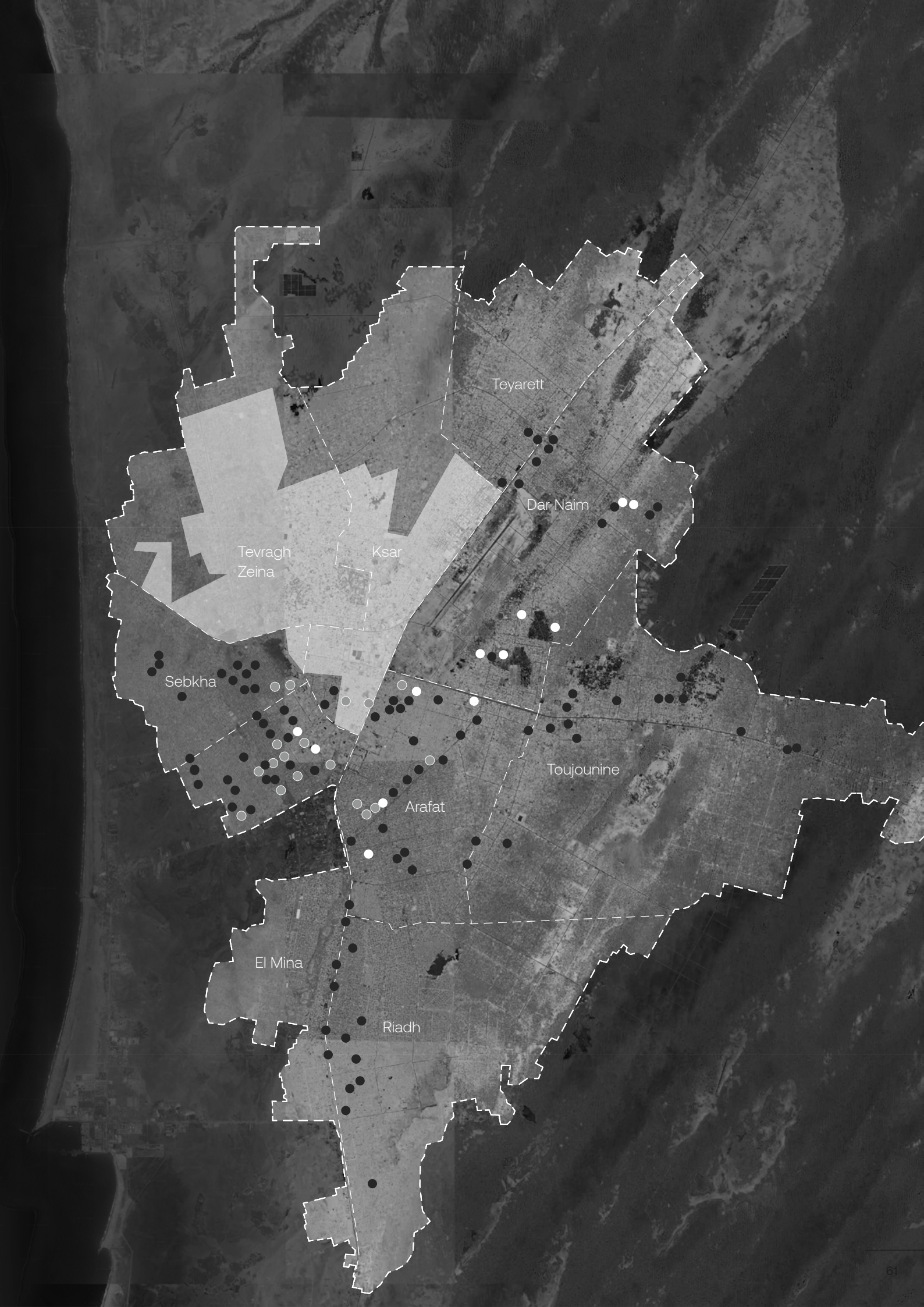
Accessibility to water

Especially when exploring the interconnection of poverty and space, the relation to accessibility to services, distribution of resources and burdens, and incorporating inclusive processes gains importance. In Nouakchott this is not given – only 58% of household in Nouakchott have an improved water source, including water taps at home, neighbor and public tabs. This standard only exists in two out of nine neighborhoods. The other 42% urban population rely on truck water, retailers, tanks and wells without pump (World Bank, 2019). Even when in proximity to one of these unimproved water sources, many people are forced to consume contaminated water.

3.9 Accessibility to water (JICA, 2018)

Home or public tab
Potable water
Contaminated water
Highly contaminated water

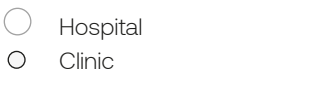
750 m


Teyarett
Dar Naim
Tevragh
Zeina
Ksar
Sebkha
Toujounine
Arafat
El Mina
Riadh

Accessibility to healthcare

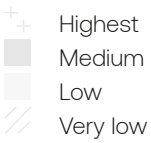
A similar problem becomes apparent when we look at accessibility to health care. The wealthy neighborhoods Ksar and Tevragh Zeina have between 14.000 and 18.000 inhabitants per hospital (JICA, 2018). In comparison the neighborhood Arafat has one hospital and a clinic for 202.516 inhabitants (JICA, 2018). Toujounine has no hospital at all, only a clinic for 167.893 inhabitants (JICA, 2018). The current health network is not equipped for any additional stresses. However, environmental challenges caused by the climate crisis will be noticeable on people's health. Standing water is a habitat for insects carrying diseases. Rising temperatures and heatwaves impact people's physical health, especially when their access to water is limited or highly contaminated.

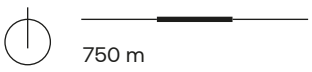
3.10 Accessibility to healthcare (JICA, 2018)




Teyarett
93.743 / 1
Dar Naim
167.381 / 3
Tevragh
Zeina
56.793 / 4
Ksar
54.904 / 3
Sebkha
89.913 / 2
Toujounine
167.893 / 1
Arafat
202.516 /2
El Mina
153.706 / 1
Riadh
135.884 / 3

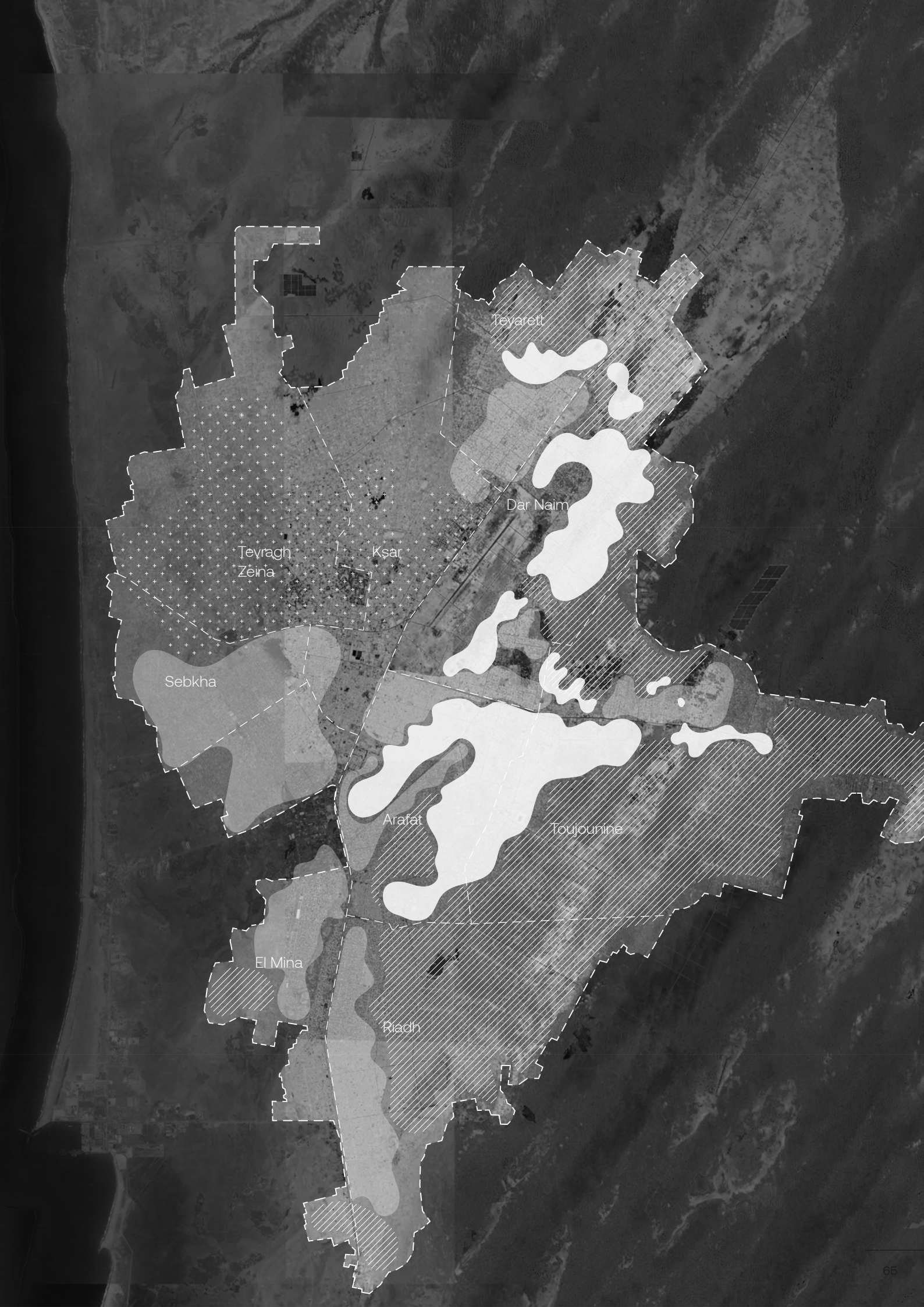
3.11 Living standard (JICA, 2018)





Sensitivity

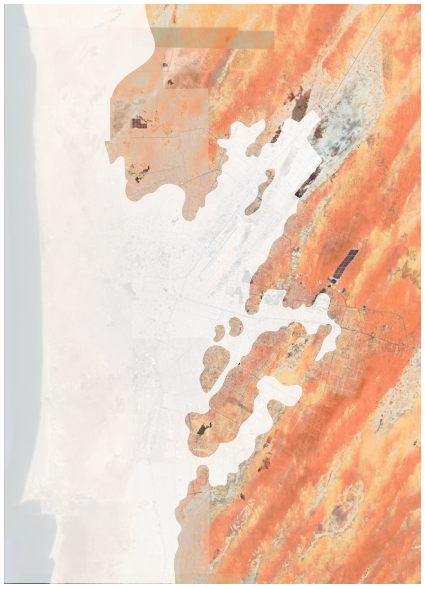
In conclusion, the eastern outskirts of Nouakchott are the most vulnerable in terms of access to clean water, healthcare, and quality housing. While neighborhoods like Tevragh Zeina and Ksar have better access to amenities, infrastructure, and resources, the majority of the city's population suffers from inadequate services. These disparities and spatial disadvantages emphasize the divided and parallel living societies in Nouakchott, highlighting the urgent need for inclusive spatial planning to address both poverty and the growing challenges posed by the climate crisis.


Teyarett
Dar Naim
Tevragh
Zeina
Ksar
Sebkha
Arafat
Toujounine
El Mina
Riadh

III . 1 . IV Scope



Water



Desert



Social Sensitivity

Nouakchott faces severe exposure caused by the climate crisis, intersecting with pre-existing social injustice and extreme poverty. Here, the climate crisis already impacts space, acting as a threat multiplier for the future. The coastline is highly susceptible to rising sea levels, leading to groundwater salinization and flooding. Simultaneously, the encroaching desert threatens the urban fabric from the east, with desertification making vast areas uninhabitable. These climatic forces, combined with rapid population growth and inadequate infrastructure, amplify the spatial injustices experienced by economically disadvantaged communities. By continuing with business as usual, almost the entire city except the city center will face severe challenges. These interconnected challenges underline the urgency of Nouakchott's future, and the need for climate resilient strategies.

This metropolitan analysis highlights the need to focus on identifying and understanding especially vulnerable communities in Nouakchott. By focusing on these communities, further analysis will further reveal the interconnected nature of social and environmental issues and their spatial manifestations.

3.12 Climate exposure and social sensitivity

Water
Desert
Vulnerable communities
No threat

750 m



III . 2 DEVELOPMENT OF THE CITY



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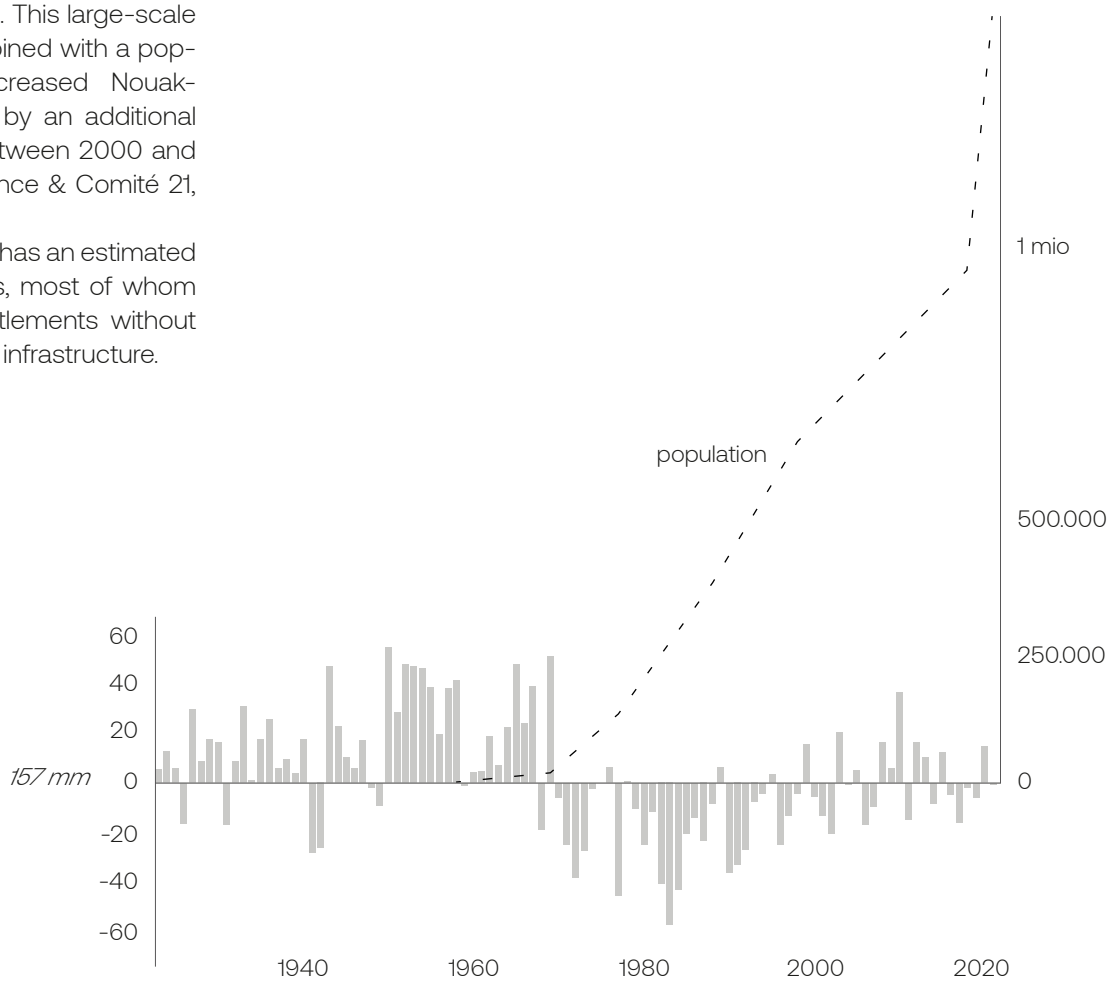
Nouakchott was designated as the capital of Mauritania in 1958. This decision was not made by Mauritanians, who felt no historical or cultural connection to the small coastal village. Mauritanians would have selected a city like Chinguetti; a religious and historical monument of immense importance in their culture and the entire Muslim world. However, at this point in time it was not for them to decide about their country. Nouakchott, which was a military post during colonial times, was chosen by the French colonialists. The reasons behind this choice are unclear, it likely has to do with Nouakchott's proximity to Dakar, the capital of French Western Africa, its location along the coast, and its emptiness, offering an abundance of space for development according to their modernist ideas.
After several drafts by the French colonial architect Lainville, the foundation stone of Nouakchott was laid on March 5, 1958, located where the presidential residence stands today. Within two years, the construction of the modernist city center was largely completed (Chenal & Diagana, 2009).

How has Nouakchott grown and persisted in its vulnerable geographical context?

III . 2 . I Diachronic Analysis

Nouakchott grew from 500 inhabitants in 1958 to about 6,000 in 1962 and 20,000 in 1969. The 1970's brought severe droughts that impacted the entire Sahara and Sahel region, reducing average rainfall from an already low level. This led to a 55% decrease in cattle herds over five years, threatening livelihoods across the country (Vermeer, 1981). Many nomadic people, unable to sustain their herds, moved to cities, causing Nouakchott's population to increase from 6,000 to over 600,000 by 2000. By this time, the nomadic population, which made up 75% in 1950, had decreased to 6% (Vermeer, 1981). This large-scale rural exodus, combined with a population boom, increased Nouakchott's population by an additional 755,481 people between 2000 and 2013 (Climate Chance & Comité 21, 2019, p. 65).
Today, Nouakchott has an estimated 1.6 million residents, most of whom live in informal settlements without water, electricity or infrastructure.



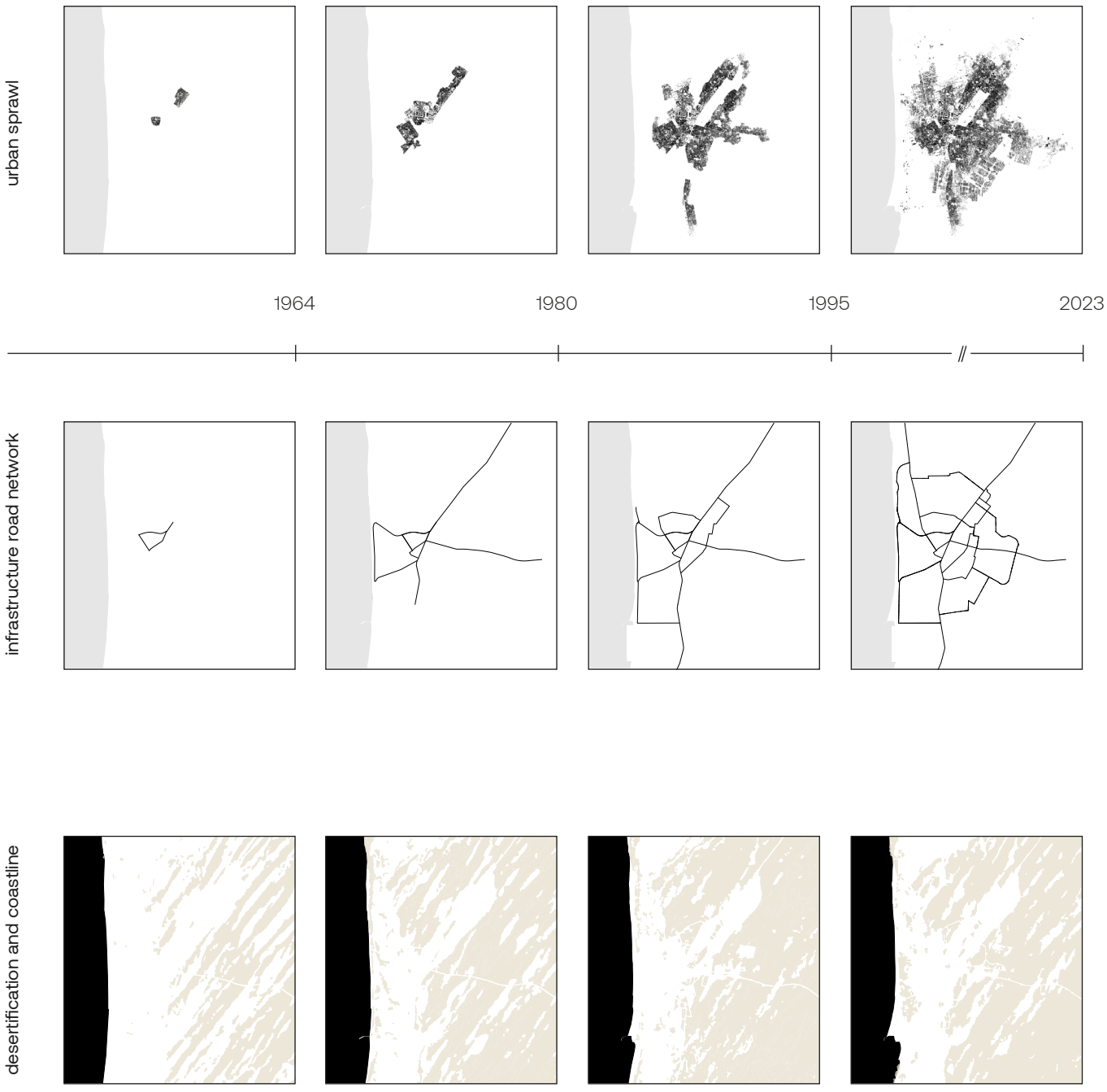
3.13 Correlation of precipitation anomalies and population growth (Worldbank, 2023)

Through time

Nouakchott was planned based on principles of inequality and segregation by creating separate centers for different social standings. These centers quickly connected and expanded through unregulated urban sprawl. Settlements at the borders of the planned city were called “bidonvilles” or “khaïmahaillons”, a French-Arab neologism meaning “tent made of rags” (Verdeil, 2012, p. 79)

Urban planning was inadequate for the rapid influx of people. Apart from the initial modernist center, no structured urban planning existed. Major roads connected Nouakchott to other important cities, but most other roads were unplanned, developing after settlements formed. This resulted in a mix of urban fabrics with varying degrees of planning and organization. Occasionally, grid structures were implemented to simplify access to water and electricity, creating a blend of urban designs across the city.

The coastline has also transformed significantly since the 1950s. Fisheries are a crucial part of Mauritania’s economy, contributing significantly to national income. The small harbor built in the 1970s quickly proved insufficient. Countries such as China saw investment opportunities in large-scale fishing, financing the harbor’s expansion. This new harbor caused significant sedimentation southwards, altering the coastline forever. In some areas the harbor construction led the shoreline to retreat 526 meters since 1980 (Faye et al., 2008; Ould Taleb, 2014: pp 28-34). Overfishing by foreign companies now threatens local fishing communities.



3.14 Diachronic analysis - urban, infastructure, landscape

III . 2 . II Disruptive Growth

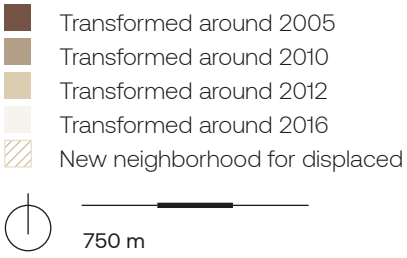
Land ownership

Due to the incredible and far-reaching urban growth of Nouakchott, most of the city is primarily shaped by informal settlements. Communities occupying these areas struggle with the governance of landownership. In Nouakchott the phenomenon on land speculation tackles a remarkable scale. The national government, and therefore through centralized power the president, has total control over land division. Since the 1970's governments have distributed land, one of the rare assets, favoring elite communities. This has led to land speculation, increased prices, and vast power imbalance causing far-reaching illegal urban sprawl. Although the nine municipalities of Nouakchott are responsible for planning and urban development, they hold no power over land tenure. This paradox leads to inefficient urban planning and complex processes, leaving room for corruption and manipulation of the system for personal gain. The same piece of land can be sold to several buyers, leading to tensions within communities. Registering land is a tedious process and secure land titles are difficult to gain. The lack of clear and fair land distribution is particularly problematic for vulnerable communities. Without access to land people live in a state of uncertainty, possibly displacing them any day (Dessie & Elisabeth, 2013).

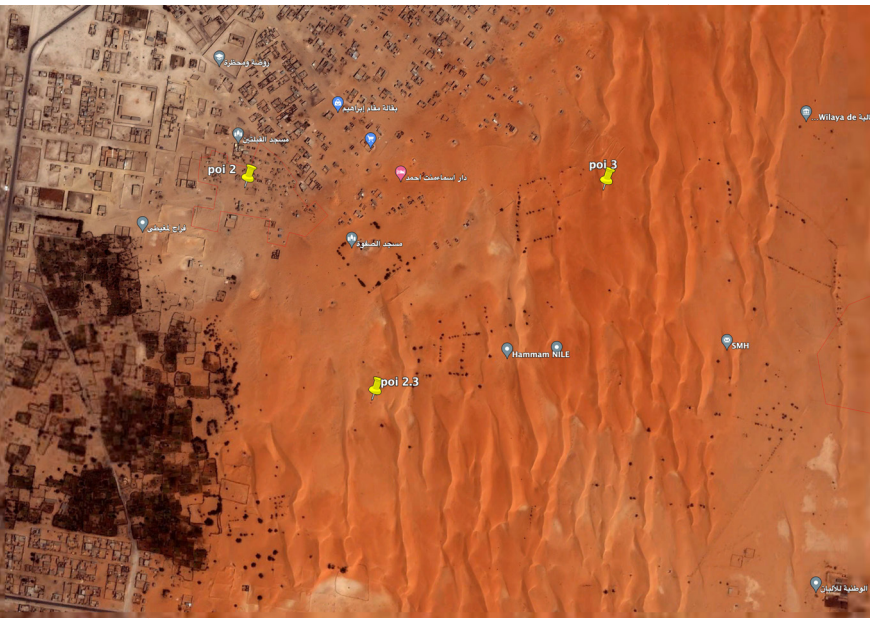
Space of transformation

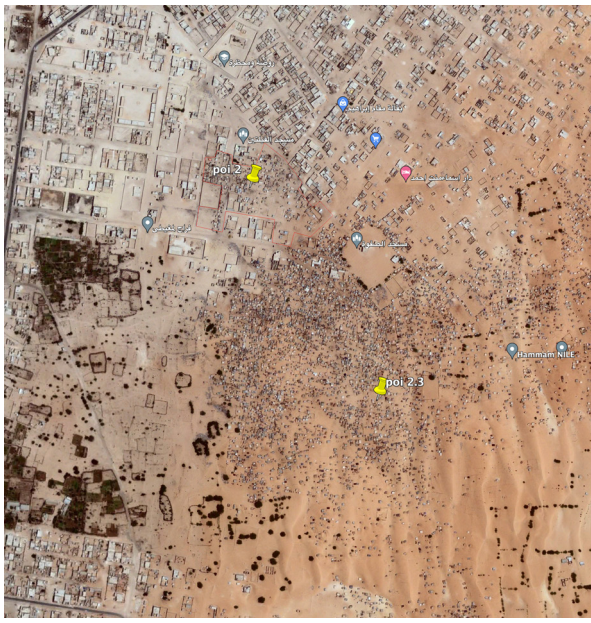
Nouakchott's urban dynamics involve both persistent development and areas that faced harsh transformation. Organic settlements are often "upgraded," opened up, and involuntary constrained into a grid morphology. These processes are financed by NGO's and the World Bank. Although done with good intentions to improve living situations and enhance water and electricity infrastructure, they also cause major displacement. In 2001, one of the largest informal neighborhoods Kebbe El Mina was restructured. This led to half of the population being resettled on site while the other half was moved south of the city. A similar process happened to the neighborhood Arafat's Gazra in 2008, where more than 20.000 households were moved to the extremely remote neighborhood Tarhil, literally meaning displaced (Les Atelier, 2015, p. 12). This process of imposing a grid and moving people to remote areas in the outskirts of the city, is extremely disruptive. Instead of conscious planning and co-creating, these large-scale upgrades seem harsh and not inclusive. However, by formalizing these neighborhoods people gain legal land tenure. In some cases, this is used for land speculation; by selling their formally obtained land and moving into other informal settlements.

