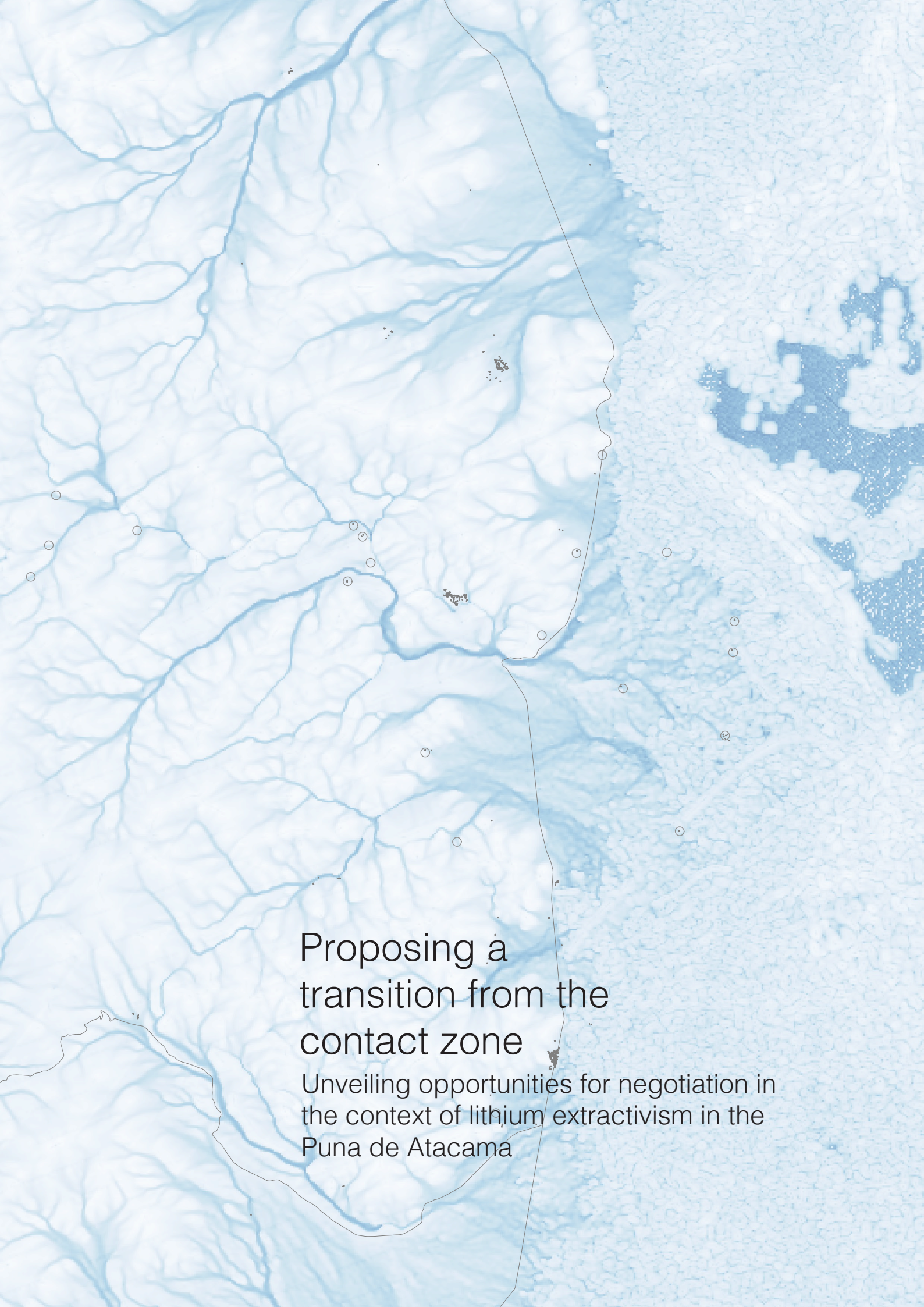
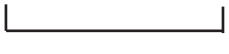


Proposing a transition from the contact zone

Unveiling opportunities for negotiation in the context of lithium extractivism in the Puna de Atacama

Cover image:
Topographic Wetness Index and San Francisco de Alfarcito pastoral units in Laguna de Guayatayoc. By author.



Master thesis
P5 Report- June 2025

Title: Proposing a transition from the contact zone

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TRANSITIONAL TERRITORIES STUDIO 24/25

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ABSTRACT

The Puna de Atacama, home to vast salt flats and fragile highland ecosystems, is now being transformed by the extraction of lithium. This mineral is central to the green transition and global decarbonisation efforts, rendering the region a geophysical asset and a site of ontological dispute. As planetary urbanisation extends its operational landscapes into remote ecologies (Brenner & Katsikis, 2020), ancestral territories become increasingly entangled in extractive logics that reframe land, water and life through the imperatives of energy storage and global market demands.

This research project explores the potential for negotiations between different ontologies. Grounded in political ecology and decolonial thought, it explores how power relations are formed and how they influence the politics of transition, knowledge hierarchies, and the rationales underlying territorial governance. Through situated case studies in the Olaroz-Cauchari and Salinas Grandes–Laguna de Guayatayoc watersheds, the investigation unfolds along three interconnected lines of inquiry: the spatial organisation of extractivist and ancestral territorialities; governance structures and negotiations between divergent ontologies; and epistemic frameworks through which territory is interpreted, represented, and acted upon.

Ultimately, this thesis does not merely critique existing paradigms; it seeks to open up the possibility of alternative territorial configurations and imaginative approaches that recognise distributed agency, ontological plurality, and the potential for a fairer, more reciprocal and context-sensitive way of inhabiting these fragile, contested landscapes.

AKNOWLEDGEMENTS

This thesis is far from an individual effort; “to be one is to become with many,” as Donna Haraway suggests. The complexity of the territory led me into worlds and disciplines I was previously unfamiliar with. I am deeply grateful to everyone who has studied, inhabited, and generously shared their ideas and knowledge about the Puna de Atacama. Thanks to them, this journey became a rich and inspiring exploration through diverse and fascinating worlds. They also helped me keep a clear horizon: understanding that many people are genuinely committed to making things better.

I would like to thank each person I had the pleasure of speaking with during the fieldtrip: thank you for helping me understand from a sensitive and situated perspective.

A Seba y Vicky, por su infinita generosidad, hospitalidad y presencia.

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A Agustina, por las catarsis necesarias.

Thank you to my parents and siblings, who make every decision and path I take easier and full of love.
To, gracias por estar siempre.

To Alen, for being home. Gracias por el cada día, por el amor y la paciencia, y por hacerme las preguntas justas que me impulsan a ser mejor.

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PROPOSE

POLITICIZE

REFLECT





Sales de Jujuy mining company
Salar de Olaroz, author 2025

INTRODUCTION

The research to be presented is the result of a Master's graduation project in Urbanism at TU Delft, developed during the 2024–2025 academic year within the Transitional Territories Studio, which frames the agency of Urban Design as the fine-tuning of ever-changing interrelations between societal practices, natural processes, and (geo)political frameworks.

The investigation takes the global push to mitigate climate change and the growing demand for critical raw materials—specifically lithium extraction,used in li-ion batteries for renewable energy storage—as an entry point to understand local assemblages, processes, and dynamics. Through a situated disciplinary lens, it seeks to explore and open up possibilities for envisioning a just transition to the future.

Framed within theories of political ecology and decolonial thought, this research situates the problem through two key concepts: ***landing*** and ***contact zone***. Both serve to interrogate territorial processes, power dynamics, epistemological frames and the contest between two territorial projects in tension: an ancestral, local one and a foreign, imposed one. The focus lies on the complex interrelations that enable, constrain, and regulate this territorialisation, thereby revealing the ontological and political disputes materialized in the territory.

As a case study, the research focuses on the "Lithium Triangle" located in the Puna de Atacama region, spanning Bolivia, Chile, and Argentina. This territory represents an extreme example, where the area is named after the resource itself, extraction technologies are constantly evolving to exploit it faster and more efficiently, and the resource exists within a highly vulnerable socio-environmental context.

landing
I use the term "Landing" to describe the process by which mining operations, as socio-technical assemblages, shift from a global to a local context. Drawing from Martin Arboleda's Planetary Mine (2020), it views the mine not as a discrete object, but as a network of infrastructures and technologies that arrive to the territory. Landing highlights the tension between two territorial projects: one rooted in local, ancestral practices, and the other imposed by external forces, focusing on the complex relationships that shape this territorial transformation.

contact zone
A "contact zone" refers to a space where different territorial projects, cultures, or ontologies meet, clash, and engage, often in the context of unequal power dynamics. Drawing from Mary Louise Pratt's concept (2010), it is a zone of friction where reciprocal processes of mediation and negotiation take place. Marisol de la Cadena (2023) expands on this by describing contact zones as pluriversal events, where multiple worlds emerge and challenge dominant perceptions, offering the potential for new understandings and expressions across differences.

Guided by the central research question, *How can a **territoriality** of **brine extractivism** on the Puna de Atacama be achieved with a balance of power over the territory for a truly ecologically, politically, and economically sustainable future?,* this research unfolds in the following chapters. The first part of the research frames the problem field by examining the geopolitical context and the politics of transition. It then explores the two ontologies present in the territory through a situated case study of the Olaroz-Cauchari and Salinas Grandes–Laguna de Guayatayoc watersheds, structured around three key ***lines of inquiry related to decolonial thought:***

Questioning territorial rationality through an urban political ecology lens in Chapter 3, "Landing and Territorial Organisation: Unveiling and Exposing Processes in Tension." This chapter unpacks both historical and contemporary territorial processes, impacts, and relations.

Questioning power relationships and agency in Chapter 4 by tracing the previous and current logics of negotiation between ontologies, through the examination of governance structures and expressions of agency.

Questioning epistemological dominance and disciplinary boundaries in Chapter 5, "How Are We Reading the Territory?" This chapter critically examines the tools and disciplinary frameworks used to interpret and represent the territory, with a particular focus on an Environmental Impact Assessment study.

In the final sections, the research moves toward design testing and proposition. In Chapter 7, it identifies opportunities for transition, working within the horizon of distributed agency. Chapter 8 proposes an alternative perspective on transition-making, testing a territorial approach both as a methodological framework and as a situated proposal. This culminates in a suggestion of a strategy and meta-project for implementing this perspective through a combination of top-down and bottom-up approaches, aiming to foster a more just and context-sensitive transition.

lines of inquiry related to decolonial thought:
Decolonial thought centers on dismantling colonial structures of knowledge, power, and being, while affirming plural ways of living and knowing. Key lines of inquiry include relationality and pluriversality, which challenge Western universalism and affirm worlds beyond the modern/colonial divide (Escobar, 2017; de la Cadena, 2023). It emphasizes autonomy and epistemologies of the South, advocating for knowledge rooted in lived experience and local struggles (Sousa Santos, 2014). These perspectives foreground intercultural dialogue, ontological plurality, and the urgency of imagining alternatives to modernity from within oppressed communities.

Territoriality (Peluso and Lund 2011; Sassen 2013, Delaney, 2005, Escobar, 2008) is a concept central to both political ecology and decolonial theory because it reveals how power is exercised through space: whether in controlling natural resources or asserting place-based identities and epistemologies against colonial and capitalist structures.

brine extractivism: Brine extractivism is a non-conventional method of extracting lithium by pumping mineral-rich brine from beneath salares and evaporating it to isolate lithium. It requires high technology and large amounts of water, impacting fragile ecosystems and Indigenous territories. It is called extractivism because it involves the large-scale removal of natural resources—often for export—without regard for local ecological or social consequences, reflecting a colonial pattern of exploiting land for external benefit.

MOTIVATION

After a personal journey that has combined academic work and hands-on practice in Latin America, and a constant fascination with understanding local practices around the world and their symbiotic relationships with the territories, what I now understand as part of what is called natureculture, I have felt a growing need to deepen my engagement with urbanism through academic exploration.
This need stems from an inner drive to question,understand, and test theories and positions in real territories with real complexities.

I hold the hypothesis—and the trust—that it is possible to foster communication between academia, practice, and territories, and that this pursuit holds transformative potential.
I was motivated to explore a complex topic that brings together technologies, practices, discourses, and knowledges, to investigate how meaningful communication between these realms can be established—without losing sight of the urgency of our times.

My interest in this specific site emerged from a contrast in discourses, conversations, and research on transitions that I encountered while studying in the Netherlands. This contrast sparked a desire to understand the complexity of the topic more deeply, especially by juxtaposing and confronting it with other realities and ways of thinking.

CHAPTER 1
PROBLEM FIELD

Politics of a Transition

We live on a planet in a process of geopolitical and ecological 'transition', where nature is at the service of a new field of accumulation and financial speculation, under a widespread 'privatisation of resources'. At the same time, the accelerated and uninterrupted consumption of the earth's vital resources is increasing their value day by day. (Fornillo et al, 2019)

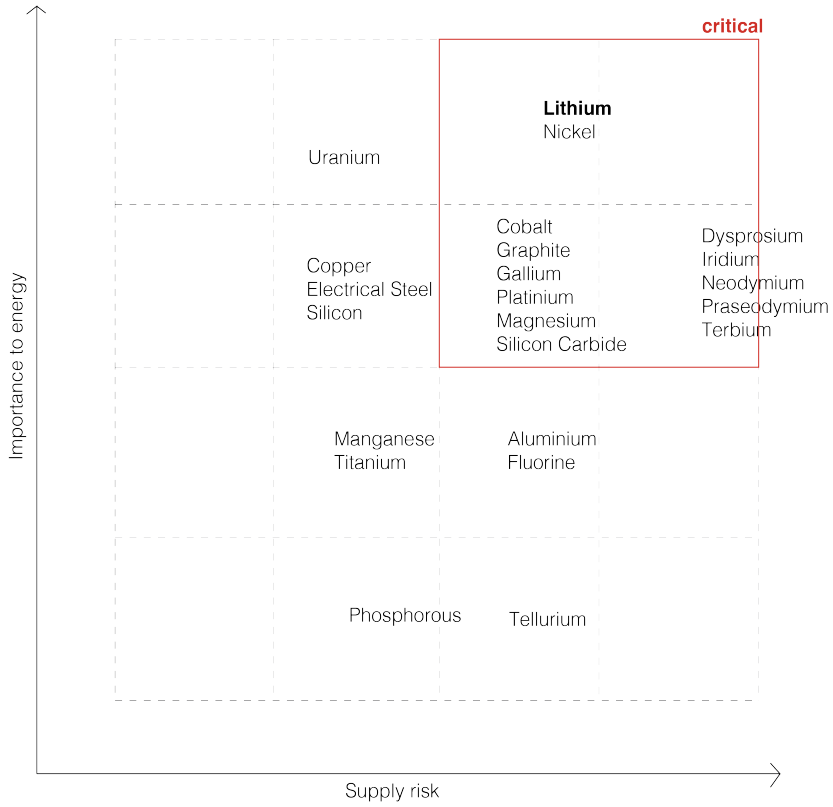
The contemporary global context is marked by a transition from fossil fuels to renewable energy sources with the objective of reducing CO2 emissions. A pivotal moment in this transition was the UN Climate Change Conference in Paris in 2015, where the global community reached a consensus on the Paris Agreement, committing to combat the anthropogenic greenhouse effect and striving to limit the rise in global temperatures within 1.5°C above pre-industrial levels. The "Paris Declaration on Electro-Mobility and Climate Change" (UNFCCC 2015) was also introduced in this context, emphasising the critical role of promoting electric vehicles (EVs) worldwide. Electromobility has emerged as a promising solution to mitigate emissions from the rapidly expanding transportation sector. However, it has also drawn renewed attention to the strategic raw materials required for battery production, including cobalt, nickel, and lithium.

This fostered the need for a supply of critical raw materials and Countries like the European Union, the United States, China, Australia, and Canada started taking steps to secure access to these essential materials, as they are key to achieving energy transition goals and maintaining technological competitiveness. In order to do so, they created "Critical raw materials lists". (CNMR,2022;EU,2011)

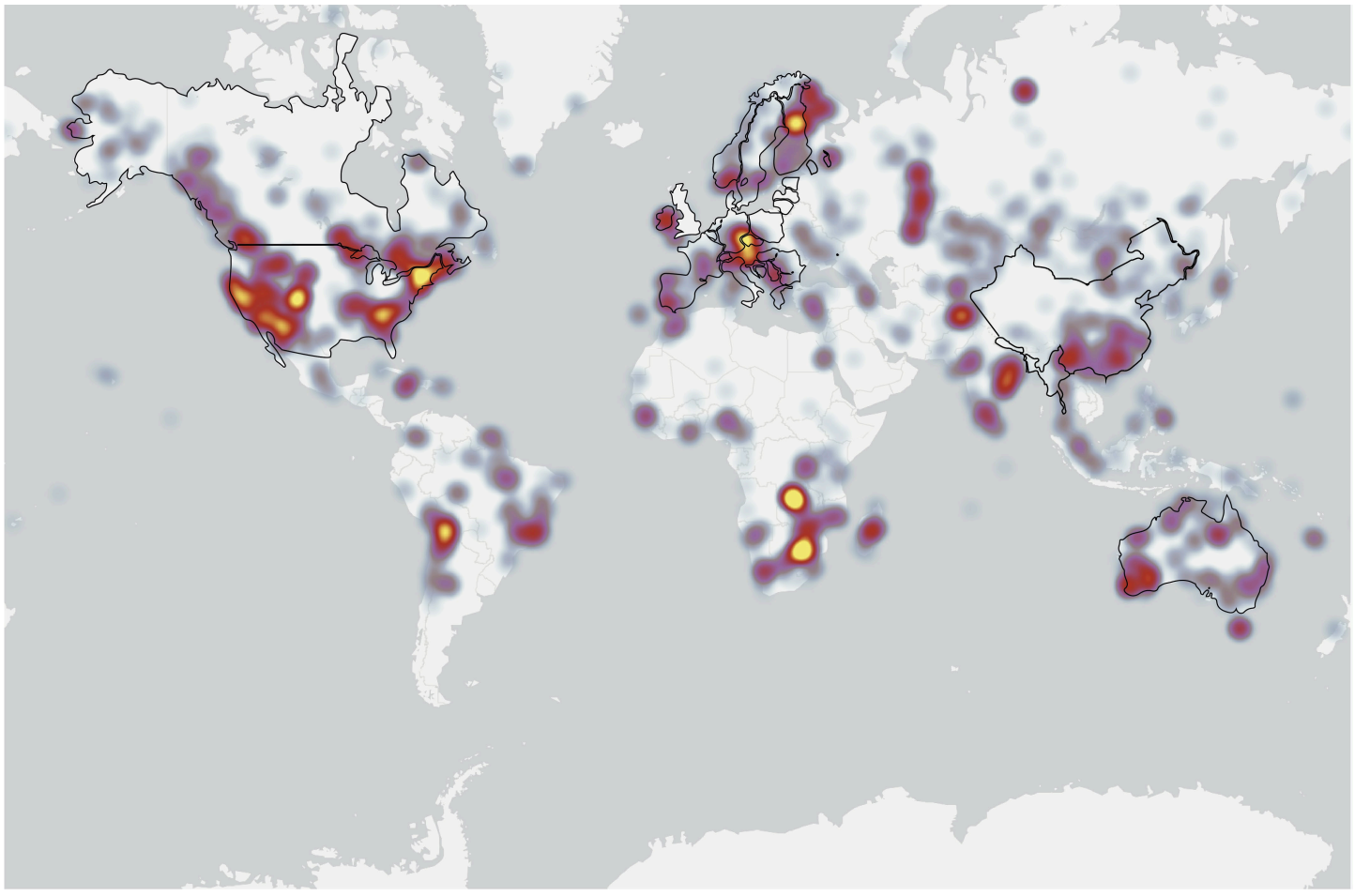
The criticality is measured with two axes: Importance (Technological, economic importance, substitution potential and impact on the transition to a green economy) and Supply Risk: (Geographical concentration, political stability of supplier countries, substitution potential, market dynamics and environmental impact)(Bogojević, S.,2024) Different countries and regions use different methodologies, but the overall goal is to ensure that supply chains for critical materials are stable and sustainable to support technological advancements and strategic goals.

Among other critical commodities, lithium has become central to the global energy transition due to the demand for lithium-ion batteries, its limited supply and concentration in certain countries, its technological applications and the need for secure and sustainable sourcing. As demand for clean energy and electric vehicles continues to grow, ensuring a stable, sustainable supply of lithium will be essential to meet global decarbonisation targets.

Lithium is a key raw material in the world of the future, as it is the raw material for the energy accumulators that power everyday electrical devices, drive the mobility that is being put into circulation around the world (bicycles, cars, lorries, trains, etc.), and store the electricity produced by alternative energies.
Lithium-ion batteries are essential to Europe's transition to renewable energy, in fact the EU will need 18 times more lithium by 2030 and 60 times more by 2050. (Wolters,Brusselaers. 2024)



Criticallity of CRM 2025-2035
U.S. Department of Energy (DOE) 2023



Global Critical Material locations

High

Countries with CRM list

Source: USGS,2023

Chapter 1
Problem Field

Lithium

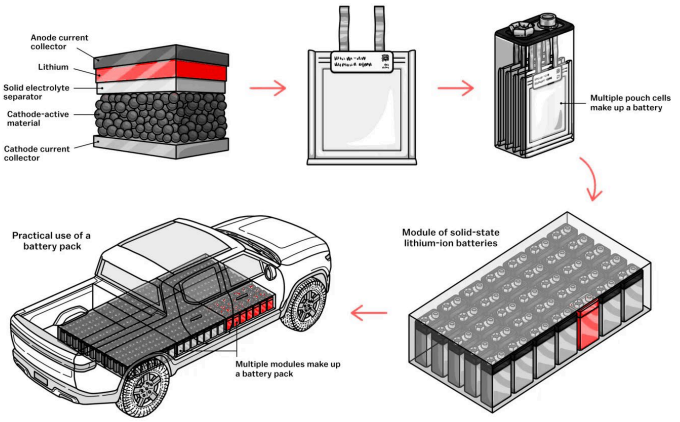
It is a soft, silvery-white alkali metal and is the lightest metal and the lightest solid element. Lithium is highly reactive and flammable, especially in its pure form, and it must be stored in mineral oil or another protective environment to prevent it from reacting with moisture or air.

The peculiar physical and chemical properties of the metal make it attractive for many applications: in formulations of lubricating greases, in the preparation of very light and resistant alloys, in additives to cements and ceramics, in refrigeration and air purification systems in enclosed spaces, in pharmaceuticals that are widely used worldwide, in nuclear technology, among others. However, the advent of lithium batteries as the most efficient energy storage device of the last decades and vital in the post-fossil society makes this application the most promising. A typical Electical Vehicle battery include about 8 kilogram of lithium. (Fornillo et al, 2019)

This element is present in pegmatites, brines, oil wells, geothermal fields, clays and even in the oceans. At present, only two production processes have proven to be economically feasible: brines and pegmatites.

Extraction from hard rock or pegmatite involves a traditional mining process, where lithium is extracted from underground or open pit mines. The ores undergo a concentration process involving crushing, grinding and flotation, from which the lithium is extracted.

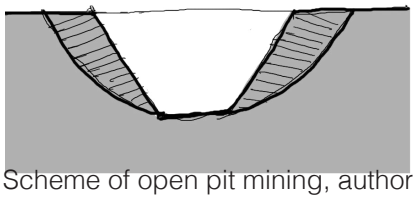
Brine extraction, known as non-conventional extraction involves brine pumping from salt flats and can be processed with two different technologies: direct extraction and extraction by evaporation. Evaporation extraction involves pumping the brine to evaporation ponds. A specific composition is then obtained and the ore is processed and refined. Depending on the project and its technology, industrial or battery grade lithium carbonate, lithium hydroxide, lithium chloride or lithium fluoride can be obtained.



Li-ion battery source:www.vox.com



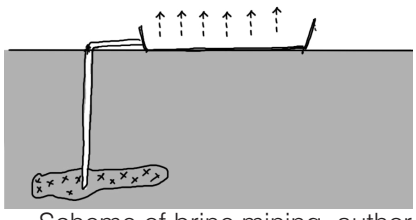
Western Australia's Greenbushes mine (Credit: Alamy)



Scheme of open pit mining, author



'Lithium Fields' in the Salar de Atacama salt flats in northern Chile.Tom Hegen



Scheme of brine mining, author



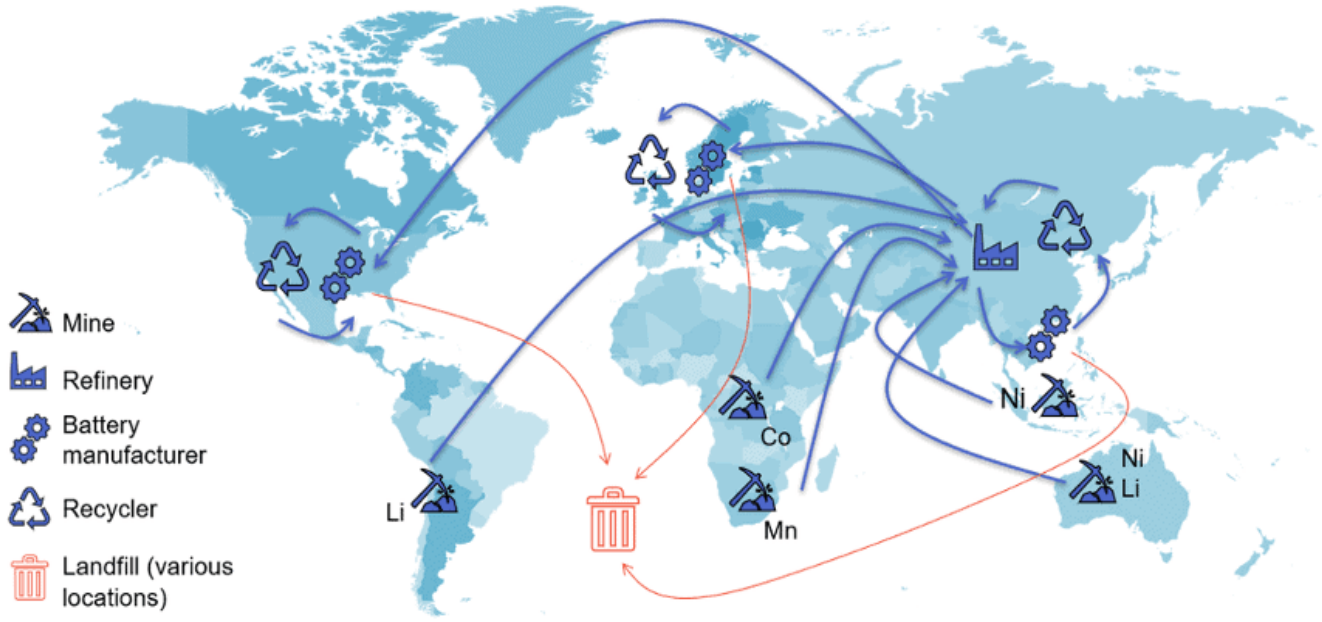
Salar de Atacama, Chile
Source: NASA Earth Observatory ,2011

Chapter 1
Problem Field

Lithium as a resource

Lithium-ion batteries global chain:
The lithium-ion (Li-ion) battery process begins with the extraction of raw materials such as lithium, cobalt and nickel from the earth. These materials are then refined into high purity compounds through chemical processes. The refined materials are then used to make battery cells, where they are combined with other components such as anodes, cathodes and electrolytes. Once manufactured, these batteries are used in devices such as smartphones, laptops and electric vehicles. At the end of their life, lithium-ion batteries can be recycled, recovering valuable materials for reuse in new batteries or other products, reducing environmental impact and conserving resources.