3.15 Diachronic analysis of disruptive growth




Location ‘Disruption’
Kebbe el Mina
Arafat’s Gazra
Tarhila



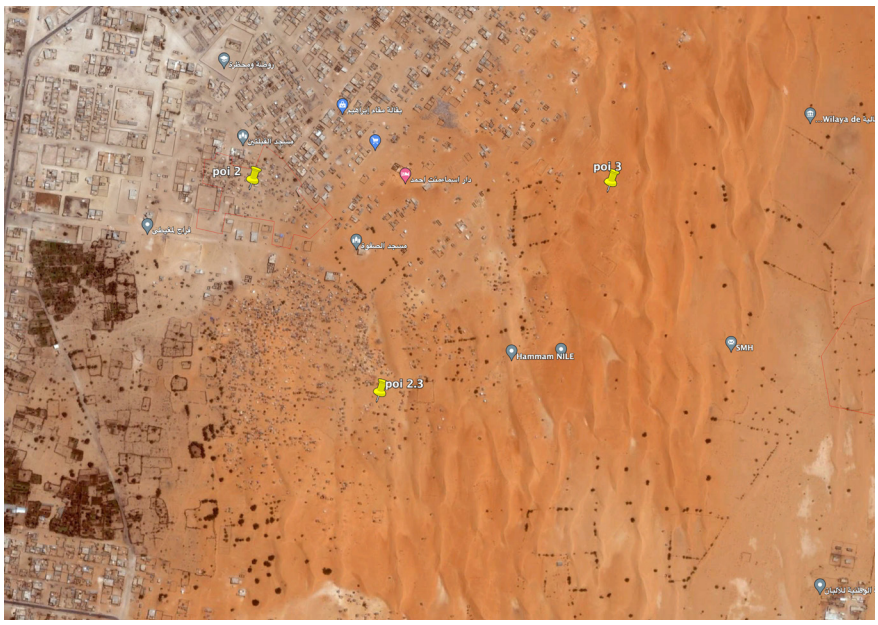


2005

2008

2010

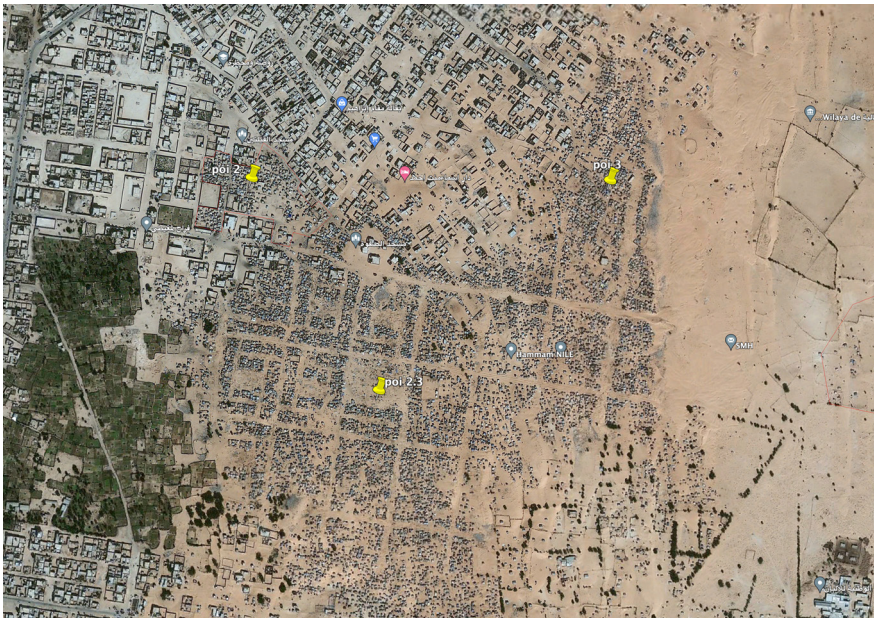
2012 - Sep





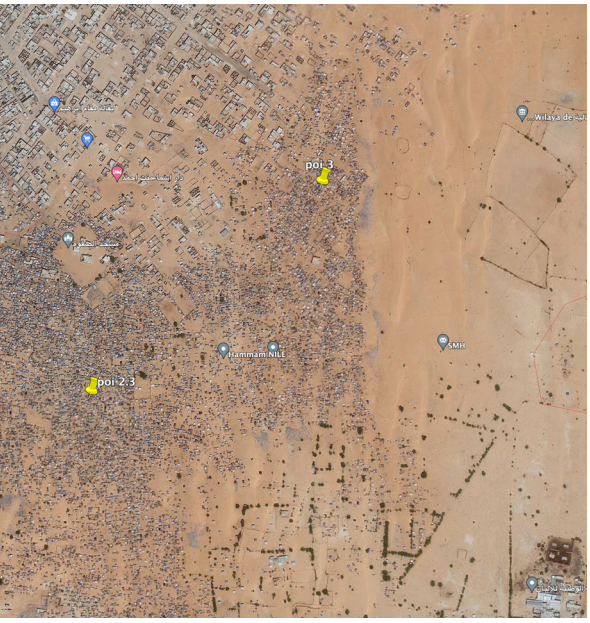
3.16 Diachronic development of location 'disruption' (google earth, 2023)

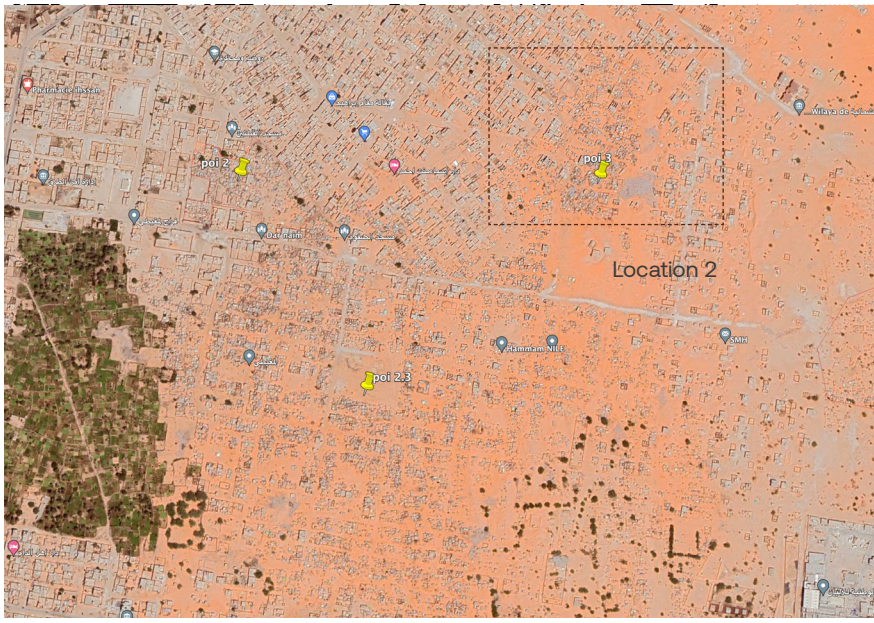




2012 - Dec

2020





III . 2 . III Persistent Growth

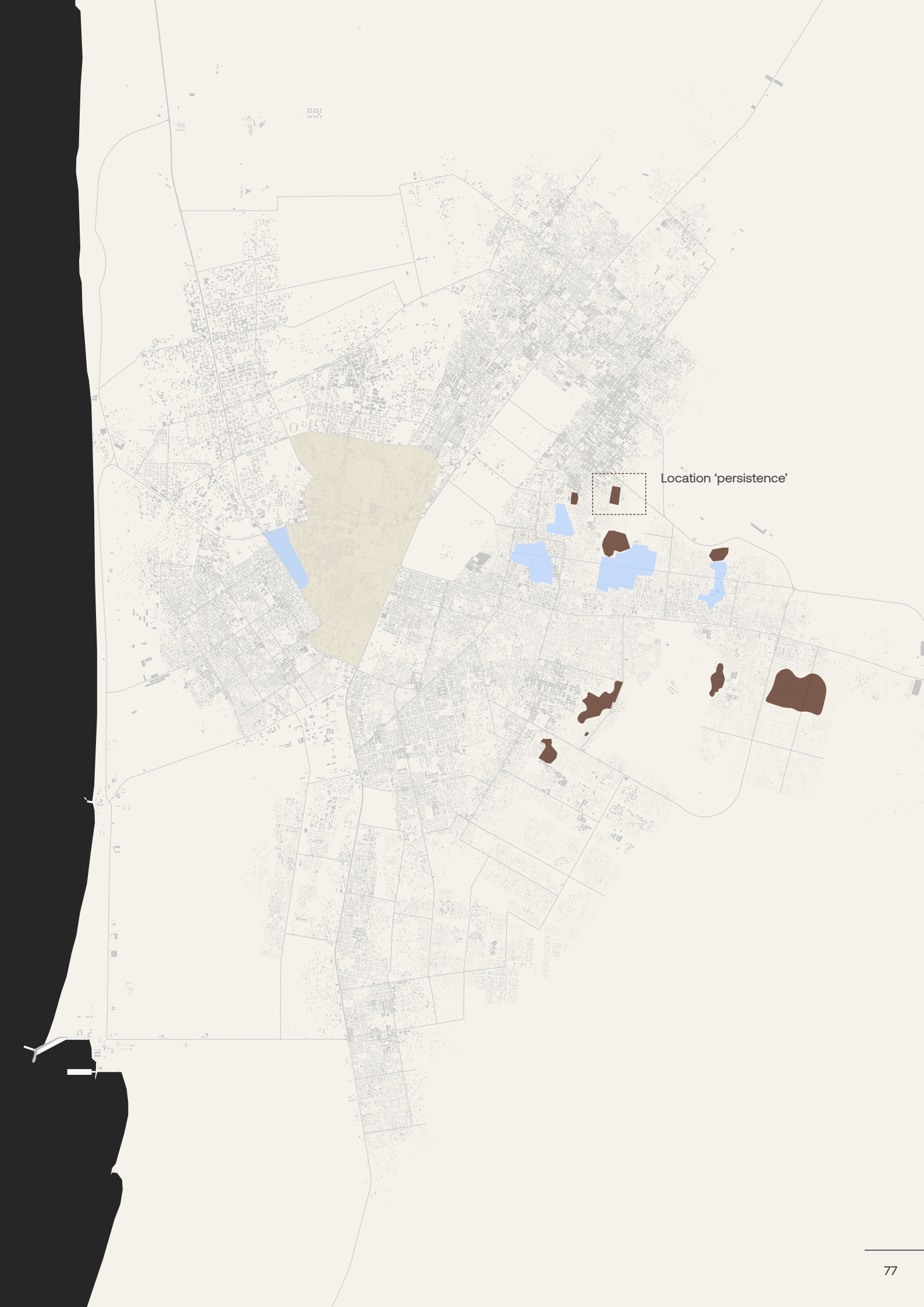
In contrast to the disrupted and altered urban space, there are two forms of persistent development in Nouakchott; planned grid structures and organic settlements that resist the harsh transformation. Planned grid neighborhoods have maintained their morphological integrity over time. Since these areas are the only spaces with urban planning, they are mainly concentrated in the city center and planned neighborhoods in the outskirts, developed for the displaced. In contrast, organic communities developed with no formal planning and resisted the harsh transformation that has occurred surrounding them. These organic settlements include small-scale dwellings, forming clusters of four to five buildings. With further development of any neighborhood, it can be observed that ecological value decreases while land pollution increases over time.

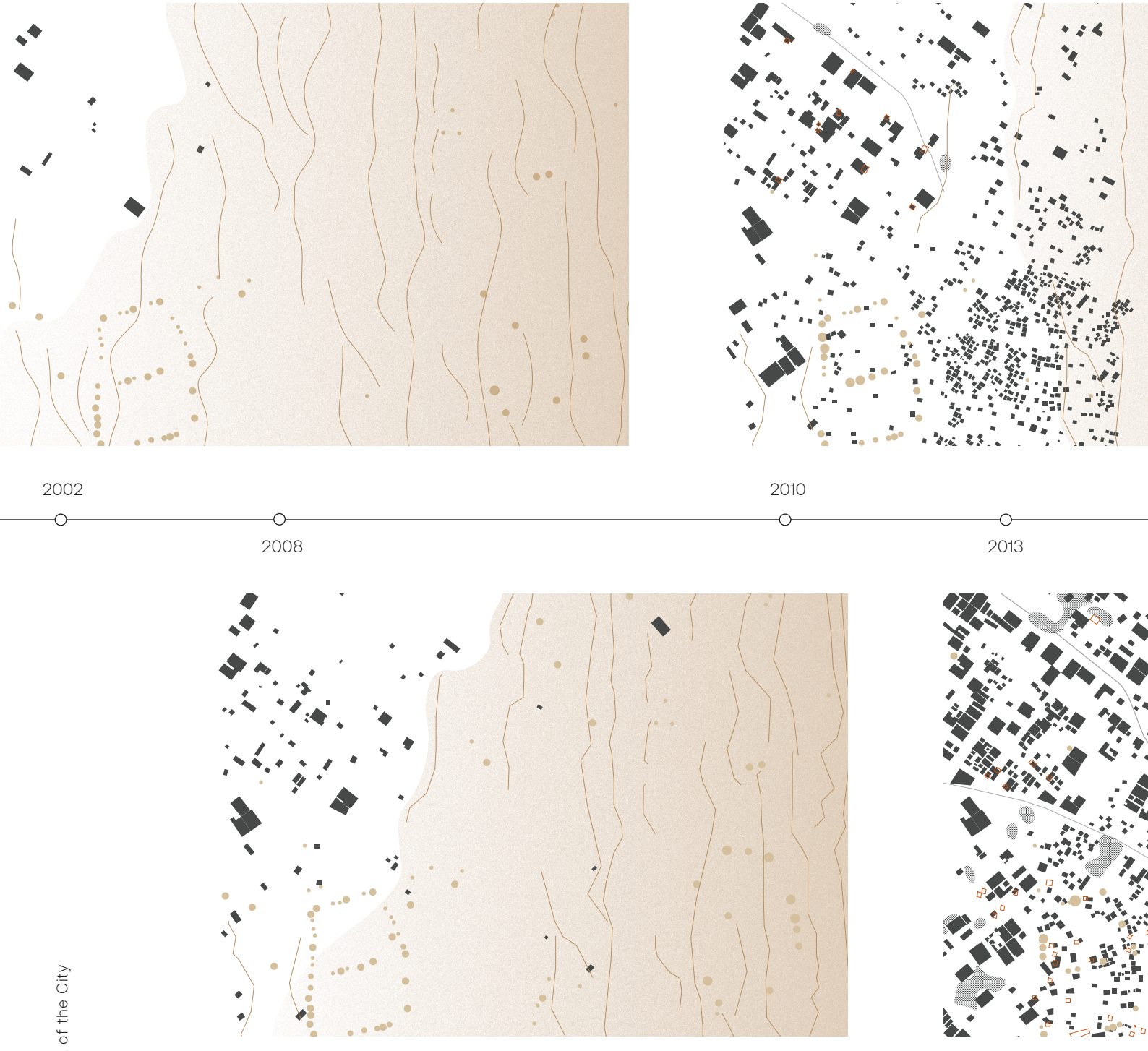
These persistent types of settlements, depending on their time of development, tend to have stronger social connections compared to parts of the city disrupted by transformation. Leaving one's social network and moving to a remote area strains people's social network that can support and bring a sense of belonging (JICA, 2018: pp 20-25).

3.17 Types of persistent space

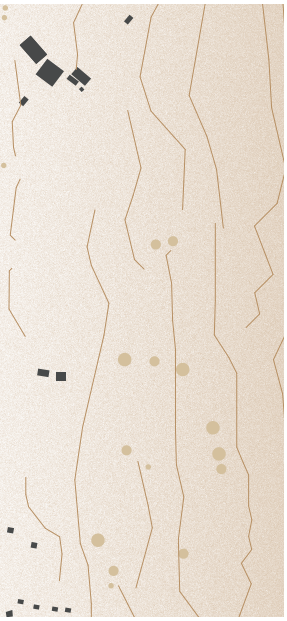
City Center
Green Spaces
Persistent organic neighborhoods

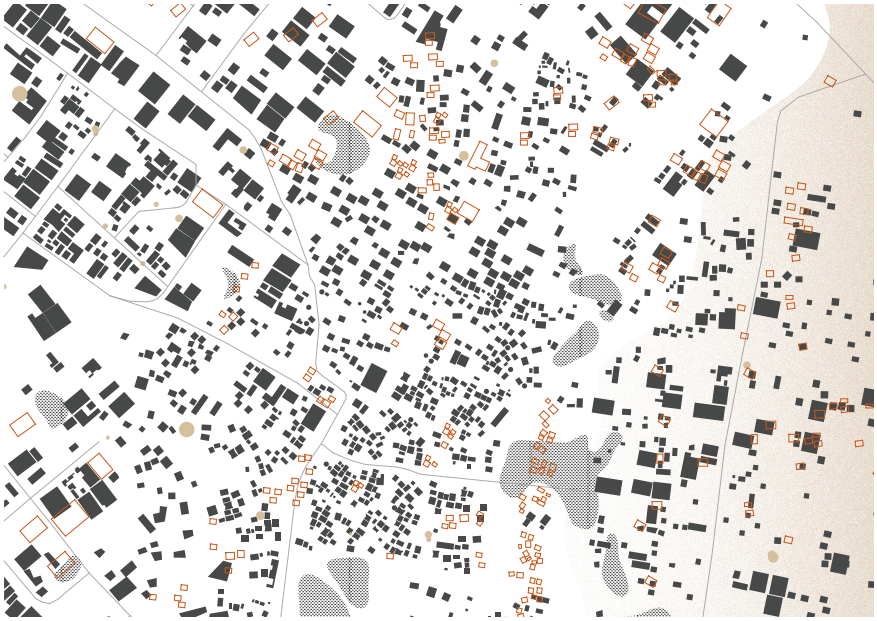
750 m


Location ‘persistence’



3:18 **Diachronic development of location** 'persistence' (google earth, 2023)

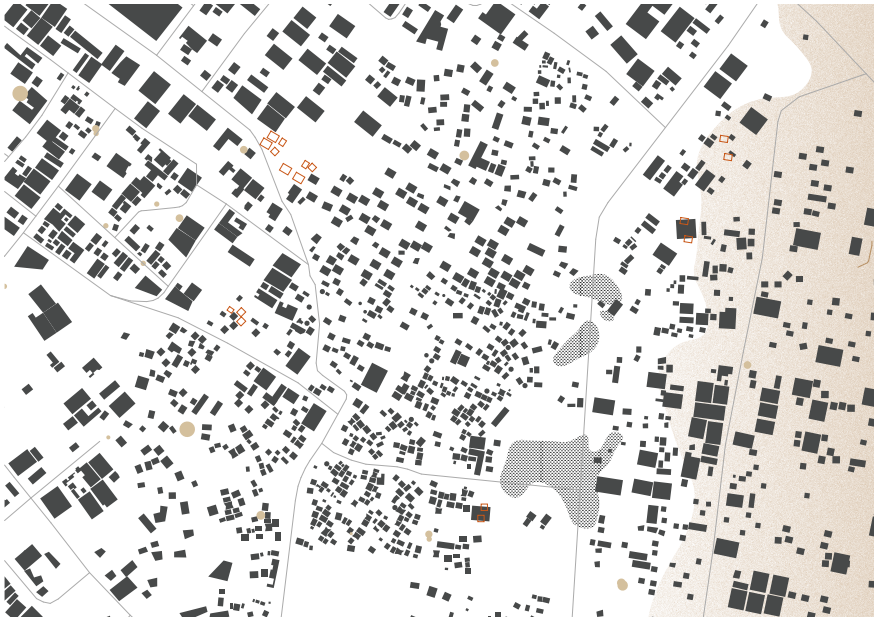




2016

2020

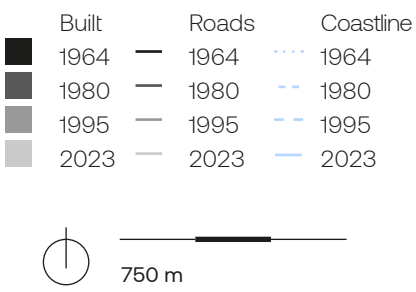


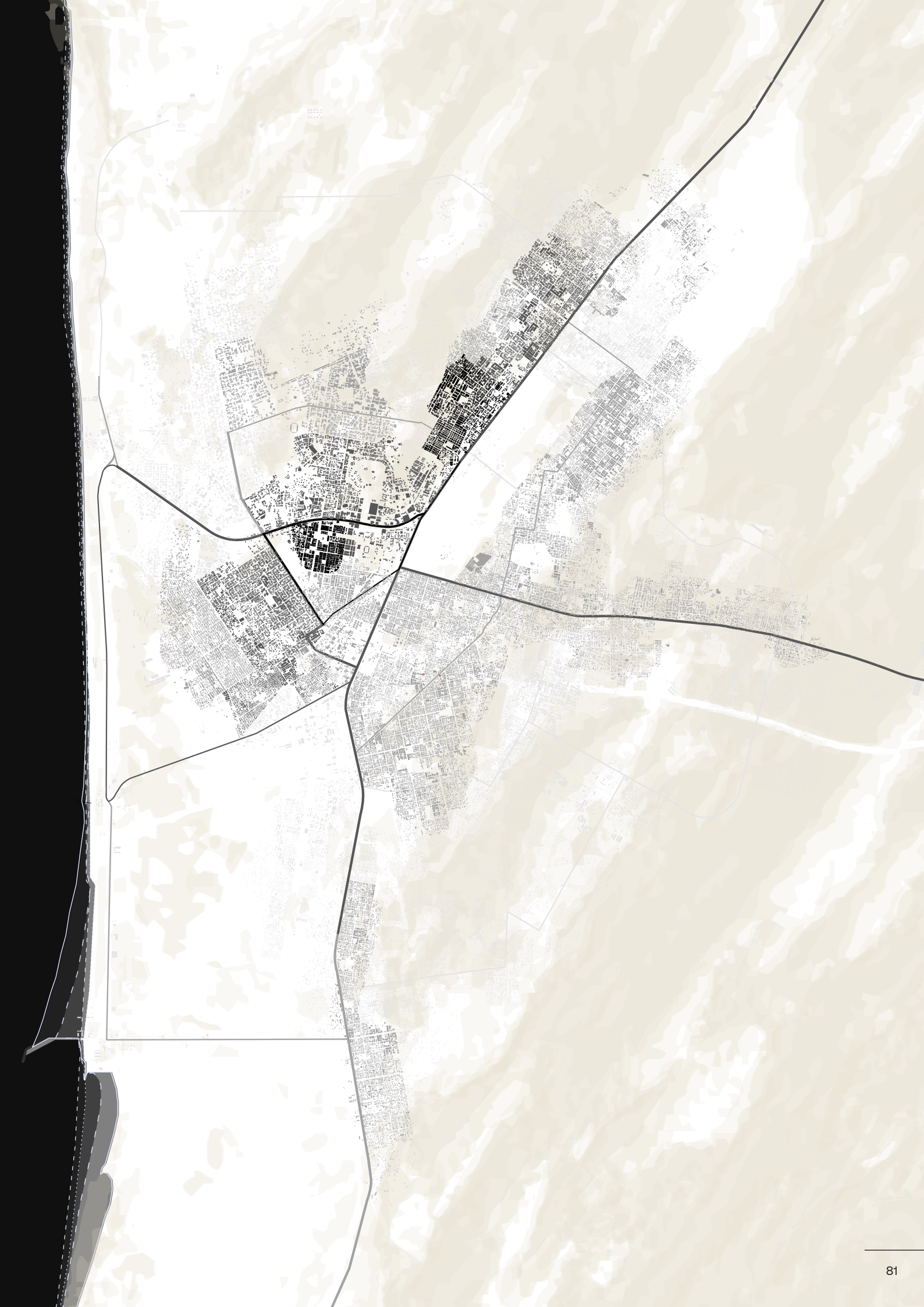


III . 2 . IV Conclusion

In conclusion, Nouakchott's unregulated development and deterioration due to human impacts are evident in many aspects of the city. The transformation of neighborhoods and the displacement of residents underscore the complex social and urban dynamics that shape cities development. The ongoing challenges in managing urban growth will become more pressing when predicted climate exposure starts to threaten vast areas of the city. Therefore, the aim of this project is to develop spatial strategies that foster urban and climate resilience, without imposing concepts of formality and order that might exclude spatial justice.

3.19 Diachronic transformation





III . 3 TYPOLOGY OF VULNERABILITY



This chapter focuses on the development of a typology of vulnerable communities in Nouakchott. This typology is assessed through two main lenses, evaluating environmental quality and the equity of space. The aim is to gain a deeper understand how these factors intersect to impact vulnerability.

Most assessments evaluating vulnerability focus either on a nationwide or household level, two extremes of scale (Naudé et al., 2009). This assessment focuses on evaluating vulnerability on a neighborhood or mesoscale to understand the 'vulnerability of place' (Naudé et al., 2009). To effectively assess this notion of place, it is important to take into account geographic environmental exposure (Naudé et al., 2009), social sensitivity, as well as the community's capacity to adapt. Country-wide vulnerability indices often separate economic and environmental vulnerability. However, this assessment integrates socio-economic and environmental dimensions, as they must be considered simultaneously when analyzing place. In order to make different dimensions comparable, each measured factor is categorized as high, medium, or low, with high being the most adapted and low representing the most vulnerable.

What spatial injustices, especially in vulnerable communities, arise in Nouakchott?

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III . 3 . I Vulnerability Assessment

Environmental factors

The environmental factors measured in this assessment include both exposure to different hazards as well as the adaptive capacity of the landscape. Key hazards include exposure to desertification and groundwater flooding. Desertification is measured by proximity to the desert, ranging from high (over 4 km) to low (0-1 km). Flooding exposure is measured based on elevation levels, with low elevations ranging from below sea level up to 2 meters, and high elevations beginning above 5 meters. The adaptive capacity is assessed through ecological value, as evidence shows a strong relationship between green spaces and reduced desertification. The last environmental factor is land pollution, which is evaluated by measuring the area occupied by landfills within a neighborhood. Neighborhoods with extreme pollution have over 2% surface area covered by landfills with the most severe case reaching over 9%.

Spatial equity factors

Spatial justice is assessed through the lens of resilience by focusing on economic opportunity, accessibility, distribution, and social integration. These financial, physical, human, and social assets play an important role for vulnerable communities when it comes to coping with stress or shocks (Naudé et al., 2009). Together, these factors help measure a community's sensitivity and adaptive capacity by examining the equity of space, resources, opportunities and accessibility.
Some of these factors are challenging to assess without place-specific data. Therefore, when necessary, this assessment works with measurable factors that can be used in a representative manner. The first factor, economic opportunity, is measured through the geographical location of a community within the city. Most of the economic power in Nouakchott lies in the city center. Thus, it can be assumed that locations far away from this center face challenges of lower job opportunities and economic resources. Accessibility to services is part of physical and human assets. By measuring the distance to schools and hospitals, we can make an informed assumption about the level of physical health and know-how of a community (Naudé et al., 2009). The third factor measures the distribution of water, since more than half of the population live from portable truck water that is bought and carried from other locations. The last factor assesses the level of integration and social network. This plays a vital role in terms of resilience. A well-organized community is less sensitive to exposure and develops a higher capacity to adapt through their support system. Social integration is measured through two representative factors; the age of the settlement and the degree of disruption a place has experienced. Spatial disruption forces part of the community to resettle in a new location, which can challenge social alliances.
These dimensions deepen the understanding of vulnerability on a smaller scale. Understanding specific conditions that amplify sensitivity and exposure, or harm adaptive capacity, provides insight into to underlying causes for vulnerability.

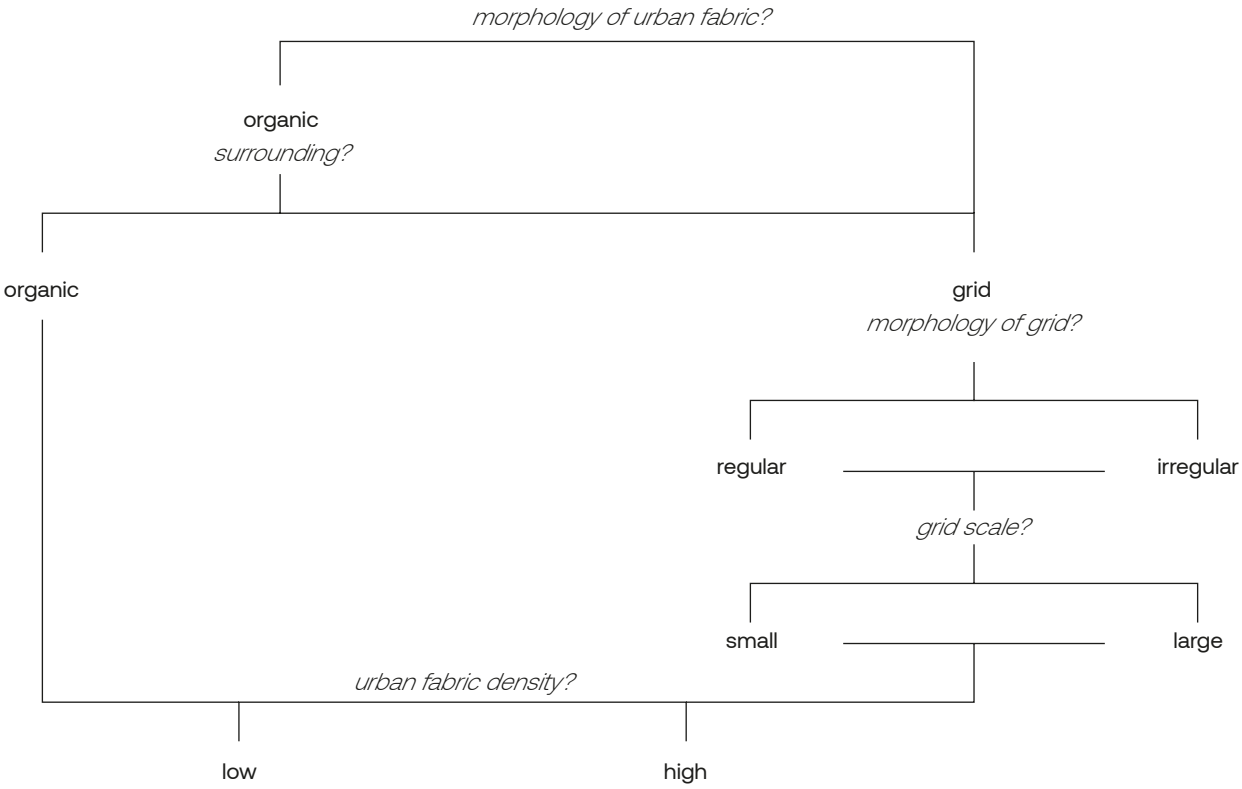


3.20 Assessment criteria

III . 3 . II Typology

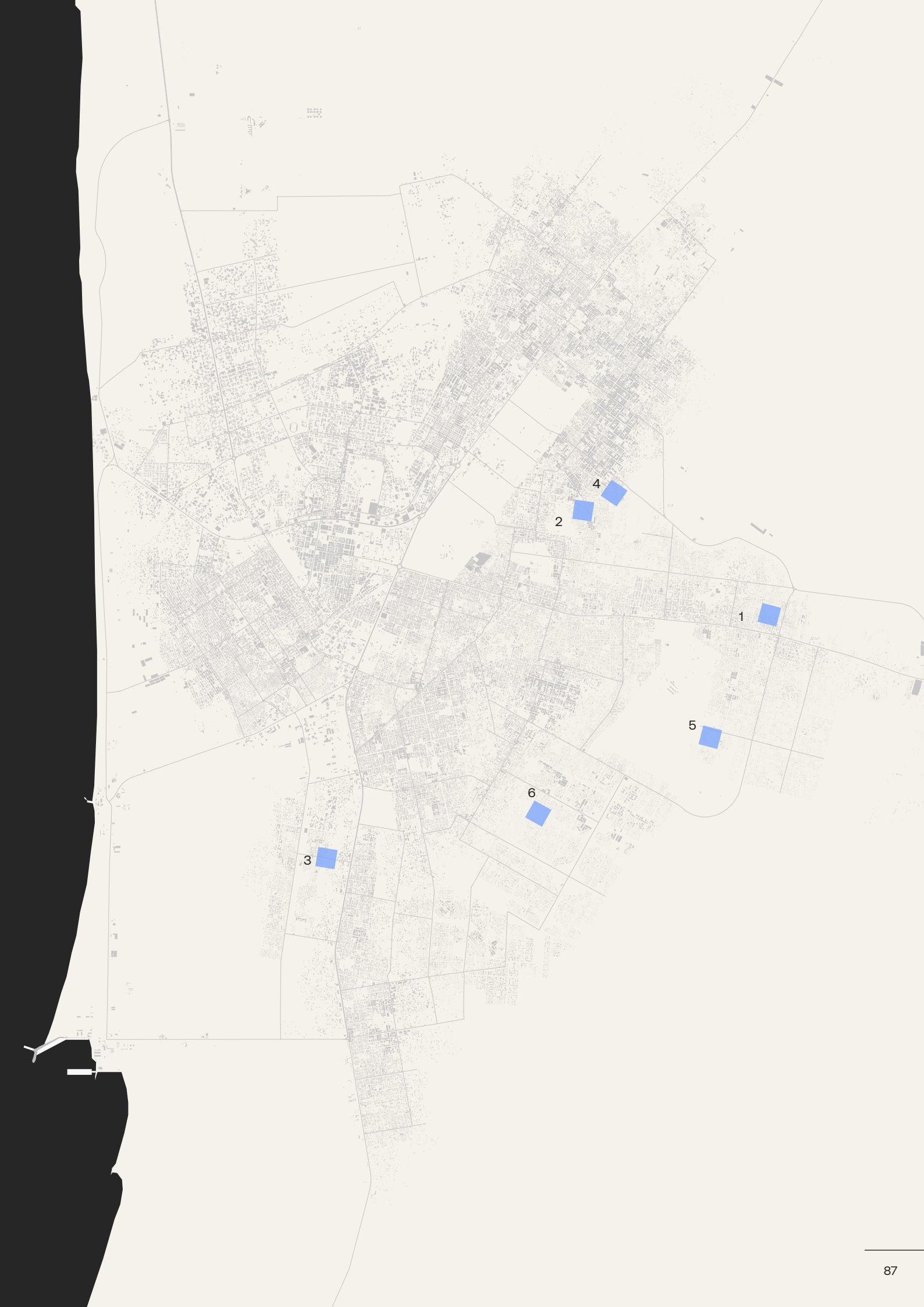
The following typology has been developed through the diachronic exploration of space. Although the formulation of the typology acknowledges the dynamic transformations of the city, this typological organization is based on the current morphological structure. Types are initially divided into grid and organic urban morphologies. Additionally, the density, regularity and scale of the urban fabric and street network are assessed. This leads to the exploration of six types of urban fabric; three are grid-based and three follow organic morphologies.

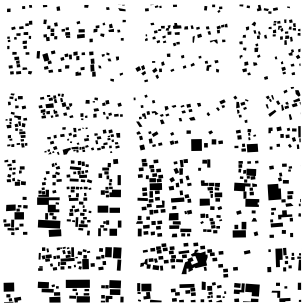
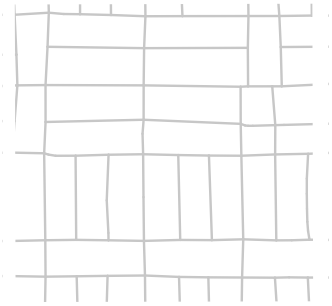
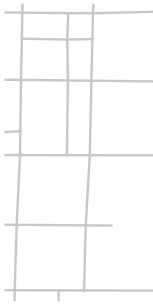
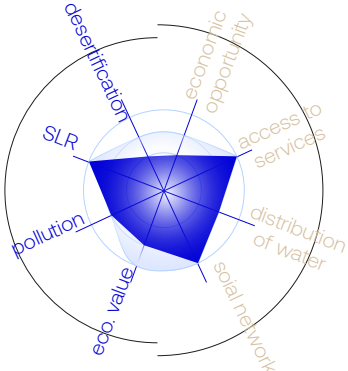
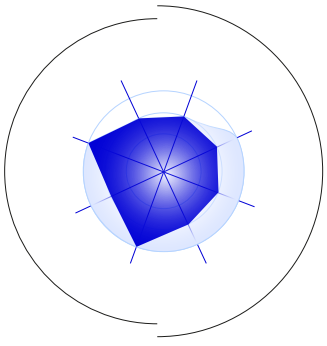
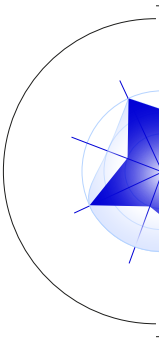
3.21 Map of Typologies



3.22 Organization of typology

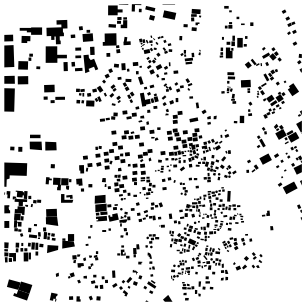
750 m


4
2
1
5
6
3

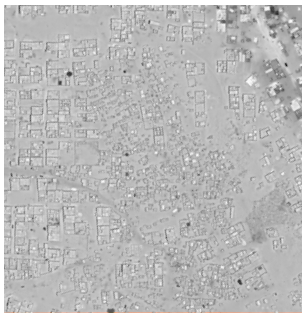
	1	2	3
Urban fabric			
Network patterns			
Satellite			
Morphology of urban fabric	Grid	Grid	Grid
Order of (surrounding) grid	Regular	Irregular	Irregular
Grid scale	Small	Large	Large
Density	High	High	Low
Age	2005	2008	2006 / 2007
Dynamics	Formalized 2012	Formalized 2012	Persistent
Assessment and Potential			

** for more detailed information on the assessment see appendix p. 160*

4



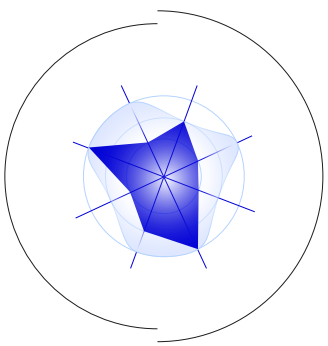




Organic
Surrounding irregular

High

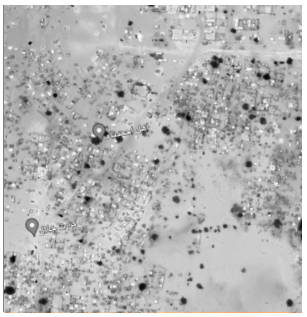
2010
Persistent



5



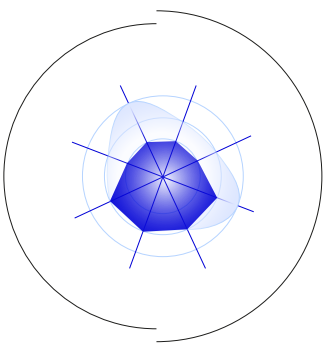




Organic
Surrounding irregular

Low

2012
Persistent for now



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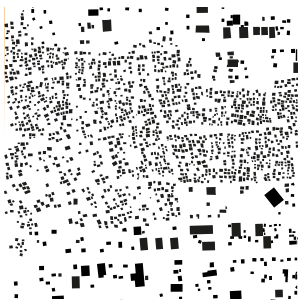
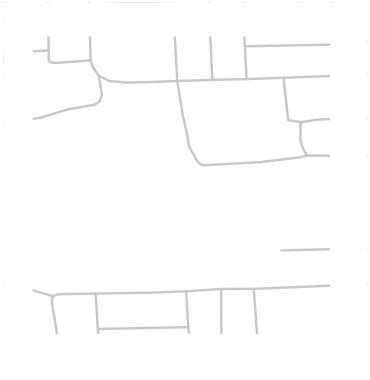
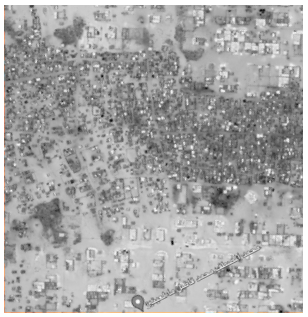
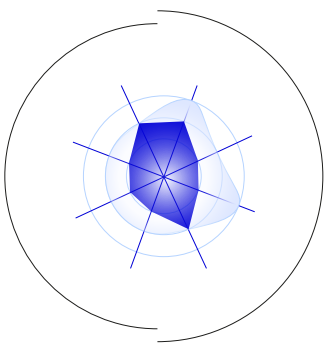






Organic
Surrounding regular
Small
High

2014
Demolished 2023/24



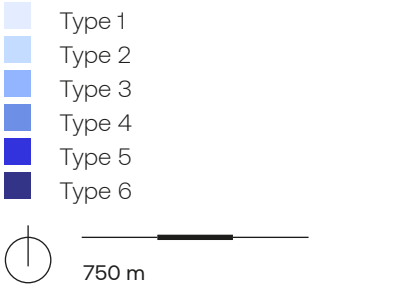
Identification of types

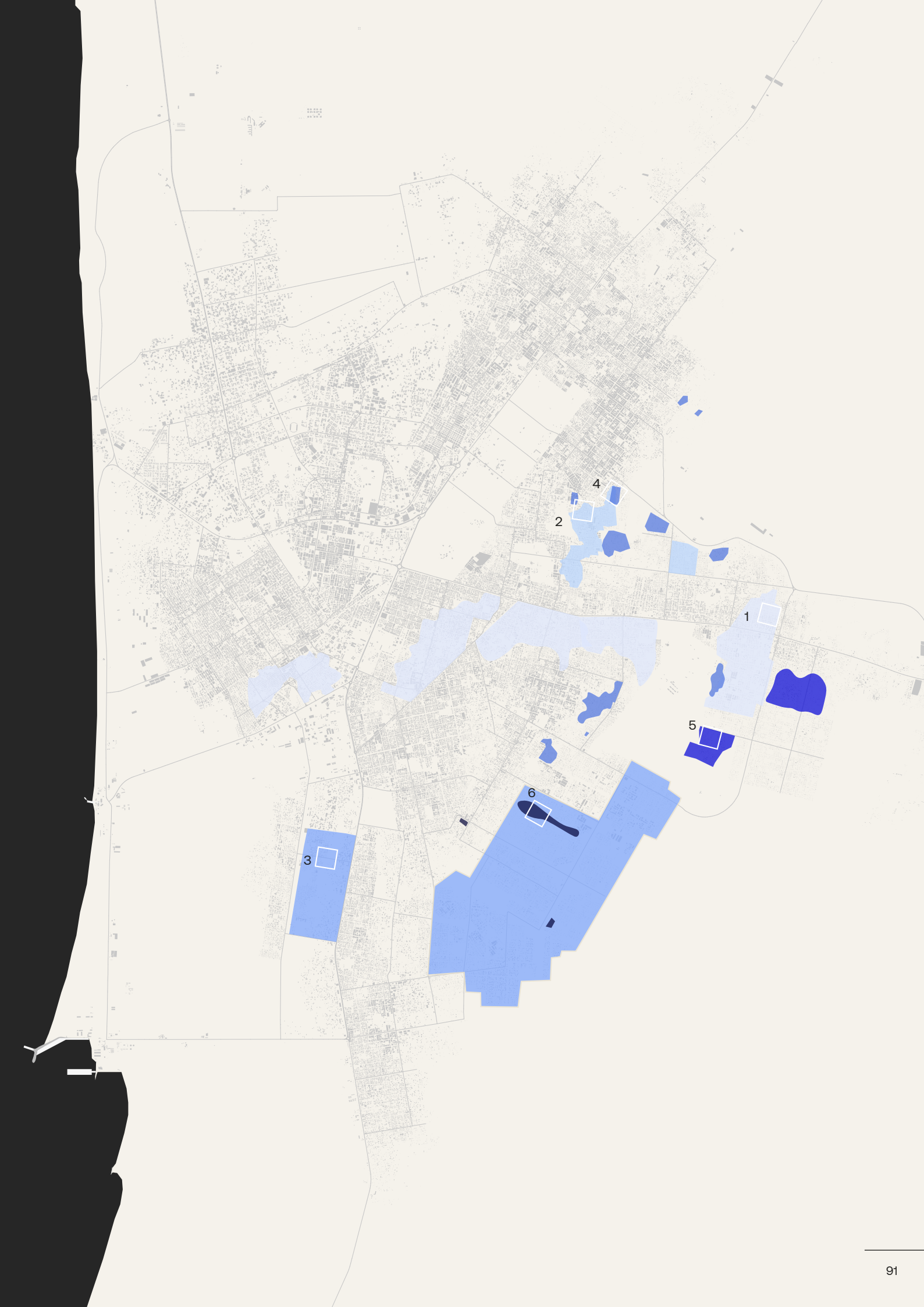
Type one is a dense, highly organized and regular grid, where blocks are divided into clear, long rectangles. Type two is more disordered in its street network but both types show a clearly imposed formality. Type three is a larger grid with larger buildings but overall lower density. This is the only type that was initially formally planned and owes its low density to its extensive exposure to flooding.
Types four to six exemplify organic morphologies. All three share a smaller scale of dwellings. However, they differ in their street networks and urban density. Type five has the lowest density and is mainly surrounded by open space. Type four and six have a higher density but emerged differently. Type four is a persistent neighborhood that resisted the surrounding formalization. Type six developed merely after a formally planed grid was constructed, organically occupying remaining open spaces.

Conclusion

The vulnerability of communities is strongly related to the geographic location they occupy. Places in the eastern parts of the city are more exposed to desertification, while the issue of flooding and salt manifestation is related to altitude, therefore exposing various unrelated areas. Although these six types evaluate differently in the vulnerability assessment, two spaces of different morphology can have a similar potential for improvement. This is due to the conscious omission of urban morphology in the assessment. Although informal settlements are known to be more exposed to environmental stresses, this vulnerability is not based on their urban morphology but rather on their exposed locations and heightened sensitivity. The following map identifies where these types replicate throughout the city. This can be challenging as certain patterns appear similar at first glance. Therefore, the map synthesizes knowledge about the transformative dynamics of the city's development into the analyzed typologies. By visualizing these patterns, we gain a deeper understanding of the spatial distribution of vulnerability across Nouakchott.

3.23 Draft: Map of Replication of Types

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III . 4 LIFE AND PEOPLE



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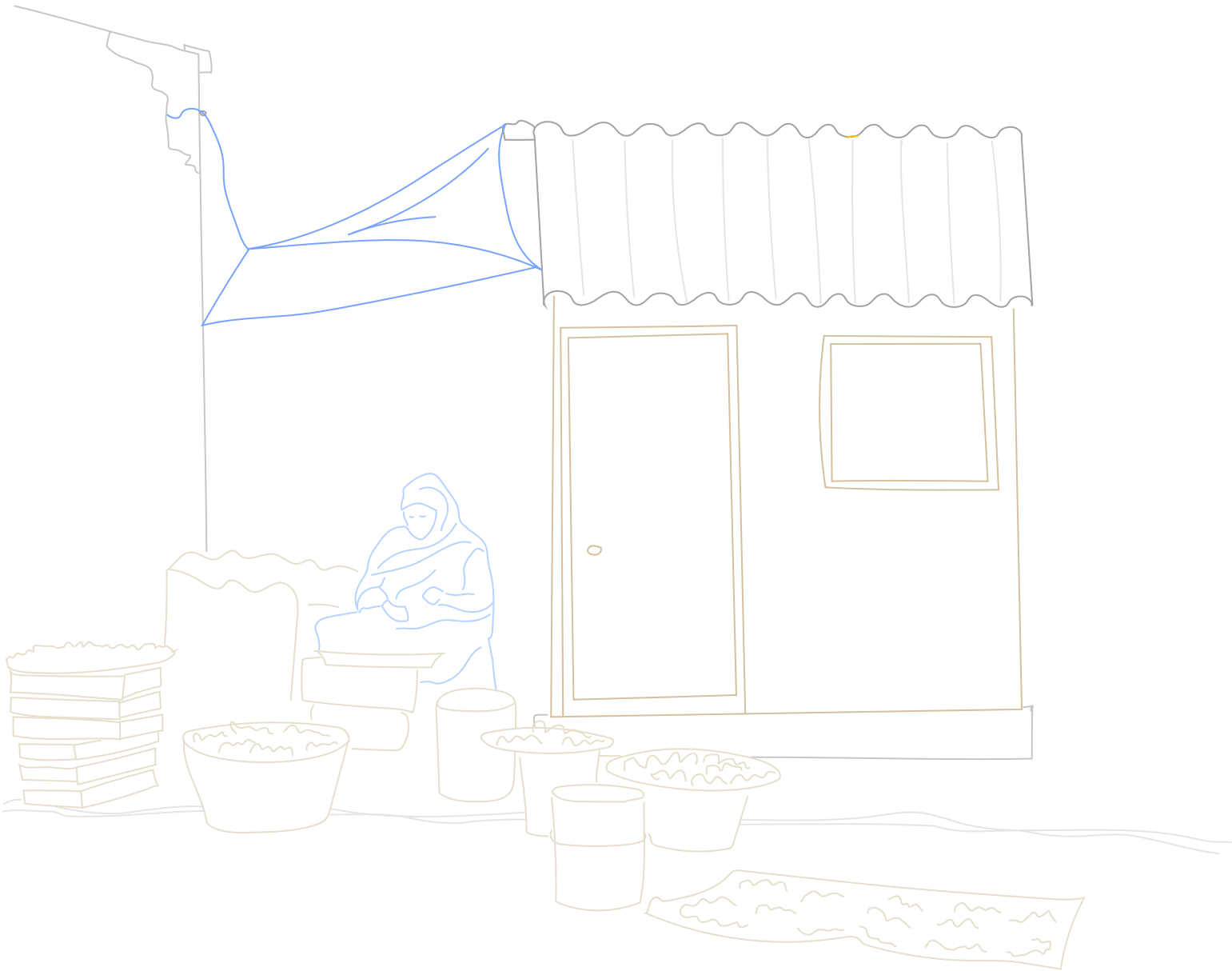
This chapter focuses on the impact of culture and tradition on daily life in Nouakchott. Through the examination of partially fictive characters, based on interviews, ethnographic research and the cultural identity of Mauritania, these stories shine a light on the daily life and struggles of Nouakchott's inhabitants. Bringing a deeper understanding on a human scale, this chapter offers a glimpse into the implications of daily activities onto space. Learning from the resident's identity and culture is a vital step when designing for any community. This chapter is my attempt of understand a community and a place without fieldwork, focusing on aspects that shape residents' everyday life.

What can we learn from the cultural identity and historic context of Mauritania?



III . 4 . I Stories



The fisherman

Ousmane N'Diaye is a Wolof fisherman working in the port of Nouakchott. He has been working here for more than 20 years, spending 10 hours a day in the raging waters of the Atlantic Ocean to make a living (ICI Radio-Canada, 2017). He wakes up at 5 o'clock every day. After his morning prayer, when most of the city is still fast asleep, he takes the bus to the bustling port of Nouakchott. He spends most sunrises on his wooden boat around the unforgiving waves that a few years before took his younger brother. It is a dangerous job, but as a Wolof man it is one of the few things he can do in Nouakchott. He knows he will never get one of those opulent and powerful jobs the Bidhan have, but dreams of the day a black man will live in the opulent presidential palace in the city center. In the far distance he sees one of the enormous foreign fishing vessels, slowly cutting through the waters but never entering the port. Its net drags along the ocean floor, capturing everything in its path, taking with it the fish that once sustained Ousmane's livelihood (Lemrabott et al., 2024).



© Yves Gabriel



© Vincent Karcher

The urban shepherd

A few kilometers outside of the busy economic center of Nouakchott, where the dunes gradually make over the concrete road, Jamel Ould Abdou dismantles his khaïma. As an urban shepherd, he travels a few kilometers with his animals in search for pastures, every day. Like many other shepherds he lives in the outskirts of Nouakchott. Originally from the Timbuktu region of Mali, Jamel has been a nomad, following his camels through various landscapes, including Algeria, before finally reaching Nouakchott. Despite the challenges of urban life, Jamel finds comfort in his role as a shepherd; his sense of home is bound to his animals. Gazing into the dunes he says “I miss the great desert. I can’t stand the city, its smells, its noise, its light,” a touch of nostalgia in his voice (ICI Radio-Canada, 2017). This desire for his nomadic roots resonates with many city dwellers. Seeking a longing to their past, they venture into the outskirts of the city for the taste of camel milk, reminding them of the life they once knew. For Jamel the dunes symbolize freedom, and a life unbound by urban constraints.



The female politician

Aïssata Kane, affectionately known as “Yaye Kadia” (Mother Kadia) or “Madame Minister,” is a prominent figure in Nouakchott (AWID, 2020). In 1975, she made history as Mauritania’s first female Minister for Family Protection and Social Affairs. “For women, it was a party to see me at the ministry,” she recalls, reflecting on her career (ICI Radio-Canada, 2017). Aïssata speaks humbly about her political past. She never expresses a negative word about her male colleagues, despite their frequent disagreements with her demands for female education and healthcare. “I defended women a little too much,” she confesses (ICI Radio-Canada, 2017). Her determination to improve girls’ education, combat traditional force-feeding, and advocate for marital rights changed the country to this day. Aïssata also fought for the introduction of a women’s quota in Mauritanian Parliament (AWID, 2020). Her political career abruptly ended with the 1978 coup d’état, during which many of her male colleagues were imprisoned. Aïssata, however, was spared, ironically remarking, “the only time I was discriminated against as a woman” (ICI Radio-Canada, 2017). Despite stepping away from politics, Yaye Kadia remained a passionate advocate for women’s rights and social progress. Her activism led to the founding of the National Union of Women of Mauritania, UNFM, and the creation of Marienou, a magazine dedicated to the emancipation of Mauritanian women. Aïssata Kane passed away on August 10, 2019, but she continues to symbolize the power and strength of women in Mauritanian culture (AWID, 2020). “We can do better; women are capable, they have abilities,” she stresses, a testament to her lifelong commitment to empowering women (ICI Radio-Canada, 2017).



© Yasmine Mehdi



The baker boy

Arouna is 12 years old. He wakes up early every morning to help in his uncle's bakery, separated by a thin curtain from where they have a mattress and some cooking utensils (McDougall, 2016). Every morning, after he has already kneaded the dough and formed his loafs, he gazes outside the bakery, watching other kids in his neighborhood on their way to school. Arouna wishes to go to school with them, but as a member of the Haratin community, his mother does not have formal papers for Mauritania, an issue many people encounter (ICI Radio-Canada, 2017). Out of fear that she will be deported, he cannot register for school in Nouakchott. Although his father fled from his master years ago, leaving behind the fields he looked after, he does not feel free. "It's as if we were always slaves," his father says when reflecting on their ongoing struggles (ICI Radio-Canada, 2017).



© Vincent Karcher

The taxi driver

Siddi is a taxi driver in Nouakchott. He dreams of one day living in Tevragh-Zeina, far away from the crowded, sandy streets where he currently lives. Every day, he drives through the bustling roads, working long hours to support his family. Driving through Tevragh-Zeina, he imagines a better life for his family and children, with access to the opportunities he never had. When asked about his past and his freedom today he says: “We have no relations with the chiefs and powerful people [of our clan] … we know only the poor” (McDougall, 2016). His daily routine, praying and knowing where to find the best tea on his daily routes offer him moments of hope - he is not alone with his struggles. Siddi’s story captures the aspirations of many Mauritanians, signed by their past, while striving for upward mobility in a society marked by deep divides.



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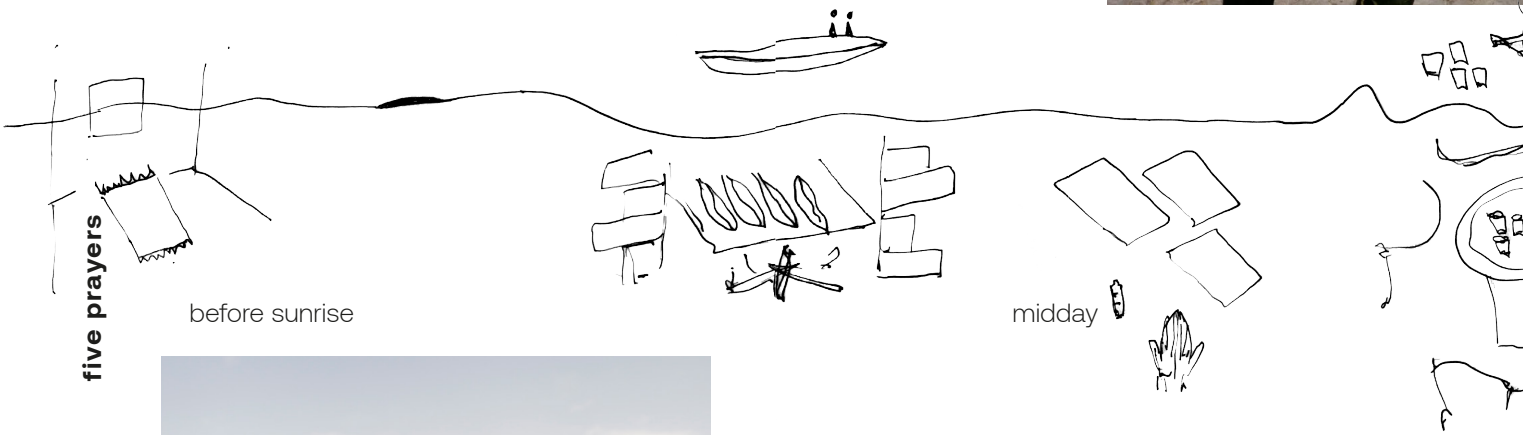
III . 4 . II Rhythm of Life

In Nouakchott, the rhythm of daily life goes beyond people's occupation; instead, it is deeply intertwined with religious and spiritual practice. The five daily prayers transform the bustling metropolitan into a standstill, as the call of the muezzin echoes around every corner. People pause for a moment, finding space in boutiques, on sidewalks, or close by a mosque to pray towards Mecca.







© Vincent Karcher

Community and family hold immense importance in Mauritania. Embedded in societal obligation is to share one's success. There is an immense importance on supporting each other and donating money to social causes. Brotherhood and family bonds are fundamental, reflecting the spirit of togetherness in society.

Central to these social bonds are the rituals of sharing food and tea. Mechoui is a slow-roasted lamb or goat, seasoned with simple spices over an open fire. It is eaten by hand from one large plate to symbolize unity and friendship. The tea ceremony, brewed with fresh mint and plenty of sugar, is served in three



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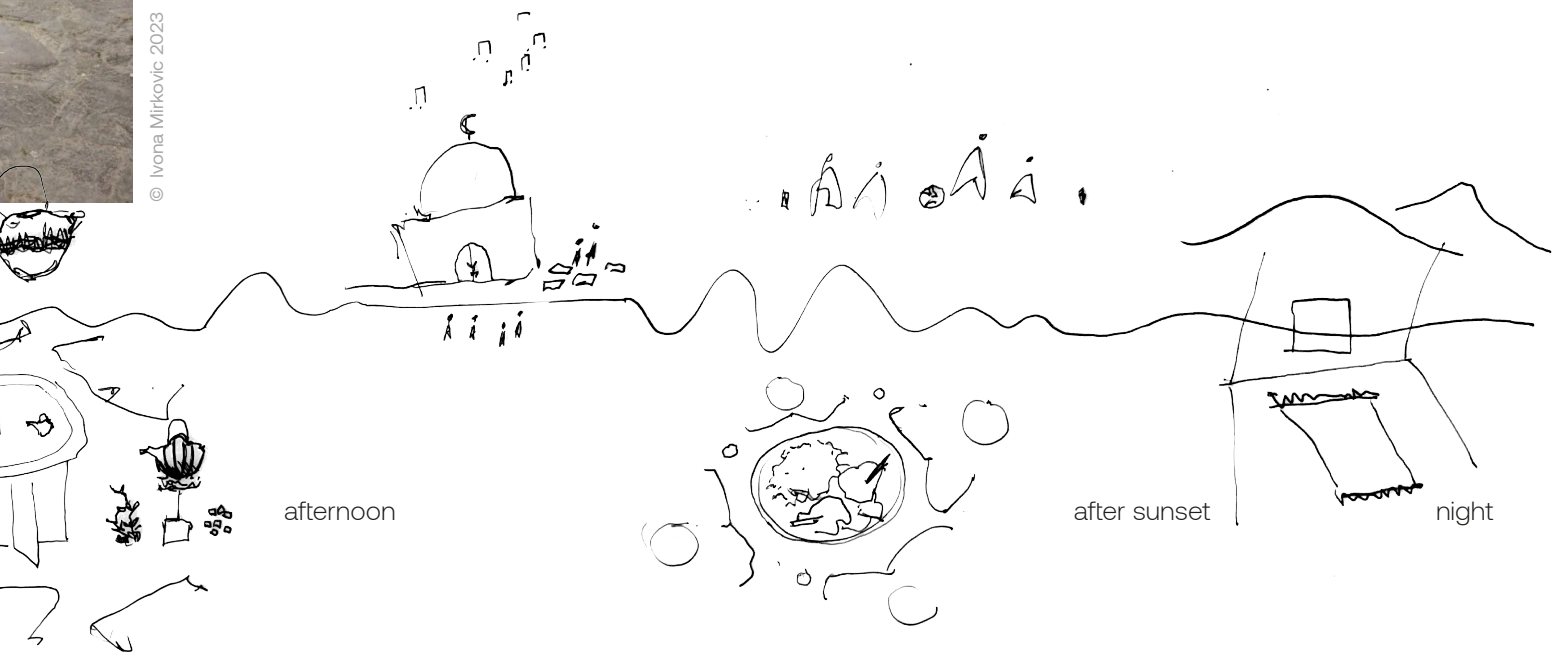
These rituals foster moments of reflection, socializing, and warmth, shaping the daily routines of life in Nouakchott. In these moments, some quiet and introspective, others lively and communal, the bond traditions and rituals create shines through.



rounds. Tea is more than a drink; it symbolizes hospitality and connection. Traditionally prepared by the head of the family it is offered to honor guests. The three rounds of tea hold deep meaning. The first is bitter like life, the second sweet like love, and the third gentle like death. Tea is a staple throughout all classes in Mauritania, served at least three times a day.



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III . 4 . III Space

The following map interprets an organically developed neighborhood (type 4). While the plot shape does not conform to the grid structure of the surrounding area, there is a distinct organization of space. The organic street layout reveals a natural hierarchy of pathways and spaces. This hierarchy creates diverse levels of publicness with some areas directly accessible from public streets, while others are more secluded and protected, evoking the intimacy of a courtyard.

The clear separation of territories, enclosing people's plot is structured through fences made of metal, wood, or tree branches. This defining of territory serves to ensure privacy, but mainly functions to distance living space from the open space, often occupied by animals. In Nouakchott, animals such as goats, sheep, camels, or cows wander freely, grazing on trees, bushes, and other plants they find as they move through the neighborhood. Animals are not guided along set paths; they are led by nomadic shepherds who naturally follow the animals' movements.

It is important to note that the illustrated activities are fictional and intended to anticipate daily routines rather than represent ethnographic observations from fieldwork. The activities reflect possible interactions and movements of the characters within space. In this way, the drawing gives a spatial dimension to the rhythm of daily life.



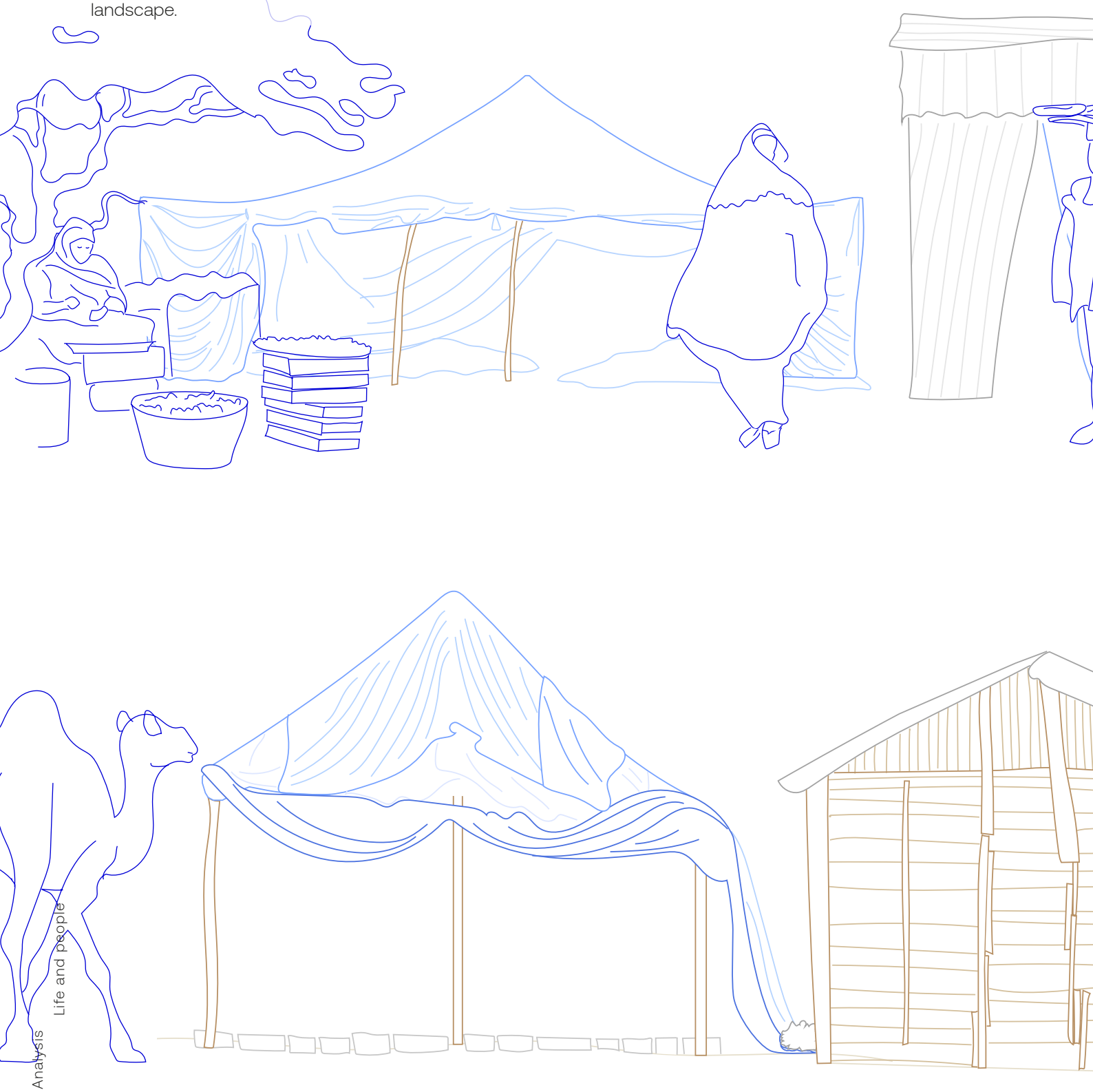
3.24 Activity in a neighborhood

- Tents or covers
- Wood and metal dwellings (certain)
- small sheds, probably for animals
- dwellings (70% certain)
- Concrete buildings
- Concrete walls
- Cars
- People
- Animals

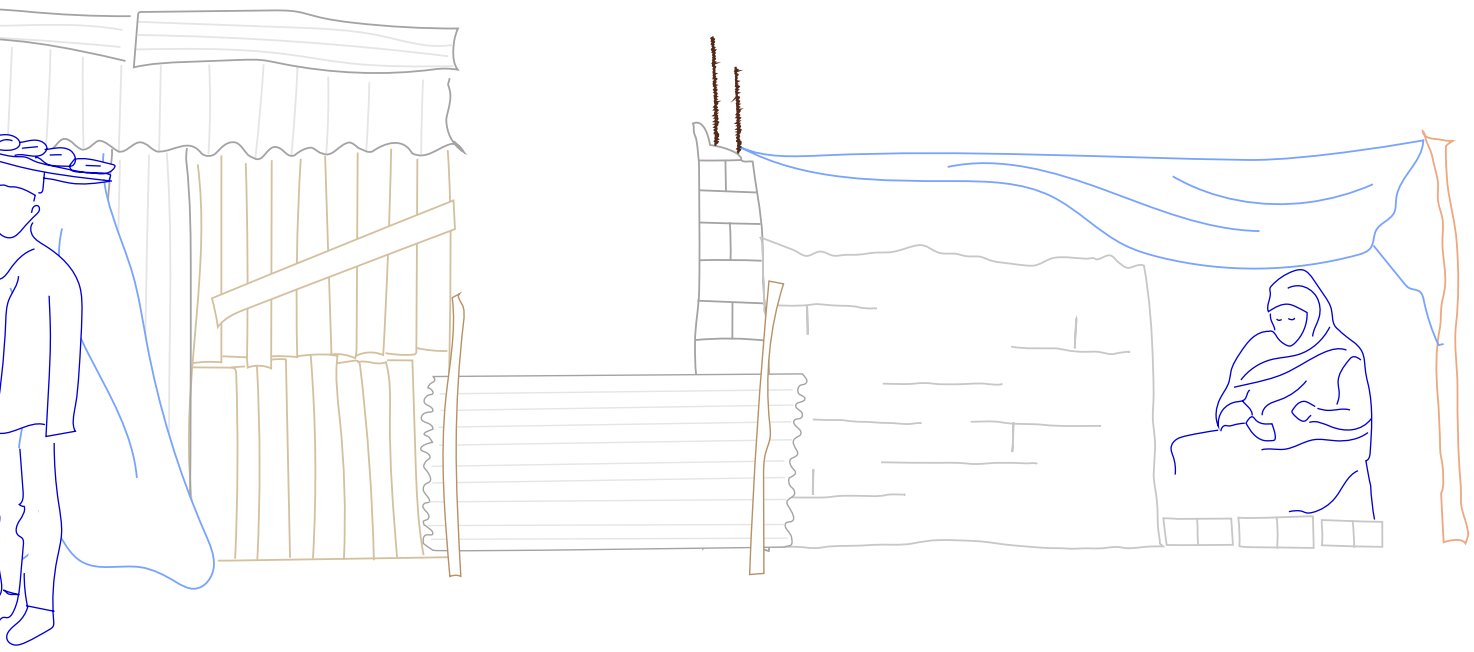


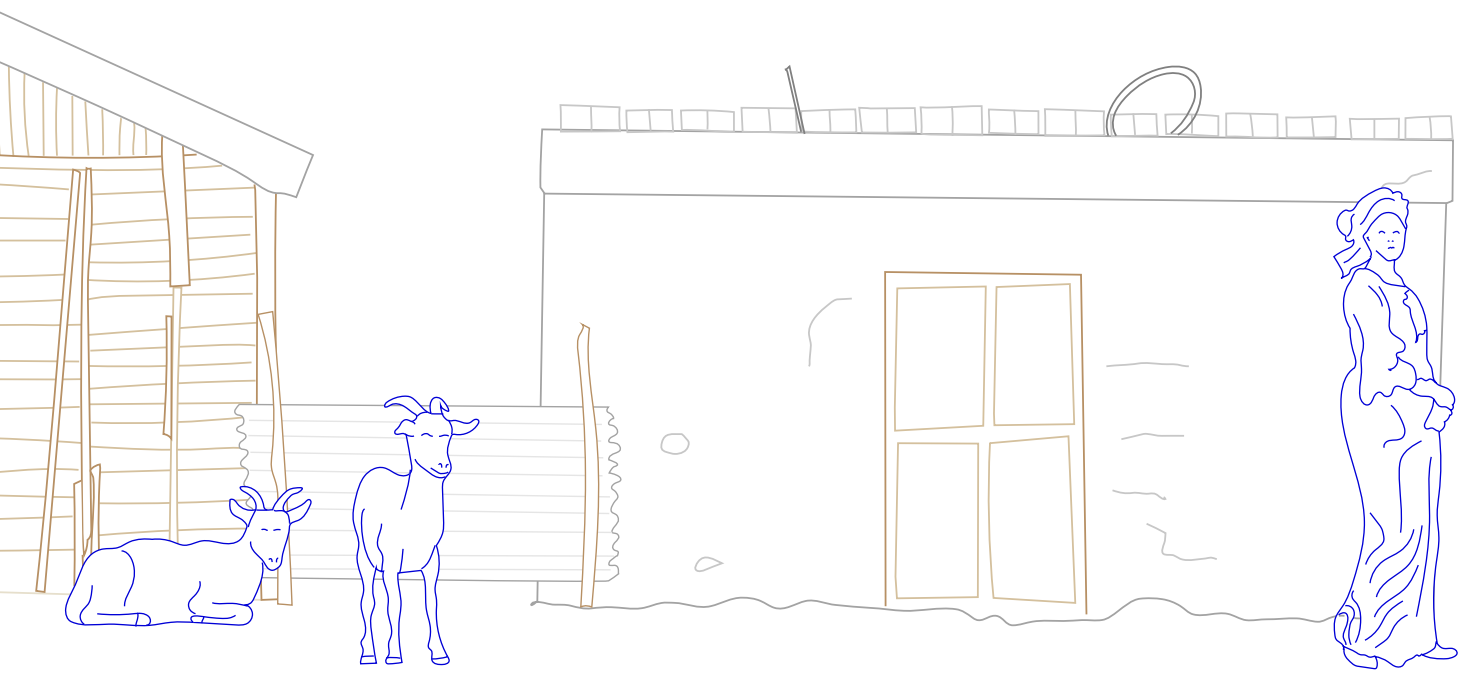
Dwellings in informal settlements are typically simple constructions, built from scavenged materials such as metal and wood scraps to construct basic shelters. Many residents view their time in Nouakchott as temporary, which, combined with extreme poverty and limited resources, results in settlements that consist of makeshift shelters and partially constructed buildings. Homes are settled between crumbling concrete structures and temporary shacks, creating a fragmented urban landscape.