According to the U.S. Geological Survey (2024) owing to continuing exploration, measured and indicated lithium resources have increased substantially worldwide and are distributed in decreasing order in: Bolivia, Argentina, Chile, Australia,China,Germany, Canada, Congo, Mexico, Czechia, Serbia, Peru, Russia, Brazil, Zimbabwe, Spain,Portugal, Namibia, Ghana, Finland, Austria and Kazakhstan.
Argentina, Bolivia, and Chile have the primary brine resources, while China and the United States have both brine and rock resources, and others such as Australia have primarily rock resources.
(Gutierrez,2024)
Compared to hard rock extraction, brine extraction is considered to have less energetic burdesome, softer soil surface impact and lower CO2 emission. This focused the attention on the area where around 60% of the brine resources are located: “The lithium Triangle” (Grosjean et al., 2012).



source:Mangrove Lithium

Chapter 1

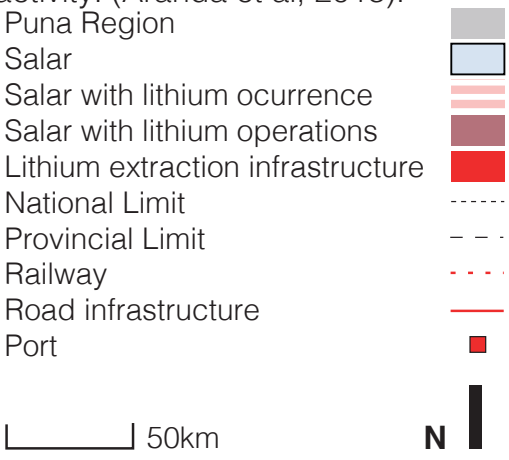
Problem Field

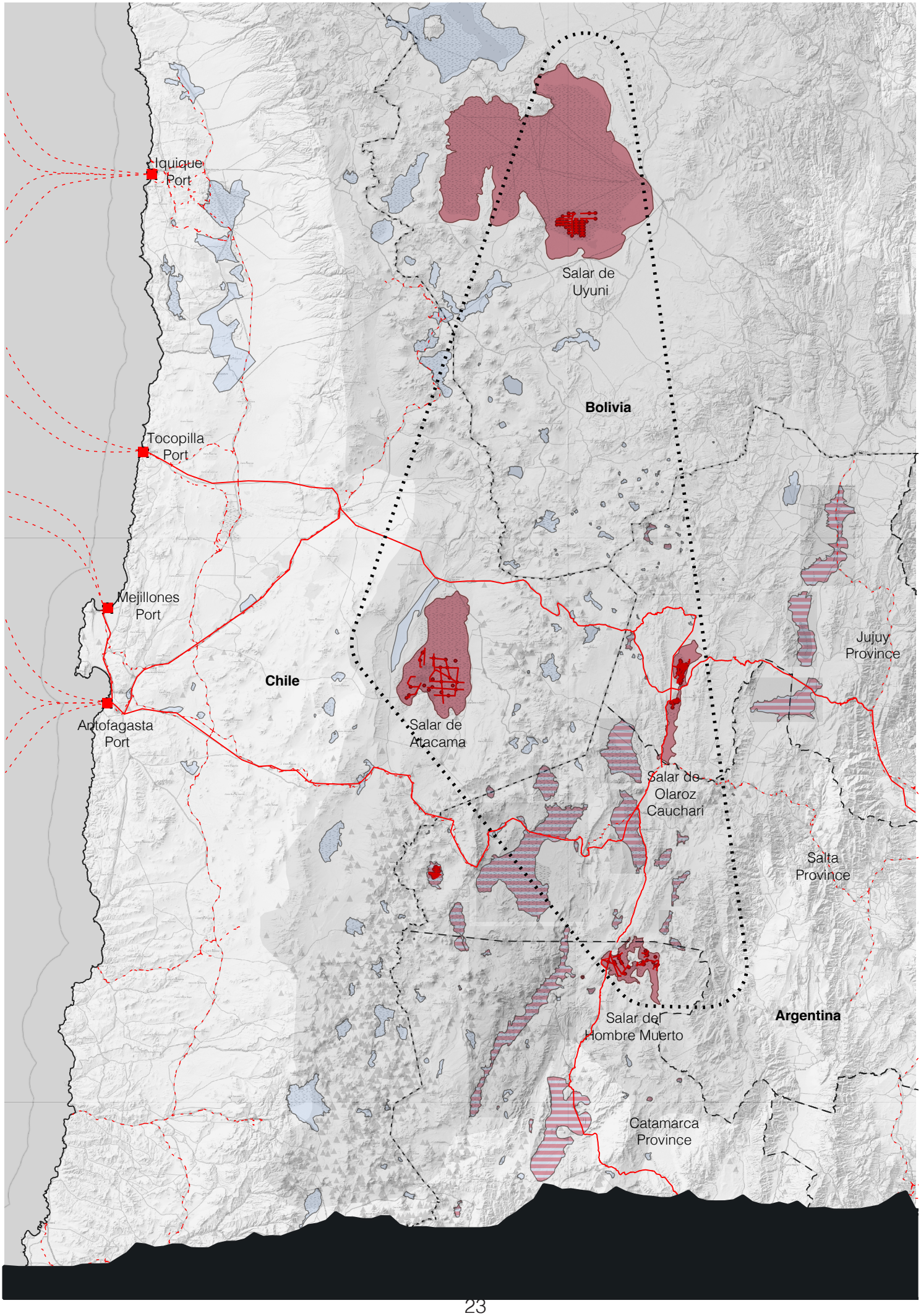
Lithium The Lithium Triangle: Urgency of Extractivism

The resource area called the Lithium Triangle is an area located in South America between the salars of Uyuni in Bolivia, Hombre Muerto in Argentina and Atacama in Chile.
Exploration of lithium occurrences in the salars is constantly being updated, with new discoveries constantly being made, but the area is considered to have around of the 60% of global lithium resources.
According to the USGS lithium occurences,many of the salares in Chile are being explored and there is a significative amount of salares in Argentina that have lithium occurrence. Currently. only four of them are mined and producing lithium carbonate.Those are located in Salar de Uyuni (Bolivia), Salar de Atacama (Chile),Salar del Hombre Muerto and Olaroz Cauchari (Argentina).
These three countries have different mining histories, resource management policies and approaches to lithium extraction and utilisation. In Chile, lithium is classified as a non-concessionable ore (1979) and is considered a strategic resource, which means that it cannot be fully privately owned. Mining is regulated by special operating contracts that involve partnerships between private companies and government agencies, allowing for joint management of the resource. This model aims to ensure both private sector efficiency and public sector oversight, balancing economic gain with national interests.
In Bolivia, Lithium is also considered a strategic resource, where the government has adopted an industrialisation strategy for evaporative resources (2010) to develop the full value chain of lithium production, from extraction to battery manufacturing.



Bolivia has an exclusivity model in which the sta te retains full control over lithium extraction. Public-private partnerships are being encouraged to create domestic industries, particularly in battery production and waste management, with the aim of achieving national ownership and technological development.
However, unlike Chile and Bolivia, Argentina has no specific lithium mining regulations. Although lithium as a mineral is considered primary resource by the country's constitution, it does not have a specific regulation. Argentina is a federal country, giving the provinces significant power. This decentralised system allows the provinces to regulate and manage their resources under the Mining Code and the Mining Activity Law.
The sector is largely driven by market forces and private investment, with provincial governments negotiating contracts and ensuring compliance with national laws.
Overall, the three Andean countries that make up the 'Lithium Triangle' share the absence of financial and technological capacity for large-scale exploration, exploitation and industrialisation transnational mining and industrial companies have made and continue to make offers to exploit the metal and export it in an almost pure state, as lithium carbonate, with practically no added value.
Thus, a resource considered strategic for national industry ceases to be so in practice and remains a raw material, the extraction of which is concessioned to foreign capital (Nacif, 2012). Private companies and national governments, which at various levels facilitate their task by allowing or downplaying the risks associated with the activity. (Aranda et al, 2018).




Iquique Port
Salar de Uyuni
Bolivia
Tocopilla Port
Mejillones Port
Chile
Antofagasta Port
Salar de Atacama
Jujuy Province
Salar de Olaroz Cauchari
Salta Province
Salar del Hombre Muerto
Argentina
Catamarca Province

Chapter 1

Problem Field

The Puna is not a resource area.

The Cordillera de los Andes is characterised by the highest volcanoes in the world, almost seven thousand metres high and active for around 25 million years. It also has a large number of closed (endorheic) basins, such as the Altiplano-Puna salares. The arid conditions that characterise the Altiplano-Puna region create a unique natural system, as the eastern mountains act as an effective brake on rainfall from the great Amazon basin and the Salta-Bolivian Chaco, and the Humboldt Current reduces the rate of evaporation in the Pacific Ocean. In this sense, it is a natural laboratory, because these characteristics of pressure and temperature create very specific physico-chemical and biological conditions. This is perhaps where the greatest richness and fragility of these socio-ecological systems lies (Fornillo et al., 2019. Gamba).

The salares, located more than 3000 m above sea level, are true oasis that sustain life in this arid region. These high Andean wetlands - salares are some of the most complex and fragile groundwater systems in the world, with influences from geology, climate, geochemistry, hydrology and hydrogeology.

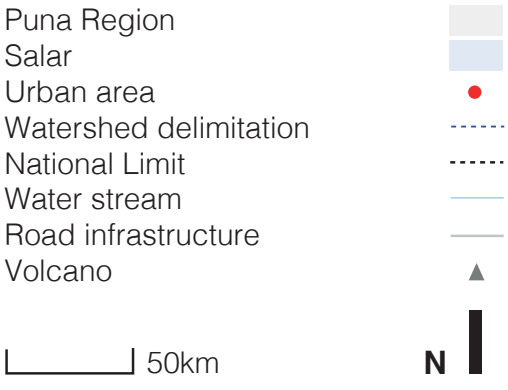
Due to these characteristics, its saline basins are also sources of potassium, boron, magnesium, as well as sulphates, carbonates and sodium chlorides, among other salts of economic interest.

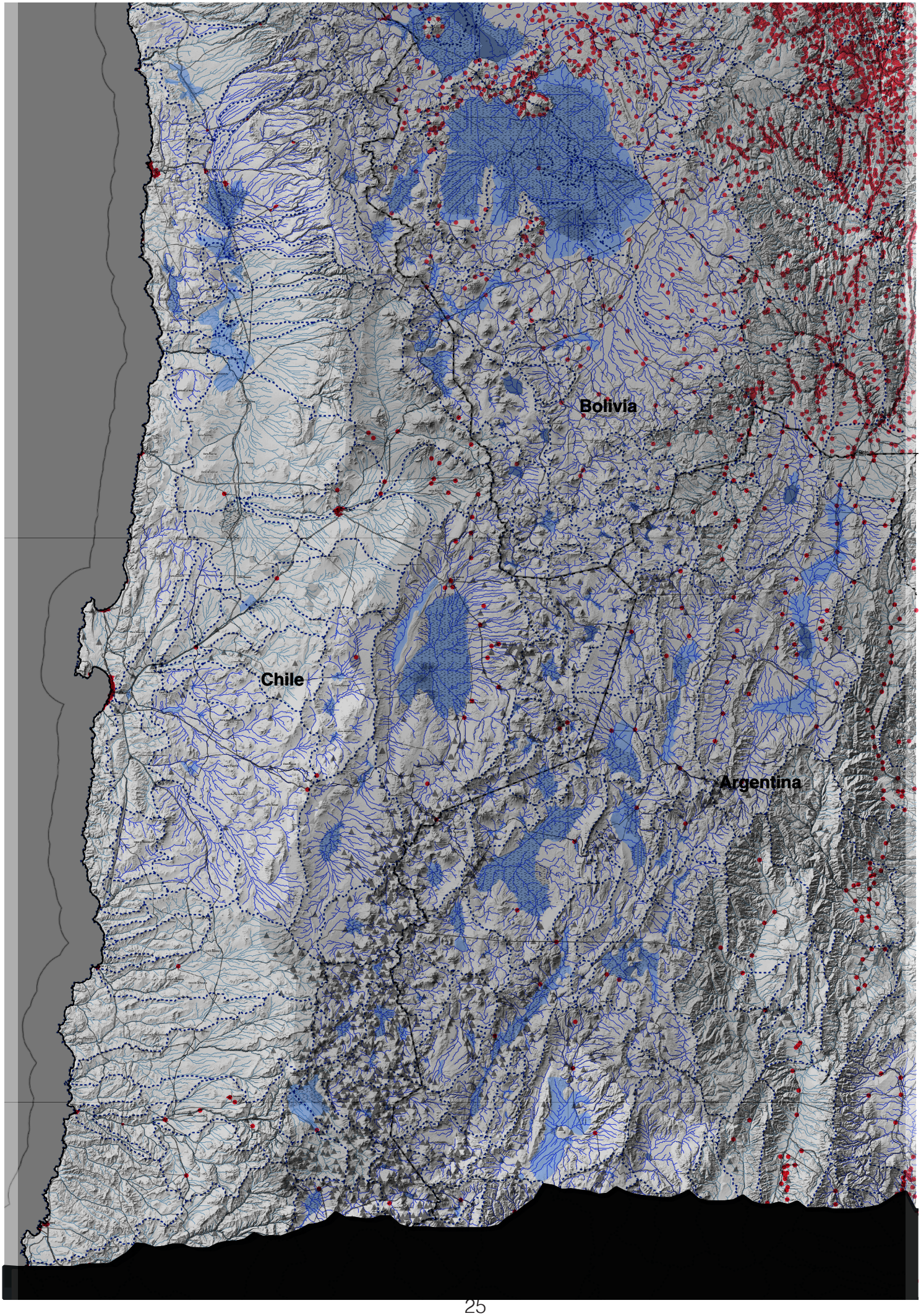
Although little information is available, some research suggests that the Puna has been inhabited for more than 14,000 years. What is certain is that it is the land of the Atacama, Kolla, Quechua and Aymara communities, with their wisdom and beliefs about the territory and nature. They believe in the Pachamama (Mother Earth), who is understood not only as the soil or the geological earth, nor only as nature, but as everything as a whole, with its processes and cycles, as a living entity that allows us to live on it and that we must take care of and preserve.

For these original communities, the salares are seen as part of their extensive history, their daily geography, the residence of their ancestors and a legacy for their descendants, part of the local ecosystem, which allows them to survive economically and culturally.(Fornillo et al, 2019)

Because of an anthropocentric logic, these communities have historically been segregated and forgotten and as Godofredo Pereira mention in Lithium:States of Exhaustion 2021, both governments and mining companies have historically described the desert as empty - depopulated -, inhabited only by small groups of ‘underdeveloped’ or ‘primitive’ peoples. It is abundantly clear that such representations, and their explicit racism, are designed to facilitate the processes of land appropriation for resource extraction.

The desert has always been the most exaggerated figure of the colonial-extractive gaze, a world described as inhuman, the presumed impossibility of inhabitation justifying its role as a sacrificial zone. This extractivist urgency and colonialist logic of the territory have led to a lack of information, dissemination and knowledge about the Puna territory, its natural cycles and its human and non-human inhabitants.




Bolivia
Chile
Argentina

Chapter 1

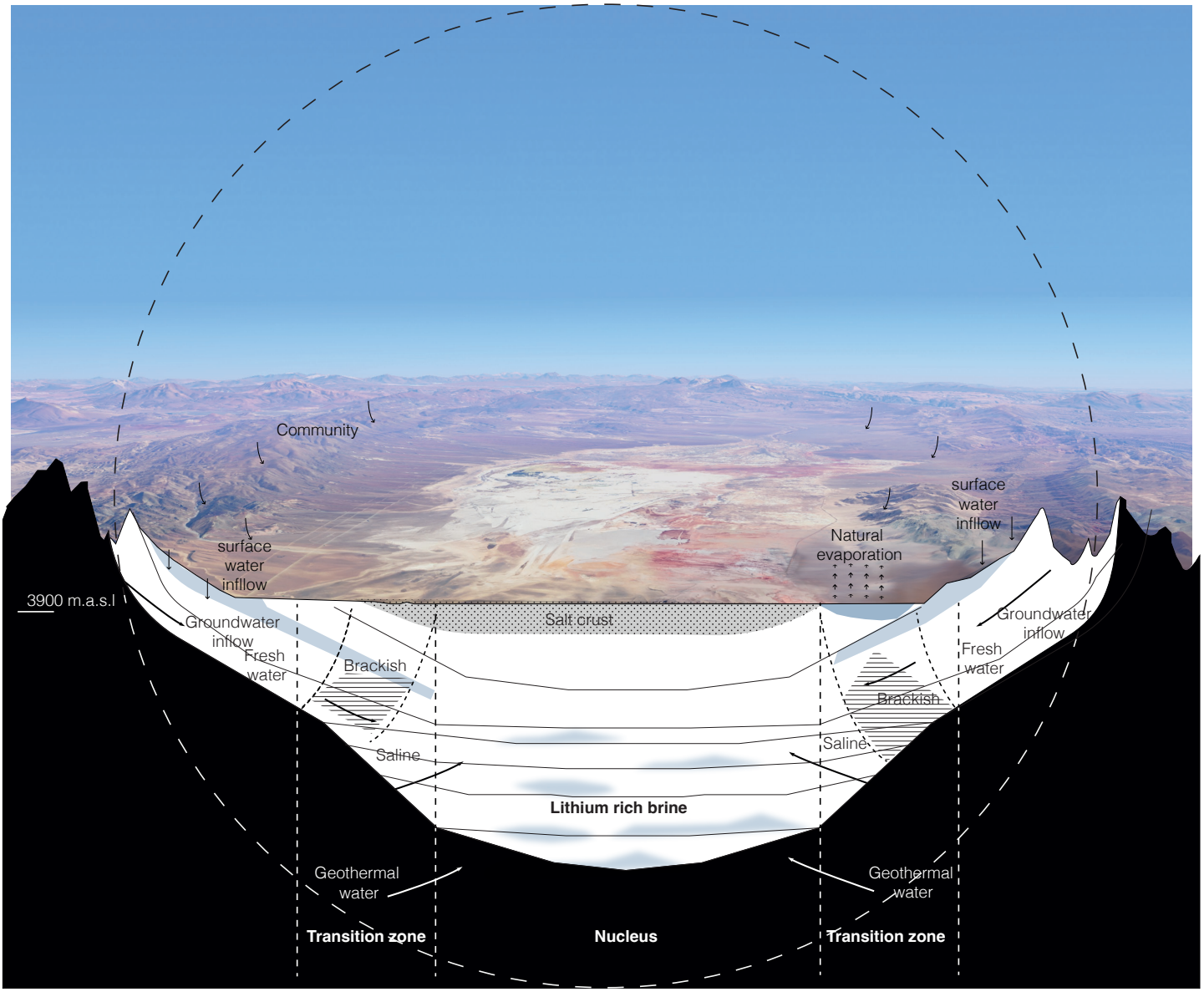
Problem Field

The Puna is not a resource area.

The particularity of the closed Andean basins is that the limited availability of water flows towards the central zone, as it is topographically lower. Thus, the depressed area is filled with thermal waters from volcanoes with high concentrations of sodium, potassium, magnesium, calcium and, of course, lithium salts. These salts are not contaminated by other sediments, mainly due to the scarcity of river systems that provide other types of material. As a result of the evaporation of the water, a build-up of chemical sediments (evaporites) is established, leaving a saline residue, mainly sodium chloride. The result is these mirror-like plains called salt flats, in whose humid interior the brine containing chemical elements, including lithium, remains liquid. (Fornillo et al., 2018. Gamba).

The type of host aquifers in the area correspond to what (Houston et al, 2011)call Immature salares. These are characterized by their greater moisture regimes (higher precipitation, lower evaporation),and hence tend to be more frequent at higher elevations and toward the wetter northern and eastern parts of the region. They are characterized by an alternating sequence of finegrained sediments and evaporitic beds of halite and/or ulexite, representing the waxing and waning of sediment supply under a variable tectonic and climatic history.

Most of the salares in the Puna de Atacama are closed watersheds that are located at high altitude and are considered fragile ecosystems. There, water is a limited and key asset for survival (Izquierdo et al, 2018) and ecosystem functioning. In them are present, in a delicate natural balance, freshwater systems (with low salinity levels), and very salty waters (“brines”), as well as fossil waters - groundwater housed in confined aquifers for hundreds of years which is a non-renewable resource - and modern.(Sticco et al, 2018).



scheme of the water cycle in Andean
Salares, author .

Chapter 1

Problem Field

The Puna is not a resource area.

The salares are endorheic systems fed by streams, rivers and vegas (which are humid areas with water-saturated soils), whose fauna is little known. According to Cristina Dorador (Diaz et.al,2021) they are the remnants of ancient paleo-lakes that occupied the entire area of the Atacama Desert and northern Chile. They house an important evolutionary heritage because of the high biodiversity and the high quantity of endemic species, which only grow and develop in these systems.
Recently, it was found that the salares are inhabited by extremophile microbial systems, so called because they are adapted to situations such as lack of oxygen and excessive ultraviolet radiation. They form complex ecosystems, carry out photosynthesis, produce a large amount of oxygen and capture carbon dioxide (Ahumada and Conicet, 2021). Each salt flat has unique microbial communities. When comparing and grouping all micro-organisms in them, you find these connecting nodes, where each node corresponds to a unique community found in a system.(Dorador in Diaz et.al,2021)

The vegas or bofedales are high-altitude wetlands, fed by groundwater, which form a small native grassland with permanent humidity. These freshwater oases support a great diversity of native fauna and flora (Conicet, 2021).



Water stream and vega at 4000masl in Jujuy, author,2025

Chapter 1

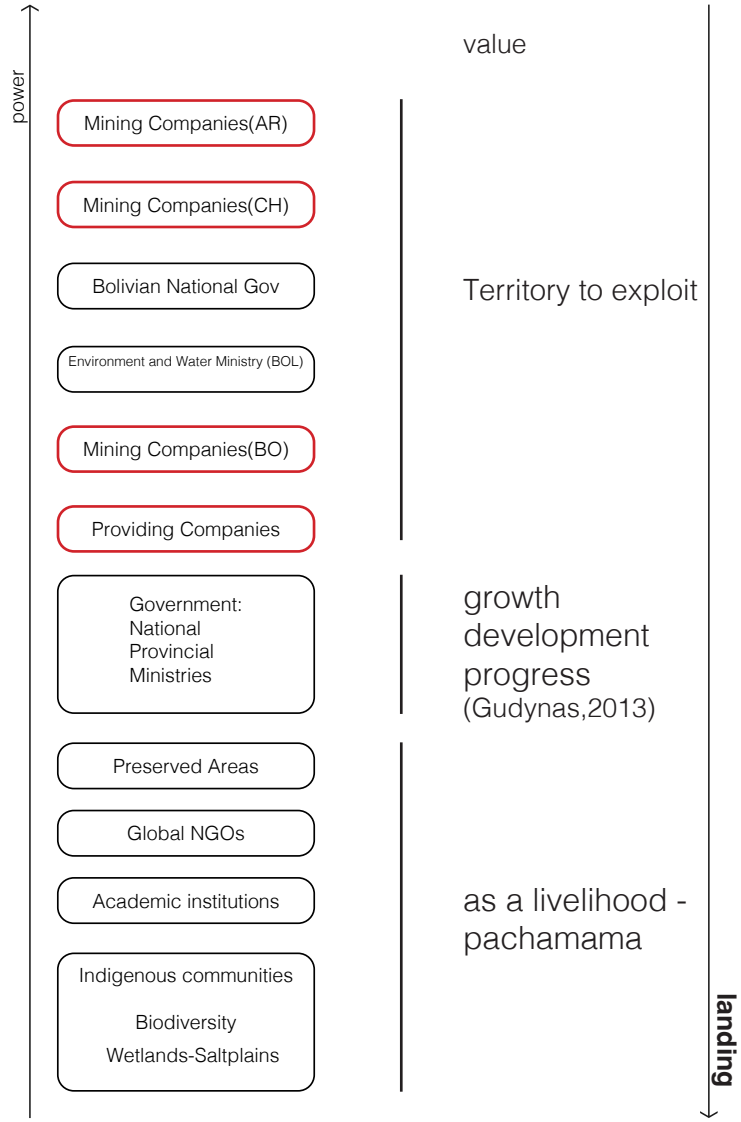
Problem Field

The Puna is not a resource area.

As mentioned in the introduction, this research is framed by the concepts of ‘landing’ and ‘contact zones’(Pratt, 2010, De la Cadena, 2023).
The power structure at the site is complex, with different stakeholders attributing vastly different values to the territory. From the perspective of global capital, the land is primarily viewed as a resource to be quantified, exploited and circulated within global markets. This logic is rooted in a modern ontology that is fragmented and dualistic, separating nature from culture, land from people, and value from life. It is also driven by local governments’ urgent desire to deliver rapid development, often at the cost of deepening power asymmetries and hiding public information, especially in regions that have long been neglected by the state.

In contrast, local communities relate to the land as Pachamama, or Mother Earth, not as a resource to be extracted, but as a living entity with which they share a reciprocal relationship. Land is not ‘owned’ or ‘used’; it is inhabited, cared for and honoured. This relationship embodies a radically different ontology, in which life and territory are co-constituted.

The clash between these two incommensurable territorial projects — one extractivist and capitalist, the other relational — creates a zone of friction. This is not merely a clash of interests or values, but a confrontation between distinct worldviews. Consequently, the arrival of extractive agendas in these territories creates a territorial and ontological contact zone — a space where multiple worlds converge, collide and compete for recognition, frequently within highly unequal power dynamics.





"Without water there is no life"
Mesa de las 33 comunidades
Source: www.chequeado.com

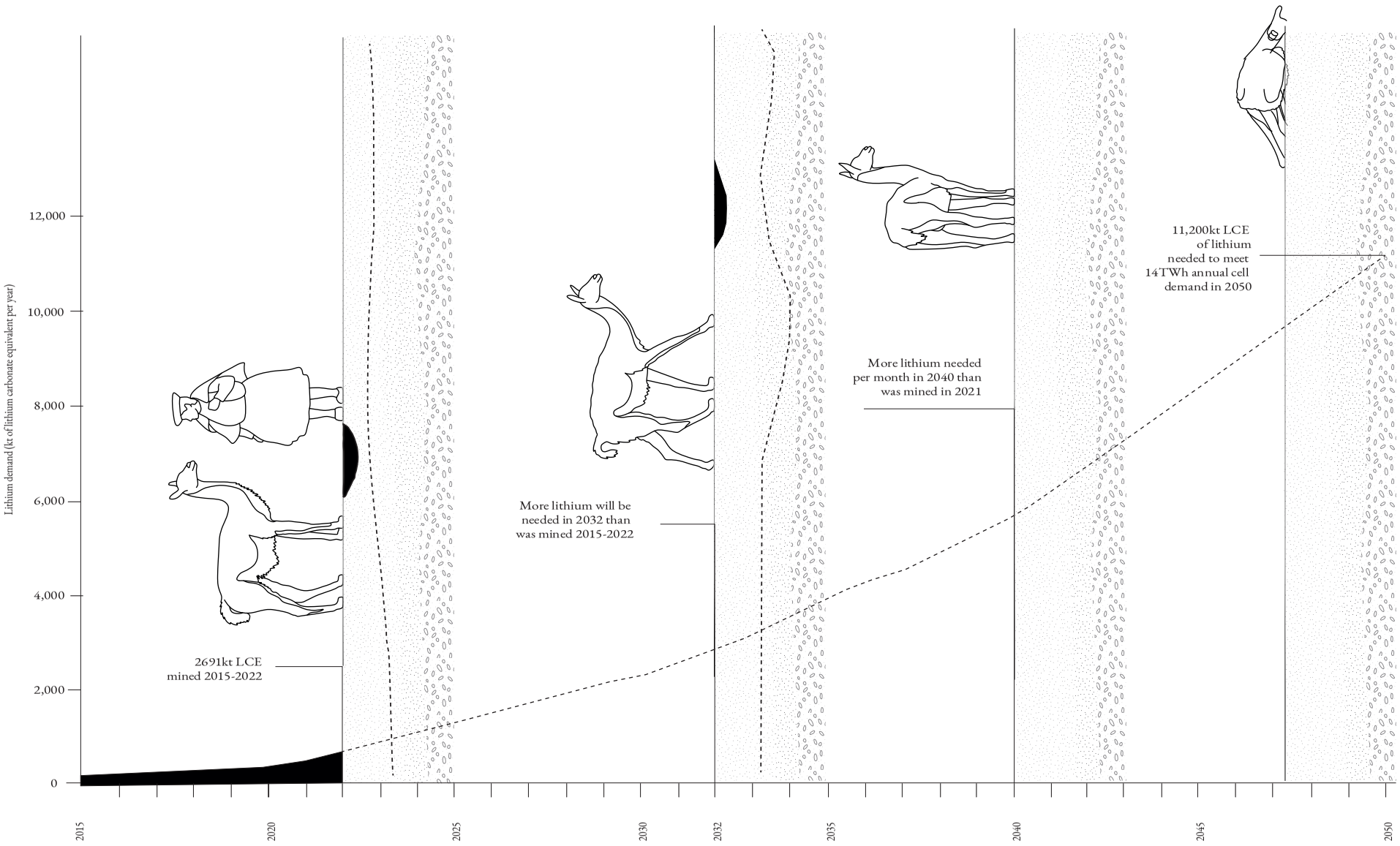
CHAPTER 2
METHODOLOGY

Problem Statement

The climate crisis and the pressure to reduce greenhouse gas emissions are driving the extractivism of critical materials such as lithium, creating ‘sacrificial zones’ under the banner of sustainability.
In the “Lithium Triangle”, located on the Puna de Atacama in the High Andean plateau, lithium is extracted through brine evaporation, an unconventional method, reinforcing the capitalist commodification of resources through advanced technologies. This extractive approach, rooted in a fragmented and dualistic worldview and driven by the need for rapid development from local governments imposes an oppressive territorial logic and offers limited public information deepening power imbalances, particularly in vulnerable areas with long histories of state neglect. While significant responses addressing the impacts of lithium mining are arising, the diversity of perspectives taken into account and lack of spatial coordination hinder the formation of a unified vision for a sustainable future.