Life in these settlements is simple. People use charcoal or small gas cookers to prepare tea and food in the open, creating gathering spaces wherever they find shade. Trees become central spaces for social encounters. People informally sell bread, nuts or vegetables on the sidewalk, some staying in one place while others walk from one meeting point to the other.



3.25 Architectural scale: colors coordinate to prior map







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IV . 1 PATTERN LANGUAGE

The following design uses the method of a pattern language to develop a flexible design outcome that responds to a context of natural, social, and political uncertainty. The aim is to provide an evolving framework that adapts to shifting environmental conditions and societal needs. Pattern languages are inherently adaptable, allowing designs to become tools of communication and co-creation, customized to specific needs. This flexibility is essential to create a unified design process that is transferable to various locations, while also addressing the complexity of spatial challenges. This co-creation process is intentionally left open-ended, focusing on the initial phases of communication, to ensure its transferability and potential application across diverse contexts, even to different continents. By breaking down complex issues into tangible patterns, this method helps manage and organize challenges in a constructive way (Rooij & Van Dorst, 2020).

IV . 1 . I Theory

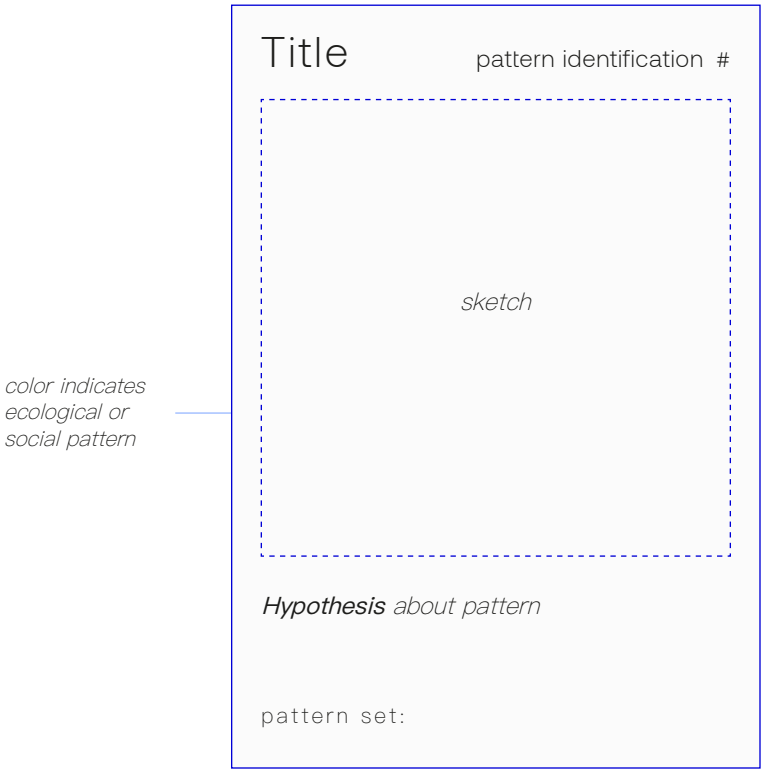
Architect and design theorist Christopher Alexander introduced the idea of patterns in A Pattern Language (1977). This approach revolutionized architecture by proposing a system of design interventions based on reoccurring spatial challenges (Alexander et al., 1977). He acknowledged the complexity and dynamic nature inherent to spatial planning and used patterns to bridge from problematic to solution (Rooij & Van Dorst, 2020). His patterns range in scale, from the layout of a room to the planning of entire neighborhoods. His key insight was that effective design comes from identifying and responding to evolving patterns in our environment.

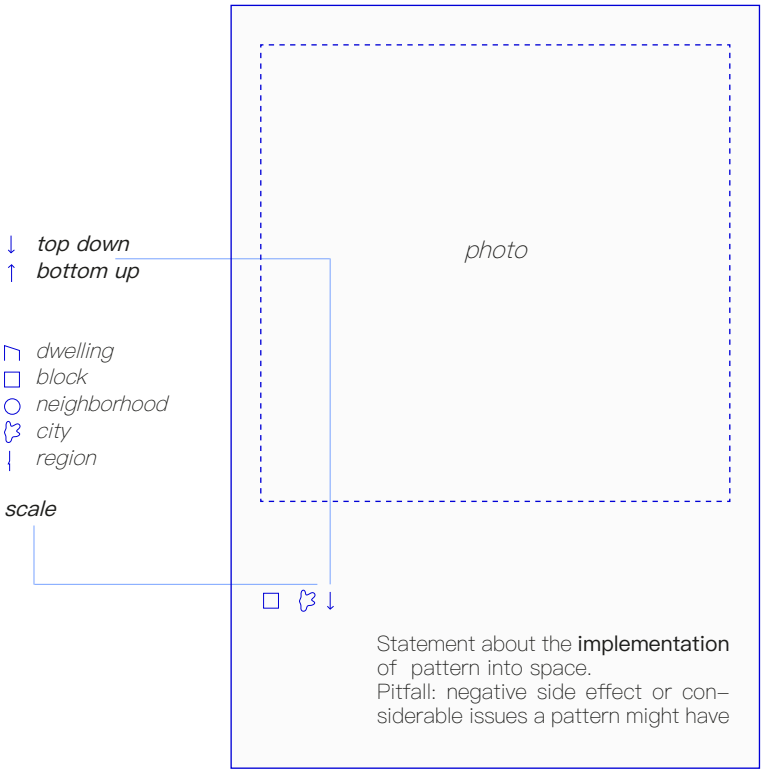
This framework has since been applied to urban design, helping systematically organize complex design tasks. By breaking down complex challenges into individual patterns and integrating visual and verbal elements, this method encourages clear communication (Rooij & Van Dorst, 2020).

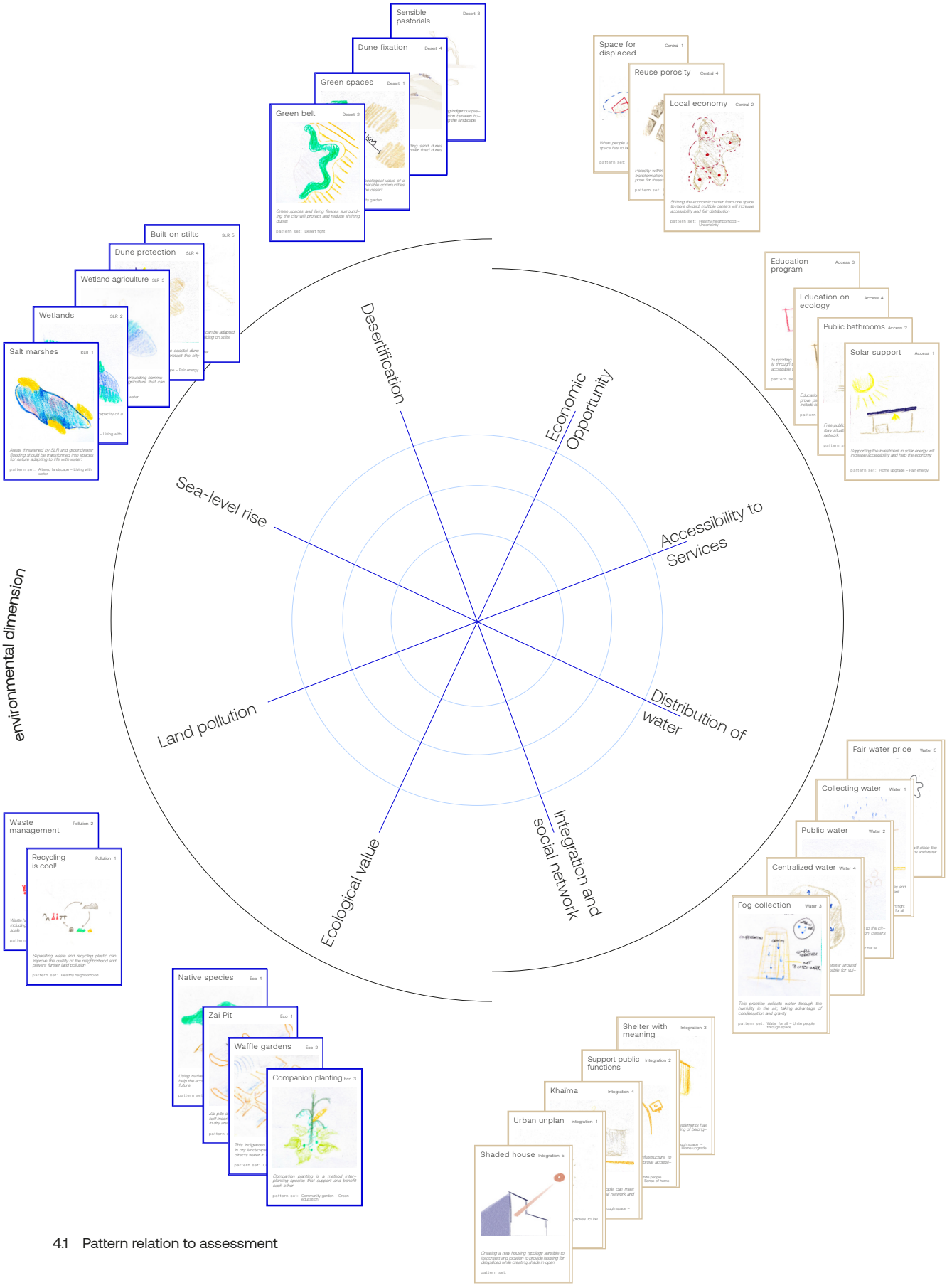
Often used to restore complexity is the concept of pattern fields. Pattern fields are created by mapping relations between all patterns into comprehensive networks (Rooij & Van Dorst, 2020). Rather than developing a broad pattern field, I focus on curating specific pattern sets that complement each other. These curated pattern sets allow for targeted solutions tailored to specific complex problems, intertwining environmental and social elements into spatial solutions.

IV . 1 . II Patterns

Developed in an iterative process of research and design, this pattern language is organized according to the previously established assessment criteria. The colored rim expresses the patterns category, divided into environmental and social patterns. Within these categories patterns are further grouped based on the primary issue it tackles, giving each pattern a unique identification number. The environmental patterns include the categories desertification, sea level rise, pollution, and ecological value, while the social patterns include economic opportunity, access to services, distribution of water, and integration and social network. Through these patterns, challenges of climate exposure, social sensitivity and limited adaptive capacity are addressed.
The back of each pattern details its implication. Symbols indicate the relevant scales each pattern approaches, as well as critical pitfalls and potential pitfalls associated with the application. Additionally, each pattern includes a symbol related to its governance requirements. The arrow indicates whether the pattern might be developed in a bottom-up approach within an organized community, given the right tools and knowledge, or if it likely requires top-down intervention from the government to address the challenge.







4.1 Pattern relation to assessment

Desertification

Green spaces — Desert 1



Greenery adds to the ecological value of a place and protects vulnerable communities against the forces of the desert.

pattern set: Community garden

Green belt — Desert 2



Green spaces and living fences surrounding the city will protect and reduce shifting dunes

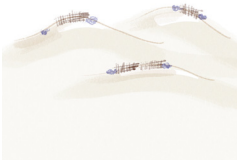
pattern set: Desert fight

Sensible pastorials — Desert 3

In this fragile ecosystem, using indigenous pastorial practices creates a fusion between human and ecosystem, nurturing the landscape

pattern set:

Dune fixation — Desert 4



To prevent dangerous drifting sand dunes we need to protect and recover fixed dunes through practices

pattern set: Desert fight

Sea level rise

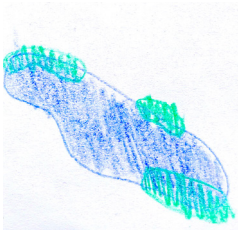
Salt marshes — SLR 1



Areas threatened by SLR and groundwater flooding should be transformed into spaces for nature adapting to life with water.

pattern set: Altered landscape – Living with water

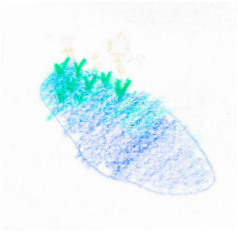
Wetlands — SLR 2



Wetlands add to the adaptive capacity of a place and conserve biodiversity.

pattern set: Altered landscape – Living with water

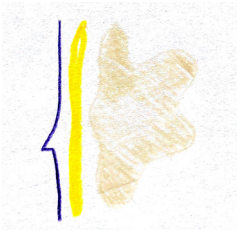
Wetland agriculture — SLR 3



Wetlands can benefit surrounding community when hey include agriculture that can sustain people.

pattern set: Living with water

Dune protection — SLR 4



Restoring and protecting the coastal dune landscape is necessary to protect the city against rising sea levels

pattern set: Altered landscape – Fair energy

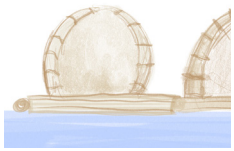
Built on stilts — SLR 5



Settlements in flooded areas can be adapted to living with the water by building on stilts

pattern set: Living with water

Mudhif — SLR 6



The mudhif is an indigenous practice, using reed to build floating islands and mesmerizing architecture in wet landscapes.

pattern set:

Pollution

Recycling is cool! — Pollution 1



Separating waste and recycling plastic can improve the quality of the neighborhood and prevent further land pollution

pattern set: Healthy neighborhood

Waste management — Pollution 2

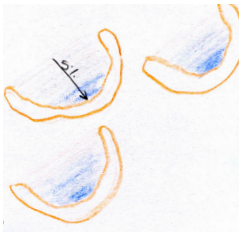


Waste has to be managed on different scales, including support by the government on a city scale

pattern set: Healthy neighborhood

Ecological value

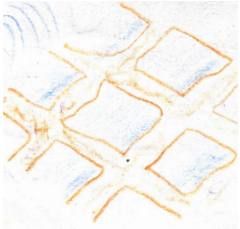
Zai Pit — Eco 1



Zai pits are an indigenous practice digging half moon shaped pits to recover soil quality in dry areas.

pattern set: Desert fight – Green education

Waffle gardens — Eco 2



This indigenous practice of the Zuni used in dry landscapes captures, stores and redirects water in communal agriculture

pattern set: Community garden

Companion planting — Eco 3



Companion planting is a method interplanting species that support and benefit each other

pattern set: Community garden – Green education

Native species — Eco 4



Using native and non invasive species will help the ecosystem restore and thrive in the future

pattern set: Community garden – Desert fight – Green education – Living with water

Integration and social network

Urban unplan Integration 1



Supporting informality where it proves to be valuable

pattern set: Uncertainty

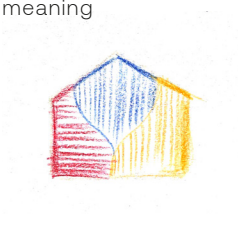
Support public functions Integration 2



Supporting existing public infrastructure to improve their capacity will improve accessibility

pattern set: Good public – Unite people through space – Sense of home

Shelter with meaning Integration 3



Painting facades in informal settlements has proven to improve peoples feeling of belonging and reduce stigmatization

pattern set: Unite people through space – Sense of home – Home upgrade

Khaïma Integration 4

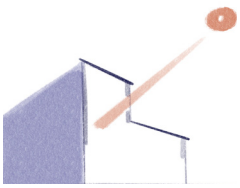


Communal spaces where people can meet and gather improves the social network and sense of belonging

pattern set: Unite people through space – Sense of home

Water distribution

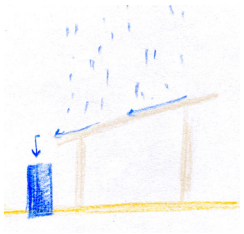
Shaded house Integration 5



Creating a new housing typology sensible to its context and location to provide housing for deispalced while creating shade in open

pattern set:

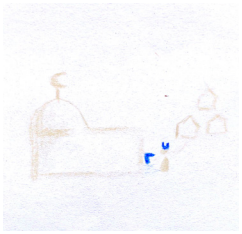
Collecting water Water 1



Collecting rain water can save resources and help families become more self-sufficient

pattern set: Community garden – Desert fight – Green education – Water for all – Home upgrade

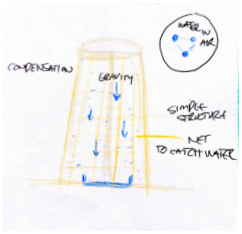
Public water Water 2



Using public buildings connected to the cities water network as distribution centers for the neighborhood

pattern set: Good public – Water for all

Fog collection Water 3

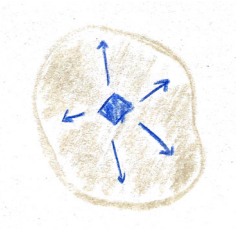


This practice collects water through the humidity in the air, taking advantage of condensation and gravity

pattern set: Water for all – Unite people through space

Economic Opportunity

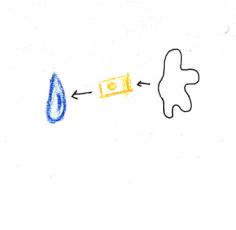
Centralized water Water 4



Having centralized points for water around the city makes it more accessible for vulnerable communities

pattern set: Water for all

Fair water price Water 5



Policies regulating water prices will close the price gab between water from taps and water transported with trucks

pattern set: Water for all

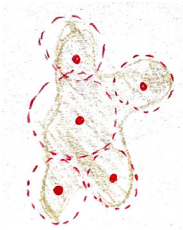
Space for displaced Central 1



When people are displaced for any reason, space has to be fund near by to house them

pattern set: Altered landscape – Living with water

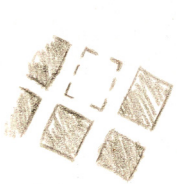
Local economy Central 2



Shifting the economic center from one space to more divided, multiple centers will increase accessibility and fair distribution

pattern set: Healthy neighborhood – Uncertainty

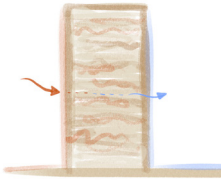
Reuse porosity Central 3



Porosity within a city are spaces of future transformation. The goal is to find new purpose for these spaces, reusing the existing

pattern set: Healthy neighborhood – Fair energy – Uncertainty

Local materials Central 4



Using local material and building techniques such as clay bricks and rammed earth improves room temperature, sense of home and the local economy

pattern set:

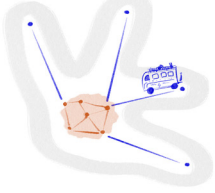
Water economy Center 5



Aquaculture and processes to win salt create new economic opportunities in flood prone areas.

pattern set:

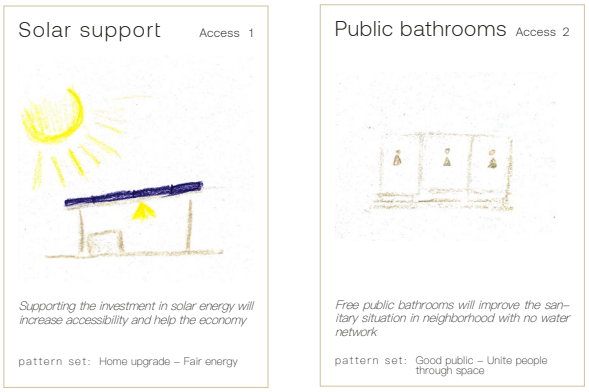
(In)formal public transport Center 6



Supporting and expanding the existing public transport especially into the cities outskirts to be more consistent

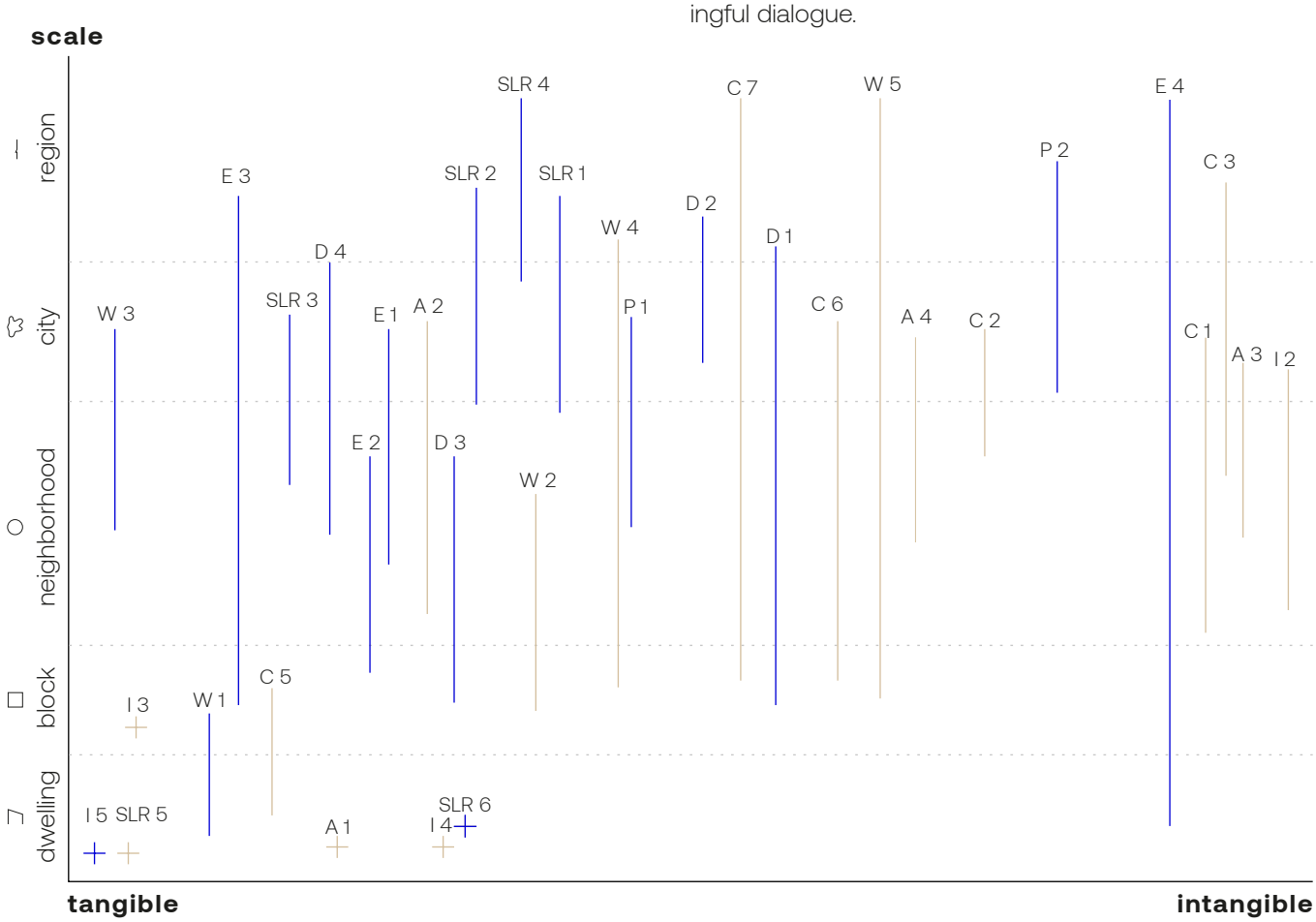
pattern set:

Accessibility to services



IV . 1 . III Assessment

The previously presented patterns are structured in a matrix to comprehend the relation between categories, scale, and tangibility. Tangibility is used as a vital notion to understand a patterns capacity to simplify complexity and create a clear design principle.
This investigation suggests ecological patterns to be more tangible than social patterns. Most patterns, except those related to interventions on an architectural scale, can be applied across several scales. These findings raise questions about the significance of tangibility. How does it affect design if tangibility is primarily achieved through spatialized patterns? Some social patterns focus on broader concepts, ideas such as promoting equity in urban spaces. As a result, these patterns might appear less tangible. This does not imply they are less important; however, the clarity of these patterns requires careful exploration. Translating these social concepts into spatial design elements may prove more challenging. Therefore, the aim was to uncover a balance between clarity and flexibility that maintains the transferability of concepts across different contexts.
Ultimately, these patterns are intended to be used together, forming an interplay that supports socio-ecological resilience and spatial justice. These reflections highlight the importance of community engagement with the patterns to continually adapt and evolve the pattern language for a specific context, fostering meaningful dialogue.

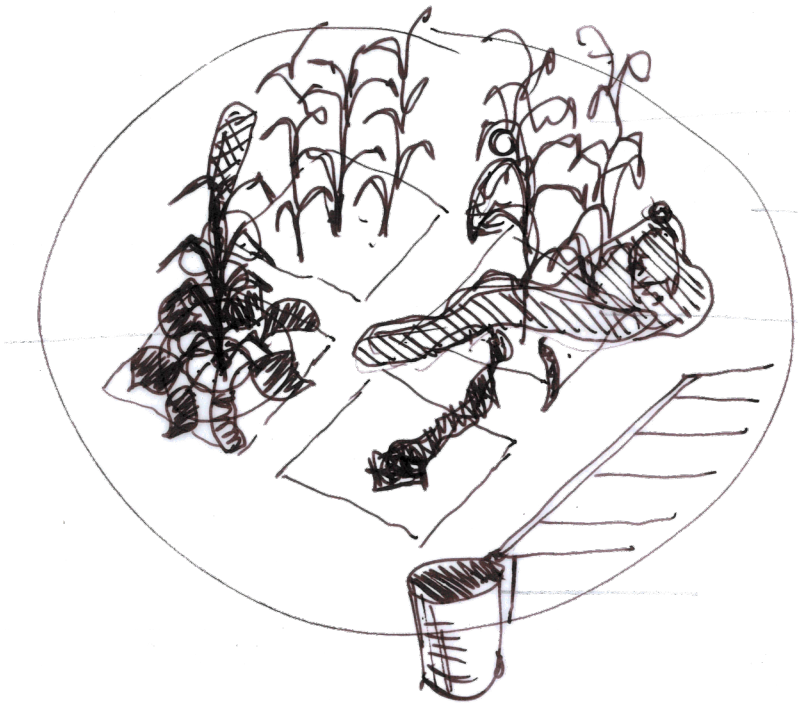


IV . 2 PATTERN SETS

The represented pattern sets have been developed in an iterative process of alteration and testing the patterns on several locations. The following sets show a minor extract of possible pattern combinations. Focusing each set on a specific condition to confront has led to a variety of sets for diverse purposes. For the purpose of creating a clear approach to the development of sets, certain rules were set based on the exploration and assessment of combinations. First, sets must contain at least one pattern of each category, ecological and social, to create the desired synthesis of socio-ecological resilience and spatial justice. Second, sets must contain at least three cards. This limitation is intended to create meaningful sets with explicit purpose, instead of creating all possibilities. Setting these limitations deepens the understanding of each individual set, its spatial implications and guidelines concerning the placement. Each set is evaluated based on the vulnerability assessment criteria to identify the potential improvement pattern sets can have on a place.

Community garden

□○ block to neighborhood scale ↑ bottom up



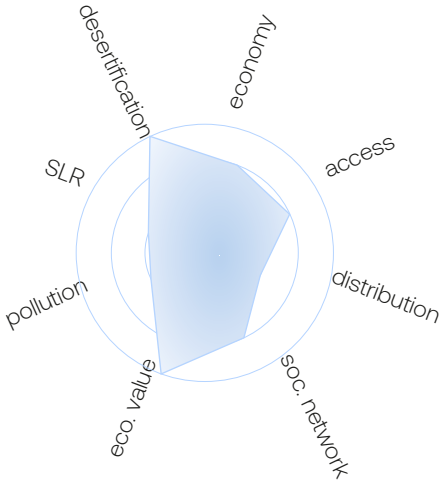
E 4 Native species

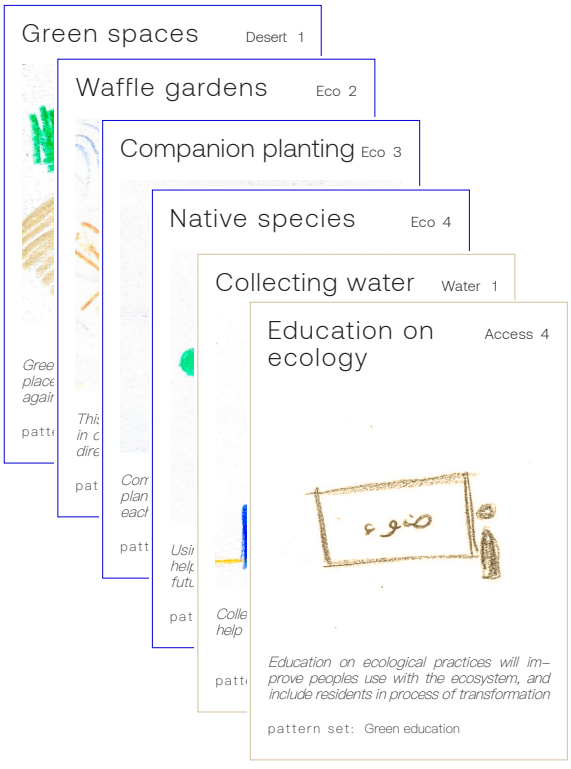
D 1 Green space

E 2 Waffle garden

A 4 Education on ecology

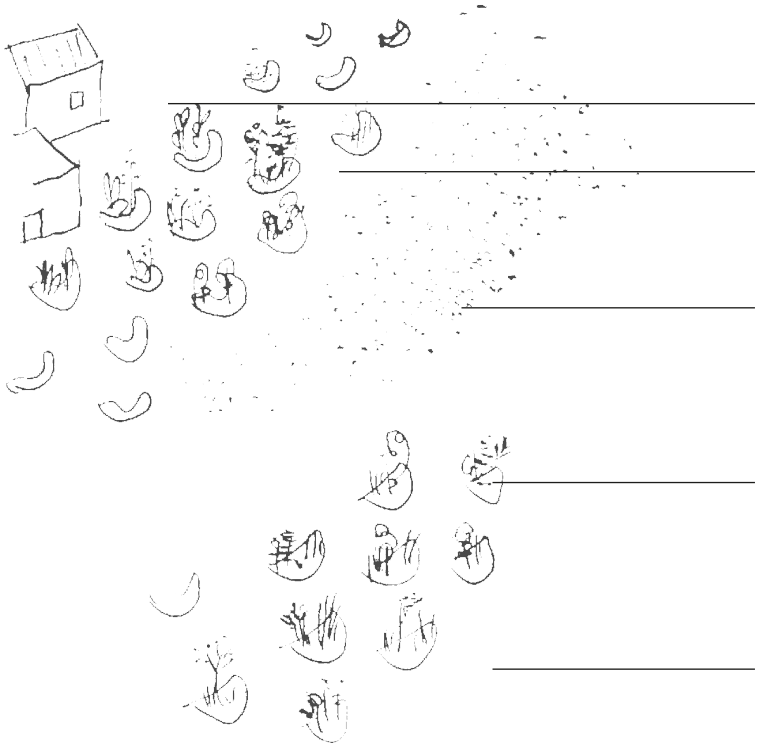
The community garden combines indigenous knowledge about planting in desert landscapes with a focus on native species that form a symbiosis with the ecosystem. A focus lays on the practicality and the users experience. In the Zuni culture, waffle gardens were community gardens led by women, ensuring harvest in areas with [limited] water and degraded soil. The sunken plots of the waffle gardens are dug into the ground, offering proximity to groundwater and keeping temperatures low. In addition, a layer of manure and gravel trap moisture in the soil and reduce water runoff (Watson & Davis, 2020). Using plant species that residents are familiar with, such as acacia nilotica, menthe longifolia, moringa stenopetala will utilize people's existing knowledge. These gardens are best placed in secluded, courtyard like spots within the neighborhood. They can also be developed bottom-up, provided that the technical know-how is shared.



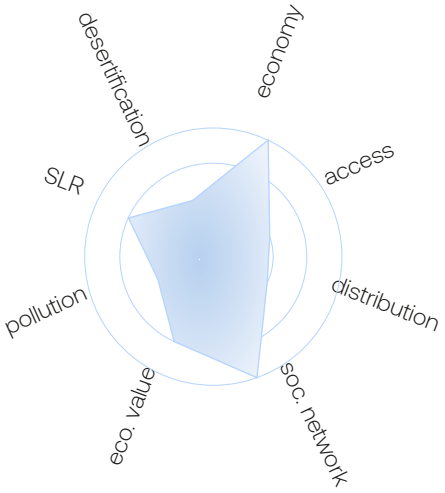


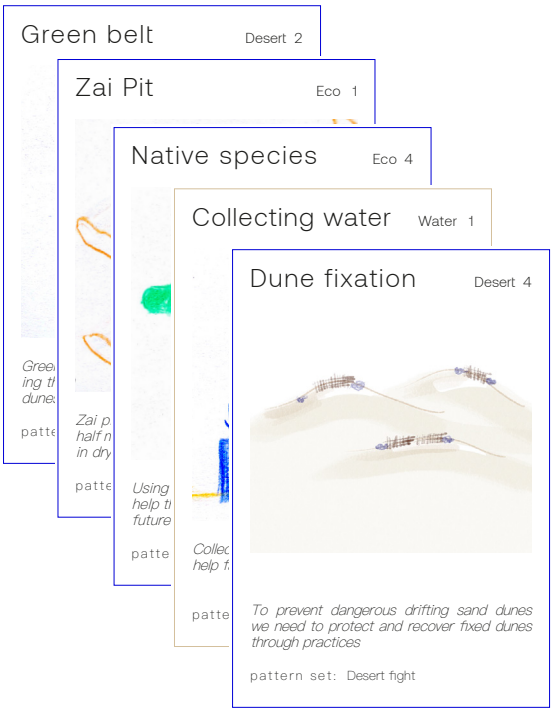
Desert fight

○ neighborhood to city scale → both



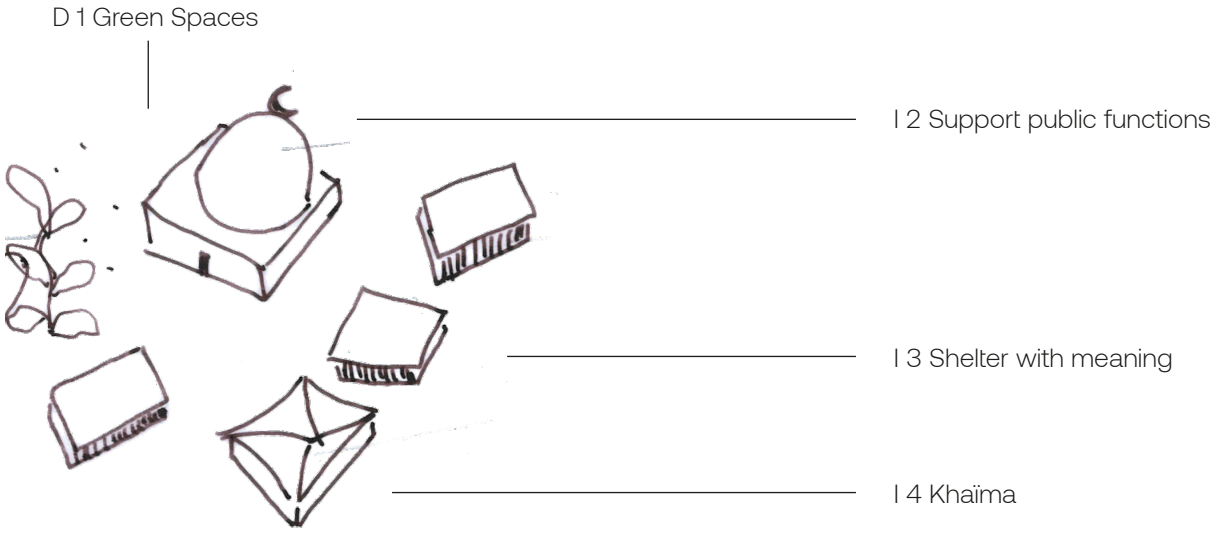
Desert fight is a strategic set of patterns formed to adapt the landscape to current and future challenges. Interacting with both the neighborhood scale and the city scale, it requires a somewhat higher level of organization and governance. This set utilizes the Zai Pit, a half-moon shape dug into the ground to capture rainwater and reduce run-off. This practice is already in use at the Green Wall Project, which operates on the scale of the entire continent to fight against desertification. Combining this practice with the planting of native plants and structures that can collect rainwater, this could provide relief for the city against the encroaching desert, as well as provide more employment opportunities for people in the outskirts of the city (FAO & MEDD, 2014: pp 111-115).



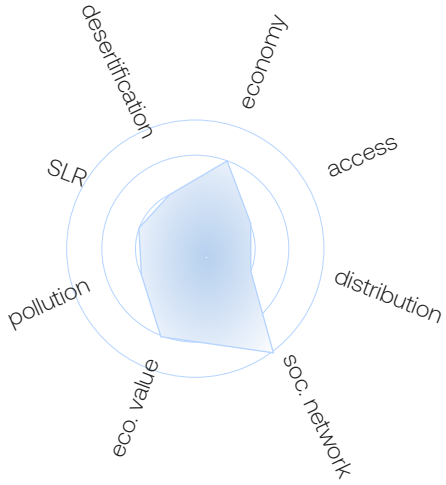


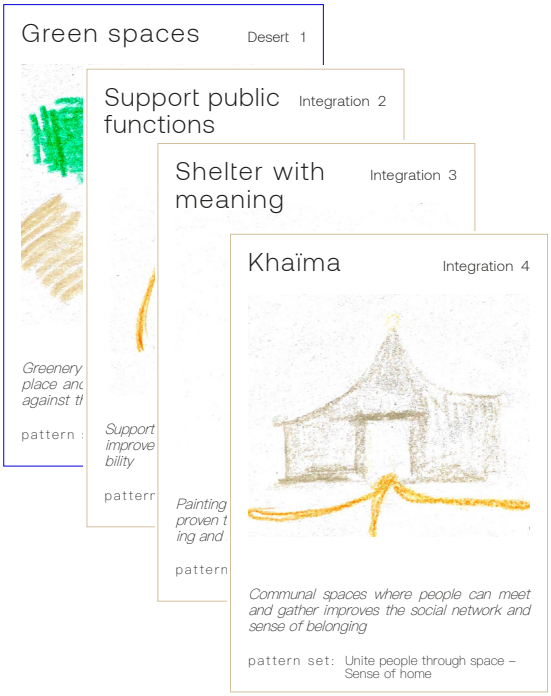
Sense of home

□○ block to neighborhood scale ↑ bottom up



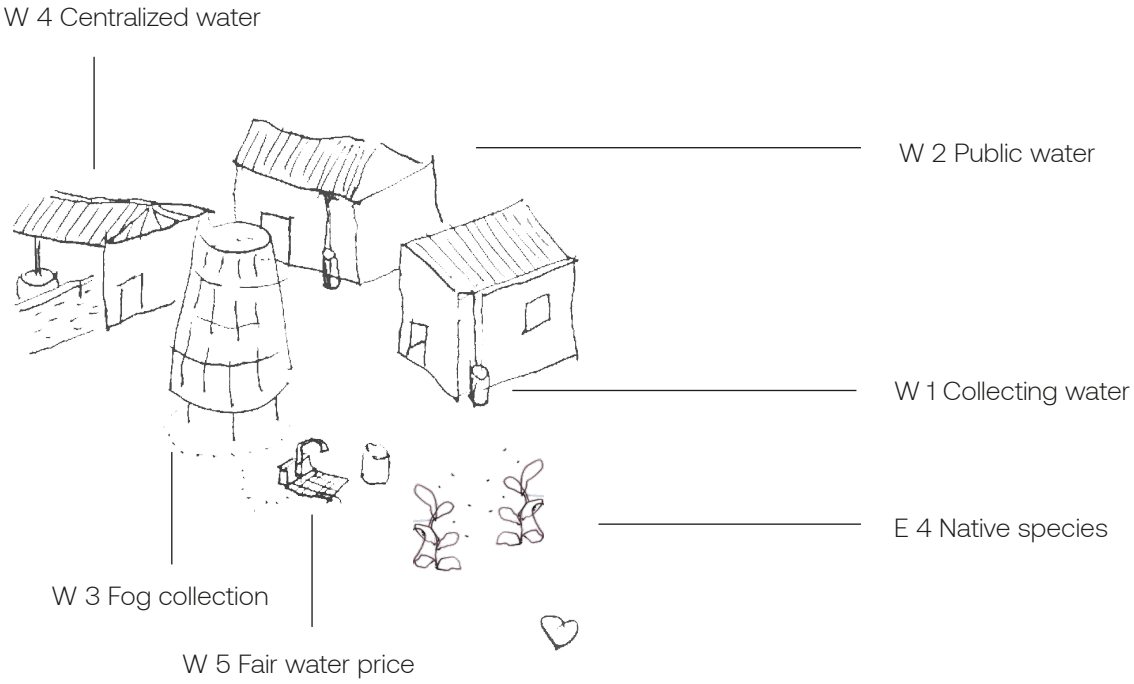
A sense of home is a vital part in creating and maintaining a social network, especially in times of strife. This pattern set is geared towards the urban block and neighborhood scales, focusing on people's perception and use of public space. Many examples have shown that small and inexpensive interventions, like coloring the facades of buildings can provide a sense of identity to a neighborhood, as well as dismantle stigmatization and thus make residents feel more connected. It is also an act of repair towards the existing buildings, that if it is done with the assistance of a public institution may create better relations between residents and local government.
By supporting local public functions, such as schools or mosques, and with the integration of more communal spaces throughout the neighborhood in the form of the traditional Khaïmas, the local community can be strengthened.



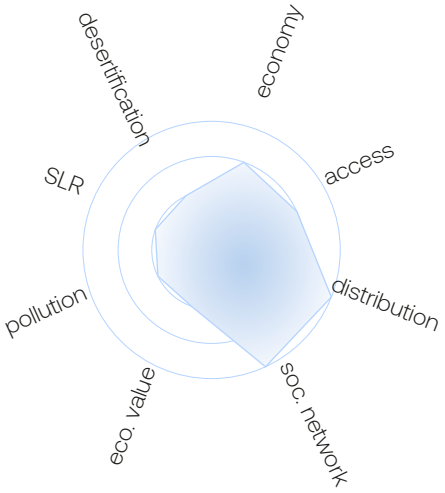


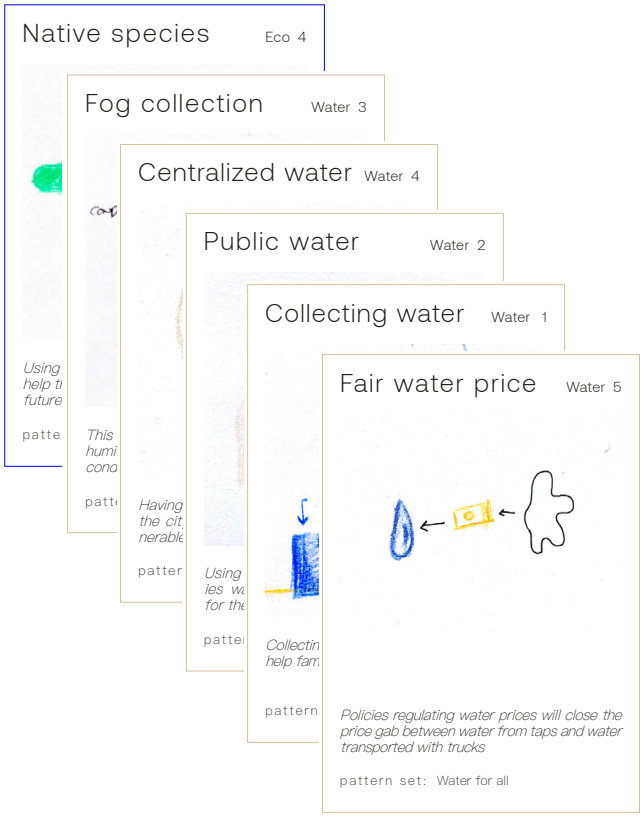
Water for all

○ neighborhood to city scale → both



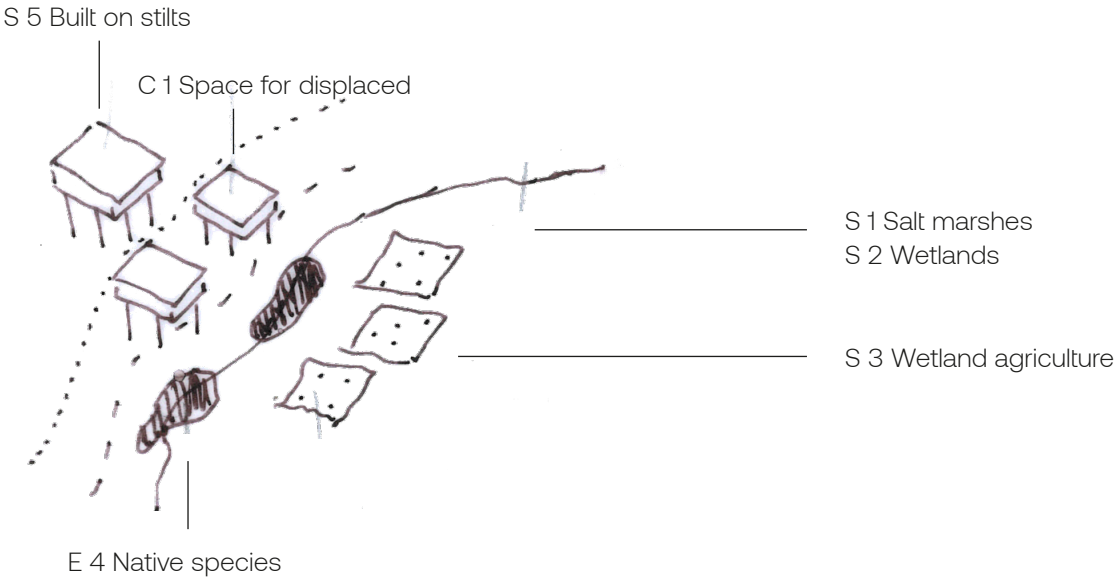
Water is the most precious resource for Nouakchott's residents, as it is both expensive and scarce – thus it is a necessity that it becomes a public good rather than a luxury. This pattern set establishes several principles for water use, in order to develop better availability and fair distribution. Most importantly, water prices need to be regulated in the form of policies from the government. Currently, water is far too expensive for people that are not connected to the central water network; however, such infrastructure can be costly and its construction very slow. In order to provide faster availability to water for all members of a neighborhood, this pattern set suggests the distribution through public functions. Making use of biophilic design principles, a fog collector in the form of a tower uses condensation and gravity, making water out of air. Each tower is easy to construct and lightweight, while it can also act as a local landmark.



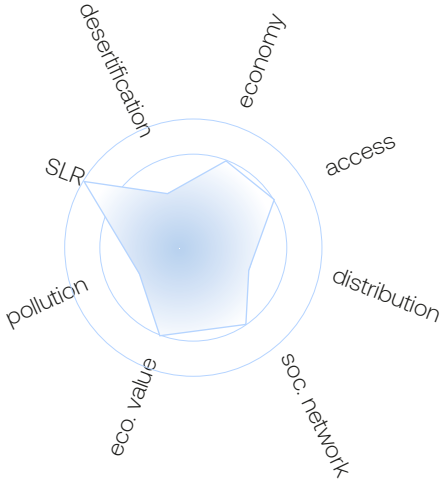


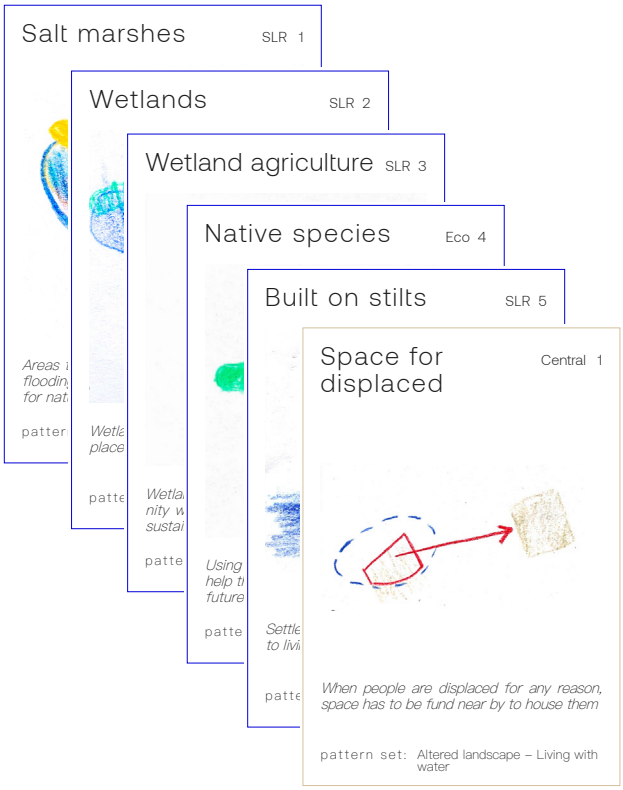
Living with water

block to city scale → both



Much of the current territory is being confronted with issues of flooding and ground-water seepage, resulting in many people being displaced from the flooded areas. This pattern set arises from the urgency of dealing with this issue, but instead of trying to fight against it, it proposes to live along with the water. New housing types that utilize construction on stilts can be embraced to provide space for the displaced, but could also be expanded in the future, making new water-based neighborhoods. Caring for this emergent landscape through careful maintenance, planting of native plants that aid in water filtration, are important aspects to ensure a healthy environment for residents, as well as employment opportunities.



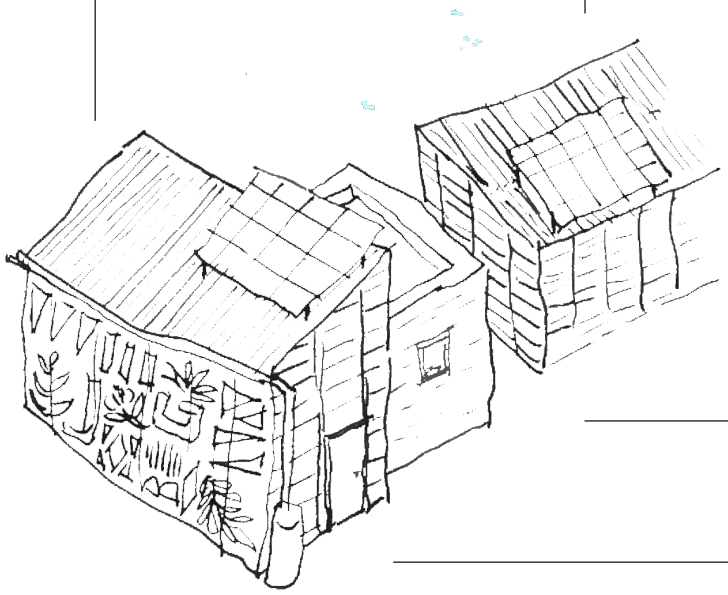


Home upgrade

dwelling scale → both

I 3 Shelter with meaning

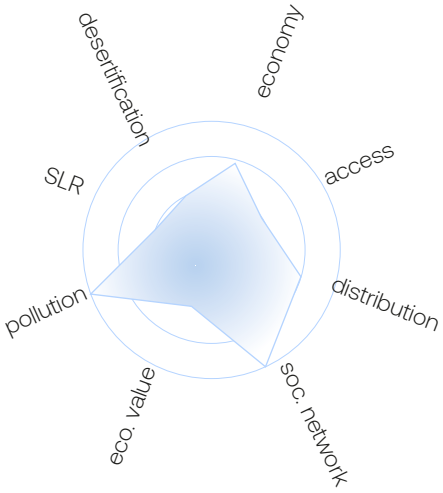
A 1 Solar support

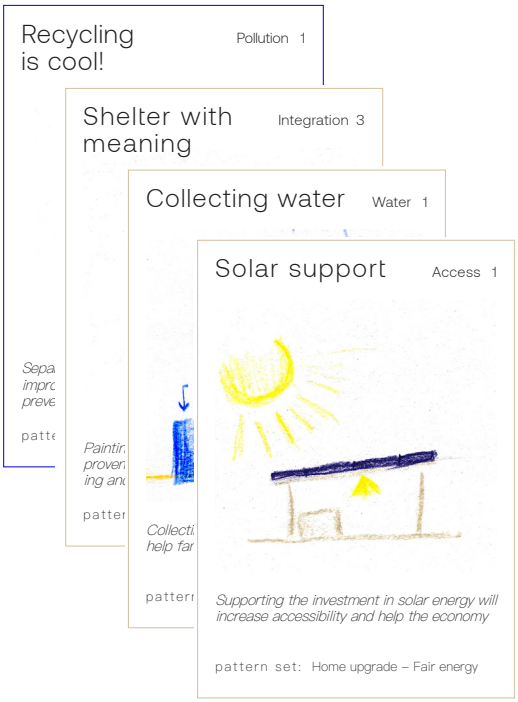


P 1 Recycling is cool!

W 1 Collecting water

This pattern set is aimed towards the adaptation of the individual home towards energy and water sufficiency, as the majority of buildings at the outskirts of the city lack basic infrastructure. This can easily be done by solar panels at the rooftops of existing houses, as well as by constructing systems of rainwater collection – making use of recycled local materials. Neighbor and local community relations should be considered here, resulting in small-scale communities that share resources. Upgrading the facades of houses with simple paint can inspire a sense of belonging and community

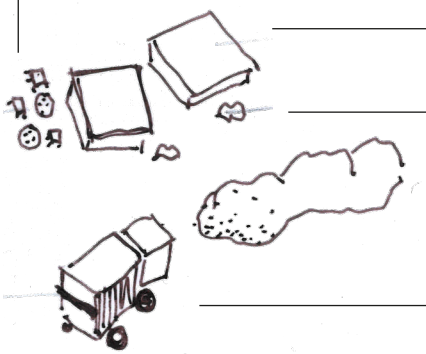




Healthy neighborhood

□ block to city scale → both

C 2 Local economy

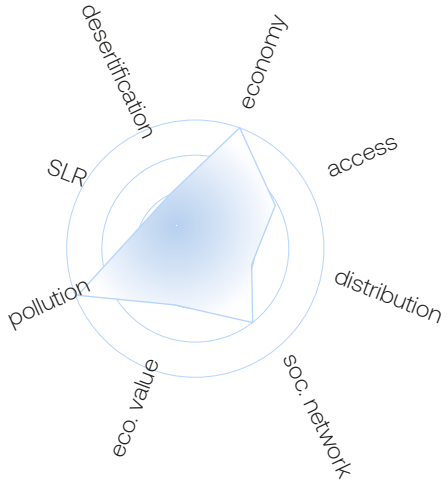


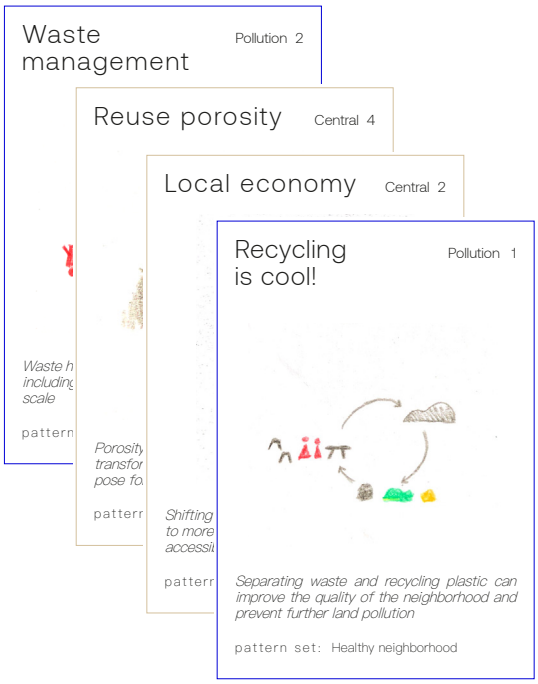
C 4 Reuse pororsity

P 1 Recycling is cool!

P 2 Waste management

The current waste management system is lacking, with existing landfills being overcrowded creating serious health issues for the residents. This pattern set addresses this widespread issue of pollution by creating employment opportunities through it. By addressing the issue of waste management in the neighborhood scale throughout the city, the volume of trash that reaches the landfills would be reduced – making it easier to short and recycle. This can be achieved by educating people on recycling practices and providing the necessary infrastructure. Moreover, job opportunities could emerge through the recycled materials, either in the form of new construction materials or crafts.

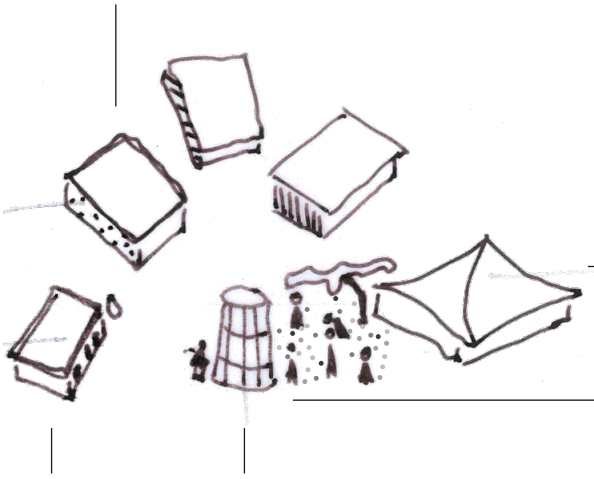




Unite people through space

□○ block to neighborhood scale ↑ bottom up

I 3 Shelter with meaning

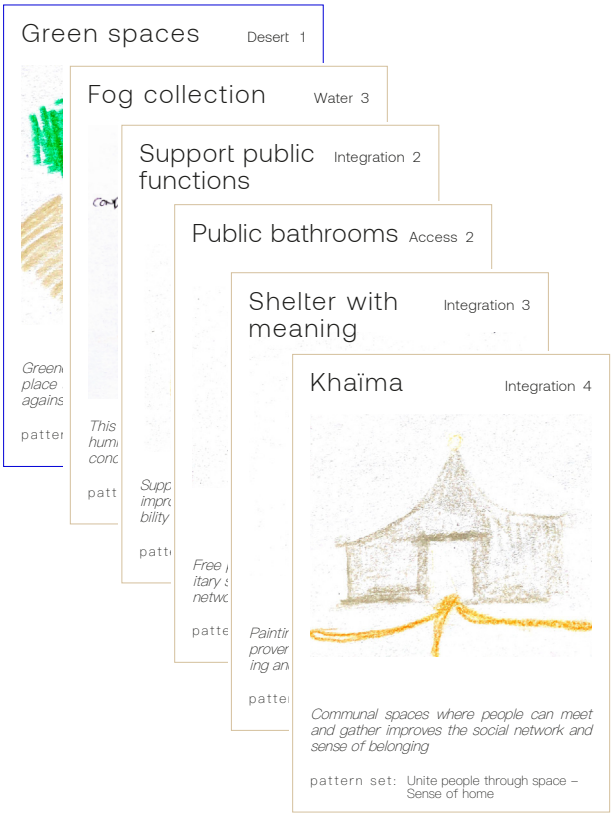


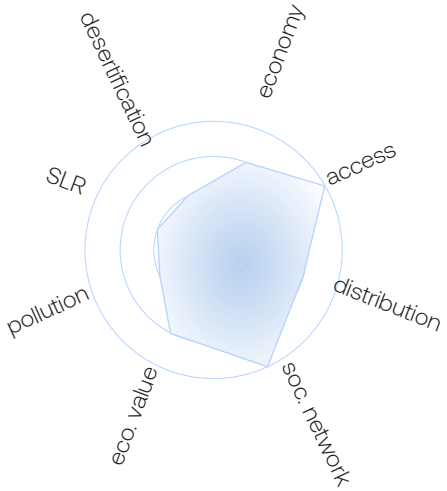
I 2 Support public functions
I 4 Khaïma

D 1 Green spaces

A 2 Public bathroom W 3 Fog collection

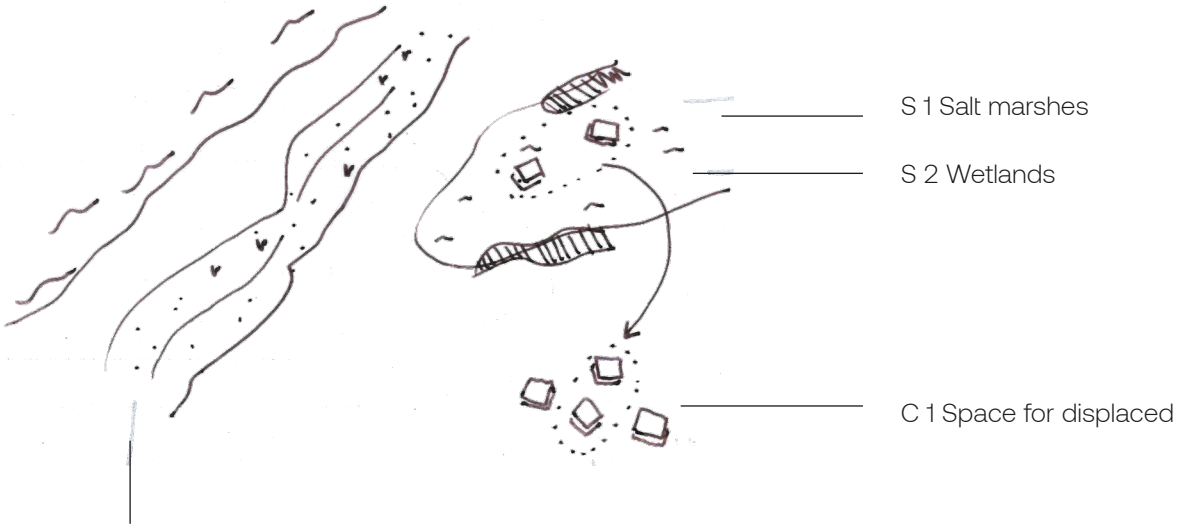
This pattern sets advocates for creating community spaces throughout the neighborhoods of Nouakchott, in order to aid in both urban and social cohesion. This can be achieved through the intensification of public services, like local water collection and distribution through the fog towers, access to public toilets, access to shade and public gathering through the Khaïmas, and access to public green. These nodes of unity should be placed at suitable locations, like courtyards, public squares or other existing open spaces throughout the city, ensuring accessibility for all residents.