Research Question

How can a territoriality* of brine extractivism on the Puna de Atacama be achieved with a balance of power over the territory for a truly ecologically, politically and economically sustainable future?
*Territoriality is much more than a strategy for the control of space,is both a social as well as a historical product (Escobar 2008; Sassen 2013, Delaney, 2009).



Lithium demand projection
Source: Benchmark Minerals

Chapter 2
Methodology

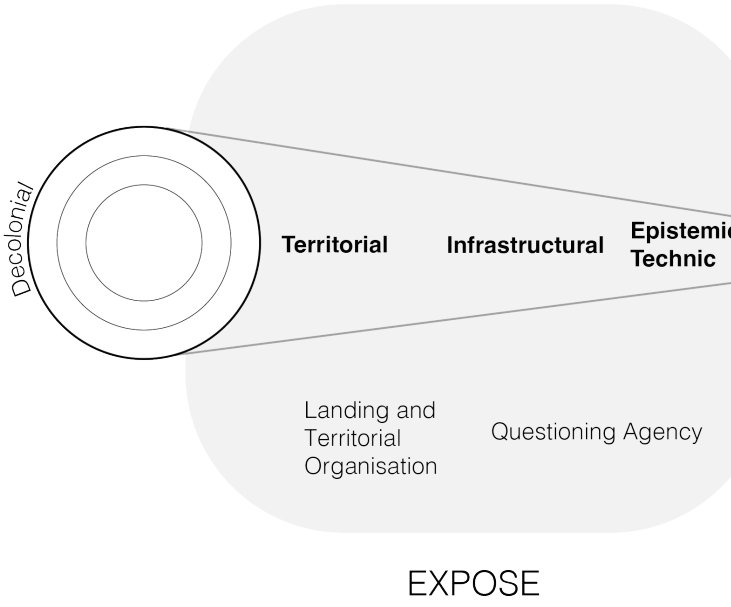
Hypothesis

By shifting the narrative and framing brine extractivism in the High Andean Plateau through a decolonial lens, opportunities for negotiations can emerge with a distributed agency that creates synergy between ontologies and thus a truly ecologically, politically and economically sustainable future.

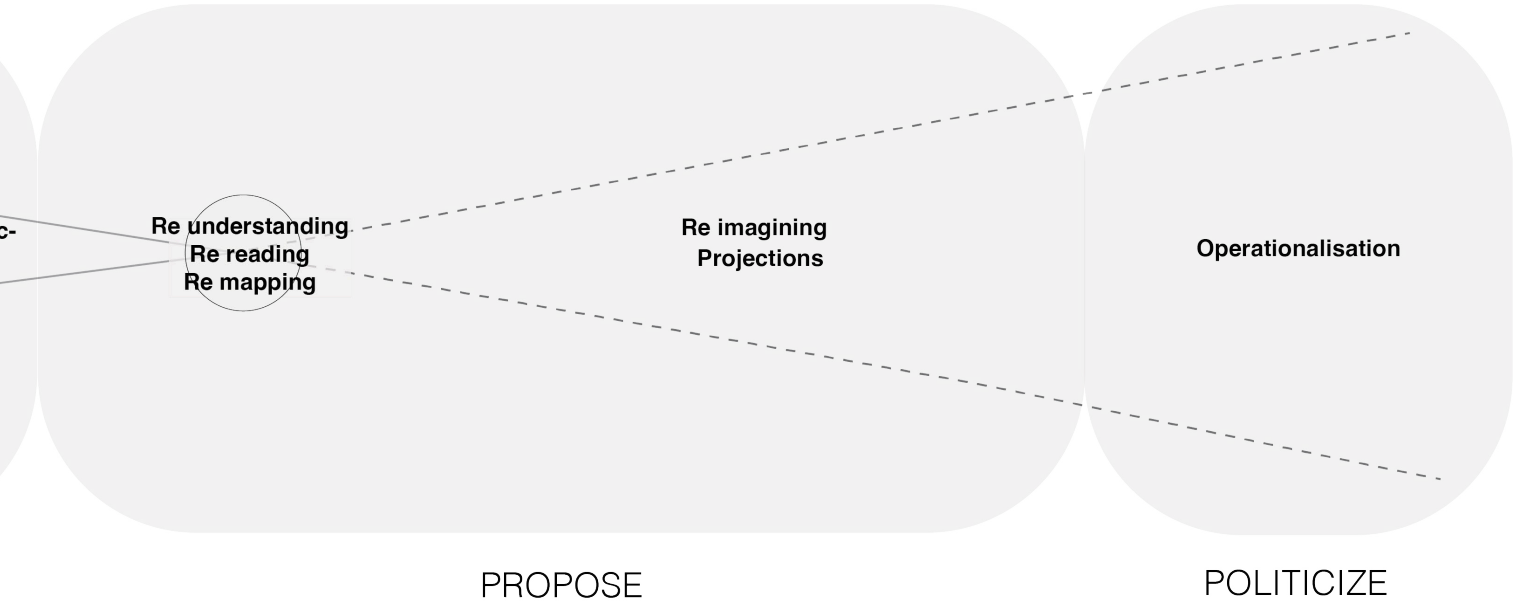
Aim

This research aims to broaden perspectives and identify shared values among different ontologies, with the ultimate goal of fostering synergies and negotiations through a framework of distributed agency.

To this end, it sheds light on the various narratives currently present in the territory to reveal the underlying logics of territorialisation. The project aligns with Peter Marcuse's (2009) critical urbanist framework, which proposes a threefold strategy of exposure, proposal and politicisation as a method for transformative spatial intervention.



EXPOSE


Re understanding
Re reading
Re mapping
Re imagining
Projections
Operationalisation
PROPOSE
POLITICIZE

Chapter 2

Methodology

Theoretical approach and Sub Research Questions

This research employs a scalar theoretical approach that organizes conceptual tools across different levels of analysis: from broad epistemic structures to local material dynamics.

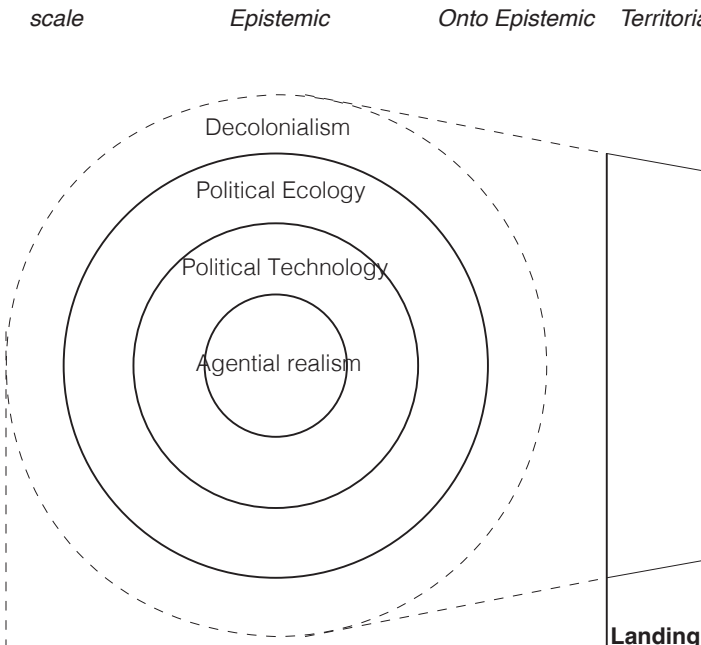
By layering theories according to scale, it becomes possible to address the complexity of lithium extraction in the Puna de Atacama through multiple, interconnected dimensions: civilizational, ontological, territorial, and infrastructural.

At the macro scale, decolonial theory provides an overarching critique of the coloniality of knowledge, power, and being, framing the analysis within broader struggles against epistemic and territorial dispossession.

Moving to the meso scale, concepts such as distributed agency and ecologies of knowledge highlight the ontological diversity and relationality of Indigenous worldviews, where humans, nonhumans, and the land co-constitute meaning and agency.

At the territorial scale, political ecology examines how environmental conflicts unfold through asymmetrical power relations, particularly in the governance of natural resources and the environmental impacts of extractivism.

Finally, at the micro or material scale, theories of political technology and agential realism enable an analysis of how legal frameworks, technical infrastructures, and extractive apparatuses act as political agents in shaping socio-material realities.



EXPOSE

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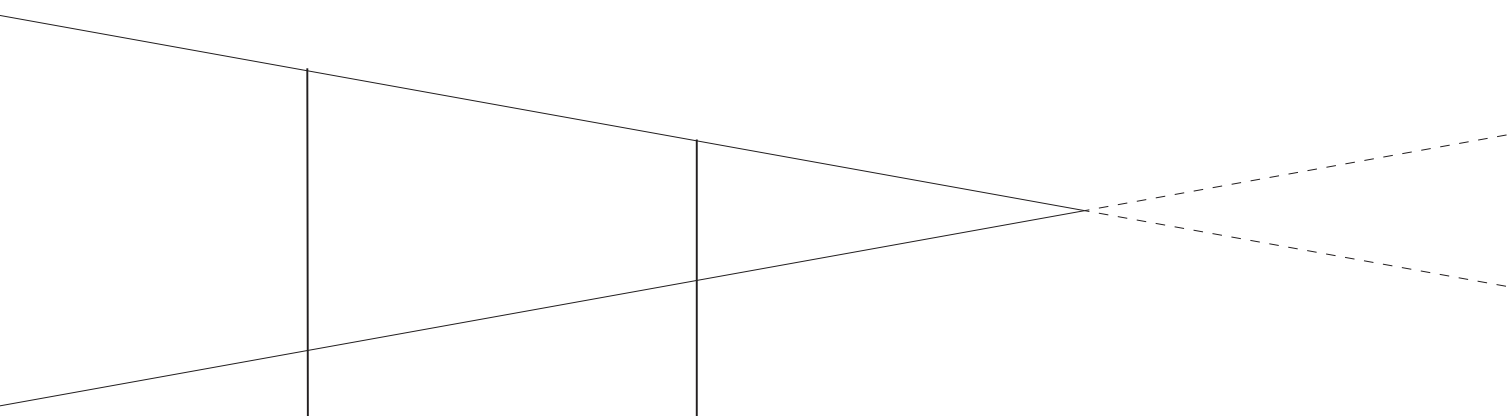


and
al Organisation

What conflicting territorial
es emerge in the operational
oes of lithium mining,
are they constituted?
these ontologies shape
l organisations, and what
socio-environmental impacts
?
hat are the points of inter-
and friction between domi-
ractive territorial logics and
itorial practices? In what
these encounters generate
nflict and potential opportuni-
more plural and equitable
l governance?

Questioning Agency

SRQ3: How has the agency of local communities historically evolved, and what forms does it take in current decision-making processes regarding territorial governance?

SRQ4:What are the agential cuts -mechanisms, instruments, and practices- through which the shaping of territory is negotiated in the context of the Salar de Olaroz and Laguna de Guayatayoc?
SRQ5: How is the territory interpreted, measured, and represented? Which knowledge and tools are taken into account in the production of territorial knowledge?

Thinking about a just negotiation

SRQ6: What forms of intervention could be proposed to enable equitable negotiation processes and spatial justice among diverse territorial actors?

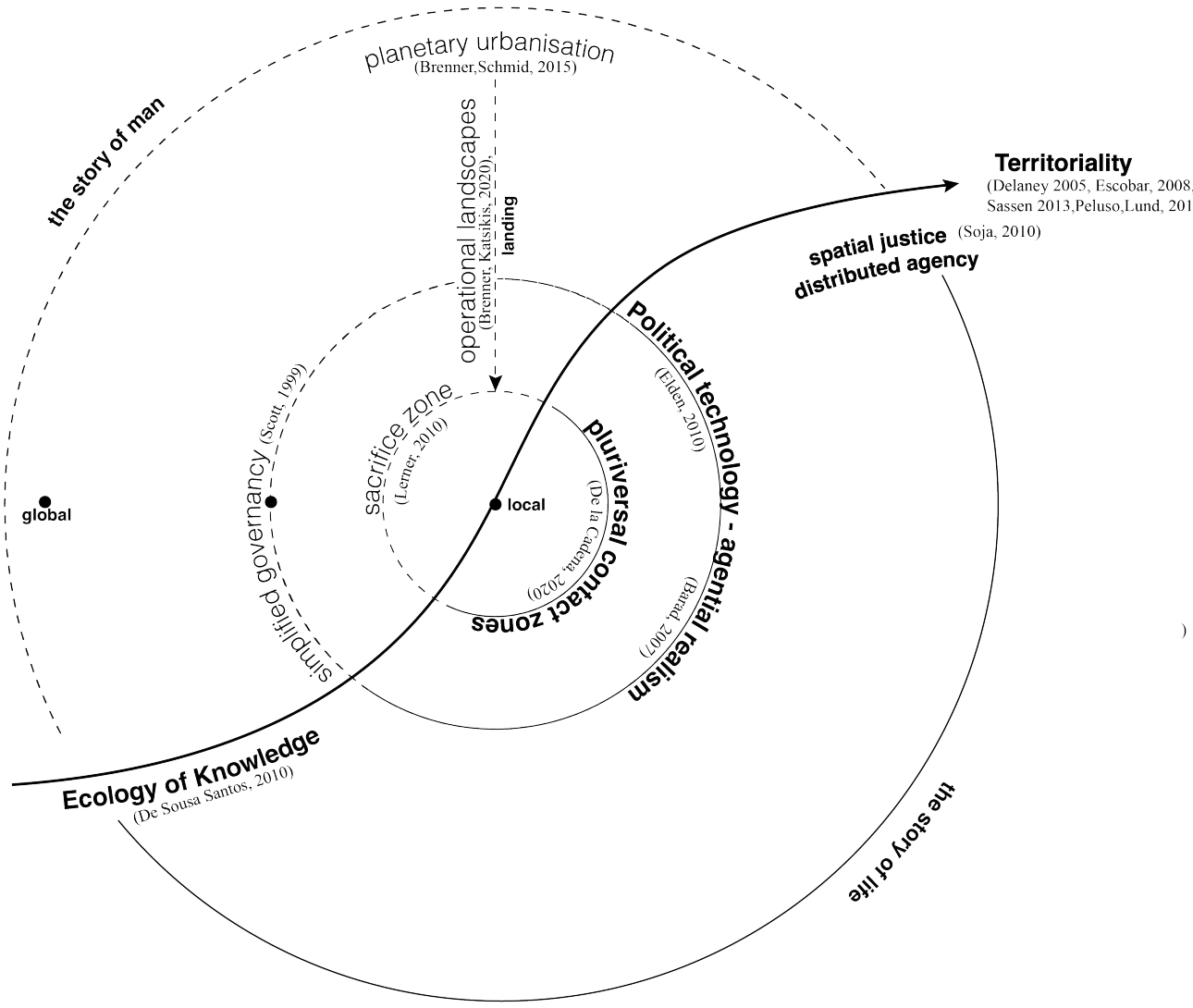
Chapter 2
Methodology
Theoretical Foundations

At the macro scale, this research is framed by a decolonial feminist perspective, using Marisol de la Cadena and Arturo Escobar's concept of "The story of man and the terricide" as a starting point for understanding the presence of a pluriverse and thus pluriversal contact zones developed in "Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds (Escobar, 2017)", "Pluriversal Contact Zones: Storying a World of many Worlds (de la Cadena, 2023). These dynamics present in these contact zones, are guided by Anna Tsing's gaze in " Friction: An Ethnography of Global Connection".

At the territorial scale, this research uses a political ecology perspective, based on these texts: Territorial organization and the space/ technology nexus (Swyngedouw, E, 1992) and 'Planetary Mine: Territories of extraction under late capitalism" (Arboleda,2020). The framing of the area and the lens was guided by Operational Landscapes: Hinterlands of the Capitalocene (Brenner, Katsikis, 2020),
Challenging the dominant anthropocentric view from a decolonial perspective based on the previously explained authors, territoriality is understood as a relational process in constant transformation, where governance is configured in close relation to ecological, social and political dynamics.

Within this framework, and in an infrastructural scale the research builds on the notion of "political technology" developed by Stuart Elden in "Land, terrain, territory" (2010) and the critique of simplified governance mechanisms developed by Scott in "Seeing like a State" (1999).

Finally, at the micro or material scale, connected with the onto-epistemic one, and after having developed the theories and understanding territory as a relational, complex, and unequal framework, also shaped by technologies and devices of power, as Stuart Elden argues, it is essential to examine the agency of the actors involved in its production.
To this end, I use the concept of distributed agency to problematise dominant ways of knowing and governing space. I use texts such as Karen Barad's Agential Realism in "Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning"(2007), and Ecology of knowledge in "Epistemologies of the South: Justice Against Epistemicide" (Boaventura de Sousa Santos,2014) to understand and challenge dominant ways of producing knowledge about space.



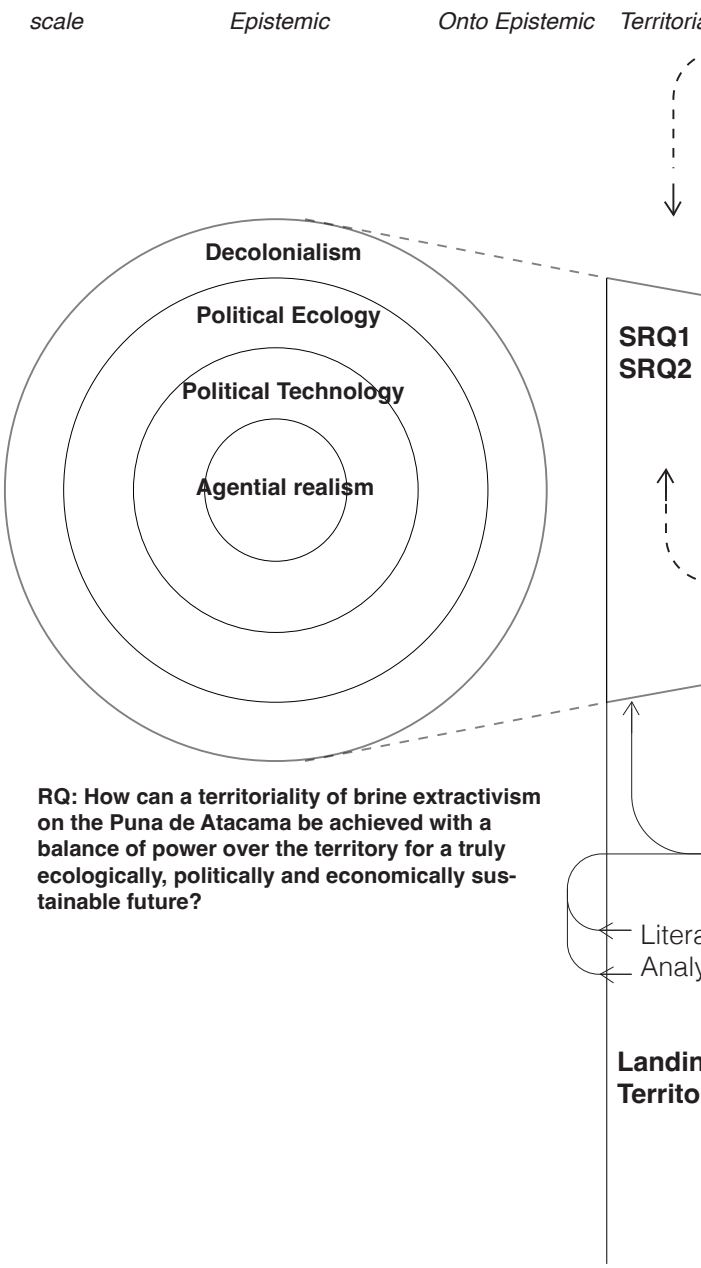
Conceptual Framework

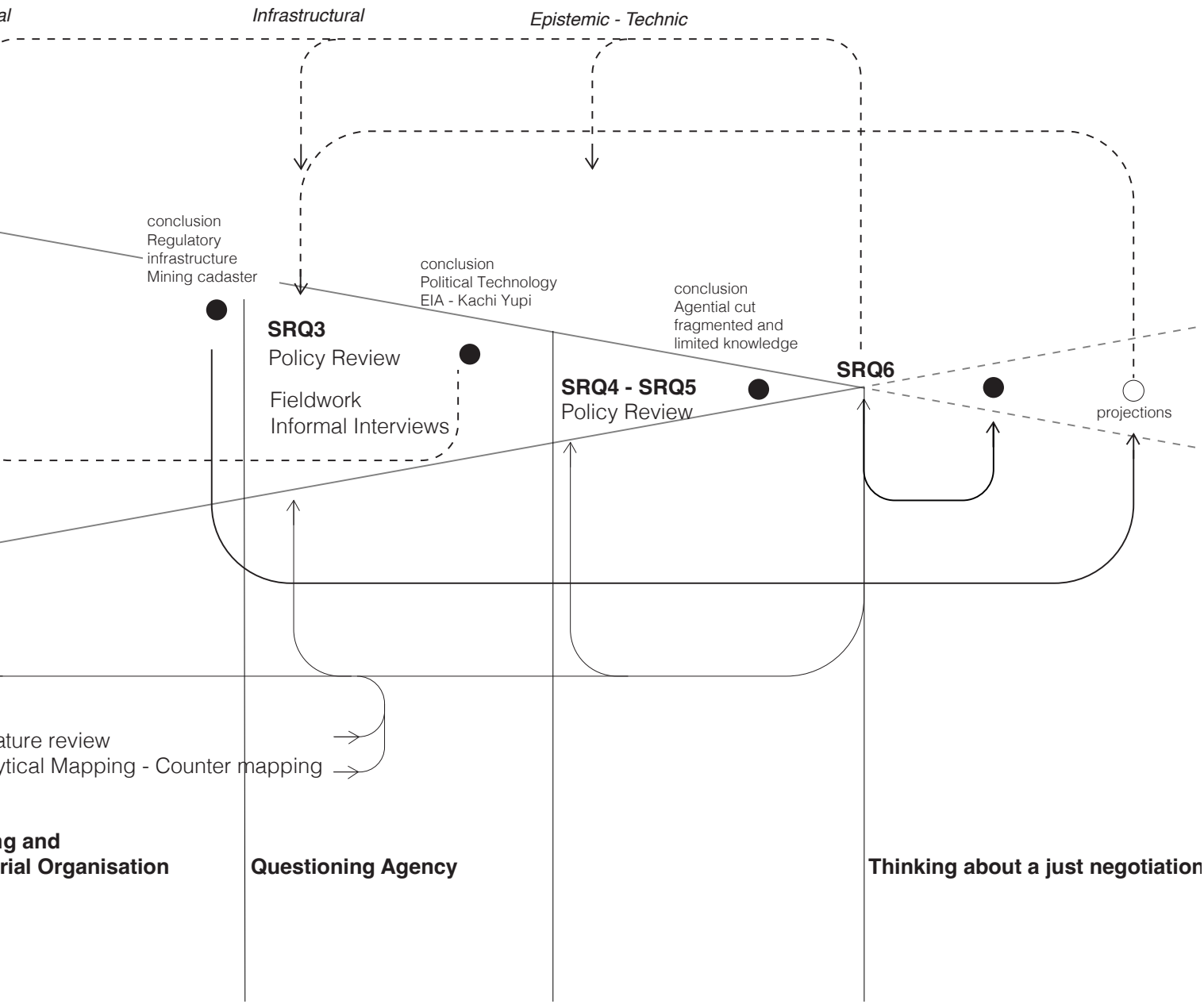
Chapter 2
Methodology
Methodological path

In line with the theoretical framework, the research methodology adopted a layered approach, focusing on the territorial, infrastructural and epistemic-technical layers of power. These layers were considered interconnected rather than separate, with insights from one layer often informing and reframing the others. The alignment and reframing of each layer was continuously informed by the conclusions and methods applied to the others.

Due to the general lack of available information, the primary structure of the research was a literature review. Combined with ongoing analytical work and counter-mapping, this review shaped subsequent methods and enabled me to focus on areas not covered by prior studies during fieldwork, as well as testing previous findings on site. This iterative process of projection and research enabled the alignment of the infrastructural layer, for example, which emerged from interactions mapped within territorial organisation and required a policy review. This critical juncture necessitated an Environmental Impact Assessment (EIA) policy review and led to the alignment of the entire research project according to the different layers studied.