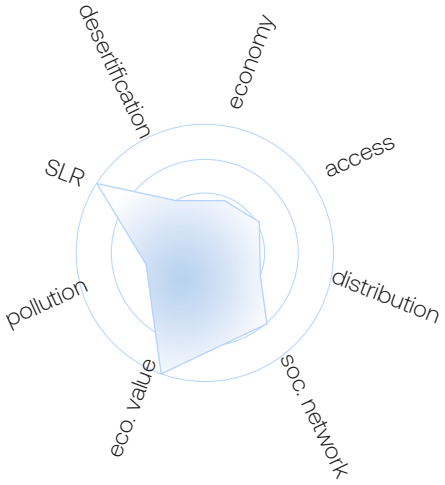


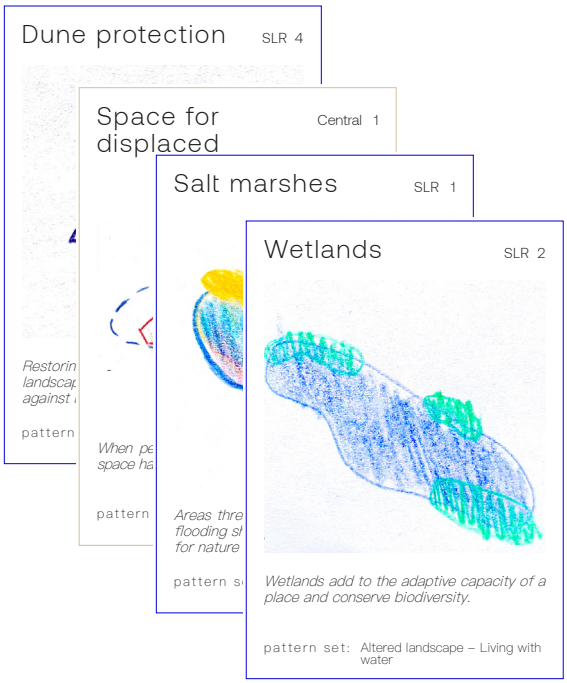
Altered landscape

neighborhood to city scale ↓ top down



The alteration of Nouakchott's landscape is inevitable. Addressing the single physical barrier between the city and the Atlantic Ocean, this pattern set focuses on the protection of the narrow dune strip. This requires consideration of both human and non-human agents – both the residents of the affected areas of corrosion but also the animal and plant ecosystems. Apart from restoration work of the dunes through groundworks and policies, the government needs to anticipate the formation of new salt marshes and wetlands, and take early action. This includes providing suitable space for the people that need to relocate, as well as thinking of new ways of living with water.

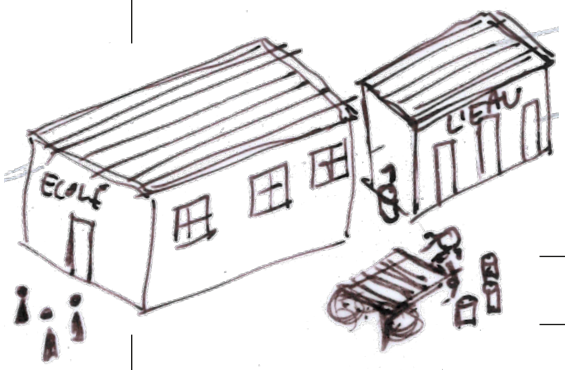




Good public

□○ block to neighborhood scale ↓ top down

A 3 Education program



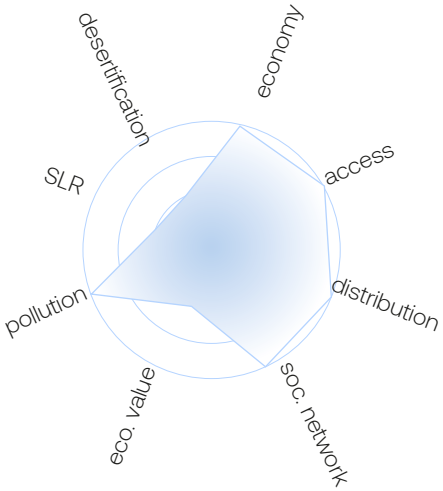
A 2 Public bathroom

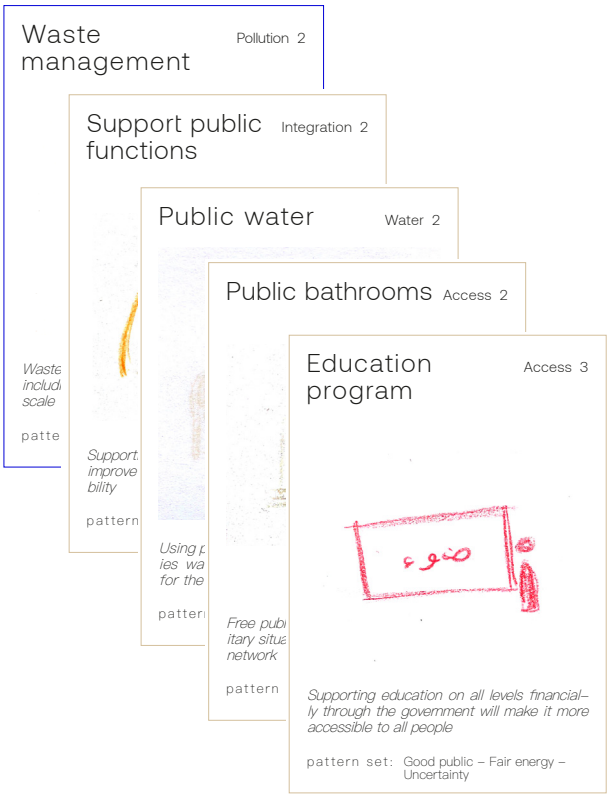
W 2 Public water

P 2 Waste management

I 2 Support public functions

Access to public services is limited, especially at the outskirts of the city. This pattern set operates at the scale of the building and its immediate surroundings and emphasizes the importance of providing such access for all residents. This is not done through costly new construction, but by supporting existing public functions like schools and mosques to provide water and bathrooms to neighbors. Emphasizing education at the core of these public program nodes, with the combination of providing access to drinking water and public bathrooms, strengthens the existing community ties that naturally develop around places of public services, instead of seeking to create new ones elsewhere.





Green education

○ neighborhood to city scale → both

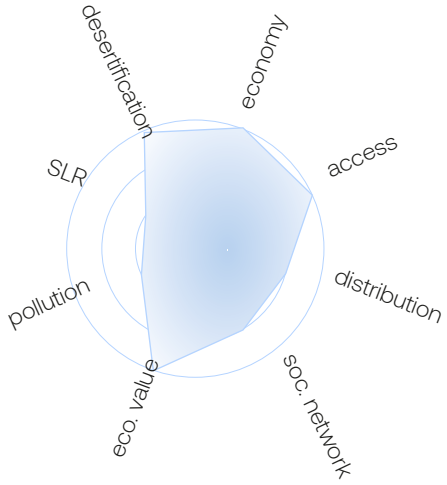


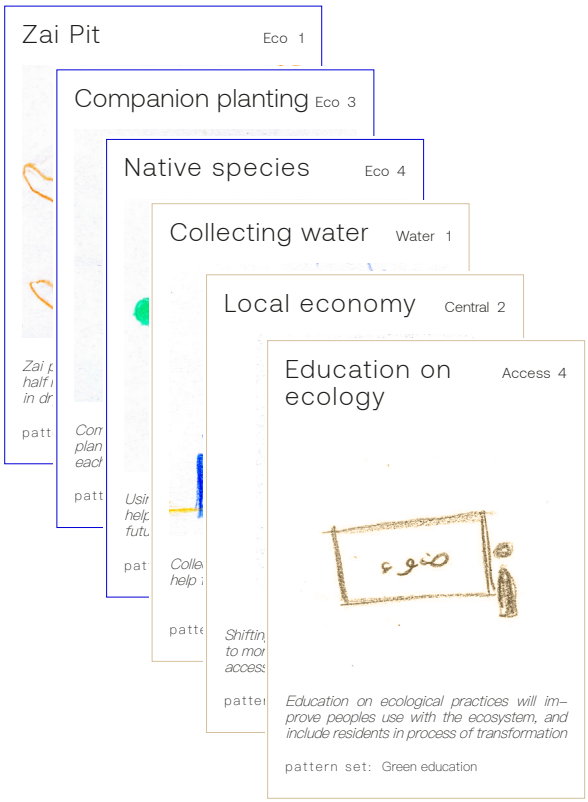
A 4 Education on ecology

C 2 Local economy

E 1 Zai pit
E 4 Native species
E 3 Companion planting

Protection against desertification requires large-scale cooperation at a transnational level; however, such efforts need to be grounded to local actions and education. Hubs of knowledge sharing should be present in close proximity to the Zai Pit landscapes, where people can get educated on the indigenous practices of caring for the land. They can also facilitate research and experimentation in a larger network of knowledge sharing throughout the Sub-Saharan region. This approach can also lead to creating a new economy around the green structures.



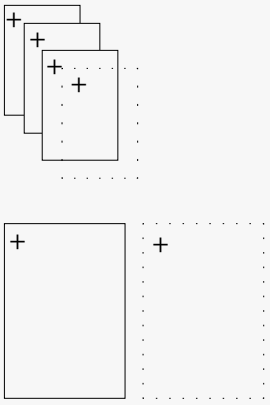


IV . 3 IMPLEMENTATION

IV . 3 . I Co-creation Process

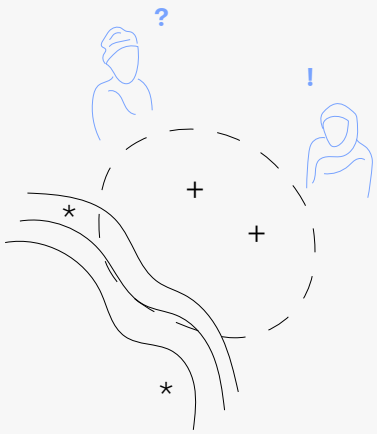
This process on the transferability of the pattern language and its use as a tool to communicate ideas in a co-creation process. The aim is to develop context-sensitive spatial strategies through community workshops that foster bottom-up engagement. The stakeholders in this process include the local government and municipality, experts on spatial justice and climate resilience and of course the community.

This framework explores the transferability of the pattern language and its capacity to act as a communication-tool within a co-creation process. The goal is to develop context-sensitive spatial strategies through community workshops that encourage bottom-up engagement. Key stakeholders include the local government and municipality, experts in spatial justice and climate resilience, and, most importantly, the community itself.

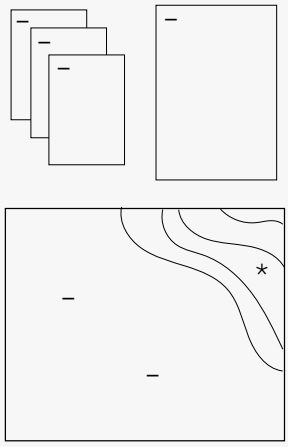


1. Orientation

1. Context analysis



2. References



3. Alter pattern language

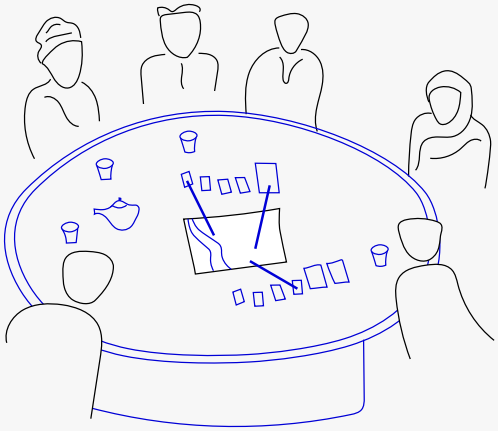
Objective: Identify key challenges and opportunities
Outcome: Adapted patterns and pattern sets

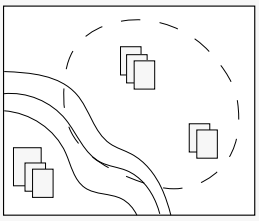
Phase 1: Orientation

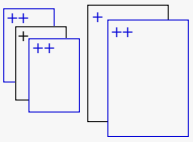
1. Context analysis
The municipality and experts collaborate to assess environmental exposure, social sensitivity and existing adaptive capacity through a mix of resident's surveys and data driven analysis.

2. References
Looking at the context specific potential, experts refer to similarities in design examples to identify relevant patterns.

3. Alter pattern language.
Alter patterns and pattern sets to fit the local context. This step includes the development of new patterns and pattern sets.







Phase 2: Visioning

4. Co-creation Workshop I
Present developed pattern language to the community. This co-creation workshop allows the community to give feedback and spatial insights on proposed ideas. Here the pattern language acts as a tool to communicate ideas.

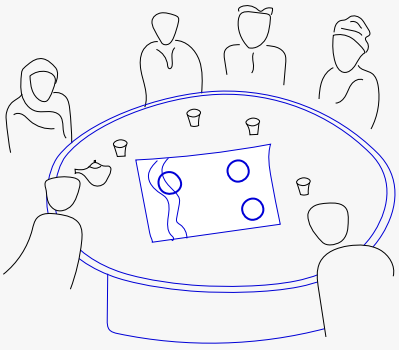
5. Draft Strategy
Based on the co-creation process, patterns are adjusted, and a draft spatial design strategy is developed, incorporating the communities' priorities and local knowledge.

Objective: Begin co-creation process with community
Outcome: Refined pattern language and draft spatial strategy

Phase 3: Taking action

6. Co-creation Workshop II
This second co-creation workshop presents the design strategy and creates a space for feedback, discussions and alterations that enrich the strategy.

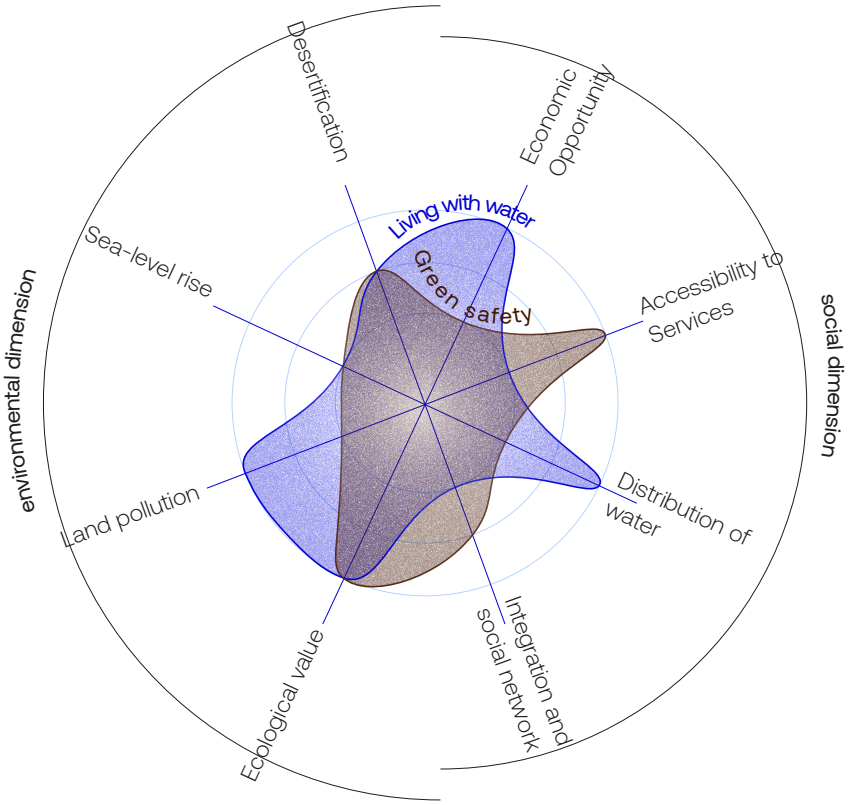
7. The revised strategy is presented to the community. This step prepares residents for the implementation, fostering the community engagement and continual conversation. The first step in the implementation phase includes learning indigenous practices from the community, as well as educational workshops on new practices to foster bottom-up initiatives.



Objective: Co-design final community strategy
Outcome: Final design strategy, ready for implementation

IV . 3 . II Choosing the Locations

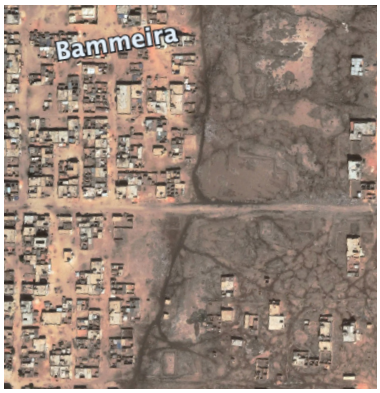
Based on the previous analysis and vulnerability assessment, these two locations were chosen for their distinct urban morphologies, positions within the city, and climate exposures. Location One (Type 4) is an organically developed area on the eastern outskirts, heavily exposed to desertification and socially sensitive due to limited water access. Its remote placement contributes to low economic power, and the community faces significant challenges with pollution. Location Two (Type 3), by contrast, follows a strict grid pattern. Situated at an elevation of -1 meter, it is primarily exposed to groundwater flooding. Closer to the economic center and benefiting from formal planning, it has better access to water resources. However, the area shows potential for improvement in social integration and social networks.

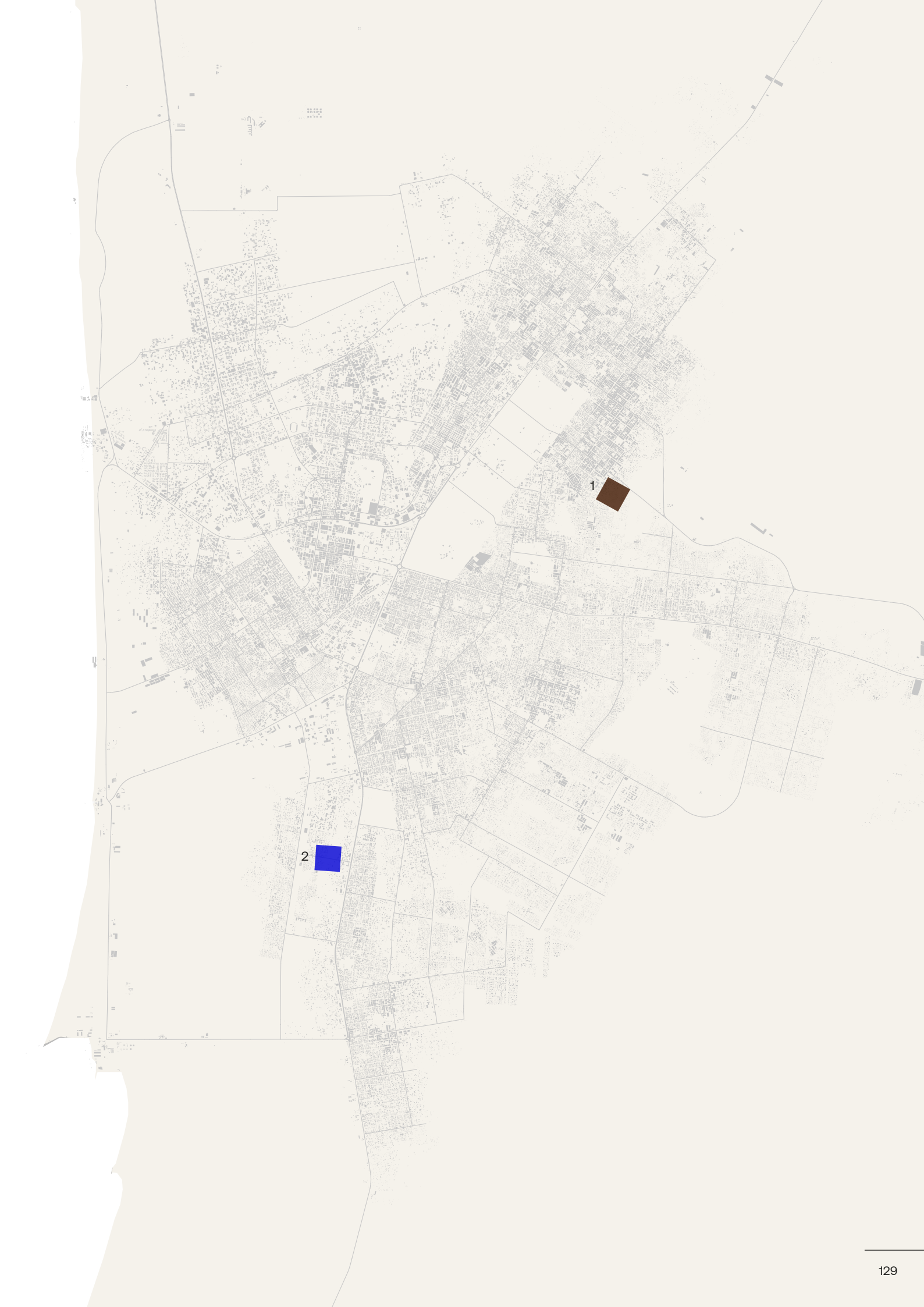


Location 1: Green safety



Location 2:Living with water




1
2

This map addresses the importance of responding to anticipated changes in the infrastructure of the city. As seen in the analysis, Nouakchott has seen waves of dynamic transformation in many informal settlements. To contain these changes to a minimum, designers have to foresee potential tensions. Therefore, the organic neighborhood is connected to major lines of infrastructure in its surrounding, minimizing displacement for the future.



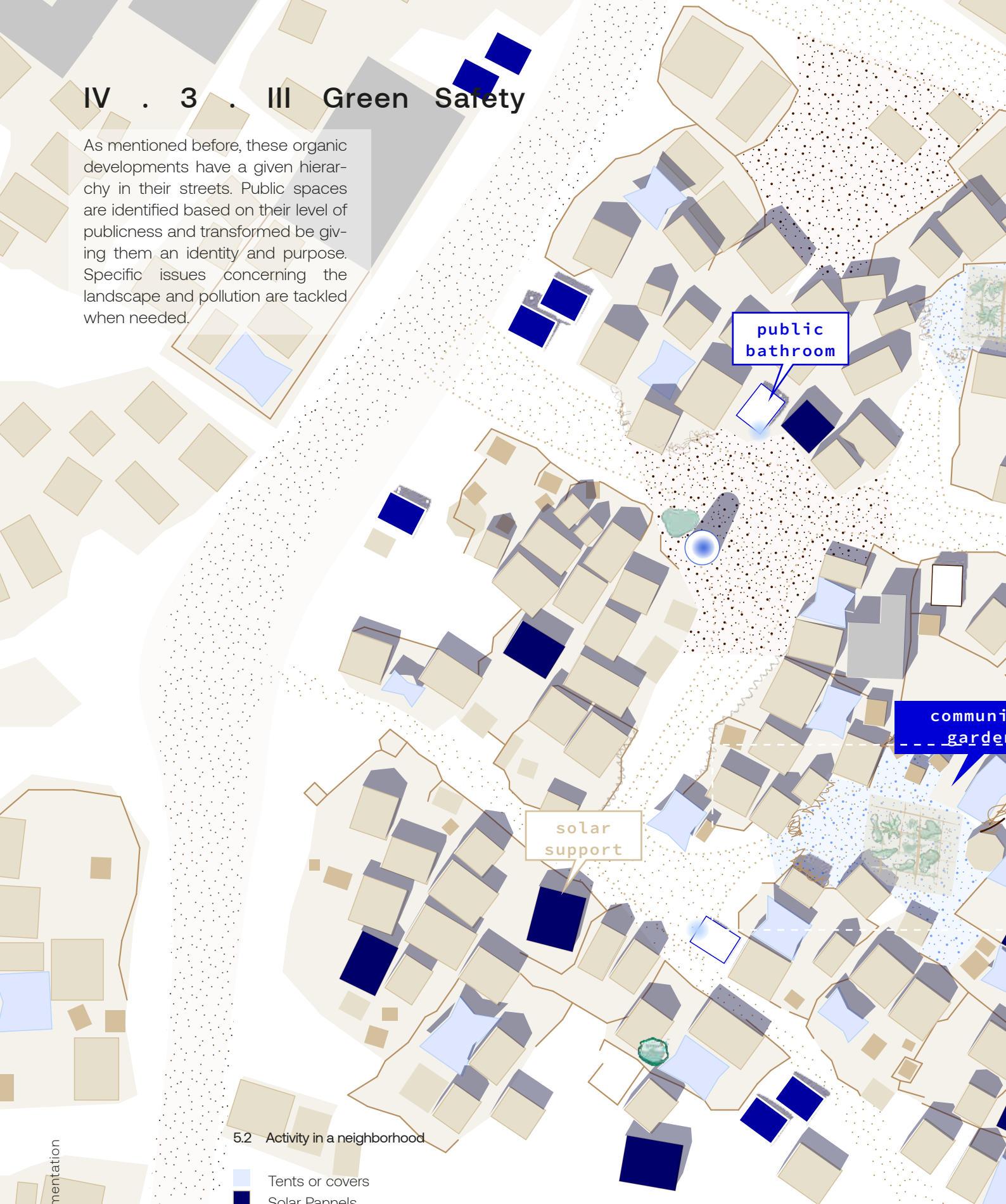
5.1 Activity in a neighborhood

- Asphalt road
- Road connected to formal grid
- Internal community roads


informal public transport
connect to formality

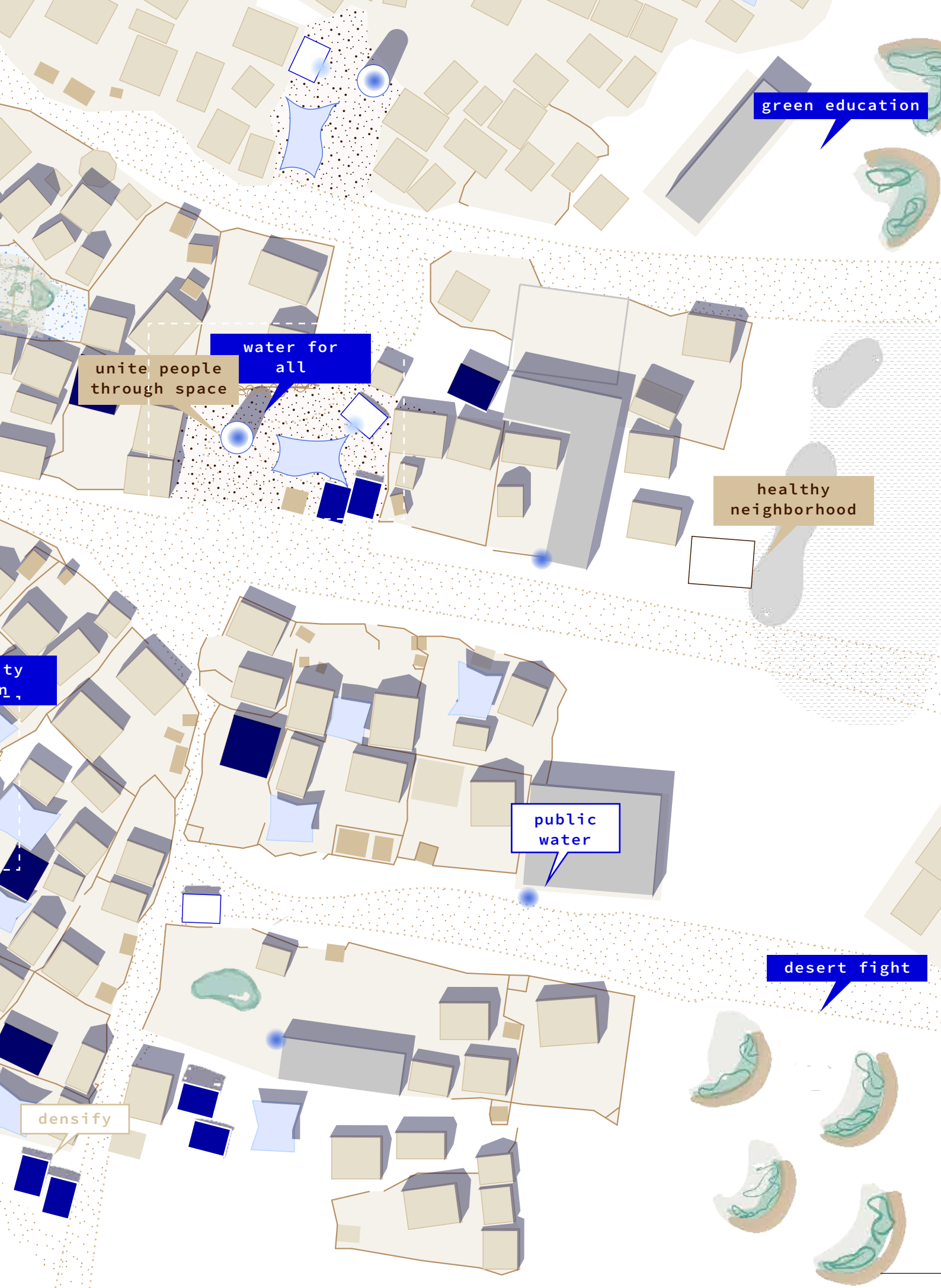
IV . 3 . III Green Safety

As mentioned before, these organic developments have a given hierarchy in their streets. Public spaces are identified based on their level of publicness and transformed be giving them an identity and purpose. Specific issues concerning the landscape and pollution are tackled when needed.

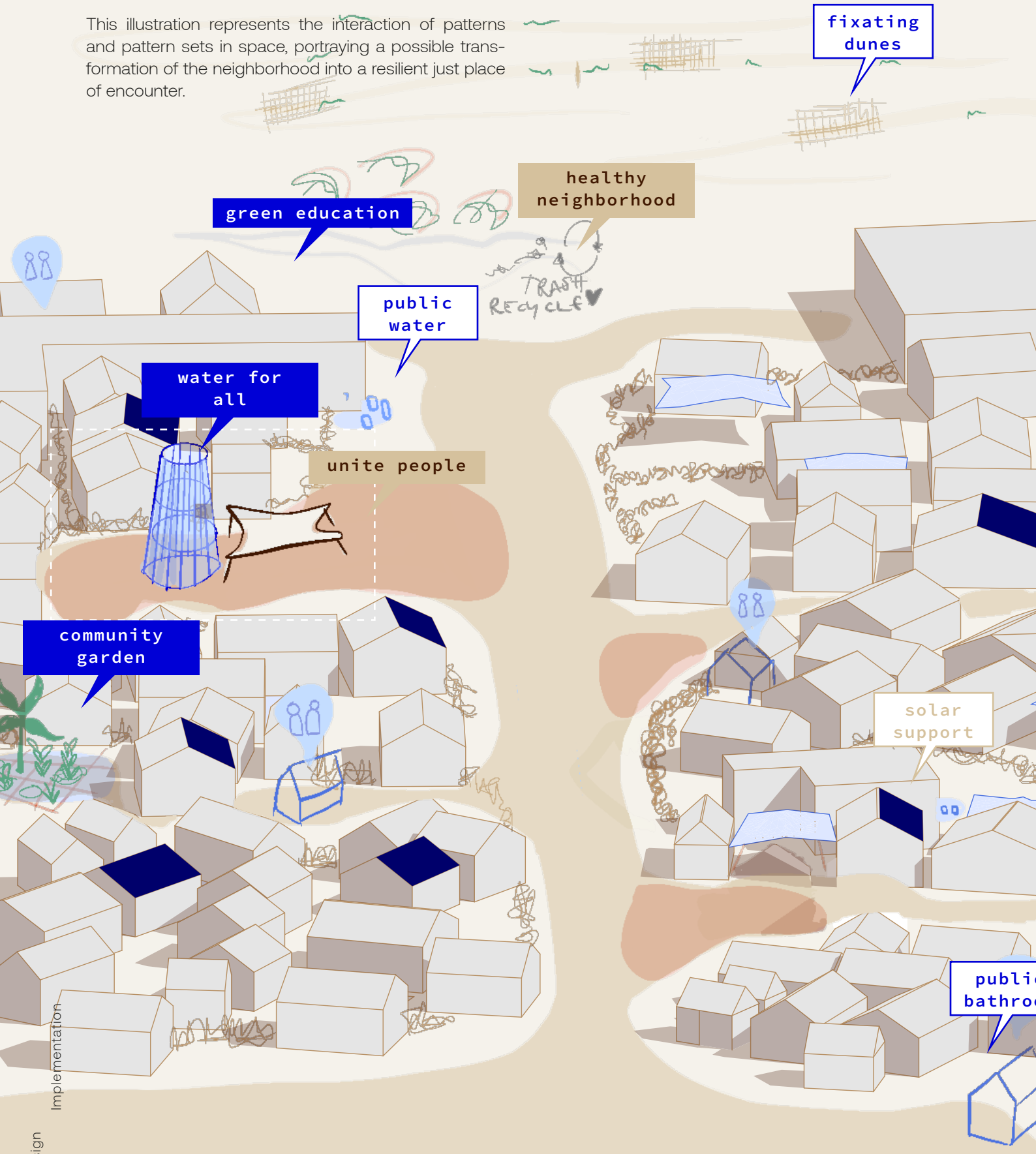


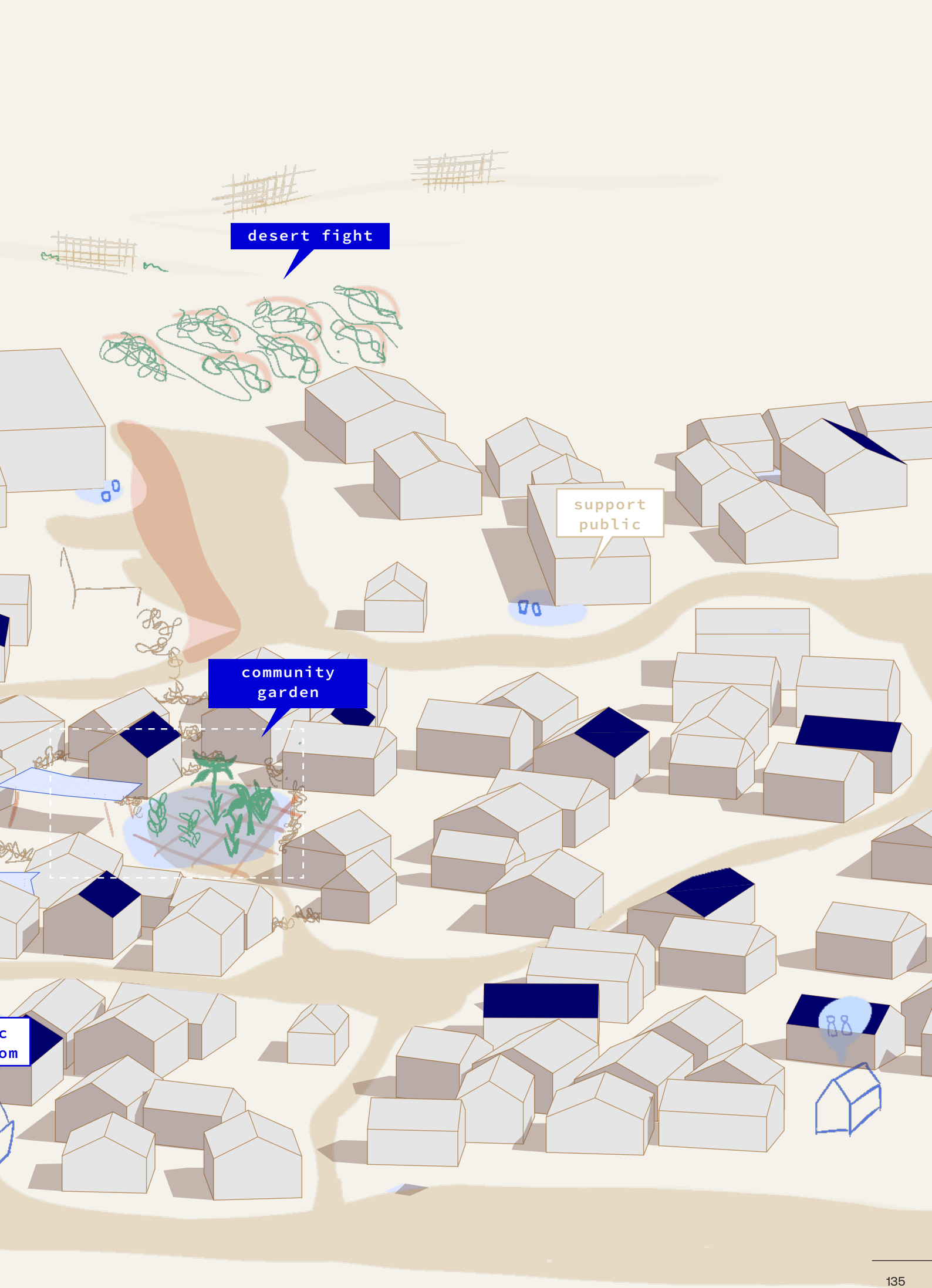
5.2 Activity in a neighborhood

- Tents or covers
- Solar Pannels
- Densification
- Road connected to grid
- Private roads within community
- Courtyard
- Public Space


green education
water for all
unite people through space
healthy neighborhood
ty
n
public water
desert fight
densify

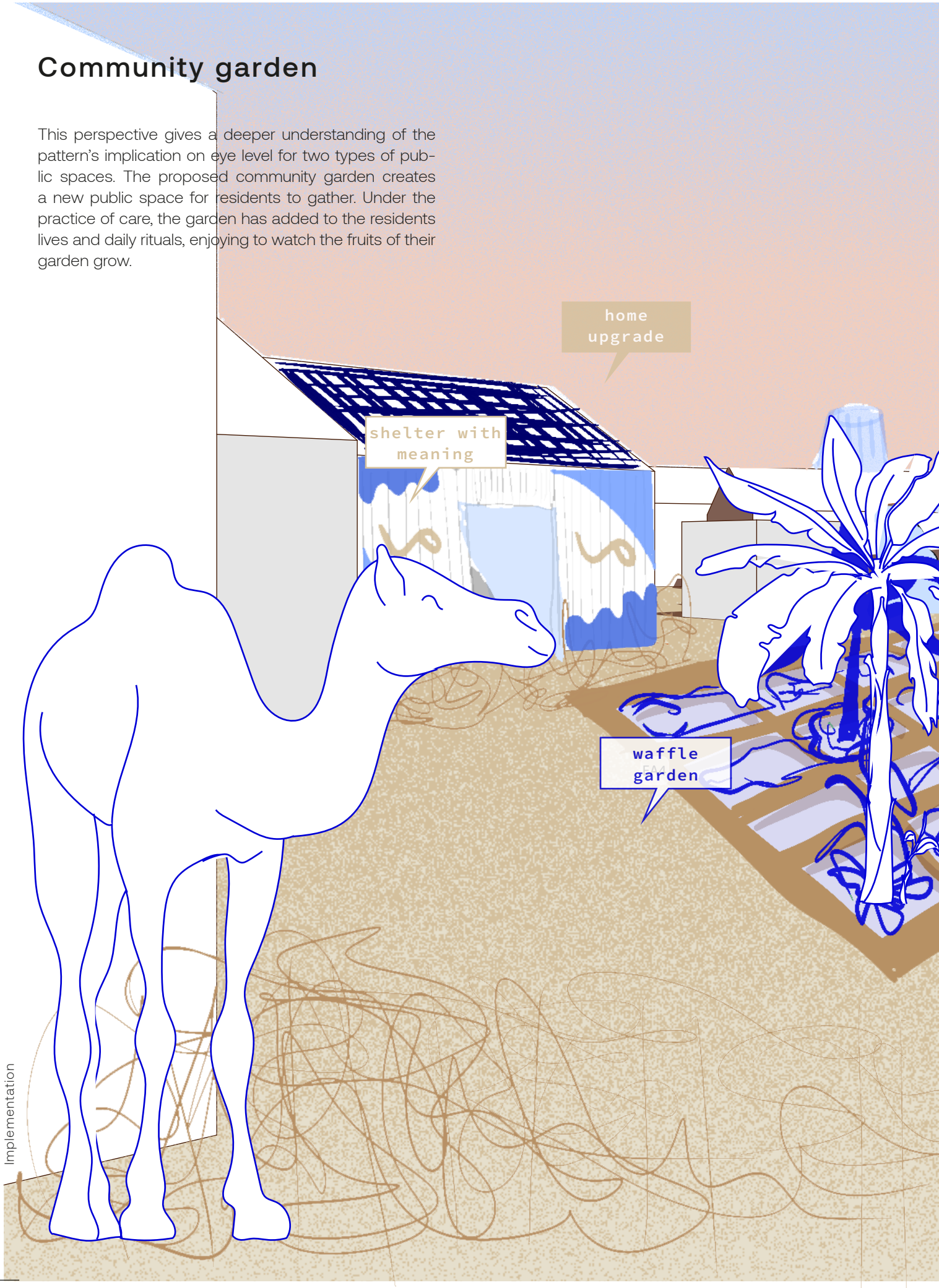
This illustration represents the interaction of patterns and pattern sets in space, portraying a possible transformation of the neighborhood into a resilient just place of encounter.

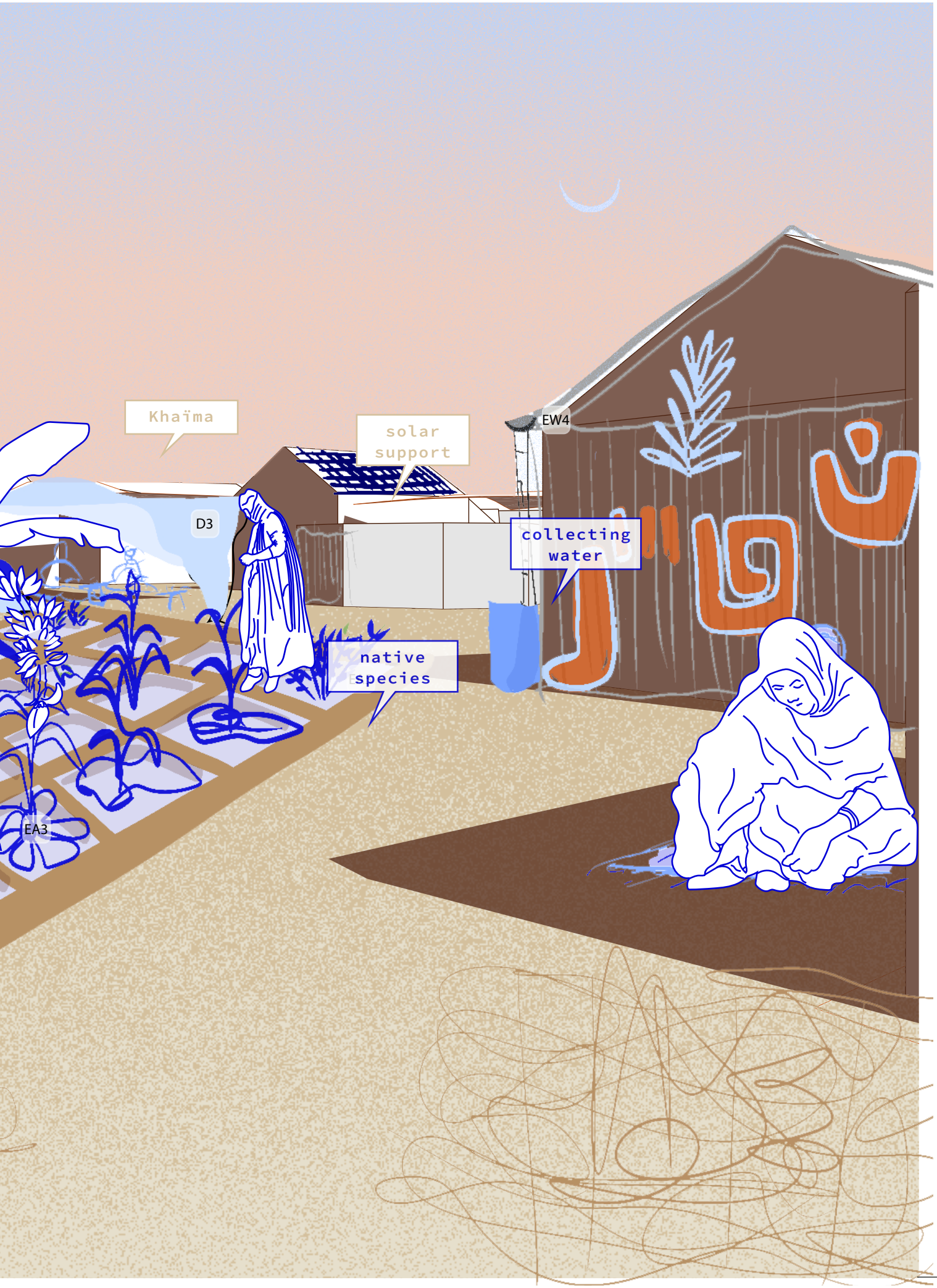



desert fight
support public
community garden

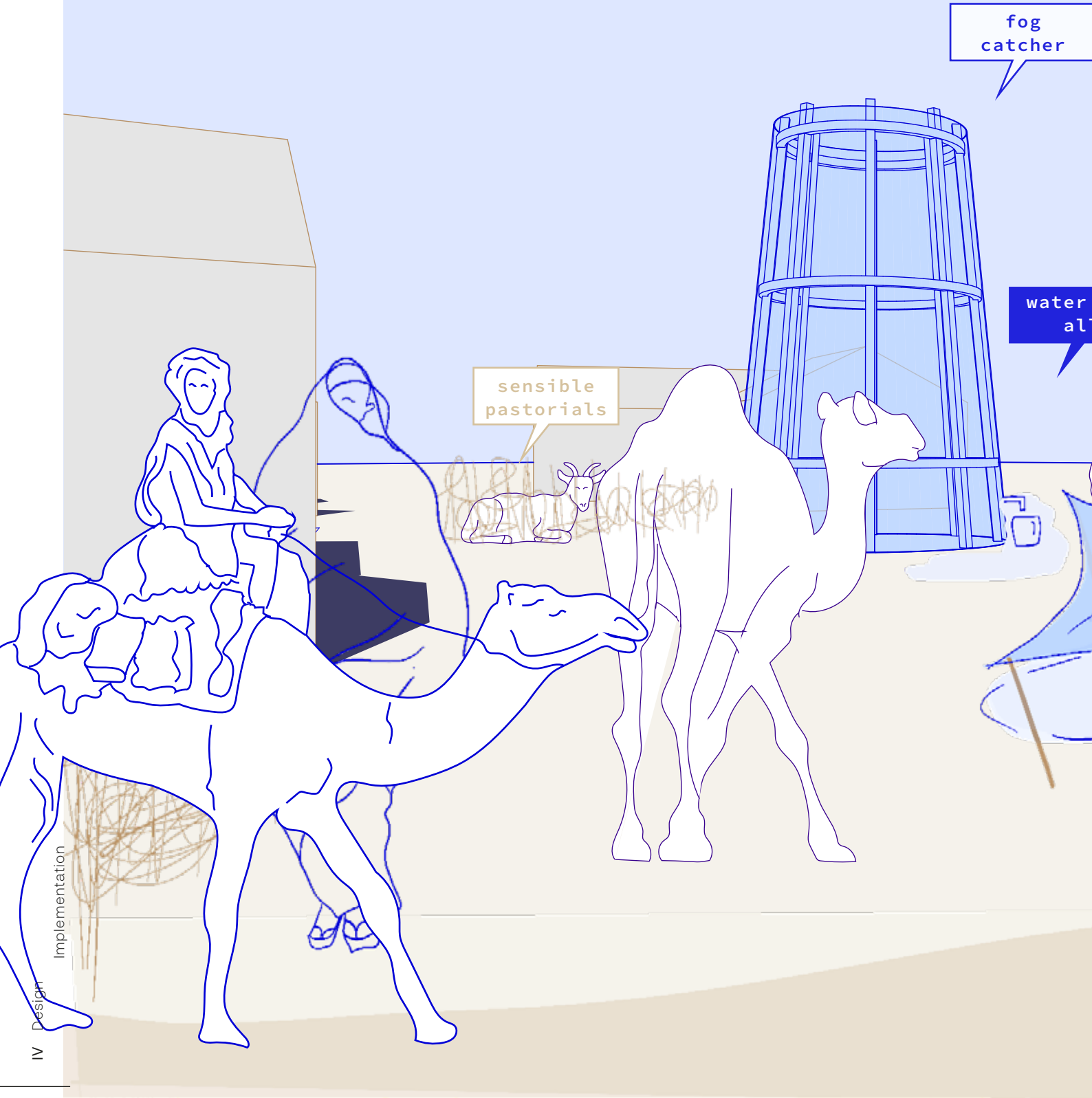
Community garden

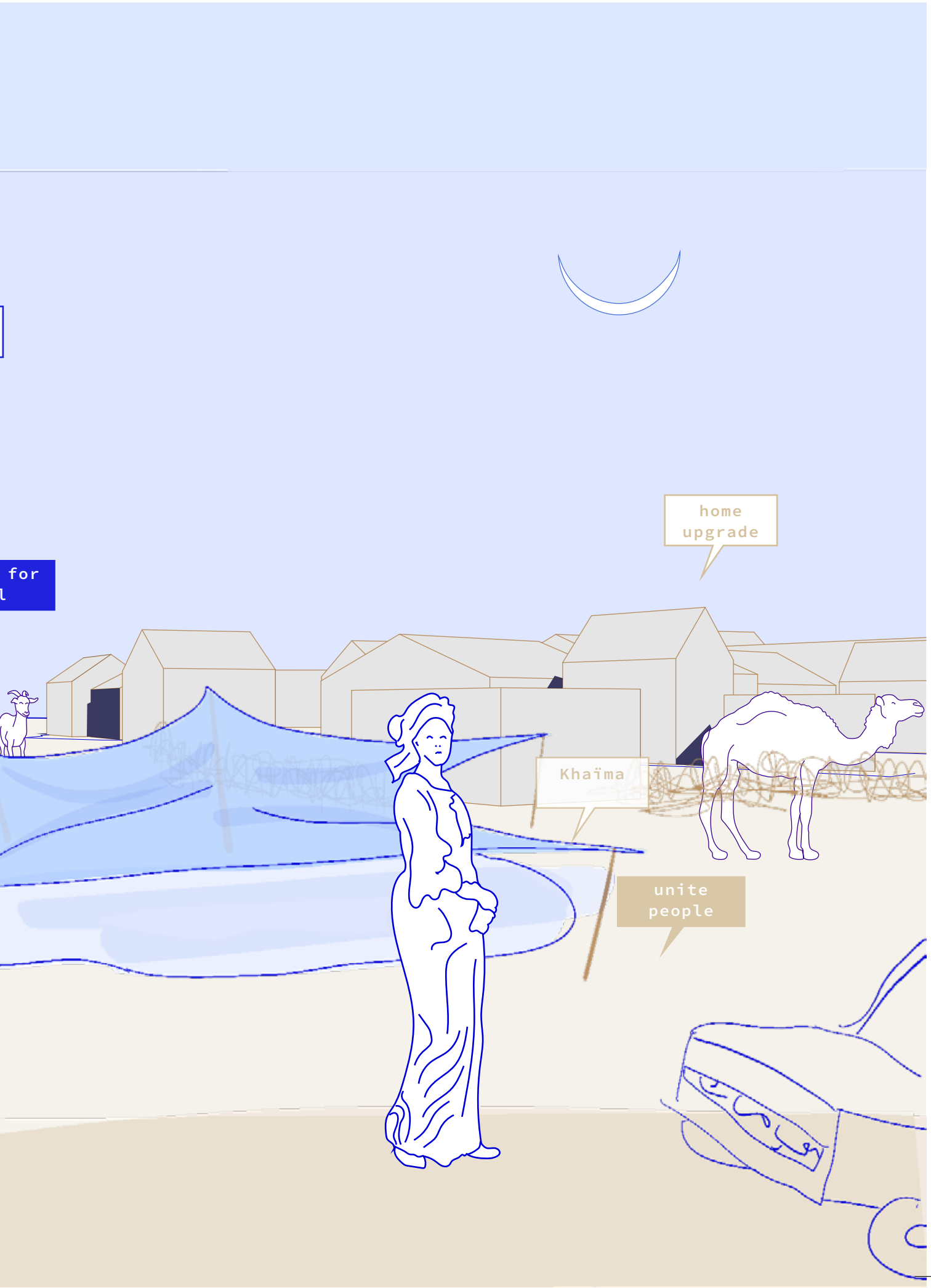
This perspective gives a deeper understanding of the pattern's implication on eye level for two types of public spaces. The proposed community garden creates a new public space for residents to gather. Under the practice of care, the garden has added to the residents lives and daily rituals, enjoying to watch the fruits of their garden grow.




Khaïma
solar support
EW4
D3
collecting water
native species
EA3

The water tower has become a landmark for the neighborhood. This is the place where people come to socialize and rest in the shade of their khaïma. The water captured through the thin net is shared and used for the tea ceremonies.

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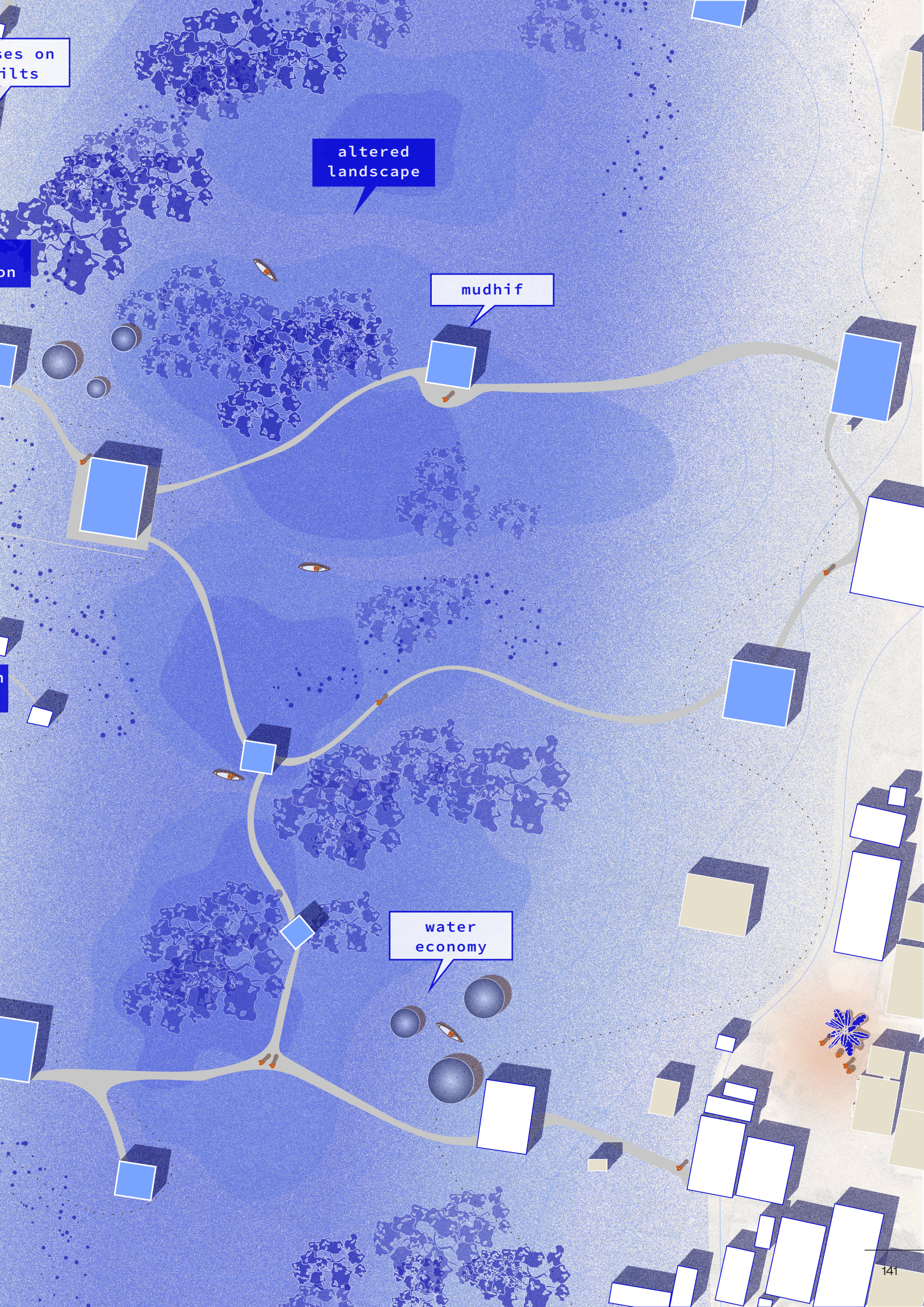
home
upgrade
Khaïma
unite
people


unite people
shadow market
good public
community garden
solar support
home upgrade
living with water
healthy neighborhood


ses on
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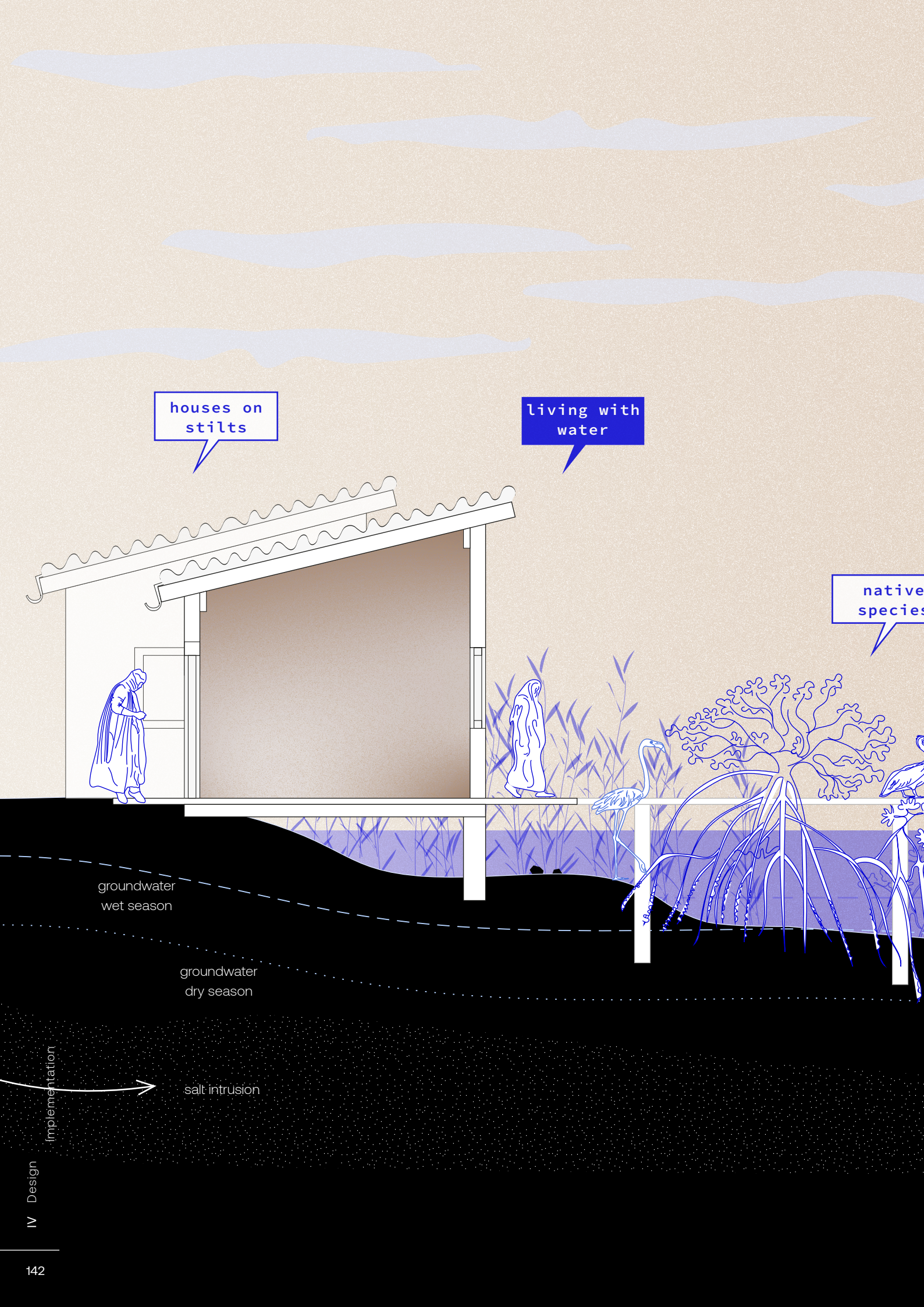
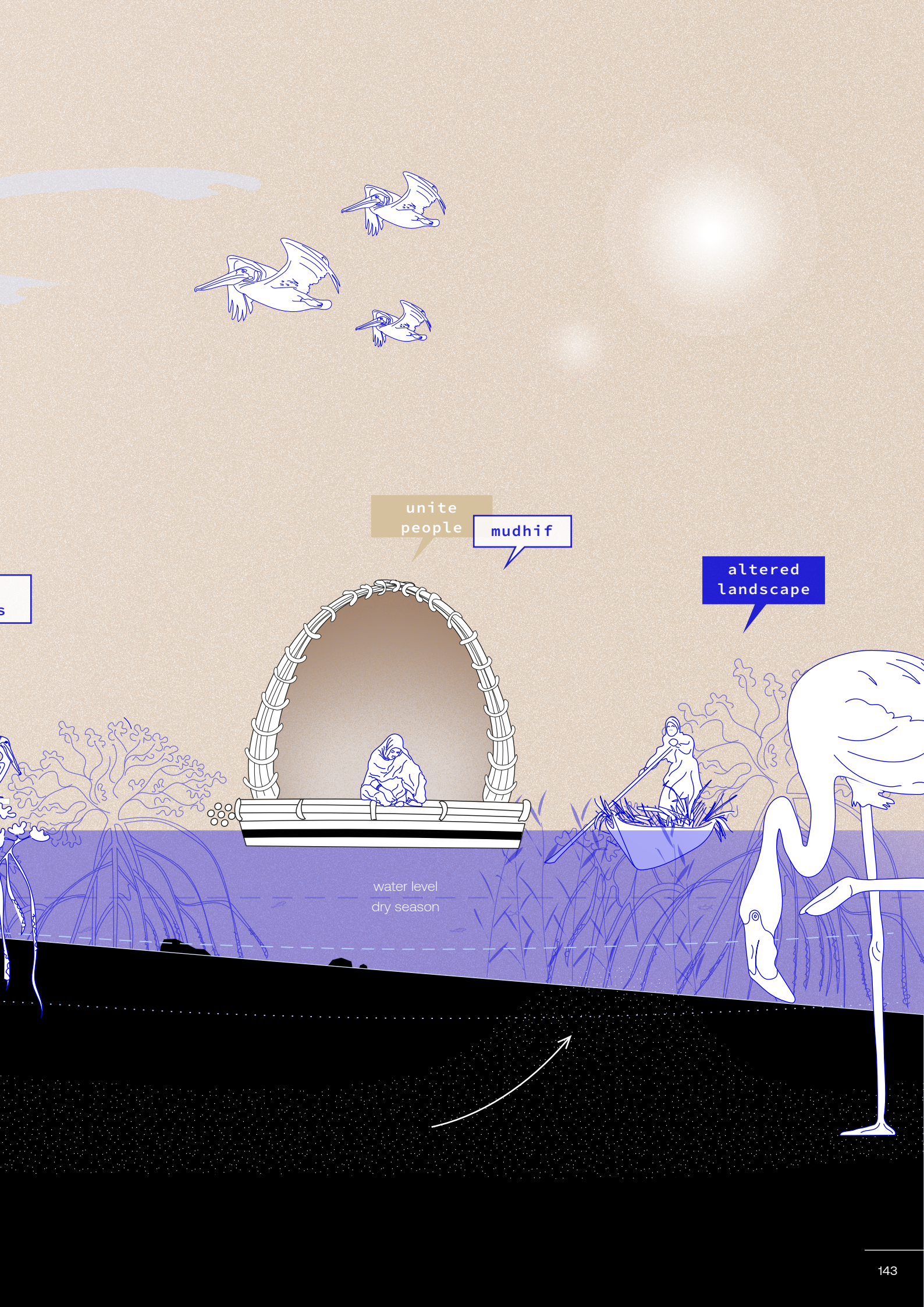
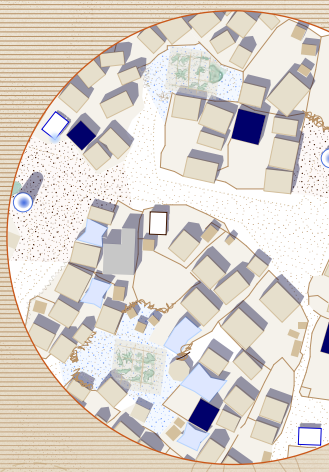
altered
landscape
on
mudhif
n
water
economy


houses on stilts
living with water
native species
groundwater wet season
groundwater dry season
salt intrusion