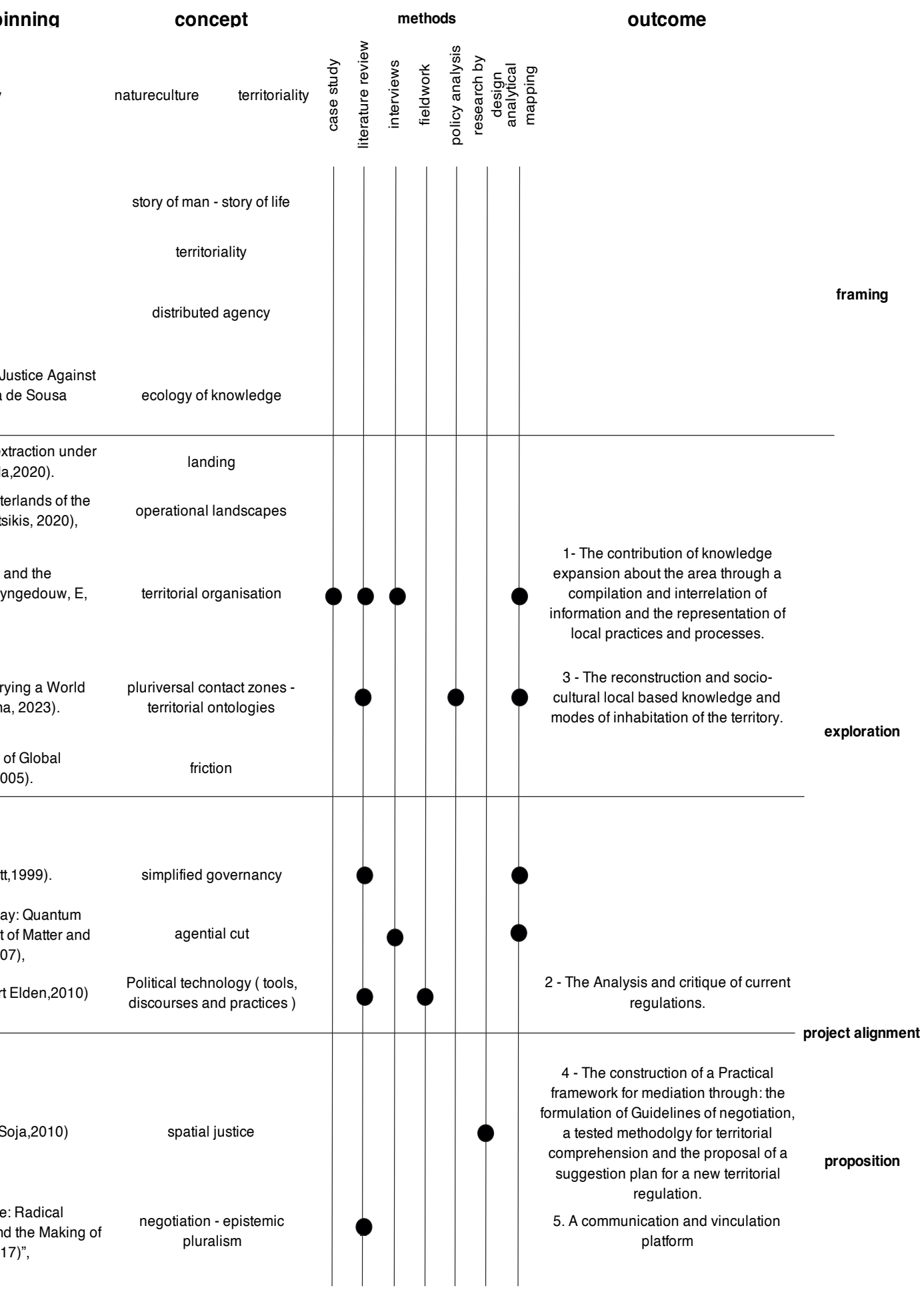
Overall, the chosen methods and methodology allowed for flexibility while maintaining a grounded, situated understanding of power relations, ensuring that the research remained theoretically informed and empirically grounded.




al
Infrastructural
Epistemic - Technic
conclusion
Regulatory
infrastructure
Mining cadaster
conclusion
Political Technology
EIA - Kachi Yupi
conclusion
Agential cut
fragmented and
limited knowledge
SRQ3
Policy Review
Fieldwork
Informal Interviews
SRQ4 - SRQ5
Policy Review
SRQ6
projections
ature review
ytical Mapping - Counter mapping
g and
rial Organisation
Questioning Agency
Thinking about a just negotiation

Chapter 2
Methodology
Research Matrix

chapter	Research questions	theoretical underp
		political ecology
	RQ: How can a territoriality of brine extractivism on the Puna de Atacama be achieved with a balance of power over the territory for a truly ecologically, politically and economically sustainable future?	decolonialism
	hypothesis By understanding different logics operating on the Puna de Atacama territory, and through a decolonial lens, opportunities for negotiation can emerge with a distributed agency that creates synergy between ontologies and knowledge, thus a truly ecologically, politically and economically sustainable future.	
		"Epistemologies of the South: Epistemicide" (Boaventura Santos,2014)
	Landing and Territorial Organisation: unveiling and exposing processes in tension	'Planetary Mine: Territories of e late capitalism" (Arboled
		"Operational Landscapes: Hin Capitalocene" (Brenner, Kat
3	Srq1: What conflicting territorial ontologies emerge in the operational landscapes of lithium mining, and how are they constituted? How do these ontologies shape territorial organisations, and what are the socio-environmental impacts of them?	"Territorial organization space/technology nexus" (Sw 1992),
	Srq2: What are the points of intersection and friction between dominant extractive territorial logics and local territorial practices? In what ways do these encounters generate both conflict and potential opportunities for more plural and equitable territorial governance?	"Pluriversal Contact Zones: Sto many Worlds (de la Cade
		"Friction: An Ethnography Connection"(Tsing, 2
	Questioning Agency and how it is shaping the territory:	
4	Srq3: How has the agency of local communities historically evolved, and what forms does it take in current decision-making processes regarding territorial governance?	Seeing like a State (Sco
	Srq4:What are the agential cuts -mechanisms, instruments, and practices- through which the shaping of territory is negotiated in the context of the Salar de Olaroz and Laguna de Guayatayoc?	"Meeting the Universe Halfw Physics and the Entanglemen Meaning"(Barad,20
5	Srq5: How is the territory interpreted, measured, and represented? Which knowledge and tools are taken into account in the production of territorial knowledge?	"Land, terrain, territory" (Stua
	Thinking about a just negotiation	
8	Srq6: What forms of intervention could be proposed to enable equitable negotiation processes and spatial justice among diverse territorial actors?	"Seeking Spatial Justice" (
		"Designs for the Pluriverse Interdependence, Autonomy, an Worlds (Escobar, 20


pinning
concept
methods
outcome
natureculture
territoriality
case study
literature review
interviews
fieldwork
policy analysis
research by design
analytical mapping
story of man - story of life
territoriality
distributed agency
ecology of knowledge
framing
Justice Against
a de Sousa
xtraction under
la,2020).
landing
terlands of the
tsikis, 2020),
operational landscapes
and the
yngedouw, E,
territorial organisation
1- The contribution of knowledge expansion about the area through a compilation and interrelation of information and the representation of local practices and processes.
rying a World
ha, 2023).
pluriversal contact zones - territorial ontologies
3 - The reconstruction and socio-cultural local based knowledge and modes of inhabitation of the territory.
exploration
of Global
005).
friction
tt,1999).
simplified governancy
ay: Quantum
t of Matter and
07),
agential cut
rt Elden,2010)
Political technology (tools, discourses and practices)
2 - The Analysis and critique of current regulations.
project alignment
Soja,2010)
spatial justice
4 - The construction of a Practical framework for mediation through: the formulation of Guidelines of negotiation, a tested methodolgy for territorial comprehension and the proposal of a suggestion plan for a new territorial regulation.
proposition
e: Radical
nd the Making of
17)",
negotiation - epistemic pluralism
5. A communication and vinculation platform

Chapter 2

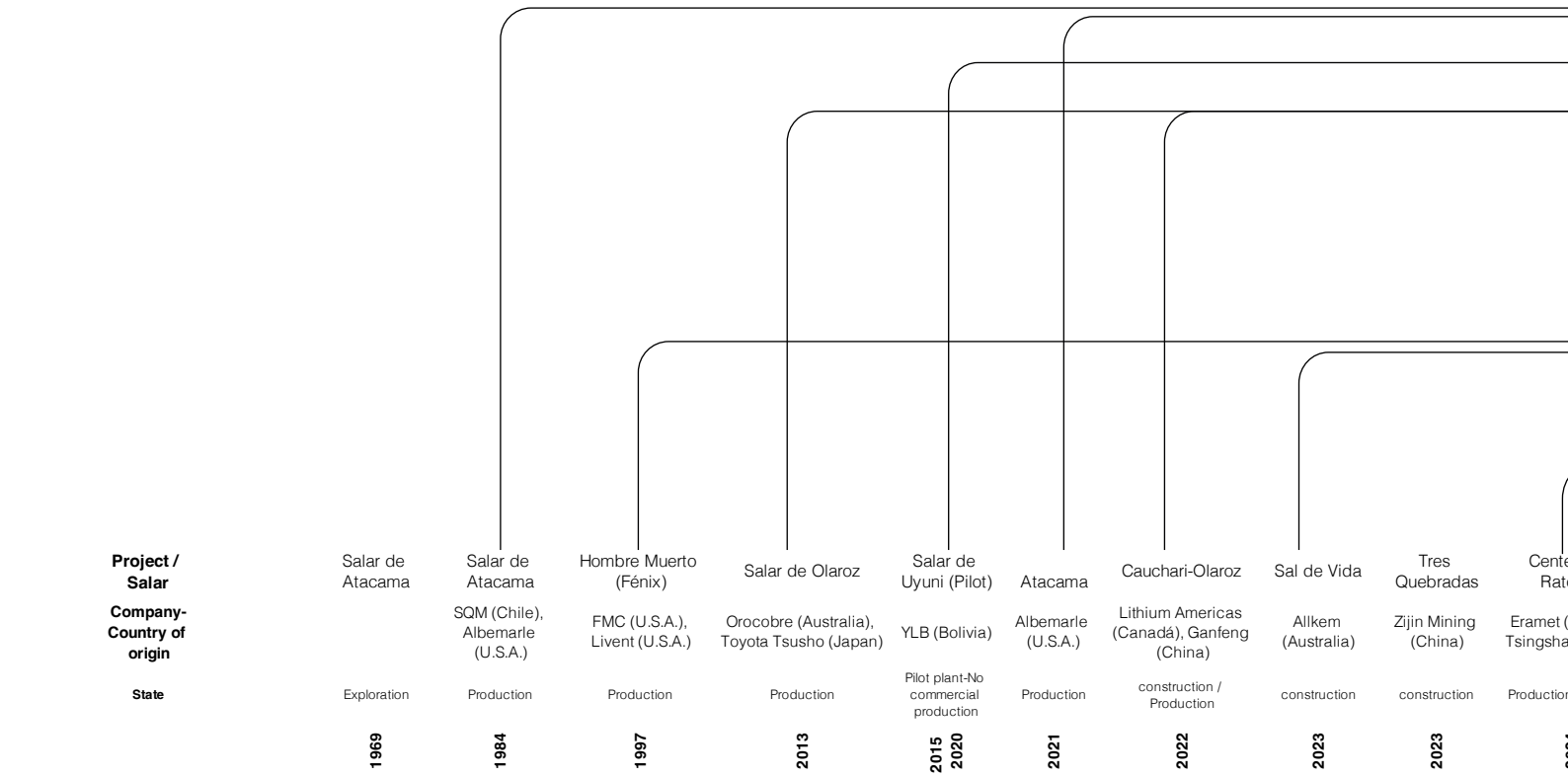
Methodology

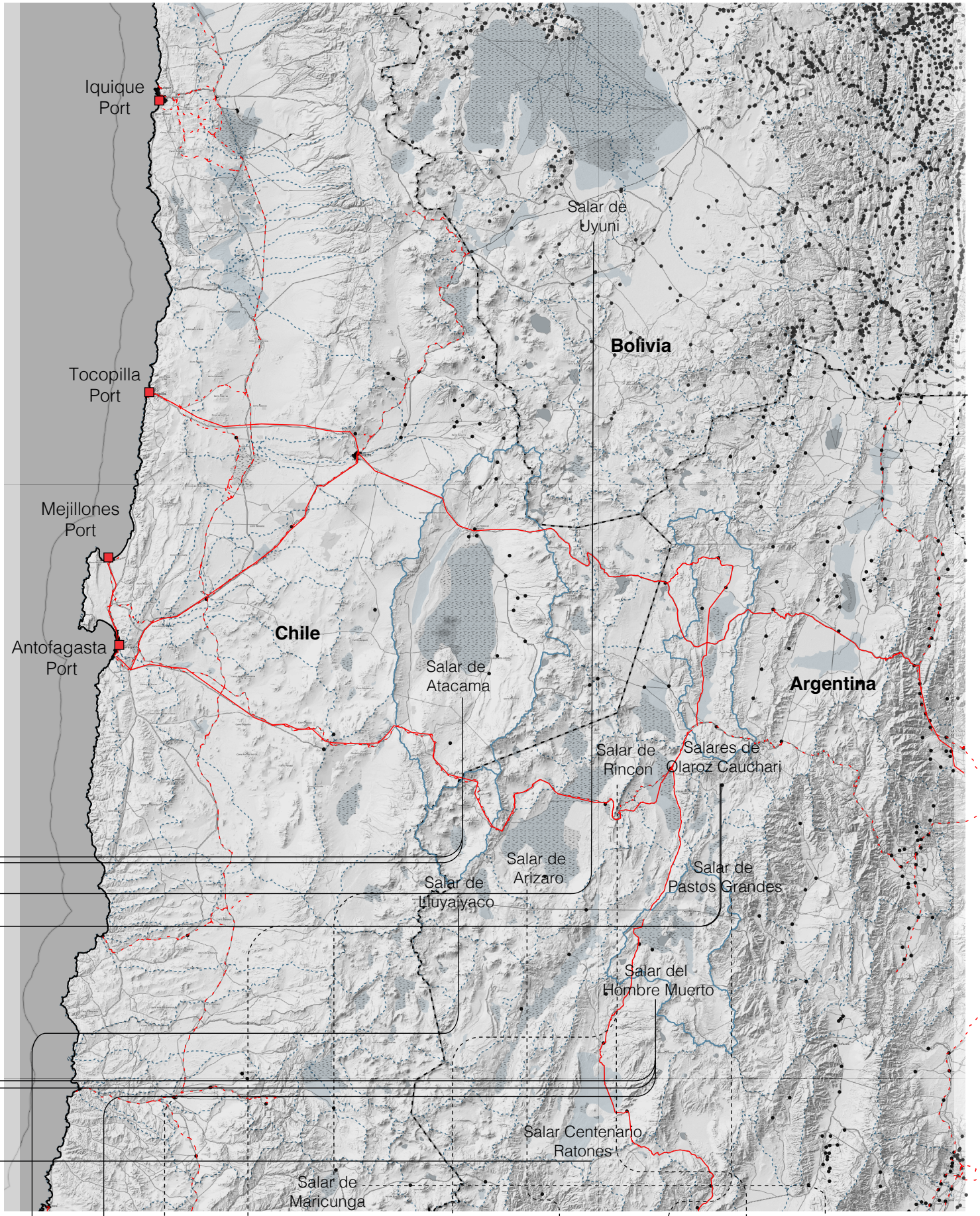
Case Study Definition

Lithium exploration in the Puna de Atacama region began around 1970, initially centring on the Salar de Atacama area. Until around 2010, exploration and production activities remained relatively limited. A significant milestone in the region's lithium industry was reached in 1997 with the commencement of commercial production at the Salar del Hombre Muerto.

Around 2010, there was a noticeable acceleration in lithium exploration in the area, accompanied by the establishment of new lithium carbonate production facilities. The Sales de Jujuy plant in Olaroz began production in 2013. During this period, multiple new exploration projects with concrete production projections targeting 2030 were initiated, effectively pushing forward and expanding the region's extractive frontiers.

There was also significant dynamism in corporate partnerships and ownership, which shaped the lithium sector. Since I began my research in September 2024, several major changes have occurred. For instance, the Sales de Jujuy operations at Salar de Olaroz, which were initially managed by Allkem (Australia) and Livent (U.S.), merged to form Arcadium Lithium in January 2024. Then, in March 2025, Arcadium Lithium was acquired by Rio Tinto (UK and Australia). These developments reflect the ongoing restructuring and realignment of key players in the lithium market.





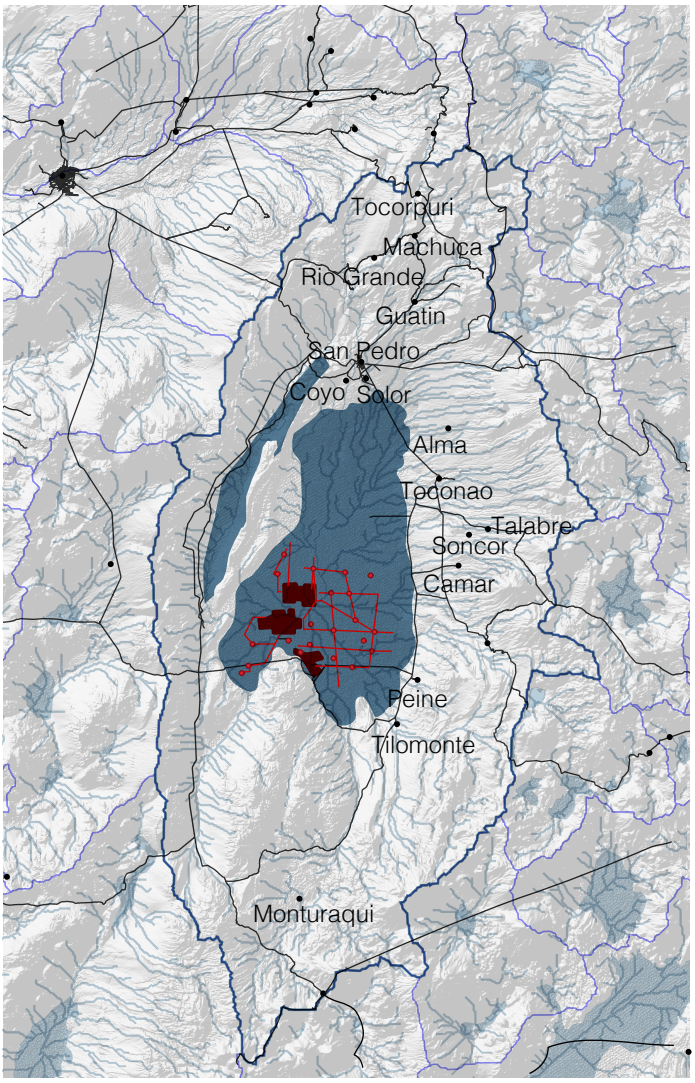
	Mariana	Sal de Oro	Sal de Oro	Cauchari-Olaroz	Uyuni + Coipasa	Rincón (Salta)	Arizaro	Pastos Grandes	Rincón Litio	Salar de Maricunga
	Ganfeng Lithium (China)	POSCO (South Corea)	POSCO (South Corea)	Lithium Americas (Canadá), Ganfeng (China)	YLB (Bolivia), CATL (China), CBC (China)	Rio Tinto (UK/ Australia)	Lithium South Development Corporation (Canada)	Galan Lithium (Australia)	Argosy Minerals (Australia)	Codelco (Chile) + private
	Production	Hydroxide plant in operation	Expansion	Expansion	exploration-construction stages: projection of production in:					
	2024	2024	2025	2025	2025	2026	2026	2026	2028	2030

Chapter 2

Methodology

Case Study Definition

A comparative analysis of various salares was done to select the case study, considering variables such as altitude, the hydrogeological maturity of the basins based on Houston et al, 2011, that indicate the depth of extraction wells as well as the impacts, extraction and processing type, the level of consolidation of extractive projects, diversity of actors involved, governance trajectories, presence of local communities and availability of information. The Salar de Uyuni in Bolivia, although it has operations, was excluded from the study due to its uniqueness within the regional context according to its centralised, state-led model of the Bolivian Government.



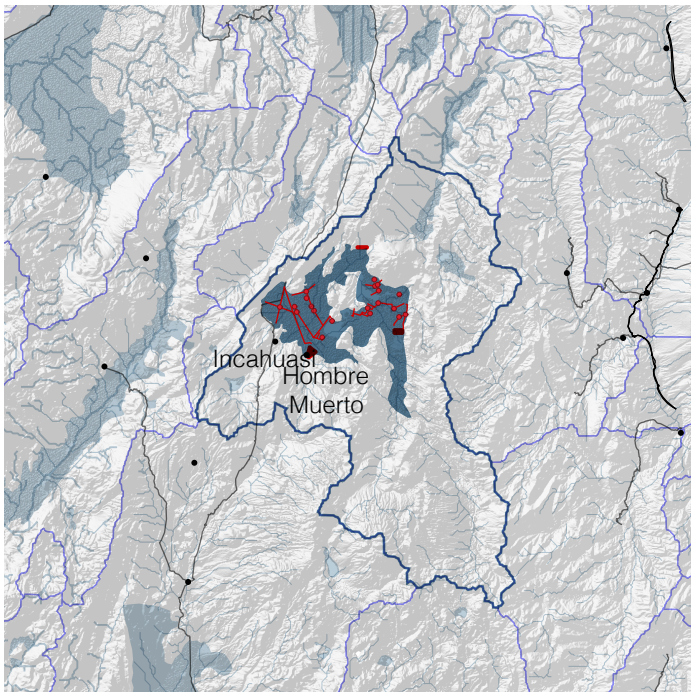
Salar de Atacama (Chile)

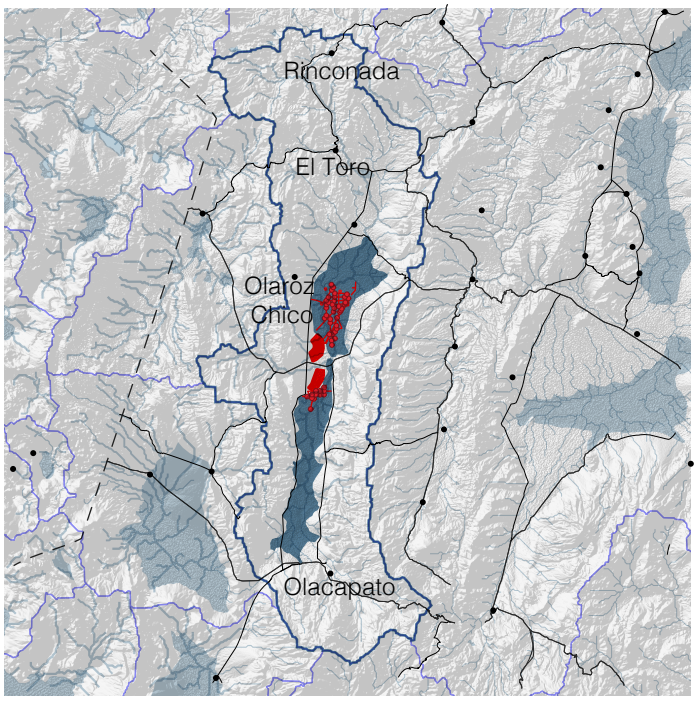
Elevation: 2,300 m.a.s.l.
Type: Mature salar
Lithium companies:
SQM (Chile),
Albemarle (USA)
In operation since: 1980s
Annual production: Approx. 40,000–70,000 tons of lithium carbonate

Water stream
Salar
Watershed
Lithium facility
Lithium pumps and wells
Community
Road
Railway

50km

N





Salar del Hombre Muerto (Argentina)
Elevation: ~4,000 m.a.s.l.
Type: Mix
Lithium companies: Livent (USA), Galaxy Resources / Allkem (Australia), POSCO (South Korea)
In operation since: 1997 (Livent)
Annual production: Plant designed for ~18,000 tons; actual production in the lower range

Salar de Olaroz–Cauchari (Argentina)
Elevation: ~3,900–4,000 m.a.s.l.
Type: Immature Salar
Lithium companies: Minera Exar – joint venture of Lithium Americas (Canada), Ganfeng (China), and JEMSE (Argentina)
In operation since: Mid-2023
Annual production:
2023: ~6,000 tons
2024: ~25,400 tons
Projected 2025: ~30,000–35,000 tons

Chapter 2
Methodology
Scales - Case Study

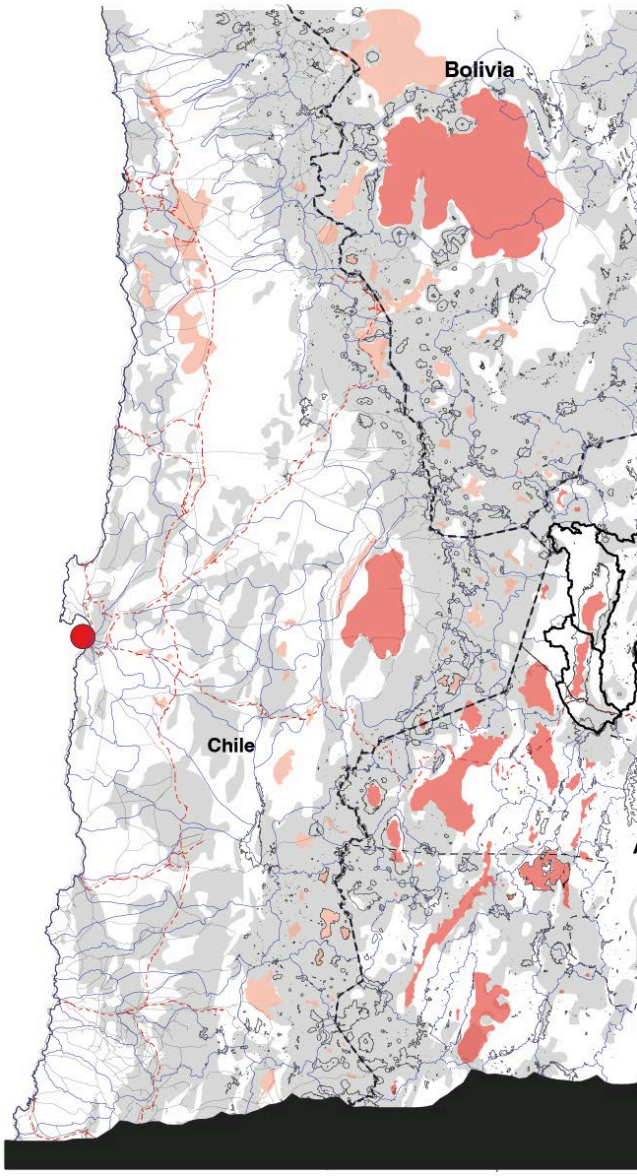
In order to carry out research that could be useful for future further studies, I investigated areas that are critical for future mining interventions in salt flats, focusing on complex cases of conflictual dynamics that present the following conditions:

Governance: as explained above, Argentina being a context characterised by more lax regulations regarding lithium extraction practices and by a neoliberal resource policy, it has a greater role in South America in the exploration in salt flats and is foreseeable a future with more mining operations.

Social: To answer the second sub-question of the research, two communities with different reactions to lithium mining were explored and analysed.

Natural: Geological composition determine both the amount of lithium and the maturity of the salar. This is related with the sediment porosity and thus the economic feasibility and the type of impact on the water table. Current explorations for future lithium extractivism are mainly on immature salars, and Olaroz Cauchari salar is the only immature salar with current lithium operations.

Further, for this reason,two main areas been analytically explored, the Salinas Grandes, the Laguna de Guayatayoc basin and the Olaroz Cauchari basin were chosen as study areas, and each water basin specifically investigated.



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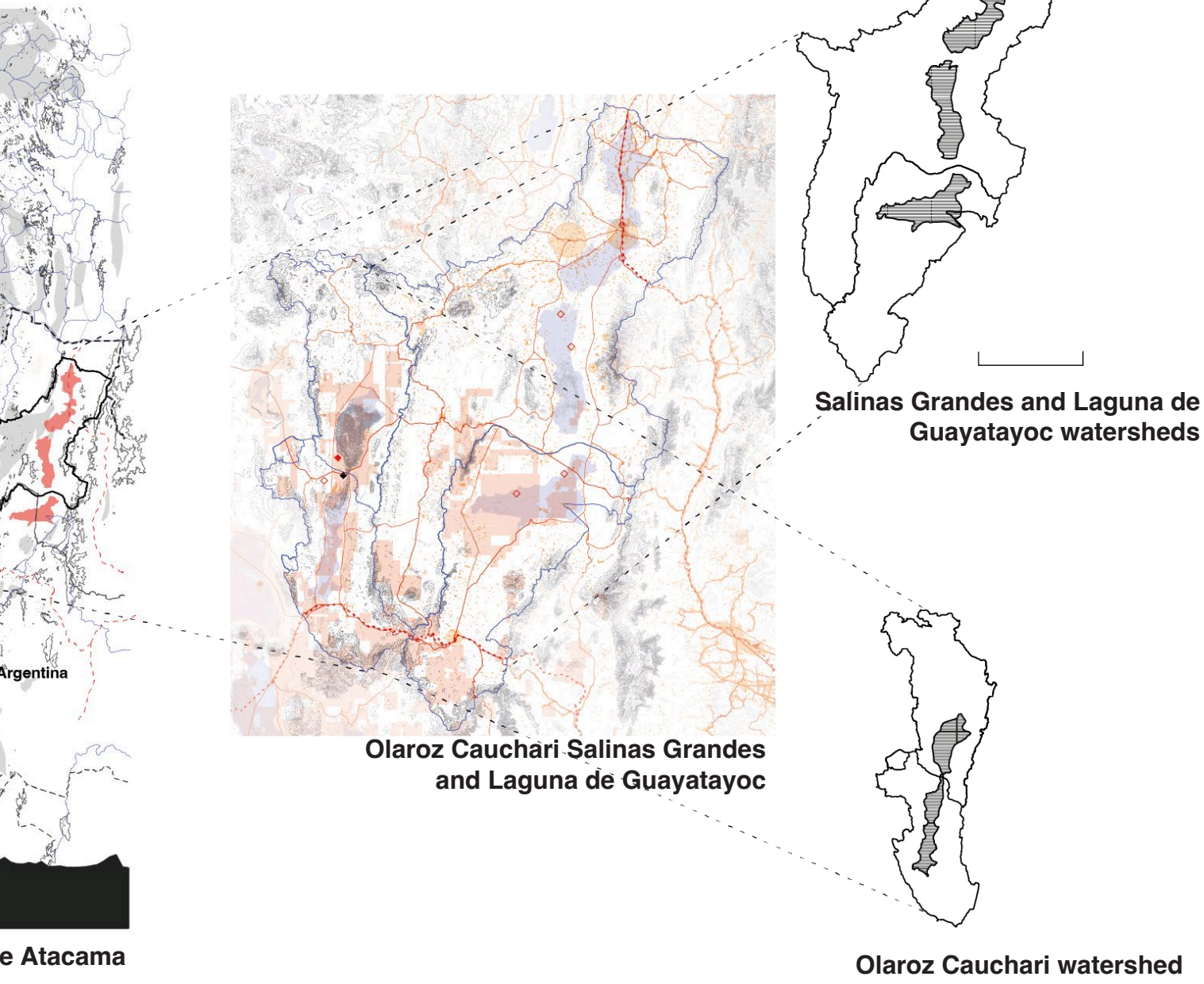
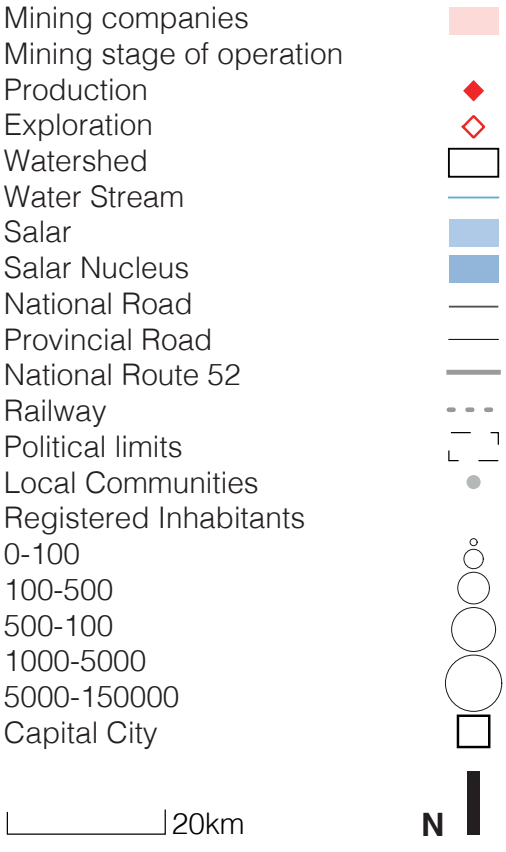
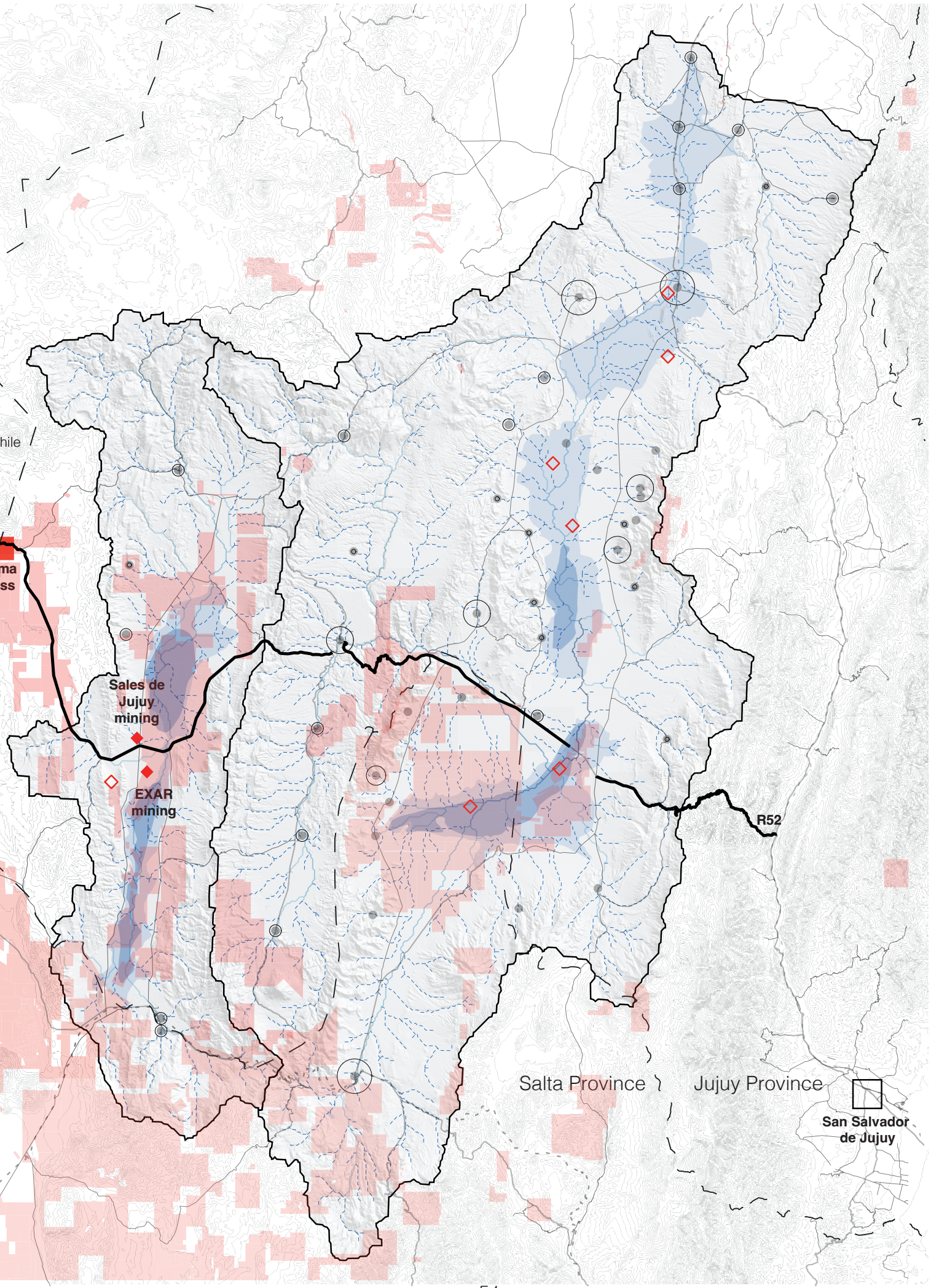

Argentina
e Atacama
Olaroz Cauchari Salinas Grandes
and Laguna de Guayatayoc
Salinas Grandes and Laguna de
Guayatayoc watersheds
Olaroz Cauchari watershed

Chapter 2
Methodology
Context-Case Study

The area is located in Argentina, between the Provinces of Salta and Jujuy. At an altitude of over 3,000 metres above sea level, it consists of two groups of contiguous basins with similar natural characteristics. Lithium mining companies began exploring the area around the same time (2008 in Olaroz Cauchari and 2010 in Salinas Grandes and Laguna de Guayatayoc) and the communities of the basins responded differently, while the 10 indigenous communities surrounding the Salar de Olaroz-Cauchari largely collaborate with the mining companies, the 33 communities living in close proximity to Salinas Grandes protest against any form of exploration and mining. (Dorn, 2021)

The area is home to ndigenous communities who identify themselves as descendants of pre-hispanic peoples and claim their pre-existence in the territories (Pragier, 2022) as pueblos Atacameños and Kollas. They are organised as small communities, widely scattered. The area is crossed from east to west by the National Route 52, which is part of a bioceanic corridor between Sao Pablo in Brasil and the Pacific Ocean through the Jama Pass crossing to Chile.




Sales de
Jujuy
mining
EXAR
mining
R52
Salta Province
Jujuy Province
San Salvador
de Jujuy

CHAPTER 3
LANDING AND TERRITORIAL ORGANISATION: UNVEILING AND EXPOSING PROCESSES IN TENSION

This chapter explores the different processes of territorialisation that emerge from the encounter between two contrasting ontological regimes: an **extractivist ontology** [1],as expressed through contemporary lithium mining practices, and an **Andean ontology,** rooted in long-standing local modes of inhabiting and relating to the land.

The chapter is therefore organised into two main sections. The first analyses the territorial organisation and spatial-material effects of lithium extraction, understood as an expression of extractivist ontology. The second engages with Andean ontologies through situated local practices such as salt harvesting, pastoralism, agriculture, and ritual life.

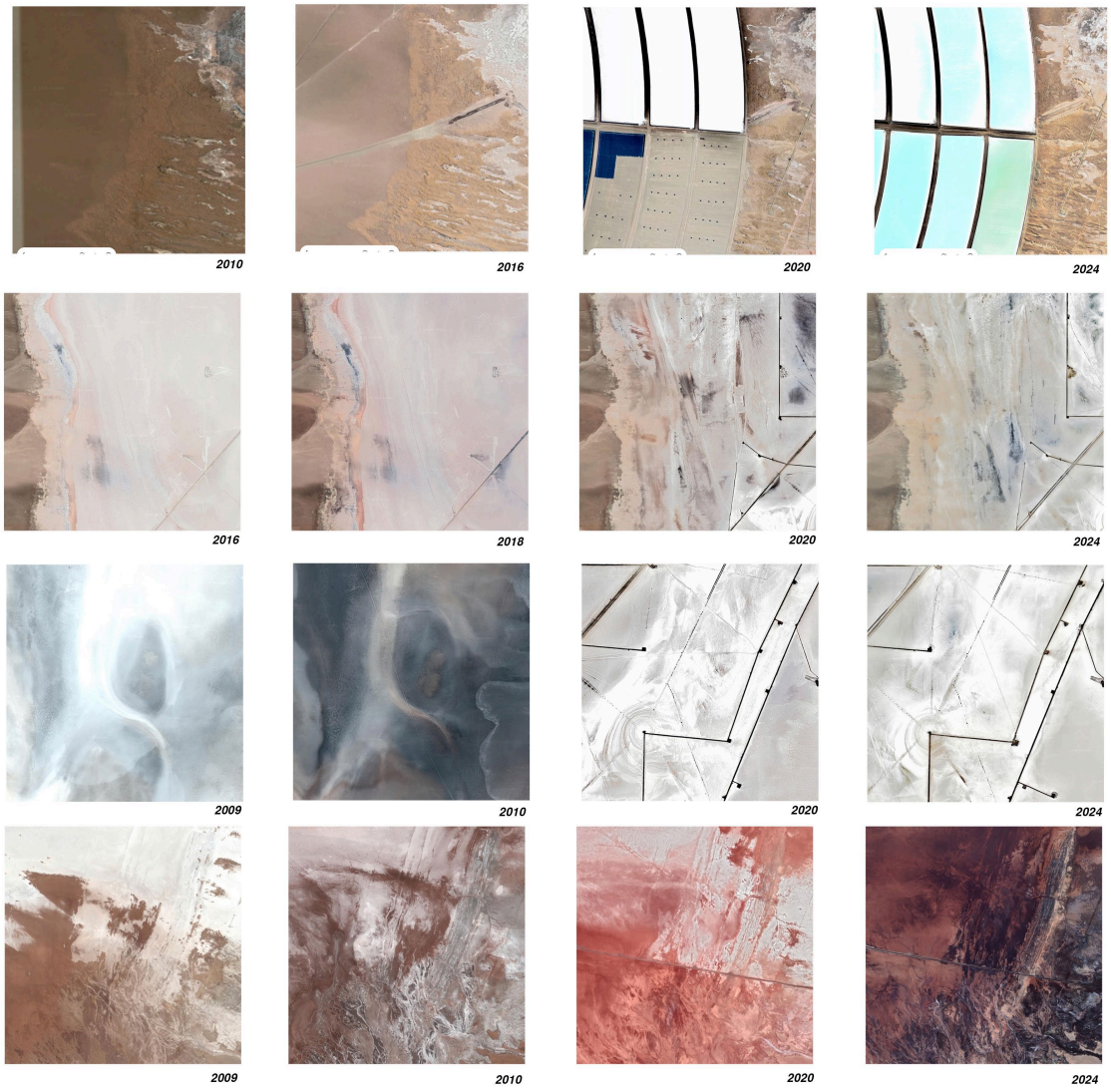
Framed by the concept of landing2 and guided by the two sub-research questions, this chapter examines territorial organisation through the lens of Political Ecology and Erik Swyngedouw's four dimensions of Territorial Organisation: Institutional and Regulatory Infrastructure, Natural Capital, Collective Capital, and Cultures of Production and Reproduction.

SRQ1: What conflicting territorial ontologies emerge in the context of lithium mining, and how are they constituted? How do these ontologies shape territorial configurations, and what are the socio-environmental impacts of them?

SRQ2: What are the points of intersection and friction between dominant extractive territorial logics and local territorial practices? In what ways do these encounters generate both conflict and potential opportunities for more plural and equitable territorial governance?

[1] The term *extractivist ontology* does not appear in the consulted bibliography; it is used here analytically, in line with decolonial theories that speak of extractivist logic or rationality (e.g., Escobar, Gudynas). It stands in contrast to relational ontologies that emphasize interdependence and non-extractive ways of being.

2Landing: Drawing from Martín Arboleda's notion in Planetary Mine, the mine is not understood as a discrete socio-technical object, but as part of a wider network of spatial technologies and territorial infrastructures: socio-technical assemblages that land and embed themselves into local territories. This act of landing introduces tensions between two territorial projects: a foreign, extractive logic and an ancestral, locally grounded one. These projects interact through complex micro-processes that simultaneously enable, limit, and reshape each other.



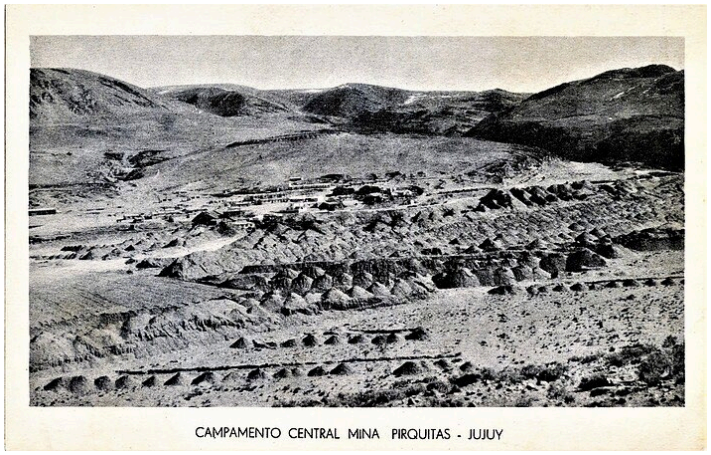
Traces of mining operations in Salar de Olaroz 2010 -2024
Soruce: Googgle earth

CHAPTER 3
EXTRACTIVE ONTOLOGY

History of mining in the Puna de Atacama

The Puna de Atacama has historically been a region of great mining interest due to its unique geographic and geological characteristics. This arid high plateau, at over 3,500 metres above sea level, is one of the driest areas on the planet, with extreme temperatures, saline soils and sparse vegetation (Houston et al, 2003). These geographical features - active mountain ranges, ancient volcanoes and enclosed landlocked basins, have been key to the formation of unique mineral deposits. In recent decades, thanks to technological advances in the extraction and processing of minerals and technocratic decisions driven by the global demand for clean energy,lithium mining (a non-conventional extraction method: brine extraction and evaporation) has consolidated, especially in the region's salt flats. Figure 1 shows the progress of mining in the Salta and Jujuy mining cadastres until 1990, 2000, 2010 and present bearing in mind that this is a panorama that is constantly and rapidly evolving.

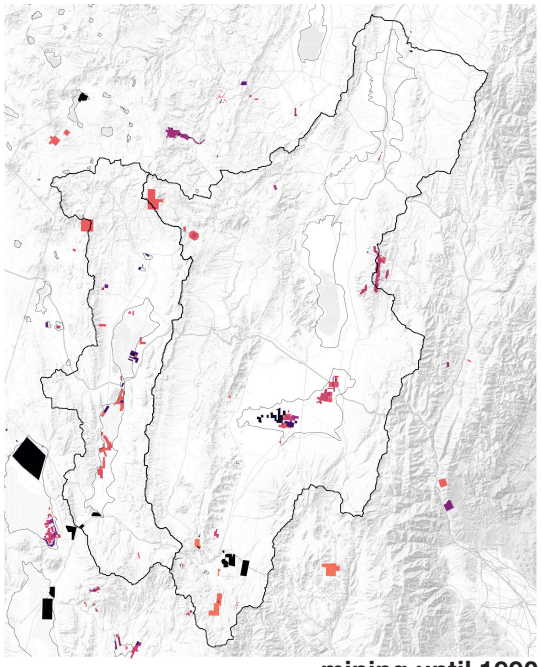
It worth noticing that this rapid growth is regarding non-conventional mining. On the map on the right it can be seen how is the current situation in the area, regarding conventional and non conventional mining solicitudes, and lithium mining stages.



Pirquitas Pb-Zn-Ag-Sn mining area, in 1944.
https://www.mindat.org/

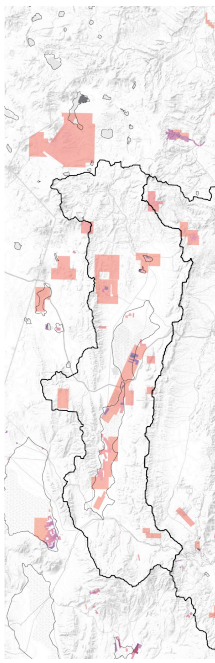


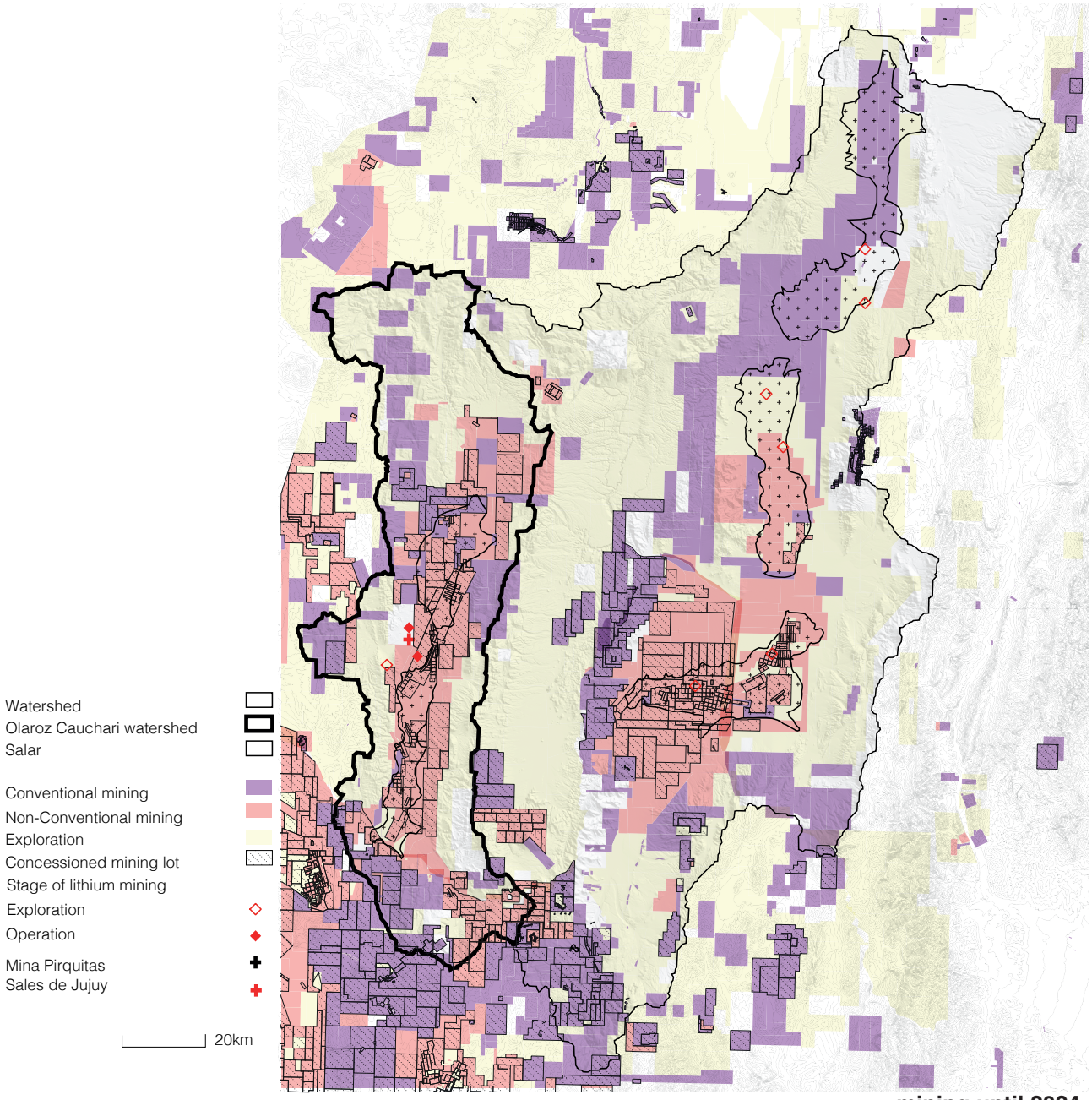
Sales de Jujuy Lithium mining, 2025
By Author



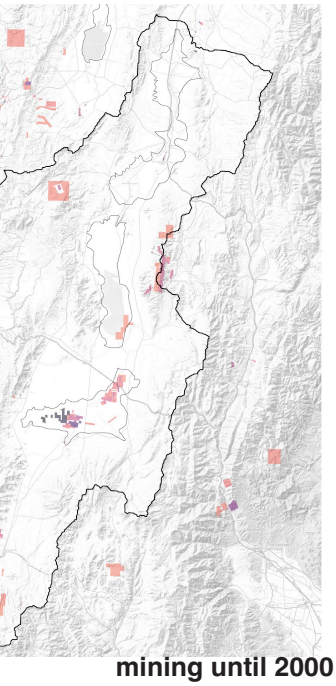
20km

mining until 1990

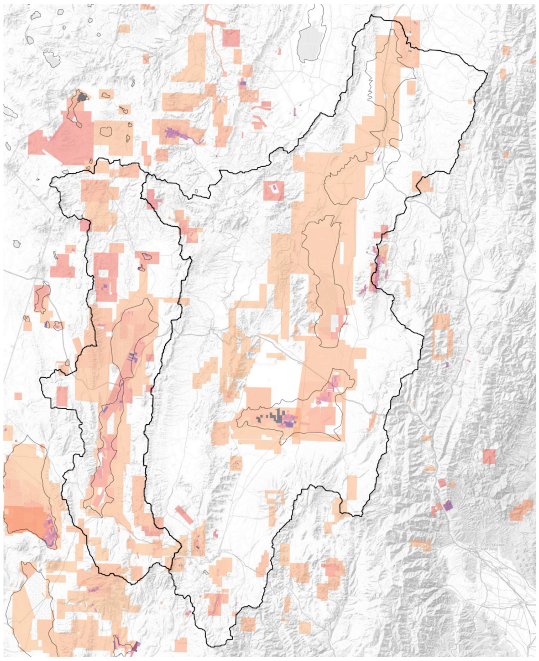




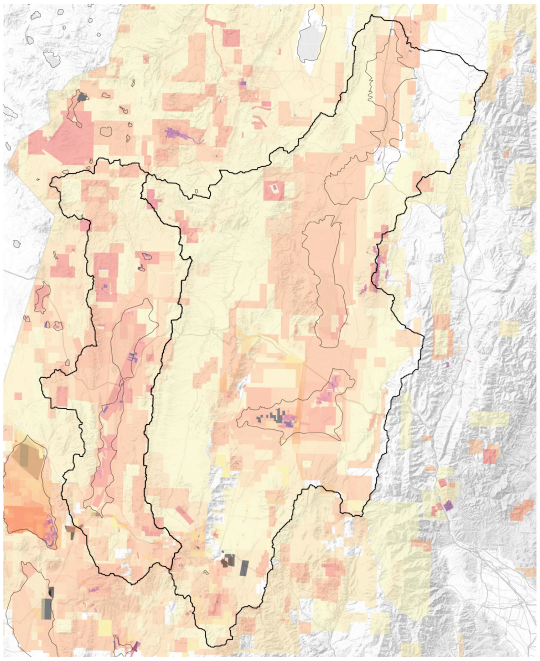
mining until 2024



mining until 2000



mining until 2010



mining until 2024

Chapter 3

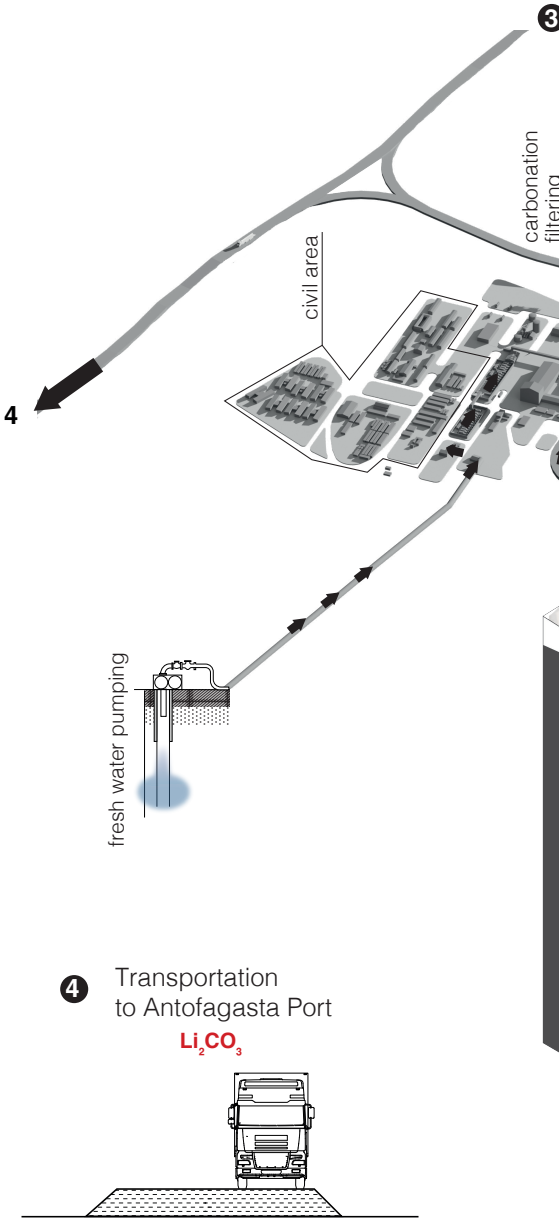
Landing and Territorial Organisation:
unveiling and exposing processes in tension
Extractive ontology.

Non-conventional mining process - Brine extraction

Although lithium mining in the salt flats of the Puna de Atacama generally follows a similar model, based on the extraction of brine and its subsequent evaporation in large ponds, there are variations depending on the chemical composition of each salar and the technologies employed.
These differences depend on the country of origin of the joint venture operating the project, the historical period in which operations began and the level of technological advancement available at the time. While brine extraction is the common denominator in all cases, the aim of this research is not to evaluate technological advances in extraction methods, but rather to understand their impact on the territory.
In a context characterised by limited and often opaque information, it was decided to focus the analysis on a specific company, collecting and analysing all available data on its operations. For several data found, analysis will be made on the operation of Sales de Jujuy S.A.

Sales de Jujuy S.A Brine extraction, evaporationa and Lithium carbonate processing process (Fig.1)

The process carried out in the salar comprises brine extraction and refining, producing Lithium Carbonate, which will then be transported by trucks along route 52 to the port of Antofagasta, in Chile.(Arcadium, 2023)
The process consists of:
1.Brine Extraction
For brine extraction, 24 wells will be used, mostly between 8 to 12 inches in diameter and between 200 to 450m.
The brine is transported from the extraction wells to the evaporation basins using HDPE pipes.
2.Magnesium Removal from Brine in Liming Plant
3.Brine Concentration in Large Scale Evaporation Ponds
4.Purification & Carbonation
5.Filtering, Washing, Drying & Bagging
6.Transportation



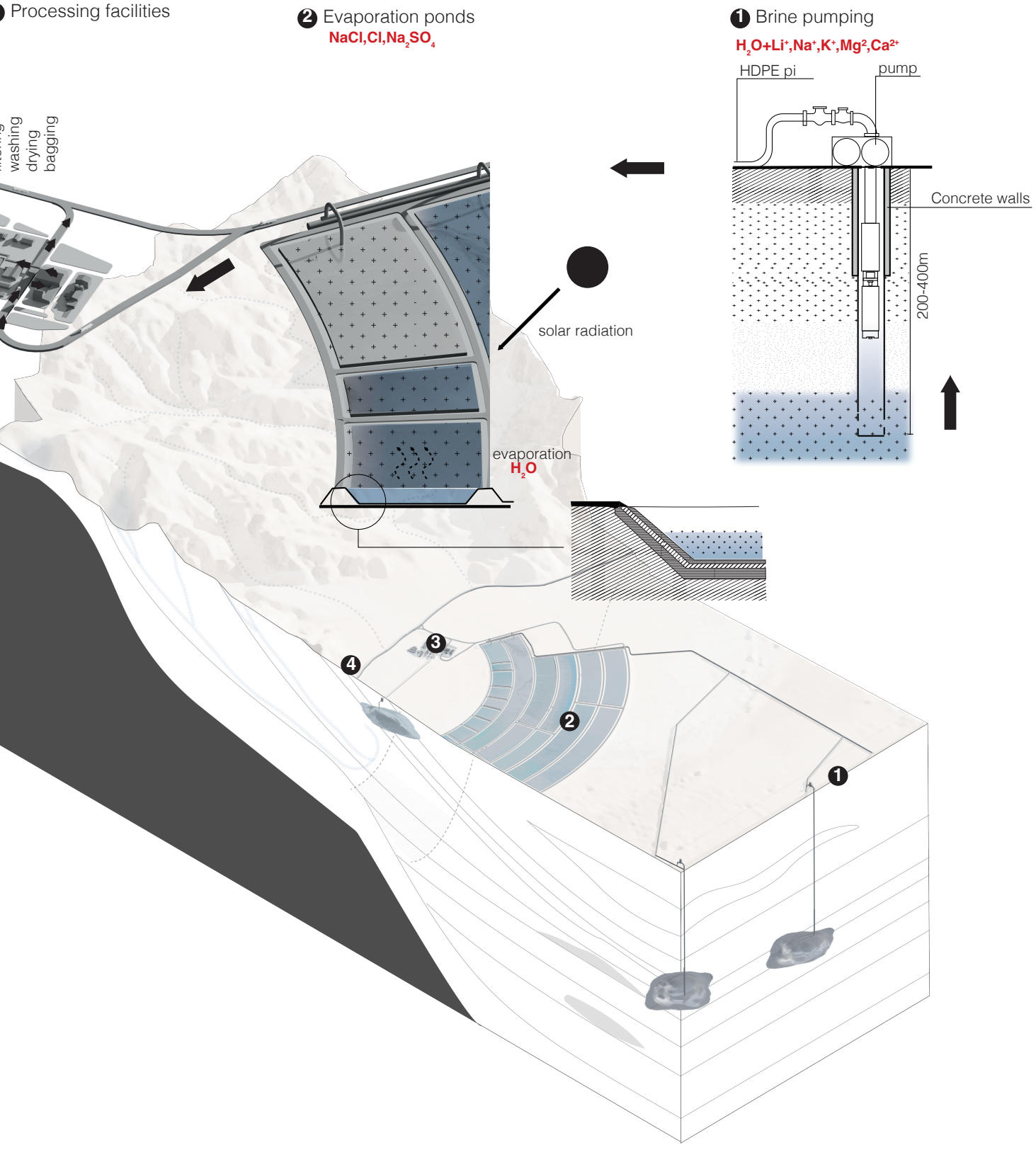


Fig.1.Sales de Jujuy S.A Brine extraction, evaporationa and Lithium carbonate processing process





Sales de Jujuy mining company
Salar de Olaroz, author 2025

Chapter 3

Landing and Territorial Organisation:
unveiling and exposing processes in tension
Extractive ontology.