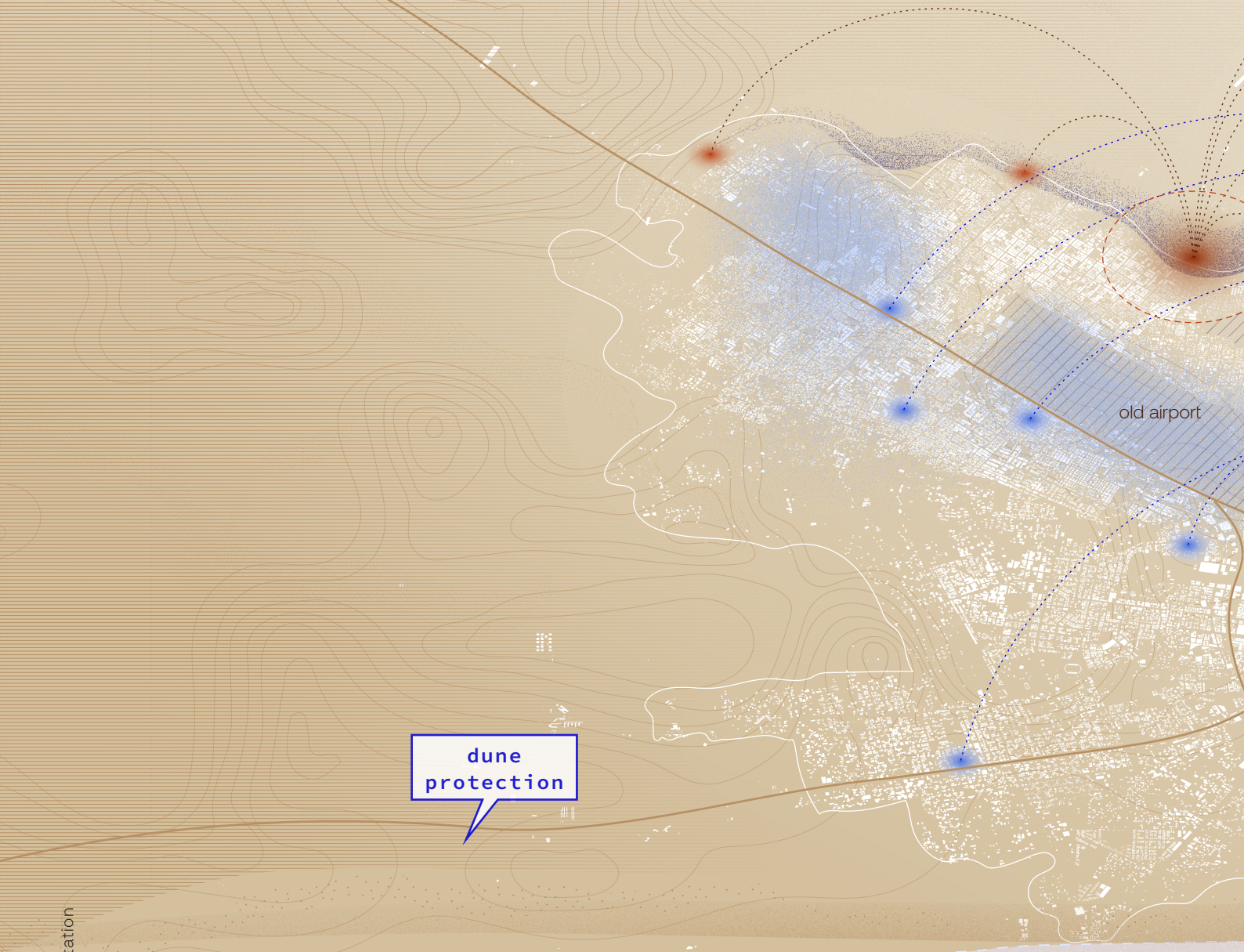

unite
people
mudhif
altered
landscape
water level
dry season

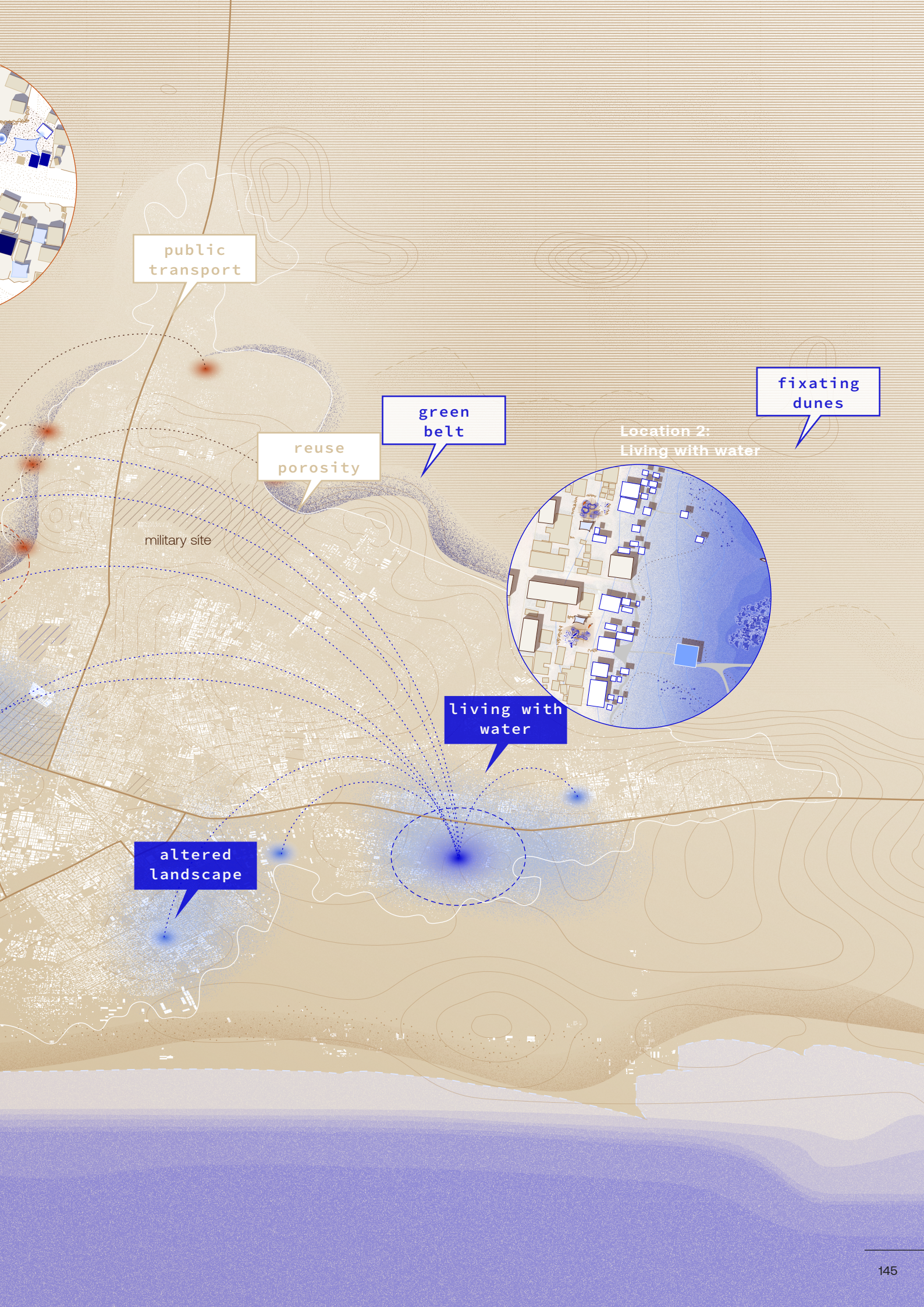
IV . 3 . V Transferability

This project focuses on designing adaptive, resilient solutions tailored to two specific locations in Nouakchott, each with unique vulnerabilities to climate exposure. The selected sites represent broader typologies within the city, allowing the proposed concepts to be transferred to other locations facing similar challenges. By applying these strategies across multiple areas, the project aims to achieve citywide impact, fostering socio-ecological resilience and promoting spatial justice and equity on a larger scale.



Location 1:
Green safety




public transport
reuse porosity
green belt
fixating dunes
Location 2:
Living with water
military site
living with water
altered landscape



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V . 1 CLOSING

This project aims to offer an approach rather than a definitive solution for addressing pressing climate exposure and spatial inequalities. By developing a pattern language, this thesis provides tools that attempt to incorporate local knowledge, urban and climate resilience, and spatial justice into vulnerable communities. This approach requires ongoing adaptation, collaboration, and refinement altered to each context.

RQ 1. What makes Nouakchott particularly vulnerable to present and future impacts of climate change?

Nouakchott's vulnerability to climate change is composed of an interrelation between exposure, sensitivity, and limited adaptive capacity, disproportionately affecting vulnerable communities. The city's exposure to sea level rise and desertification owed to its geographic context, leads to frequent and persistent flooding, groundwater salinization, and sand encroachment, directly threatening the urban fabric and its inhabitants today and in the future. These environmental pressures amplify sensitivity among socially disadvantaged residents, often living in informal settlements that lack basic infrastructure. Access to clean water, healthcare, and stable housing is not a given to these communities, making them highly susceptible to climate impacts. High sensitivity intensifies people's lack in adaptive capacity. Vulnerable communities are preoccupied with the struggle for everyday necessities, leaving them unable to develop adaptive capacity. This lack in adaptive capacity is also visible in governance due to short-sighted politics and extensive corruption, limiting effective problem solving. This dynamic leaves vulnerable communities trapped in cycles of amplifying poverty, threatening livelihoods with intensifying exposure.

RQ 2. How has Nouakchott grown and persisted over time in its vulnerable geographical context?

Nouakchott has grown and persisted over time despite its vulnerable geographical context through a complex interplay of unregulated urbanization and extreme cultural resilience. Established as the capital in 1958 the city seemed unattractive to the mostly nomadic population. Severe droughts in the 1970s jeopardized the nomadic lifestyle leading to the city's exponential growth. Inadequate urban planning allowed informal settlements to develop, creating a patchwork of organic growth and imposed grid structures. This influx was only achievable due to the resilience of nomadic communities, who are highly skilled at adapting to harsh environments. However, their resilience is not reflected in the city itself, which has deep intrinsic vulnerabilities. Nouakchott's growth reflects both the persistence and resilience of its communities, as well as the systemic inequalities and spatial injustice rooted in its historical development.

RQ 3. What spatial injustices, especially in vulnerable communities, arise in Nouakchott?

Spatial injustice is deeply rooted in Nouakchott initial planning, characterized by spatial segregation and inequality. Here, spatial injustice is not only an outcome, but a process influenced by discrimination and rigid social structures, that has marginalized vulnerable communities and relegated them to highly exposed areas.
This interconnection between climatic exposure and socio-economic vulnerability exacerbates injustice. Vulnerable communities often inhabit locations with greater environmental hazards and pollution. This dynamic is further complicated by a lack of secure land tenure, leaving residents vulnerable to displacement and a lack of social stability. Additionally, the absence of essential services and resources, such as education, healthcare, economic opportunities and water, increases their sensitivity and limits their adaptive capacity.

RQ 4. What can we learn from the cultural identity and historic context of Mauritania?

Mauritania's cultural identity, ingrained by a history of migration, nomadic tradition, and religious guidance, reflects a resilience and adaptability that has long shaped local life. The fusion of Arab and Black African worlds has created a society that, despite divides and intrinsic social hierarchies, finds unity in shared rituals. Central to this unity are Islamic practices that bring both a rhythm and determination to daily life, grounding people in faith while fostering a profound sense of community. Through religion, people are reminded of their relation to a greater purpose, where acts of charity are seen as a responsibility for the greater good. This spirit is deeply tied to nomadic life, where hospitality, generosity and mutual support are essential to survival. Their cultural identity conveys a deep connection to the landscape they inhabit, contrasting with the harsh realities of urban life. People's sense of identity remains deeply entwined with nostalgia, envisioning a lifestyle in harmony with the landscape rather than confined by the urban. This resilience, rooted in cultural identity, communal bonds, and a connection to the landscape, emphasizes the strength of Mauritanian society, adapting while preserving its values.

RQ 5. How can indigenous practices and technological solutions inform the design of an adaptive pattern language?

Indigenous practices and technological solutions both play a vital role in developing an adaptive pattern language that addresses Nouakchott's environmental and social needs. Indigenous practices are grounded in the conscious symbiosis communities have with the harsh environments they inhabit. These practices contribute to resilience by promoting ecological balance, aligning with the needs of both people and ecosystems. Technological solutions add further depth, enhancing infrastructure and resource accessibility, critical to increase spatial justice in Nouakchott. Together, they work to bridge gaps in access to resources and opportunities, thereby addressing inequalities that persist within urban spaces. This integration of indigenous and technological elements in the pattern language not only provides pathways for urban resilience but also reinforces the city's ability to promote more equity.

Main RQ How can context specific spatial interventions focused on climate urgencies contribute to urban and climate resilience, while improving spatial justice in Nouakchott?

An adaptive pattern language fosters context specific interventions for climate resilience and spatial justice by breaking down complex urban issues into manageable and tangible elements. In Nouakchott, this structured yet flexible approach has enabled the development of patterns that respond to environmental and social challenges in vulnerable communities. By integrating visual and verbal elements, the pattern language can act as a tool to bridge gaps between stakeholders, promoting effective engagement and a co-creation process that respects the cultural context and integrates local knowledge. Creating interconnected pattern sets with patterns from both fields allowed for interventions that focused on urban and climate resilience while incorporating spatial justice. Rather than conflicting, these two concepts enrich one another when thoughtfully intertwined. True spatial justice can arguably only be achieved when space is urban and climate resilient and vis versa.
This pattern language approach, therefore supported exploring and strengthening the interplay between resilience and spatial justice in the context of Nouakchott. Although the patterns presented here are transferable to locations within Nouakchott, a different context will ultimately require alterations and the addition of patterns to be effective in its proposal.

V . 2 REFLECTING

Evolution

The decision to focus this thesis on a lesser-known, under-researched place comes from a deeply personal connection. Although this is not my place of origin, and I will always be an outsider to this community, this project provided an opportunity to explore a territory where I once lived through a new light. While I will always be an outsider to this community, this thesis has allowed me to better understand Mauritania's unique challenges and strengths.

Initially, I believed the focus of this project would revolve around drinking water, as it is essential to life and not a given in a desert environment. However, the project evolved to embrace much more, shifting the focus from what I thought people needed to the people themselves. This led to a significant realization: the fact that these communities survive in such a hazardous environment is proof of their resilience. Rather than imposing my ideas, it became clear that I should learn from their practices and how they sustain life in this unforgiving landscape.

Although this project presented challenges, finding a focus was never one of them. From the beginning, the vulnerable communities, most overlooked and neglected were central to this spatial exploration. Time became an important notion in the process of analyzing spatial dynamics. Both in terms of past and future alterations of the landscape, but more importantly through people's activity in space. The importance of time become more apparent when looking into indigenous knowledge. Indigenous practices create a symbiosis with their environment by understanding and managing time as an essential element of survival in harsh conditions.

Relation to Urbanism, Research and Design

This thesis explores the intersection of climate vulnerability and spatial injustice in a delicate urban context. Shaped by extreme poverty and a fragile ecosystem, Nouakchott acts as a case study for designing with vulnerable communities. These theoretical concepts, belonging to the environmental realm and social science, find their intersection and development of practical solutions in the field of Urbanism. Focusing earlier projects in this master's program on self-sufficiency, social justice, and designing with informality, has shaped my path to apply these themes to a more complex context.

The studio of the urban fabric has shaped my research, design and overall methodology and approach by allowing for exploration while being practical and design oriented. It has given freedom to an explorative process, navigating with ease between research and design. With this project I embraced an iterative process, alternating between research and design process that informing and influencing each other strongly. Although presented in later chapters, the development of a pattern language began early and was heavily influenced by the theoretical research on indigenous practices. This allowed me to view space through the lens of nomadic communities and their deep connection to the ecosystem they inhabit. This led to a design approach rooted in the realities of the people it seeks to support.

Assessing the approach

Throughout the development of this thesis, it was necessary to discover alternative methods of analysis. Faced with limited existing research on the specific context, I turned to methods beyond the conventional scope of urbanism. This exploration highlighted the importance of unconventional approaches in enriching the urban design process. By using a combination of qualitative and quantitative methods while maintaining a systematic approach, I was able to explore the complexities of this context. Although the methods used come from the spatial exploration of Nouakchott, they are transferable to other locations that share similarities in vulnerability and spatial dynamics.

Because I was unable to conduct fieldwork, qualitative methods like analyzing interviews and portraits offered a valuable glimpse into the cultural context. Fieldwork would have significantly benefited this project, providing firsthand insights and allowing for a more inclusive process. The absence of fieldwork also meant that the pattern language I developed could not be tested in collaboration with the community, a step that would have grounded the design in local realities.

Dilemma and limitations

Unfortunately, the spatial segregation seen in Nouakchott mirrors its deeply hierarchical social structure, shaped by ethnic belonging, history, as well as social status. This creates a torn and highly segregated society, where issues like population numbers and ethnic identity remain sensitive topics that have sparked violence in the past. Although the societal structure is addressed in this thesis, it does not form the basis for spatial analysis. This was a deliberate choice rooted in my position as an outsider. What the project fails to address is how the design overcomes this social stigmatization, given the intertwined nature of Mauritania's ethnographic structure. Properly tackling these social dynamics would have required a different approach, based on deeper ethnographic research that I lacked the time and resources to conduct.

This brings me to the dilemma of this project, although there is a clear correlation between spatial and social division, these topics are treated separately to avoid making uninformed assumptions or evaluations. This separation leaves a gap in understanding how design could bridge these social divides inherent in the city's structure. This leads to a design that acknowledges how space can foster communication but not fully account for social change.

Scientific and social relevance

The scientific relevance of this graduation project lies in its ability to fuse disciplines, environmental dynamics and social sciences, through the field of urbanism. By exploring climate-resilient adaptation strategies and spatial justice, this thesis contributes to the larger discourse on how the climate crisis will impact equality and justice in cities. This project synthesizes existing research across fields to understand underlying causes and spatial patterns of injustice. This leads to an adaptive while still tangible design approach.

From a societal perspective, this project addresses the present and future threat of the climate crisis on vulnerable communities. It attempts to give a voice to a community, that is neglected and overlooked by politics and the western world. By uncovering the inequality of space while shedding a light on the resilience of indigenous practices this thesis emphasizes the importance of social sciences in the field of urbanism. This project prioritizes vulnerable communities and their right to the city, uncovering their patterns of resistance and resilience. This project advocates for their right to the city and promotes design strategies that enable them to claim space.

Transferability

One of the main objectives of this project is to ensure the transferability of design strategies. The pattern language method was specifically chosen to develop a flexible design framework that can adapt to different contexts and uncertainties. Whether dealing with unpredictable natural forces or uncertain cooperation with the government, the design focuses on user engagement and communication between stakeholders, rather than just the final spatial outcome. This approach allows communities to create and modify patterns based on their specific needs, ensuring adaptability and relevance to different environments.

Future

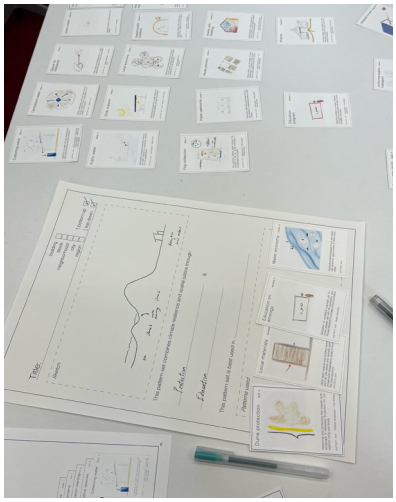
The future of this project lies in its potential to foster community participation and open dialogue. The next critical step would be testing the pattern language collaboratively, allowing residents to shape and adapt the design to their own spaces. However, an important political step toward achieving this would involve reforming landownership policies, ensuring that people have security in their claims to space. Engaging the community is crucial, as it empowers them to speak up and contribute to be part of a solution towards urban resilience.

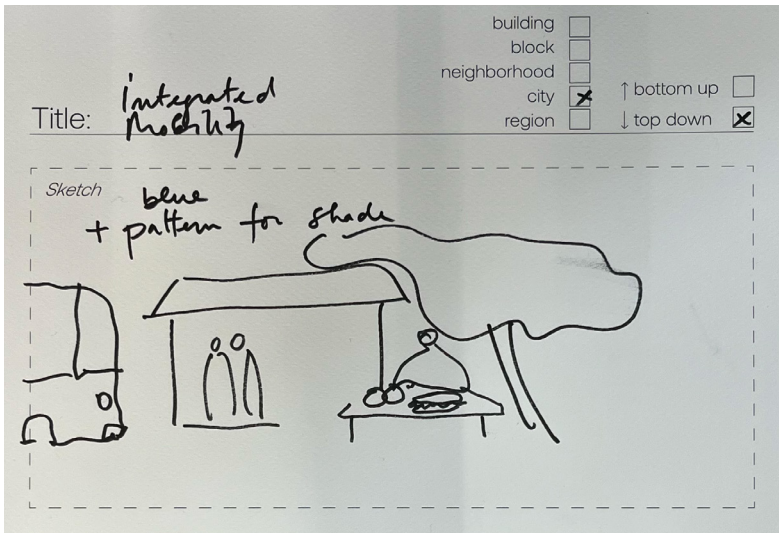
Spatializing the design was limited to one (soon to be two) locations. This deliberate selection was made based on the assessment of the typology, choosing two distinctive locations. In the future, the same process can be applied to other locations, testing the adaptive capacity of the pattern language and sets. This project opens the door to further research on indigenous knowledge, especially in the context of nomadic life and practices in fragile ecosystems. Learning from the community, their traditions and practices is an important aspect of co-creating in the design process.

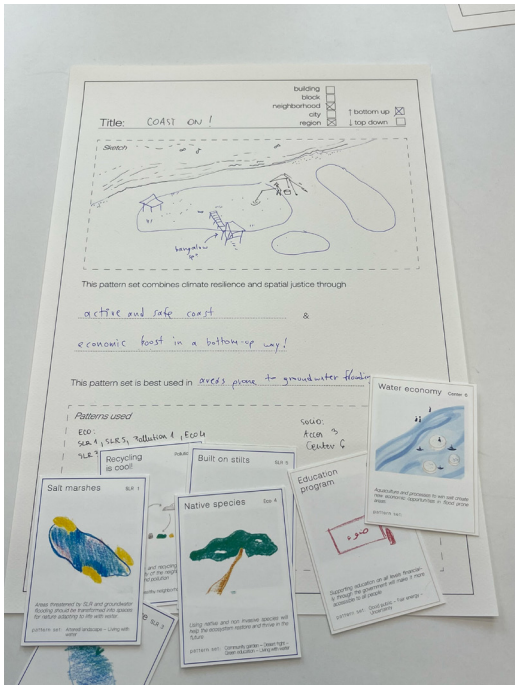
P5 Participation Assignment



The P5 presentation incorporated a moment of participation and reflection. Using the patterns developed for this design assignment, my mentors, friends and family got to explore options of using different patterns to create new pattern sets, combining social and environmental values.







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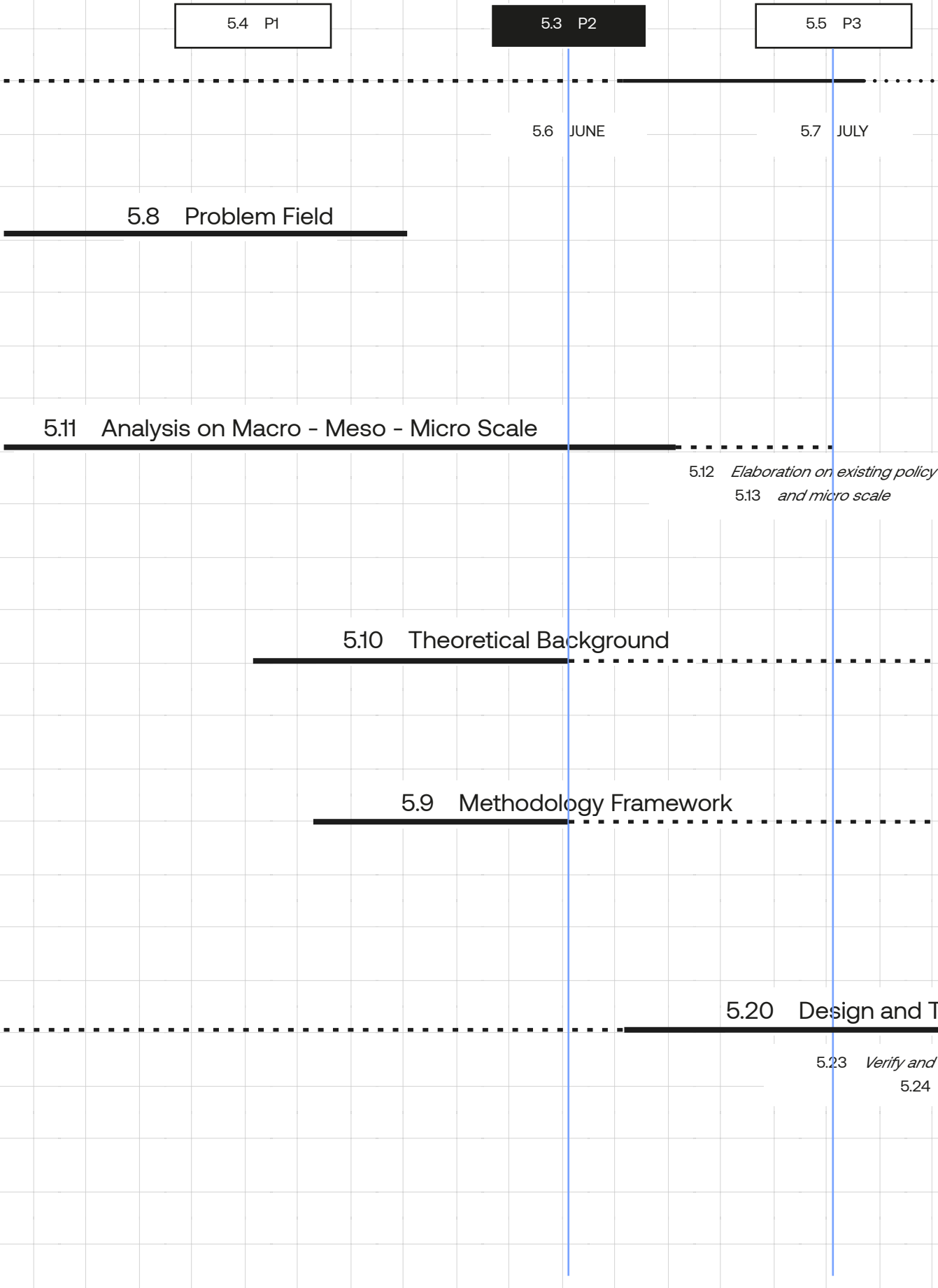
VII Appendix

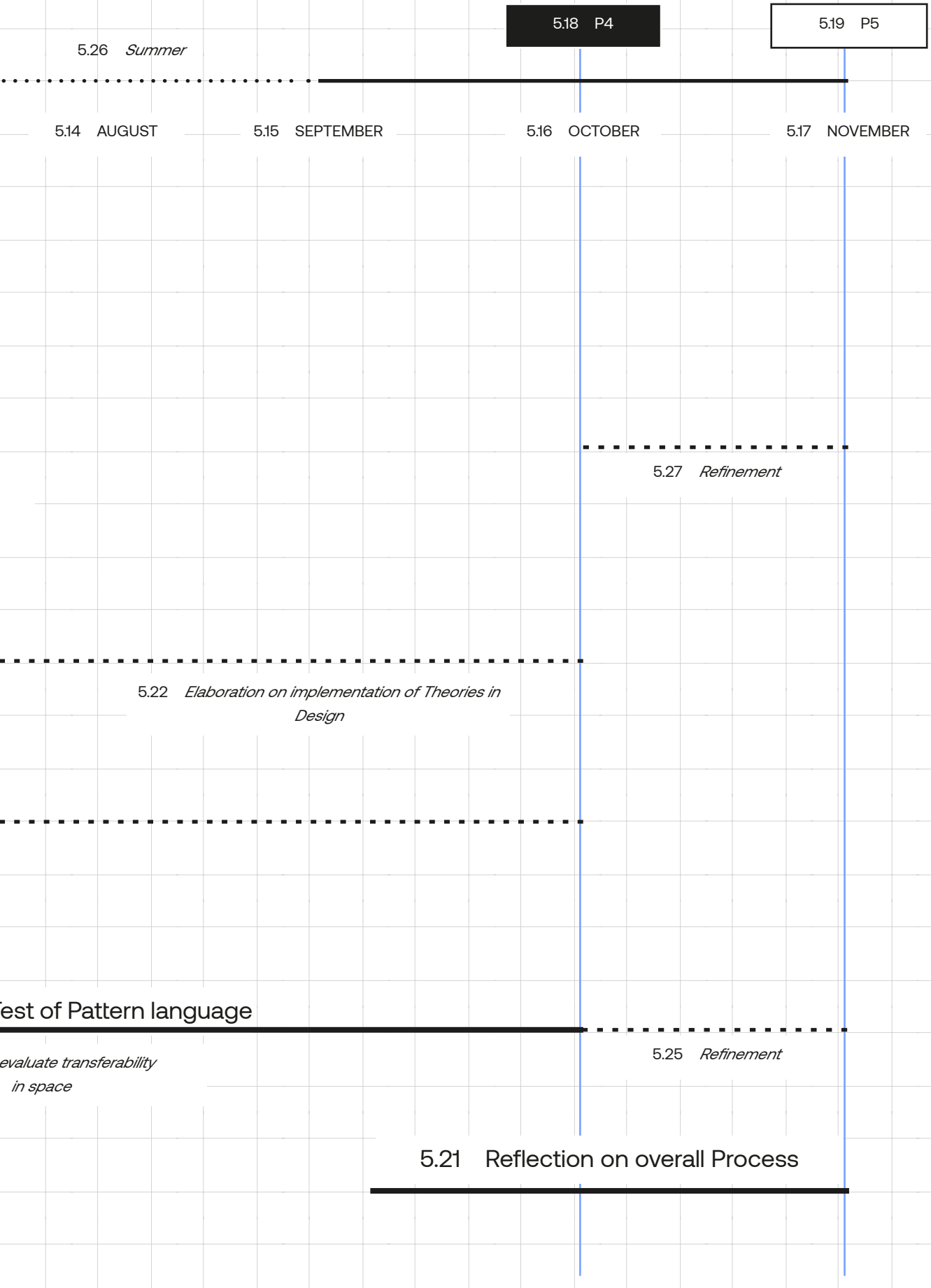
Vulnerability assessment

Category	Desertification	SLR	Land pollution	Ecological value	Integration and social network			Distributi
Measured factor	Proximity to desert (km)	Lowest Altitude (m)	Area / landfills (m^2)	Proximity to green and (number of trees)	Persistance; age of existing typology and degree of disruption (2:1)			Distance t connectio water syst
High	+4 km	5	0 - 0,5 %	0-1 km		L		connectio
Medium	1-4 km	2-5	0,5 - 2 %	1-4 km		M		1-4 km
Low	0-1 km	Below 0 - 2	3 %	+4 km		H		+4 km
1	0,8 -1,5	2	0,88 %	1	2012	H		
2	1,8	5	0,94 %	0,5	2013	H		
3	4,5	-5	0,14 %	5,9	2008	L		
4	0,6	4	9,20 %	1,1	2011	M		
5	0,35	-5	0,92 %	3,1	2016	L		
6	2,2	0	2,71 %	4,7	2015	M		
Poi 8	0,65	0	0,01 %	7	2023	L		
poi14	7	-3	0,00 %	2,5	2008	H		
Source	Google earth	https://coordinates-converter.com/en/altimeter						

on	Accessibility	Remoteness		Area (Hektar)	Land pollution
to water point; n to infrastructure tem	Distance to school, hospital	Position of neighbourhood (three zones from centre)			Area (and proximity to) landfills (m^2)
n to water network	0 km	> 4 km			4000+ m^2
	0-1 km	4-8 km			2000-4000 m^2
	+1 km	+8 km			1-2000 m^2
				307.300	2700
				975.000	9200
				1.200.000	1700
				43.500	4000
				587.000	5400
				360.400	9750
				18.000	1
				1.240.000	1

VII . 1 GRADUATION PLAN




5.18 P4
5.19 P5
5.26 Summer
5.14 AUGUST
5.15 SEPTEMBER
5.16 OCTOBER
5.17 NOVEMBER
5.27 Refinement
5.22 Elaboration on implementation of Theories in Design
Test of Pattern language
evaluate transferability in space
5.25 Refinement
5.21 Reflection on overall Process

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