Non-conventional mining

Inputs

mine workers:
Fig.1. According to the sustainability report in 2023, more than half of the “Human capital”[sic] of Sales de Jujuy are local. According to some informal interviews, the shifts of the employees are of 12 hs, 15 - 7 day rotation.

measuring natural inputs:

brine:
There are no public records of the amount of brine extracted from the salar, but according to Alvarado,et al. 2022, the amount of brine can be assumed in relation with the amount of lithium carbonate production.

Fig.2 depicts amounts of brine extracted, related with the amount of lithium carbonate.

Fresh Water:
Fresh water is used in both the liming plant and the lithium carbonate production process. According to Alvarado et al. (2022), in 2021 the company used approximately 42,840 m³ per month—equivalent to one bathtub every 9 seconds.
However, the terminology used in different documents varies: fresh water is sometimes labeled as industrial water, salty water, or other terms, which complicates consistent tracking and transparency.

gas:
The facility is connected to the Atacama gas pipeline.

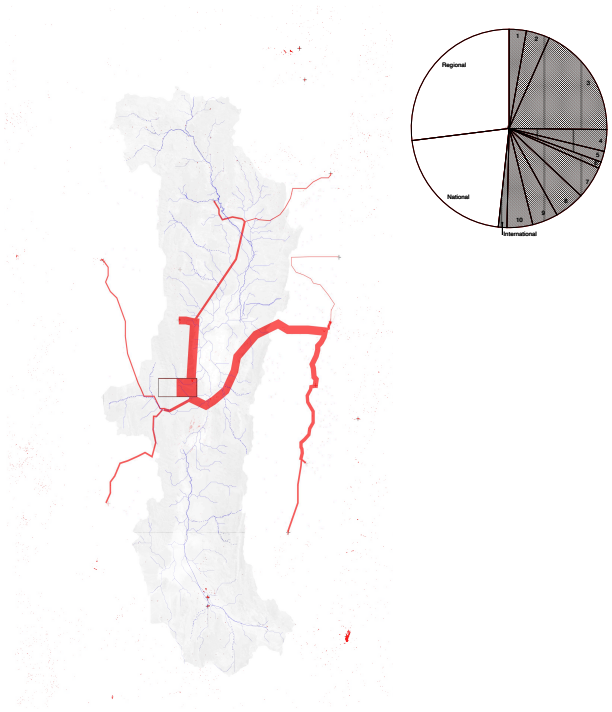


fig.1

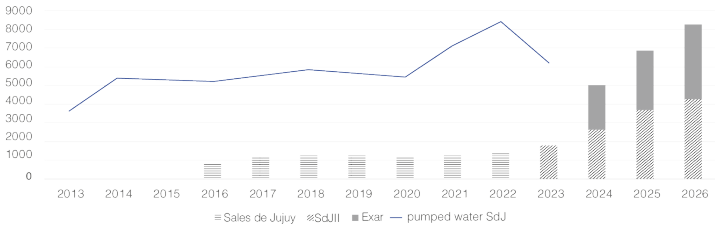
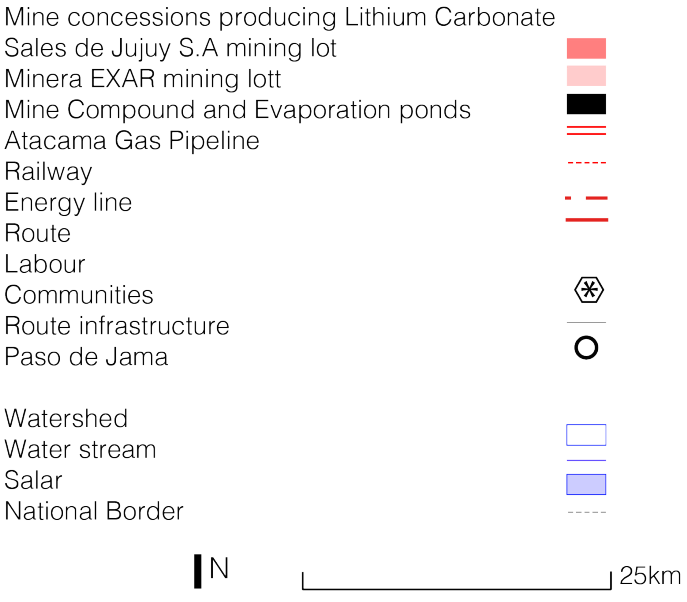
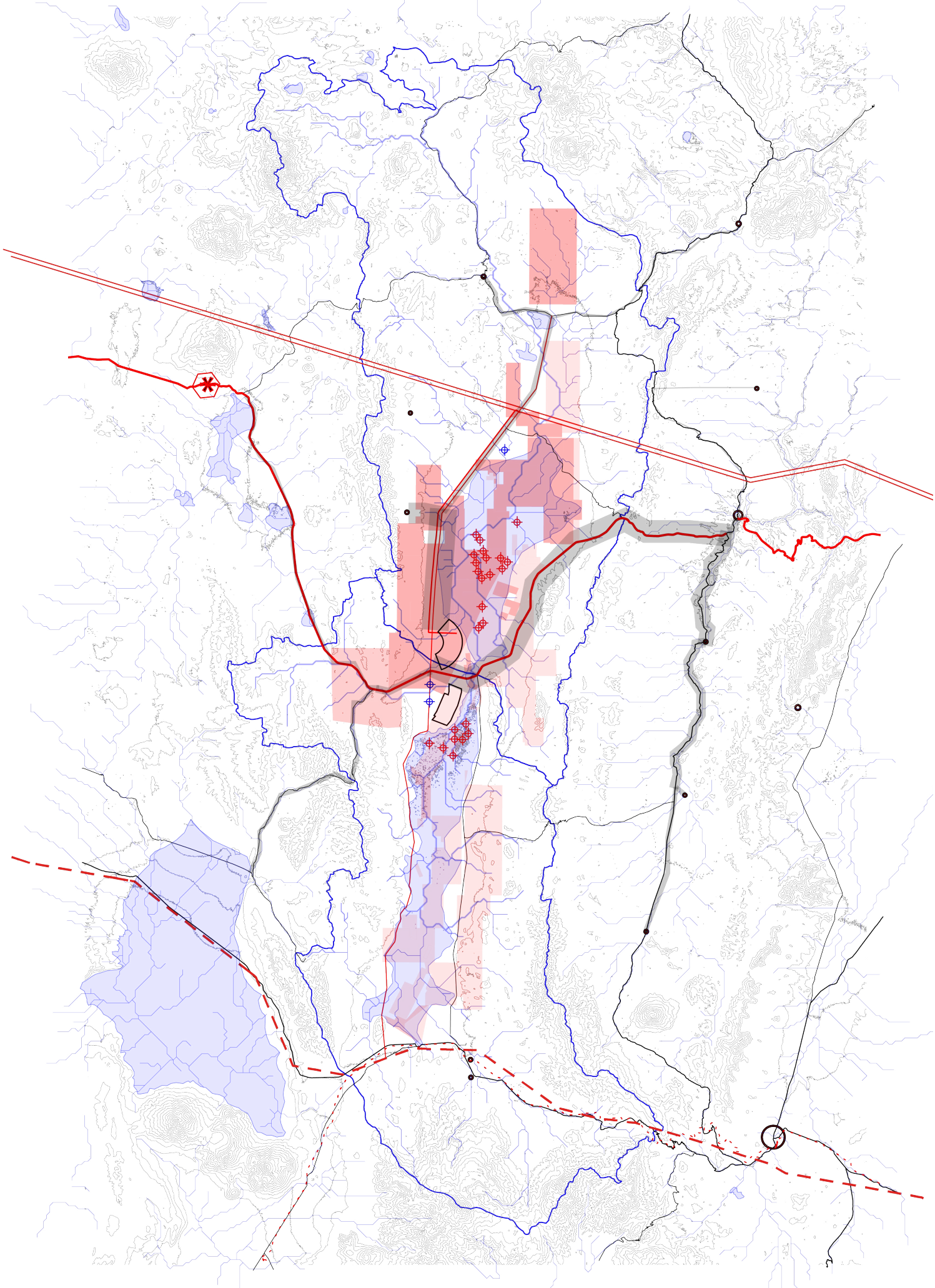


fig.2





Chapter 3

Landing and Territorial Organisation:
unveiling and exposing processes in tension
Extractive ontology.

Non-conventional mining

Impacts

Although there is scarce information about real water extraction (brine and fresh water),there are some estimatives and as the production increases, there is more water extraction (fig.2) That is impacting the whole watershed bioecologic cycle.

Although there is no measured information, due to a information can be assumed that as physical natural impacts that can be measured are(fig.1):
1. Subsidence in the Salar Nucleus

Subsidence refers to the gradual sinking or collapse of the ground surface. In this case, it occurs in the core of the salt flat (salar). This is often caused by the excessive extraction of brine, which is rich in lithium and other minerals. This leads to the compaction of subterranean layers. Over time, this deformation can alter the topography, damage surface crusts and affect the area's natural hydrology. It can also lead to long-term instability, complicating both environmental recovery and future extraction operations.

2. Drainage of vegas (wetland areas)
Vegas are high-altitude wetlands that rely on a delicate balance of groundwater flow. Increased water extraction can disrupt this balance, resulting in the drying up or shrinking of these ecosystems. As vegas disappear, so do their vital ecological functions. They act as water reservoirs and carbon sinks, as well as providing habitats for a variety of endemic species.
The loss of wetlands also affects traditional pastoralist and agricultural practices that depend on these water-rich zones, particularly in arid Andean regions.

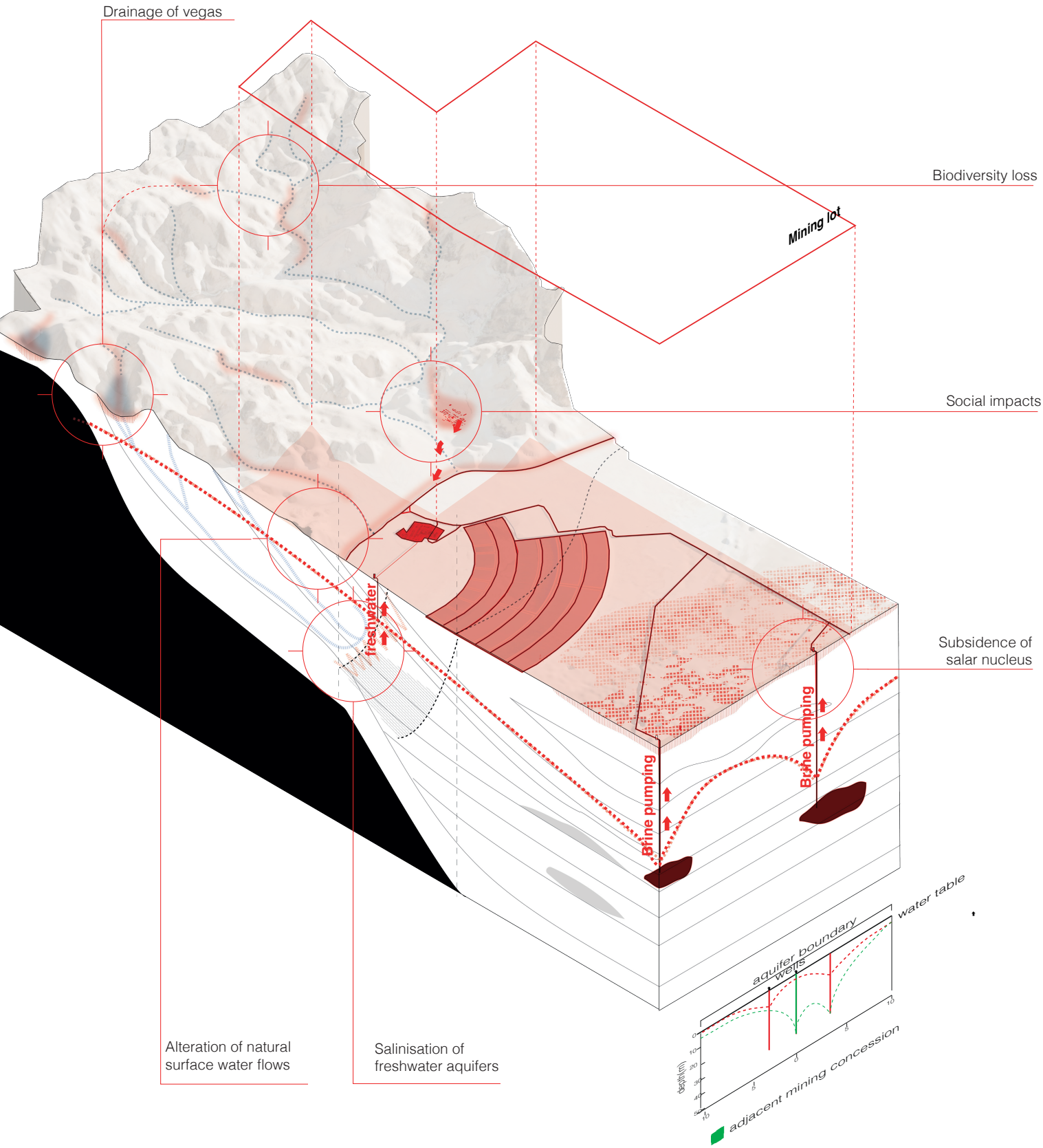
3. Possible salinisation of the salar transition zone

The transition zone of a salar acts as a buffer between the brine-rich core and the surrounding freshwater systems. As extraction intensifies, changes in pressure and flow gradients may allow brine to migrate outwards into fresher zones. This could lead to the salinisation of soils and groundwater, reducing water quality and harming vegetation and fauna adapted to lower salinity levels. Over time, this could make the surrounding area less suitable for agriculture or traditional land use.

4.Social impacts

The social impacts of lithium extraction are mixed. On the one hand, it generates jobs and improves local infrastructure and services in areas that have been neglected by the government, particularly in remote regions. However, it can also fragment communities due to the influence of mining companies and competition for benefits. Furthermore, extraction often leads to water conflicts, cultural disruption and an unequal distribution of benefits, which disproportionately affects Indigenous communities. These groups usually have little influence over decisions and bear the environmental and social costs without receiving a fair share of the economic benefits.

5. Degradation of the Socio-Natural Environment
The combined environmental and social impacts of lithium extraction contribute to the degradation of the socio-natural environment. This includes biodiversity loss, the disruption of traditional livelihoods, and the weakening of community and cultural structures. This degradation is further exacerbated by the fragmentation of information regarding environmental and social impacts, which limits transparency, hinders informed decision-making, and weakens community responses.


Drainage of vegas
Biodiversity loss
Mining lot
Social impacts
freshwater
Brine pumping
Brine pumping
Subsidence of
salar nucleus
Alteration of natural
surface water flows
Salinisation of
freshwater aquifers
water table
aquifer boundary
wells
adjacent mining concession

Chapter 3

Landing and Territorial Organisation:
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Extractive ontology.

Non-conventional mining
Territorial Organisation

Conclusion:

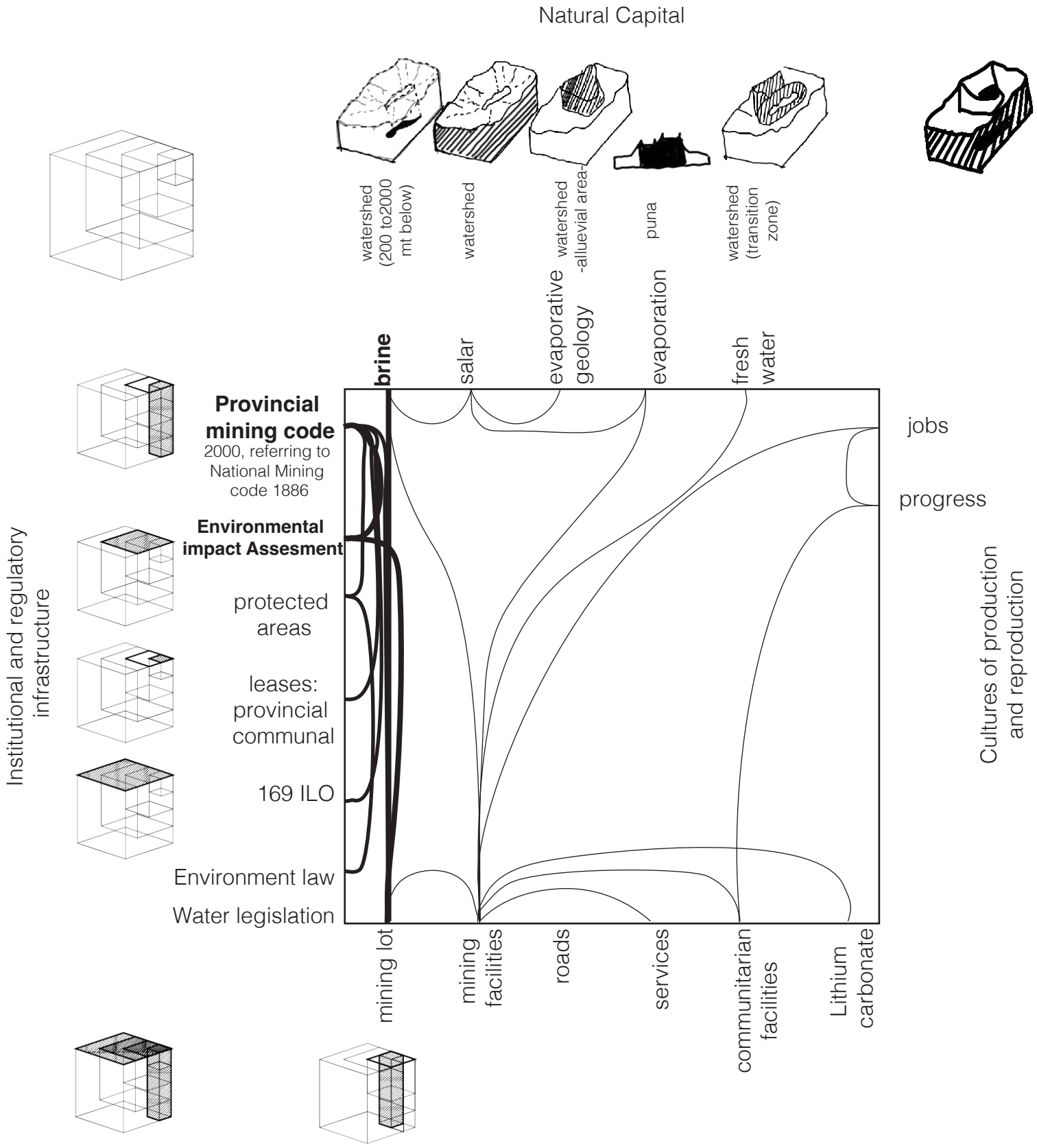
Applying the political ecology matrix developed in the Transitional Territories studio reveals intense interconnections between Institutional and Regulatory Frameworks and Natural Capital. The mining code and mining lots play a central role in this, shaping the intersection of environmental laws with the classification and governance of mining lots and facilities, particularly with regard to brine extraction. Together, these legal instruments ,including the Mining Code, ILO Convention 169 and environmental and water legislation determine how natural capital is accessed, managed and controlled.

Moreover, when spatial and temporal scales are incorporated into the analysis, it becomes clear that the current regulatory structures do not capture the full extent of the impacts of lithium extraction.
Existing assessments often neglect the broader watershed, which bears the cumulative effects of extraction, by focusing narrowly on the mining lot defined by the provincial cadaster. Consequently, many impacts remain unmeasured or underestimated, thereby limiting the effectiveness of environmental governance in these sensitive ecosystems.

This fragmented governance and narrow territorial focus align with Göbel's (2013) observation that lithium reconfigures the local matrix of spatial use: it displaces, renders invisible, and pits against each other other forms and practices of relating to nature. Lithium extraction establishes an inherently globalised territoriality that is deeply embedded in international markets, which differs substantially from existing local or regional territorialities (Göbel, 2013).

Contemporary lithium mining process

Brine evaporation mining process



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Landing and Territorial Organisation:
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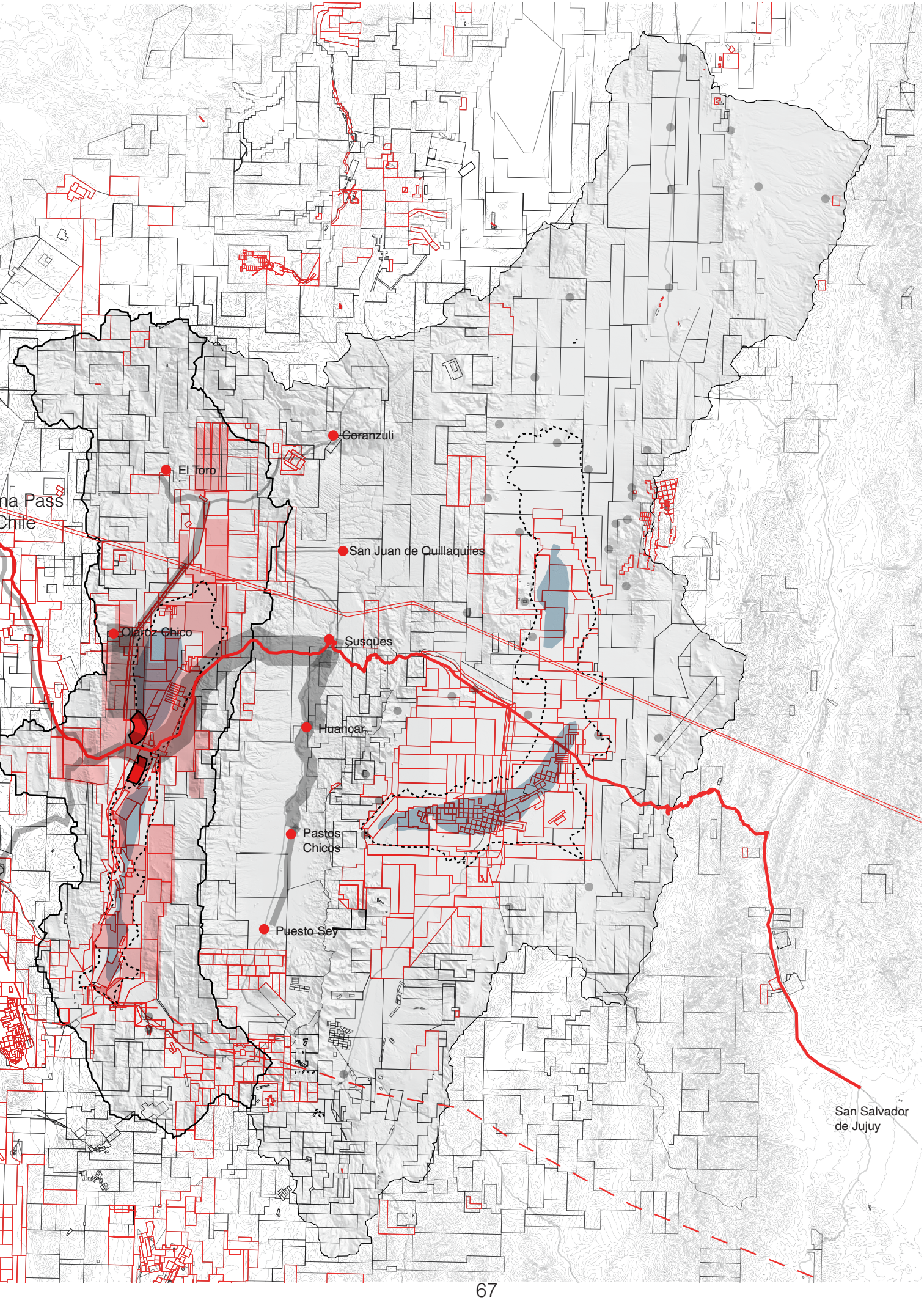
Territorial Organisation

Conclusion:

Moreover, The mining cadaster's division of territory into lots fragments the exploitation landscape in a manner that is fundamentally incompatible with any vision of a sustainable future. A key issue is the lack of integration between mining concessions and hydrological systems.Current regulatory frameworks do not establish a functional relationship between extraction rights and the water dynamics of the region. Given the geological characteristics of the salares and the use of deep pump wells in lithium extraction, the spatial separation of wells cannot be accurately measured or managed across multiple concessions operating within the same watershed (Lopez,Fong,2019). This disconnection creates a significant risk of cumulative and overlapping impacts, potentially accelerating the depletion of the water table and undermining the ecological integrity of the basin.




Coranzuli
El Toro
San Juan de Quillaquiles
Susques
Huancar
Pastos Chicos
Puesto Sey
San Salvador de Jujuy

CHAPTER 3
ANDEAN ONTOLOGIES

Andean ontologies (in the plural, as they are not homogeneous) articulate a deeply relational worldview, in which there is no sharp separation between nature, humanity, and the sacred.
In the communities of northwestern Argentina, particularly among the Kolla and Atacama peoples in the provinces of Jujuy and Salta, this way of understanding the world is manifested in a relational ontology that recognizes the earth, mountains, waters, and other elements of the environment as living beings with agency.
Central to this understanding is the concept of Pachamama, who is not only seen as Mother Earth but also as Home and a living entity with which humans maintain a relationship of care and reciprocity. (Fig.2)

This cosmology also includes different realms such as Ukhu Pacha (the inner or lower world), Hanan Pacha (the upper world), and the Apus (sacred mountains or spirits), as well as Inti (the Sun), all of which are interconnected and form part of a larger, sacred order. (Fig.3)

Time is conceived as cyclical, linked to agricultural, lunar, and solar rhythms, and the territory is understood not as property, but as a relational space inhabited by humans and non-humans, where ritual practices such as offerings to Pachamama or rituals to the mountains sustain relationships of reciprocity and care.



Whipala
White: Time and Dialectics: Cyclical story
Yellow: Energy and Strenght: Reciprocity, complementarity and moral principles
Orange: Society and Culture
Red: Planet Earth: Visible and material
Purple: Politics, social and community ideology
Blue: Space, Cosmic, energy
Green: Economy and production: Natual wealth, flora and fauna, hydrological and mineral, land and territory

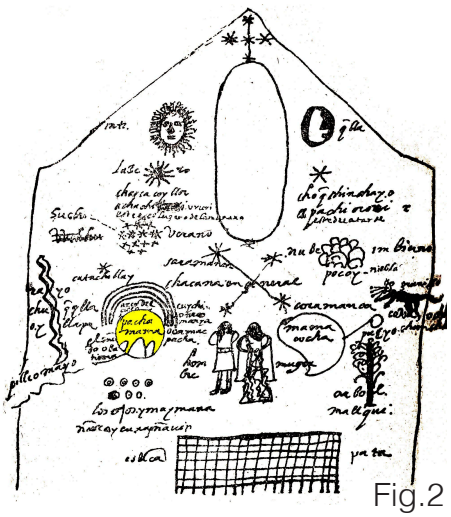


Fig.2
Representation of Pachamama in the cosmology. Juan de Santos Pachacuti Yamqui Salcamaygua (1613)

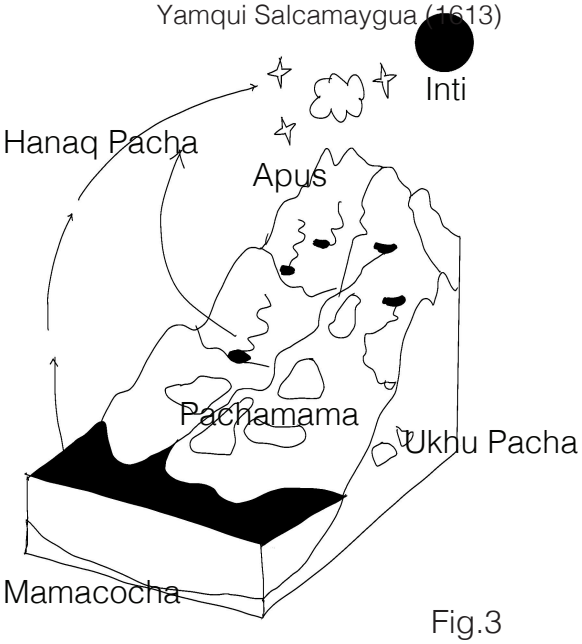


Fig.3

The communities of Salinas Grandes y Laguna de Guayatayoc express a concept of development rooted in their deep identity and long-standing relationship with the land. “We have always been salt collectors, cattle breeders, farmers, textile artisans and, in recent years, tourist guides” (Kachi Yupi,2015). Their work is not just an economic activity, but a reflection of a cultural and ontological connection to the territory.
For these communities, development is not about external economic growth, but about maintaining traditional practices that have sustained their relationship with the environment. Salt extraction, agriculture and livestock are carried out in harmony with natural cycles, while textiles and tourism share the cultural heritage without exploiting the land. For them, development is about continuity with the land - a form of sustainable growth that respects the earth and preserves their identity.



Salt Harvesting
source: Bajo la Sal,2019



Sheperdess in El Moreno, author 2025

Chapter 3

Landing and Territorial Organisation:
unveiling and exposing processes in tension

Andean ontologies

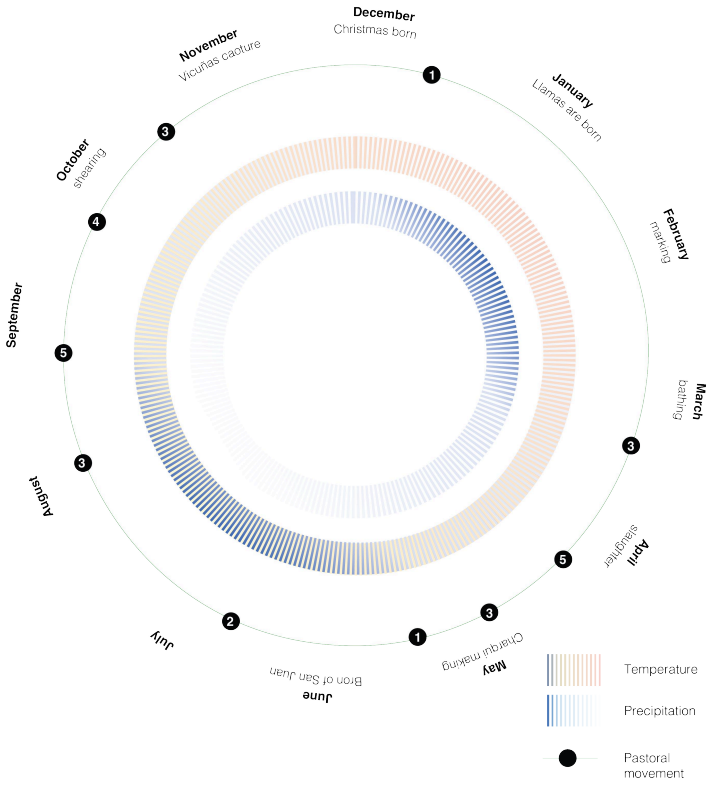
Pastoral Practices

Pastoralism, understood as a mobile form of animal husbandry typical of arid and semi-arid regions (Turner, 2009), goes beyond a purely economic practice. Ethnographic studies (Göbel, 2002; Tomasi, 2013) highlight its deep ties to specific ways of life, human-animal relationships, and symbolic understandings of the landscape. Mobility is not only about accessing resources but also about the symbolic appropriation of meaningful places (Tomasi,2013).

In the Andean region, pastoral life creates distinct spatial patterns, combining seasonal movements with fixed, yet temporarily inhabited, settlements (Núñez, 1995). Punean pastoralism is marked by cyclical movements between ecological zones, with flexible strategies to cope with environmental unpredictability, such as mixed herds and inter-group exchanges (Khazanov, 1994).

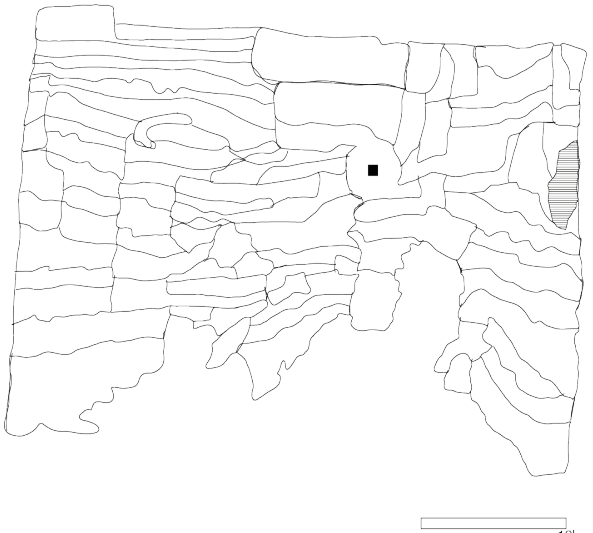
Local herds, called haciendas or tropas, ften include llamas, sheep, goats, and occasionally cows. A 2009 livestock census reported an average of 126 animals per herd, predominantly goats (42.72%), llamas (28.7%), and sheep (28.11%) (Göbel, 2002). The inclusion of different species reflects a risk-reduction strategy.

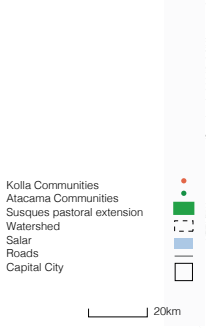
Pastoralists distinguish between “fields” (open, lower-altitude areas with water access) and “hills” (higher, rockier, sheltered zones), each shaping mobility and settlement practices. Seasonal mobility between 3,500 and 4,200 meters above sea level allows access to diverse pastures and shelter options (Galaty & Johnson, 1990), structured not only by ecology but by social relationships and traditional knowledge. Although domestic units are shaped by ancestral social dynamics and practices, such as respect for cattle and communal organisation, it becomes evident that they are consistently located alongside water channels. Furthermore, during the winter, these units tend to move to higher, more sheltered areas to seek protection from strong winds and harsh conditions. This seasonal mobility demonstrates a flexible and responsive approach to occupying the territory, which is deeply rooted in an understanding of environmental rhythms and microclimatic variations.

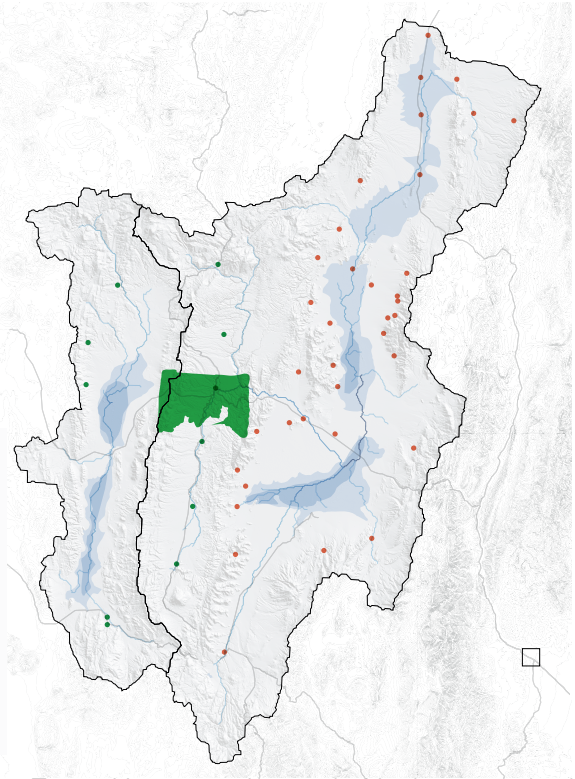




Domestic unit 1, Author

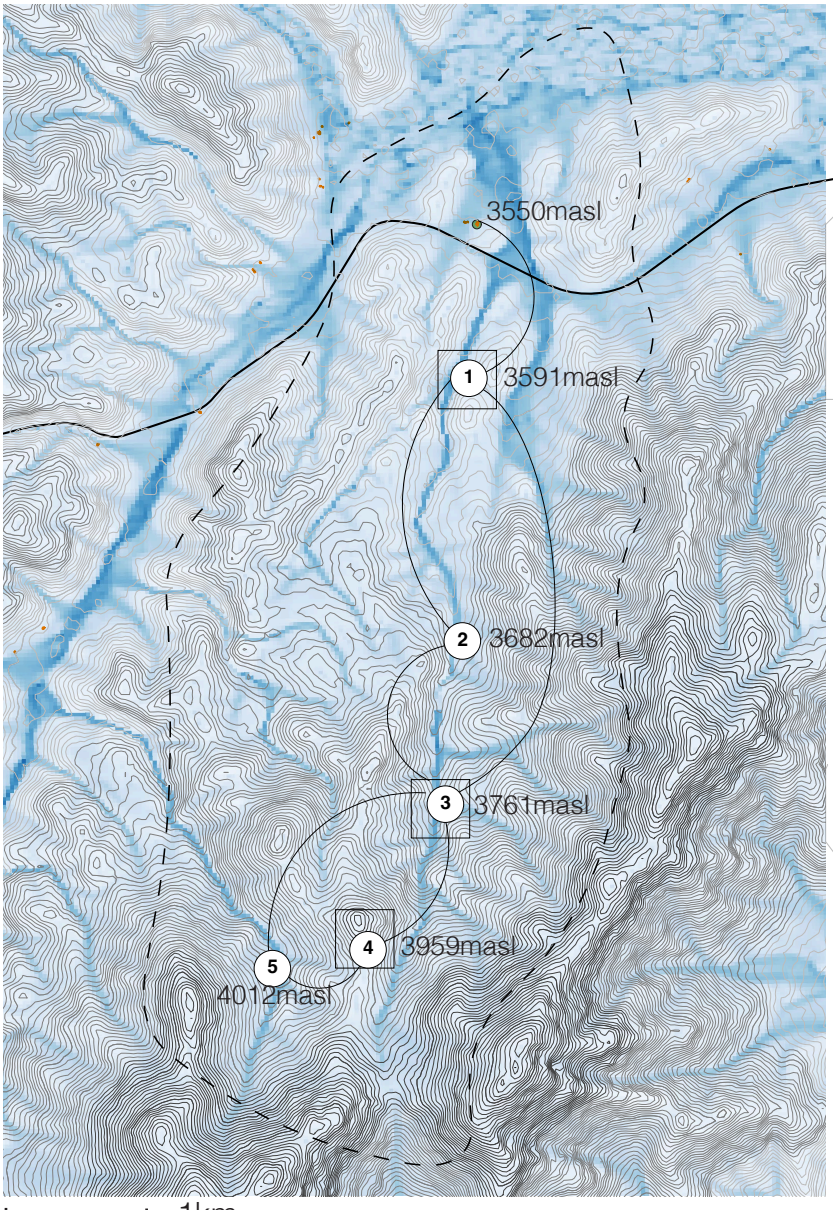




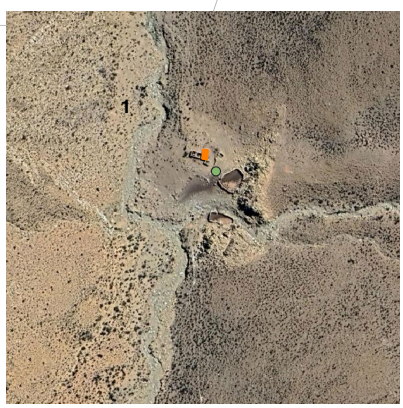


Susques pastoural units according to Tomasi,2013

Tomasi interpretation scaled in the watershed









Chapter 3

Landing and Territorial Organisation:
unveiling and exposing processes in tension

Andean ontologies

Agricultural Practices

Agricultural information about the Puna region remains limited, with most available records dating from the 1990s or earlier. In both academic research and media narratives, agriculture is often overlooked as an ongoing and vital practice. However, fieldwork conducted for this research revealed that agriculture continues to play a crucial role in sustaining local communities.

My field observations documented active forms of cultivation, particularly in the form of small agricultural plots, or “boxes,” located along natural watercourses and adjacent to inhabited areas. These plots are typically cultivated by individual families, but production and seeds are frequently shared or exchanged among neighbours.

In El Moreno, cultivation occurs longitudinally along a central irrigation canal, with smaller ditches branching off to feed each plot. This system creates a horizontal distribution of water, closely aligned with the topography of the valley. In contrast, San Francisco de Alfarcito presents a terraced form of agriculture, with irrigation channels descending from the hills and feeding stepped plots arranged vertically along the slopes. Both systems reflect an intimate and place-based knowledge of the landscape and its hydrological dynamics, as well as flexible, adaptive strategies for managing water in high-altitude environments.

A particularly relevant insight emerged from the seasonal agricultural calendars developed collaboratively with local communities and incorporated into school curricula in Santa Catalina (Vila & Arzamendia, 2016). These calendars offer a contemporary, community-based record of planting and harvesting cycles and demonstrate how traditional ecological knowledge is actively transmitted across generations.



Building a participatory environmental calendar in Santa Catalina, Jujuy, Argentina Vila , Arzamendia, 2016.



50m San Francisco de Alfarcito



Agriculture terraces in
San Francisco de Alfarcito.
Author, 2025



200m El Moreno



Agriculture crops in El Moreno.
Author, 2025

Chapter 3

Landing and Territorial Organisation:
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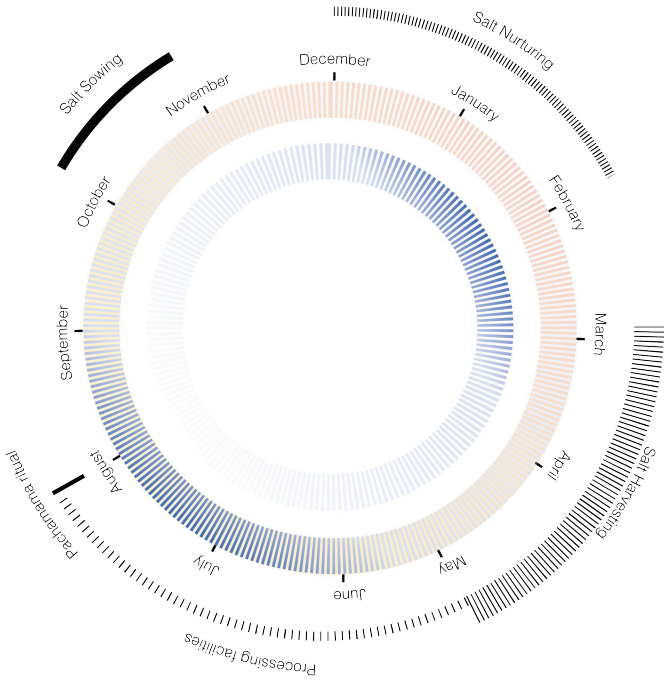
Salt Harvesting:

Salt extraction in Salinas Grandes reflects a deeply Andean understanding of interconnection and care what Miranda (2022) refers to as 'vital configurations', in which all beings are alive and interconnected. Through fieldwork, documentaries such as Bajo la Sal and En el Nombre del Litio, and anthropological studies (Miranda, 2022), I have identified three primary methods: salt cutting (an ancestral practice used in small-scale trade), communal salt harvesting (through collective crystallisation pits) and salt hauling (mechanised scraping for industrial purposes).

All of these methods follow the salt cycle: the salar floods in December, evaporation and crystal growth take place throughout the summer, crystallisation occurs around March, and harvesting continues until August, culminating in rituals dedicated to Pachamama and marking the start of the spring sowing season. These seasonal rhythms not only structure production, but also community life, decision-making and rituals, which are deeply rooted in reciprocity and collective responsibility.

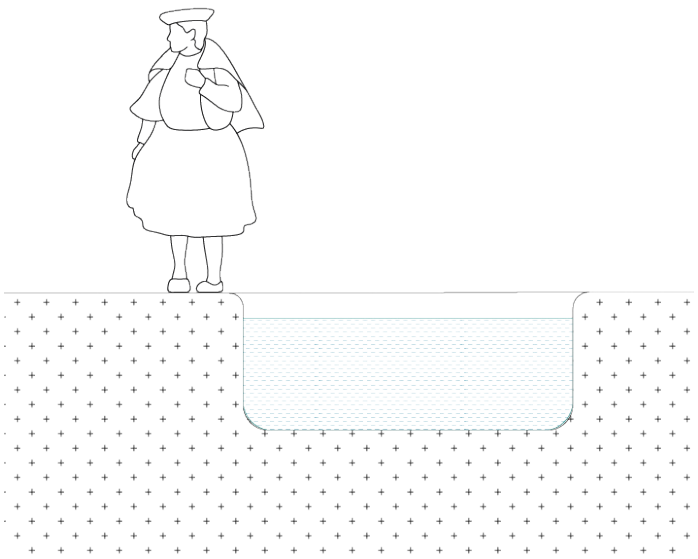
These practices are sustained by communities such as San Miguel de Colorados, Pozo Colorado and Santuario de Tres Pozos, and are institutionally supported by the Cooperativa Mineros de Salinas Grandes, which was founded in 1994. Despite the large salar productive surface area, salt production remains mainly manual and seasonal. Crystallisation pondsare built on a human scale, reinforcing a non-extractive relationship with the territory.

The map on the right page shows the spatial distribution and relational scale between communities and the salar.

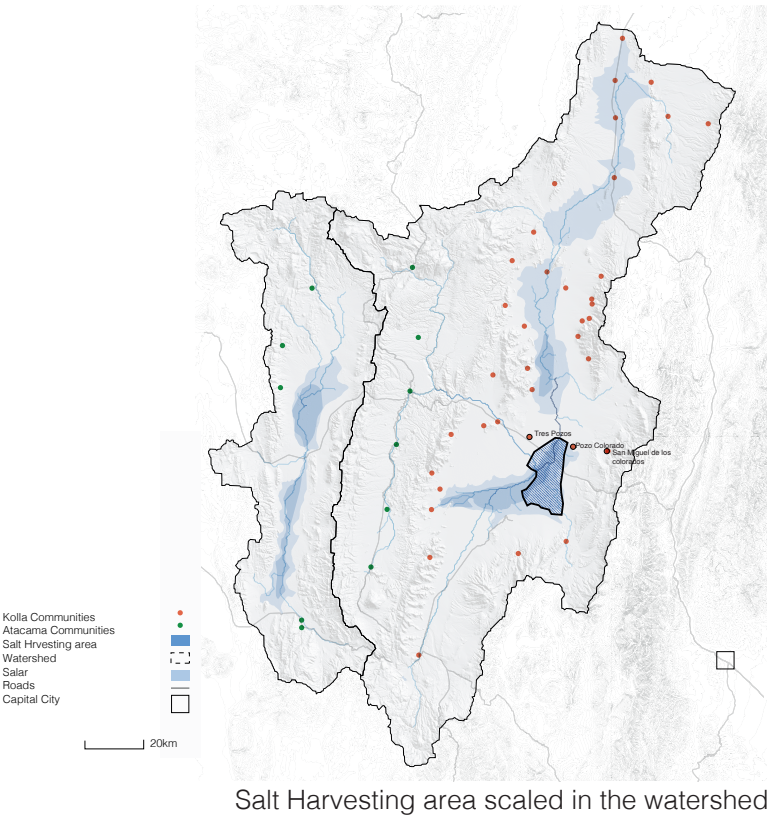




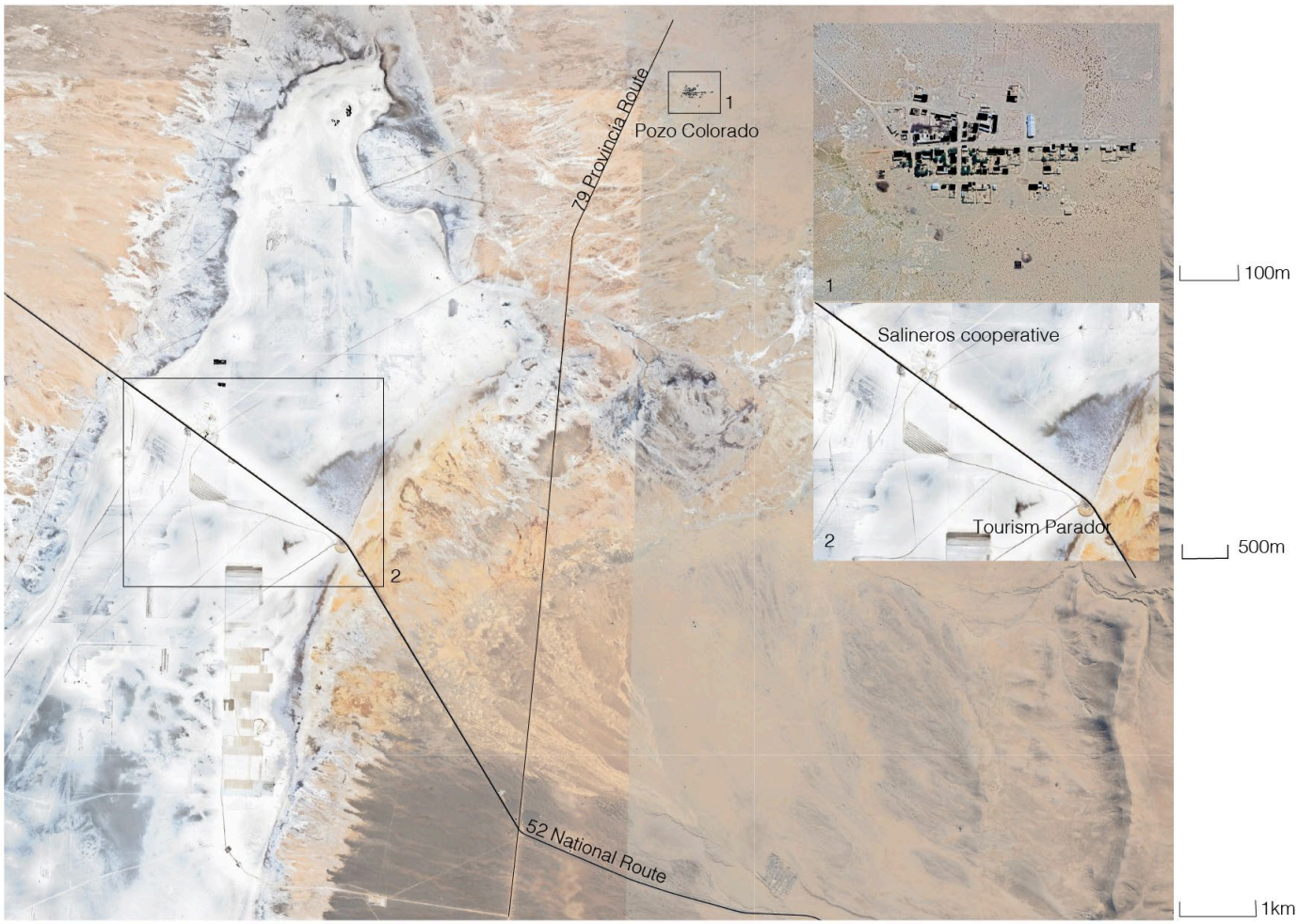
Salt Mining facility in Salinas Grandes
source: Bajo la Sal,2019



Salt Harverst pond diagram
Author, 2025.



Salt Harvesting area scaled in the watershed



Salt Harvesting area in Salinas Grandes. In relation with Pozo Colorado community.

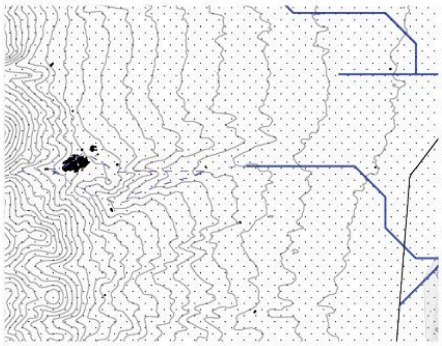
Chapter 3

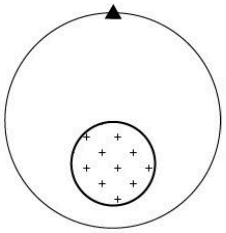
Landing and Territorial Organisation:
unveiling and exposing processes in tension

Andean ontologies

During fieldwork, I visited several communities to understand their practices, the extent of their activities, and how these overlap. I found that each community maintains a distinct relationship with the landscape, shaped by factors such as soil type, water access, elevation, and historical land use. For example, some communities are more focused on pastoral activities, moving livestock seasonally, while others emphasize agriculture, taking advantage of irrigated lowlands. In areas with better road access or reduced traditional activity, mining has become more prominent, often due to the absence of strong communal land-use practices that otherwise regulate and protect local resources.

These differences reveal how local knowledge systems and environmental conditions directly influence land use, conservation decisions, and even the vulnerability of territories to external pressures like extractive industries.

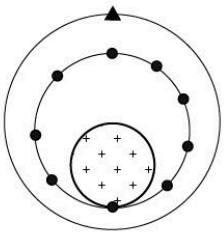




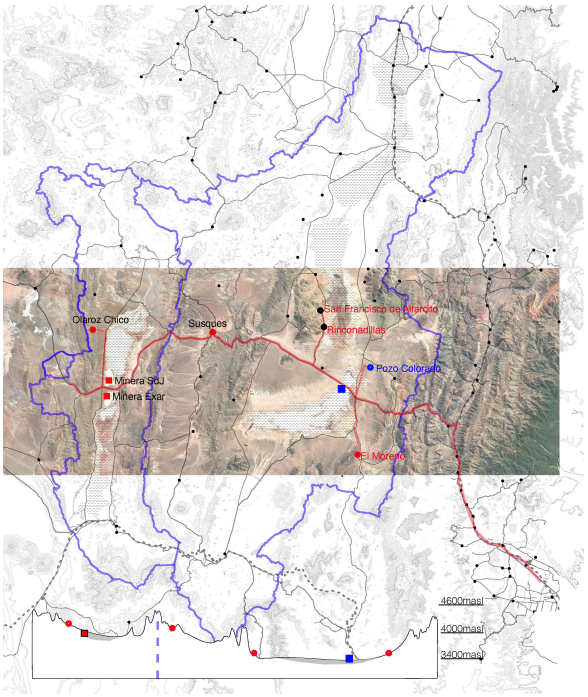
Olaroz Chico
height: 4175masl
inhabitants: 183

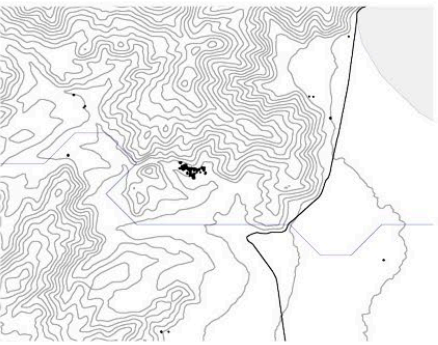


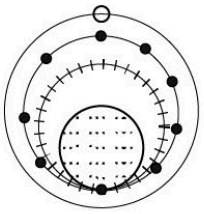




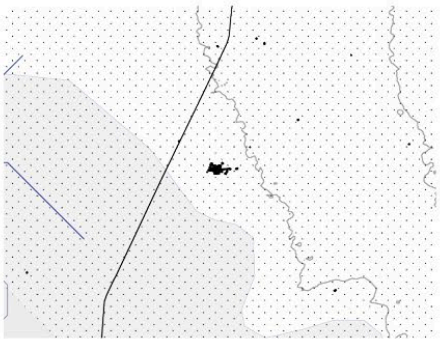
Susques
height: 3600masl
inhabitants: 1611

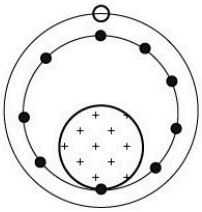






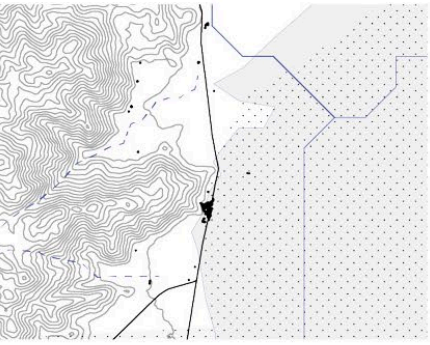
San Francisco
de Alfarcito
height: 3525masl
inhabitants: 60

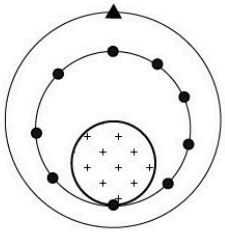




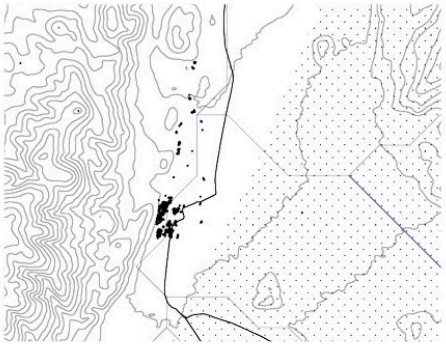
Pozo Colorado
height: 3425masl
inhabitants: 28

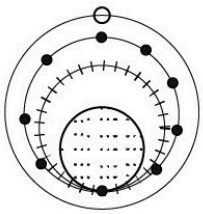




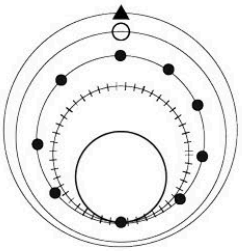


Rinconadillas
height: 3500masl
inhabitants: 50





El Moreno
height: 3525masl
inhabitants: 281



Mining
Tourism
Pastoural Practices
Agriculture
Soil

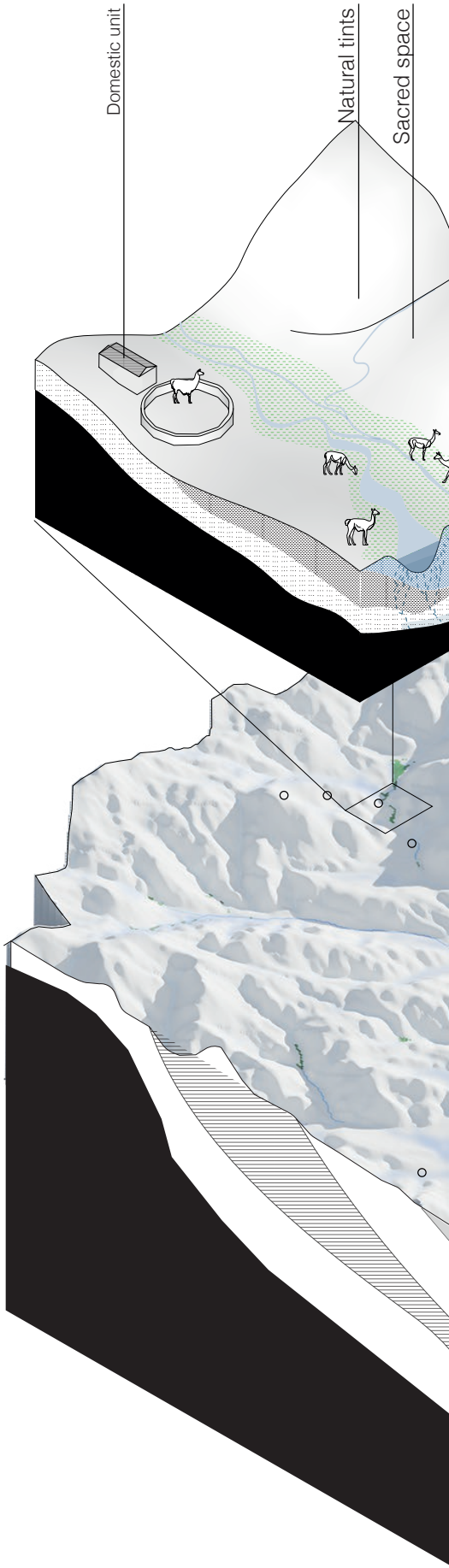
Elevation 25m
Route
Water streams
Buildings
Salar
Sedimentary geology

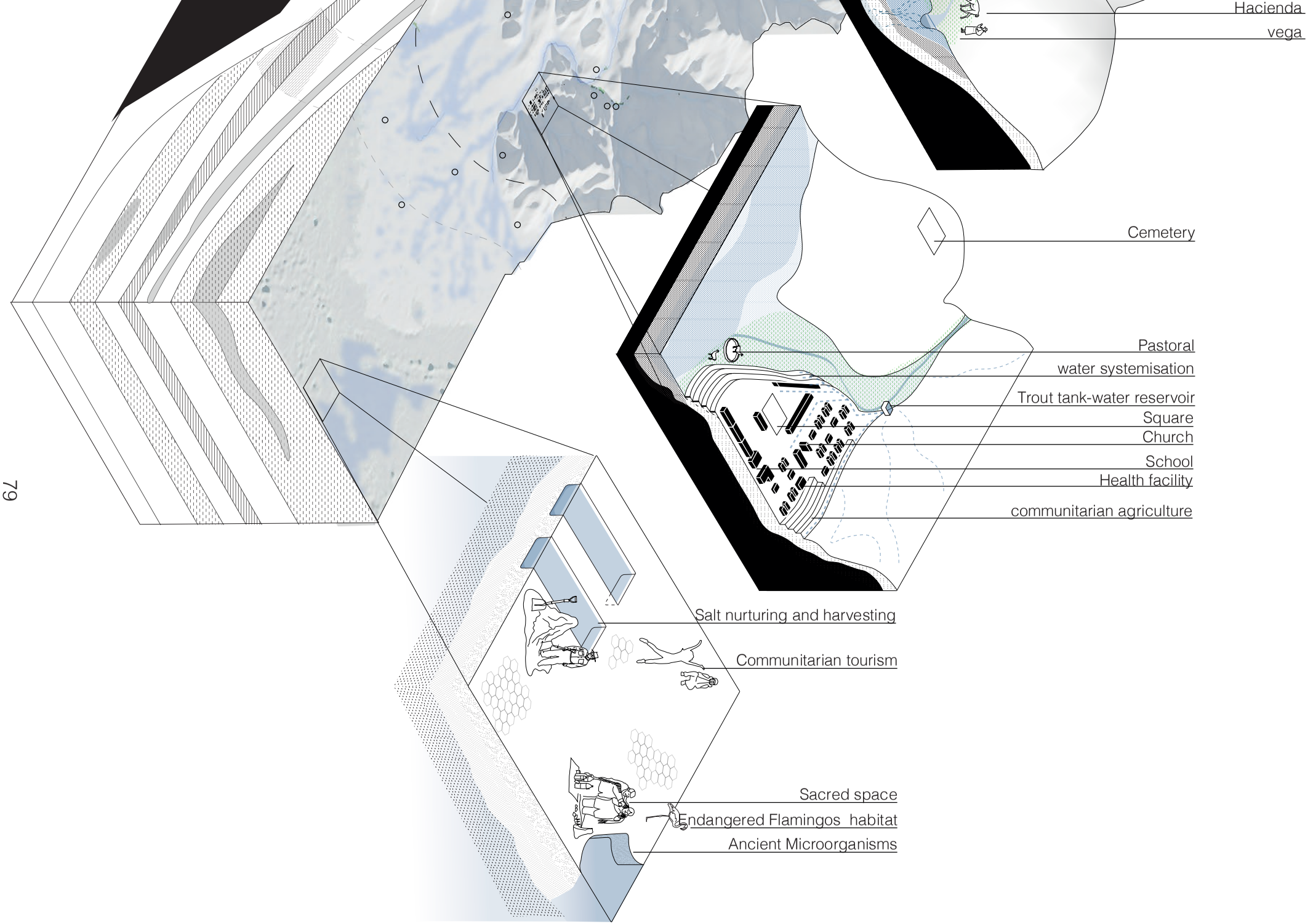
Chapter 3

Landing and Territorial Organisation:
unveiling and exposing processes in tension

Andean ontologies

In order to spatialise local practices and informed by the insights gained during the research, I observed that, although each community and family maintains its own rhythms, practices and territories — closely tied to soil types and water availability — certain ancestral methods of working with the land, irrigation and crafting persist. To better grasp Andean spatialities, I have grouped practices according to natural characteristics. Community-based tourism, salt harvesting and sacred areas and rituals are primarily located in the salar, while agricultural activities, social interaction, public services and festivities tend to be concentrated in settled communities, which are often associated with areas of a high topographic wetness index and natural wind shelters. Finally, pastoral and domestic units are generally situated in relation to high-altitude vegas (wetlands). This classification does not seek to generalise or essentialise local practices, but rather to offer an understanding of how environmental features, historical land use and social organisation intersect in specific territorial arrangements.




Hacienda
vega
Cemetery
Pastoral
water systemisation
Trout tank-water reservoir
Square
Church
School
Health facility
communitarian agriculture
Salt nurturing and harvesting
Communitarian tourism
Sacred space
Endangered Flamingos habitat
Ancient Microorganisms

Chapter 3

Landing and Territorial Organisation:
unveiling and exposing processes in tension

Andean ontologies

Microstory: Natalia

Natalia was born in San Antonio de Alfarcito, where she grew up with her eight siblings, helping her mother herd cattle through the hills. After her mother passed away, the family opened a weaving shop at home, coinciding with the rise of communal tourism in the area.

Now a mother of two school-aged children, Natalia stays in the community while her older sisters manage the cattle in nearby pastoral units. She dyes yarn, weaves textiles, and runs the shop, using seasonal materials, some collected from higher elevations for special colors.

The community is shaped by close ties between pastoral, agricultural, and communal life. A water canal system with a trout pond irrigates family gardens, and residents often exchange vegetables and cook together for tourists. Key communal spaces include a school, emergency room, football field, square, and church, all central to gatherings and celebrations.

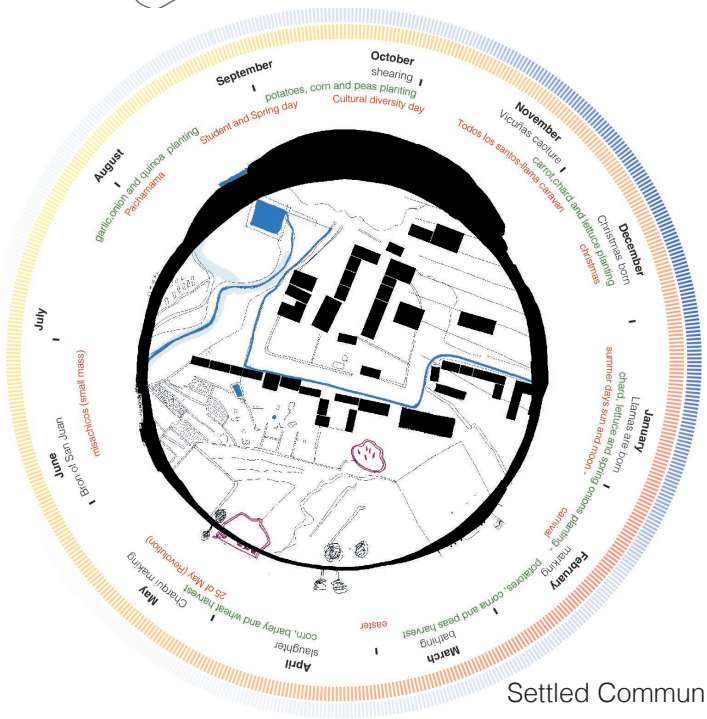
The community does transhumant grazing, moving animals between high mountain shelters in winter and lower watershed areas in summer. These seasonal patterns align with shearing in October and the birth of sheep and llamas.

Scarce water sources, wetlands, non fertile soil, and dispersed pastoral units structure the territory. And it is managed with traditional knowledge passed through generations guides environmental decisions, like adjusting herd size or mobility to respond to climate variability.

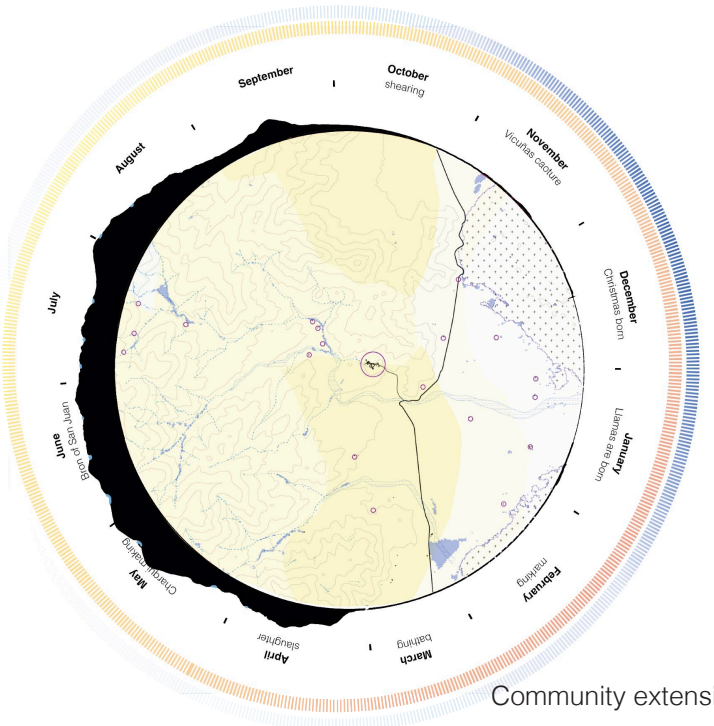
Together, these practices reflect a resilient, cooperative system where land, culture, and sustainability are deeply intertwined.



Every day practice



Settled Community



Community extension

The How

In ancient local practices and knowledge systems, the nature-culture interaction is rooted in mutual parenting and care. This relationship is based on mutual respect: humans care for the land, and in turn, the land provides for them. It is not a one-sided exchange, but rather an ongoing, respectful conversation. Humans seek permission from nature and give back through practices that honour the environment.

This mutual care is embedded in the ethnobiological kosmos-corpus-praxis (KCP) complex, where beliefs, knowledge and practices are inseparable. Humans and the land are partners in maintaining balance and nurturing each other. The land provides food, materials and teachings, while humans ensure its stewardship and preservation. This cycle creates a biocultural memory where knowledge is passed down and the relationship with nature continues to evolve.

At its core, it is about fostering a mutually respectful relationship in which humans and nature are interconnected and co-dependent, shaping both the land and its people.



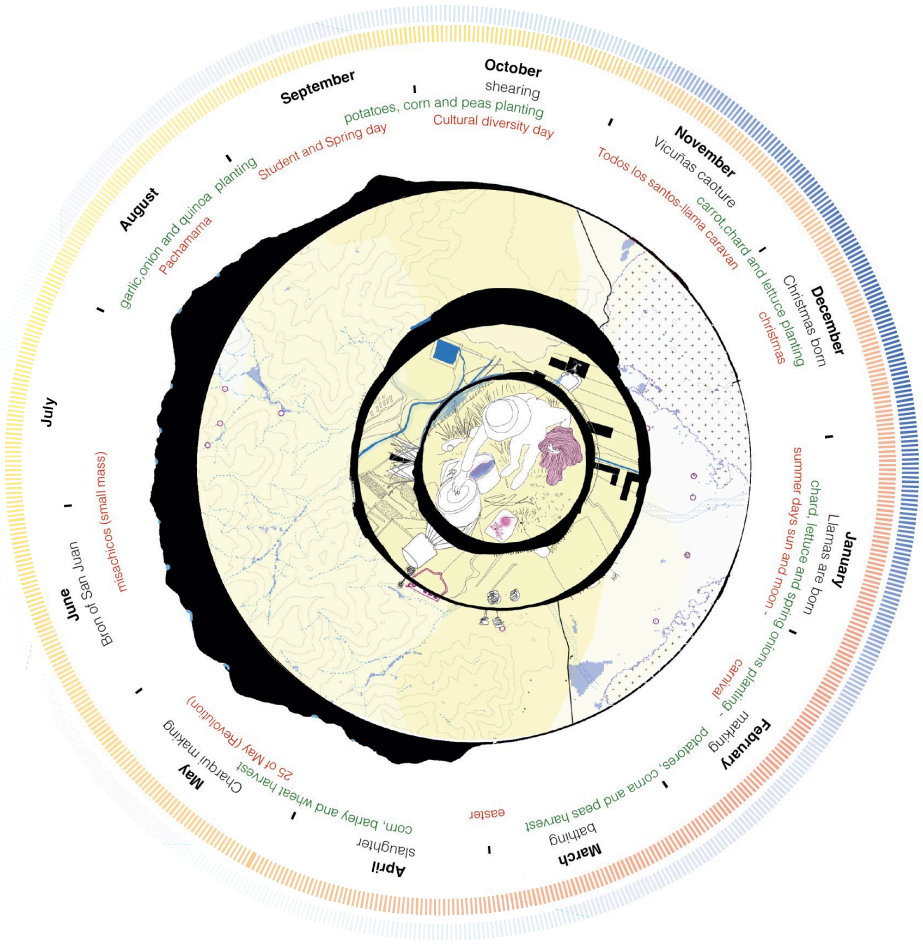
Chapter 3

Landing and Territorial Organisation:
unveiling and exposing processes in tension

Andean ontologies

Conclusion

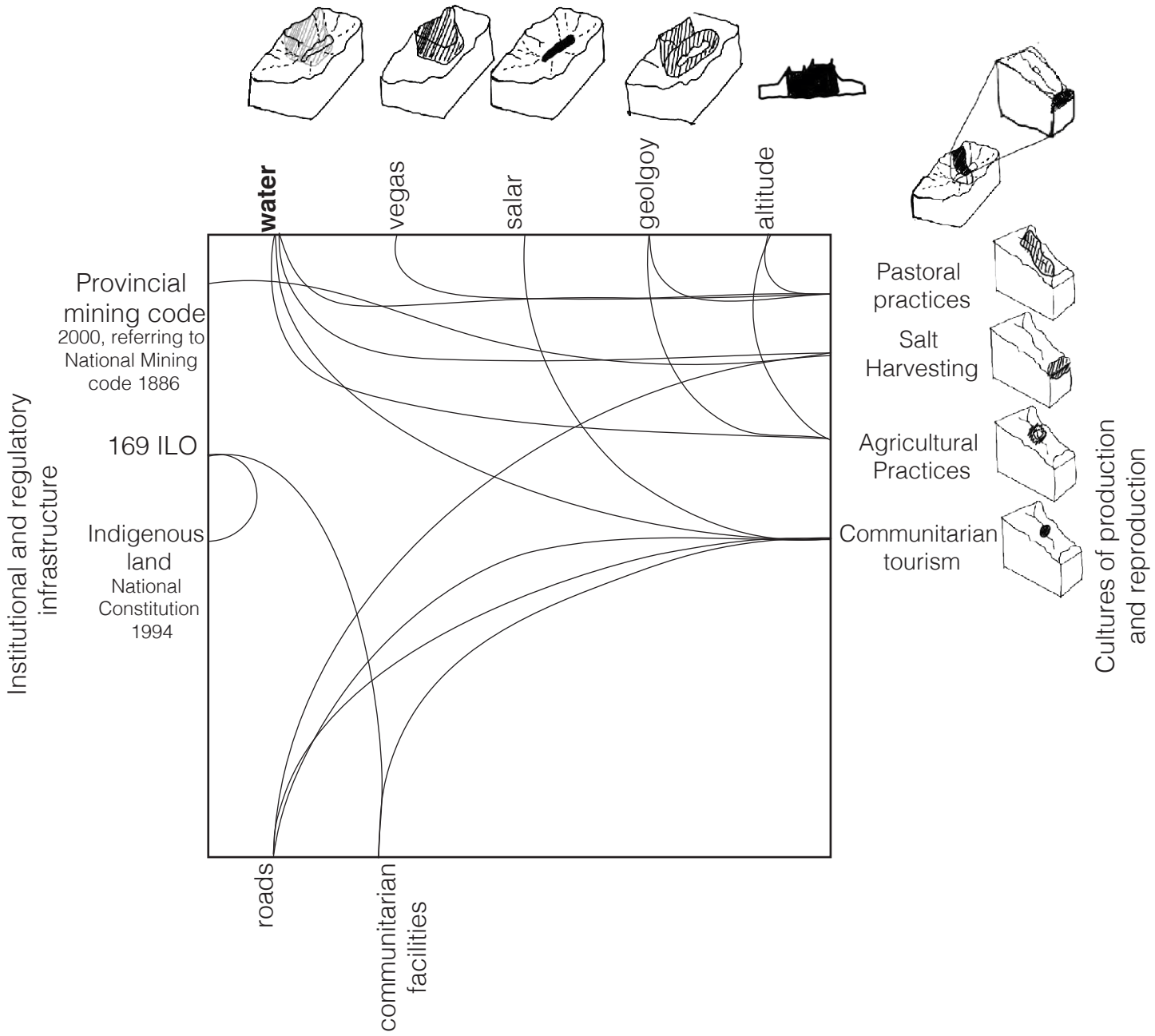
Adding the framework to local practices, such as salt harvesting, small-scale agriculture and community-based tourism, reveals intricate networks between natural capital and cultures of production and reproduction. These practices are rooted in relational and mutual forms of care and stewardship that reflect multiscalar logics and cyclical perceptions of time. At the territorial level, these practices significantly influence, and are influenced by, local environmental management decisions. They primarily operate at the watershed scale for natural capital and at the sub-basin scale for cultural practices. This highlights the importance of understanding conservation and production as dynamic, interrelated processes embedded in specific spatial and temporal contexts, rather than as isolated or static entities.



Ancient local processes and practices

Salt Harvesting, Pastoral practices,
small scale agriculture

Natural Capital

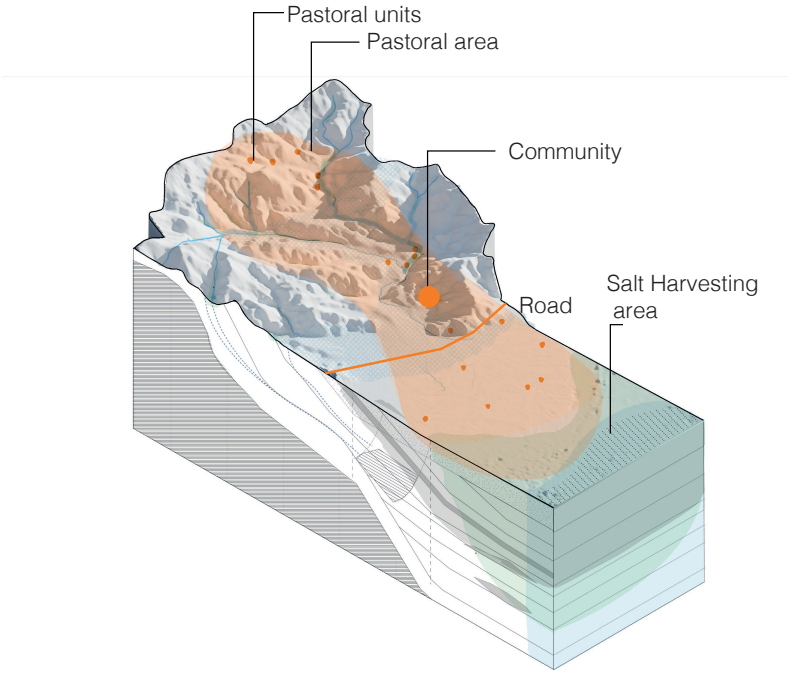


Collective Capital

Conclusion

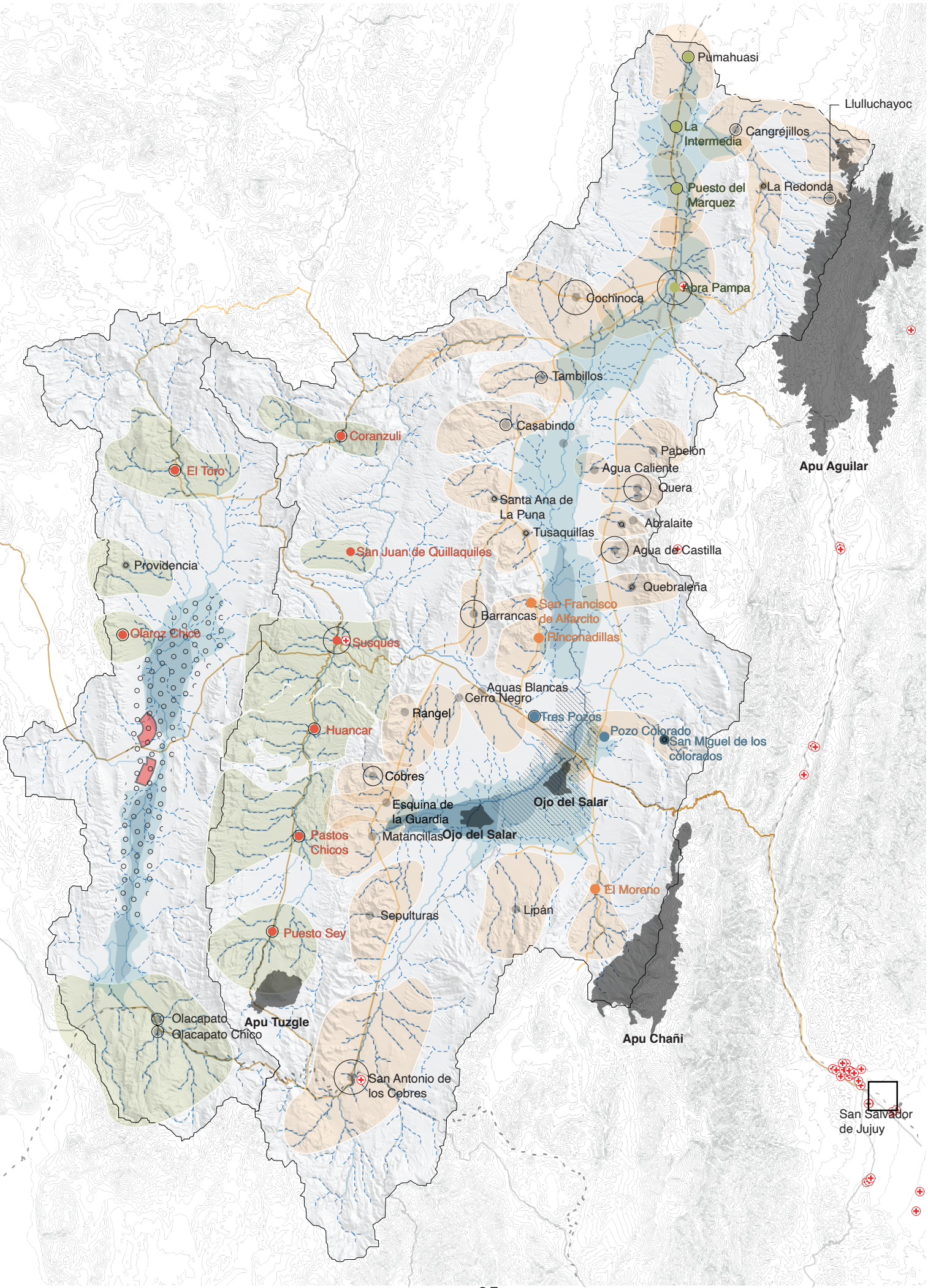
To represent local practices at the watershed scale, I drew on informed assumptions based on Andean spatialities. This involved mapping domestic units and irrigation channels around settled communities. The map also shows the main livelihood activities associated with each community and how these are distributed across watershed boundaries.

However, it is important to emphasise that each community is different. One of the key lessons of this research is the importance of avoiding generalisations and recognising the specificity of each territorial configuration. The assumptions made here aim to offer an alternative perspective that values relational and situated practices, but accurate, grounded mapping ultimately requires direct engagement with each territory and its inhabitants.



Communitarian Tourism
Agricultural practices
Salt harvesting cooperative
Salt Harvest area
Workers of Lithium mines
Lithium mining area
Lithium mining company
Community
Kolla Communities extension
Atacama Communities extension
Sacred area
Hospital
Registered Ihhabitants
0-100
100-500
500-1000
1000-5000
5000-150000
Road
Disused Railway
Watershed
Water stream
Creeks
Salar
Salar nucleus
San Salvador de Jujuy
Capital City

20km


Pumahuasi
Llulluchayoc
La Intermedia
Cangrejillos
Puesto del Marquez
La Redonda
Abra Pampa
Cochinoca
Tambillos
Casabindo
Coranzuli
Pabelón
Agua Caliente
El Toro
Quera
Apu Aguilar
Santa Ana de La Puna
Abralaite
Tusaquillas
Agua de Castilla
San Juan de Quillaquiles
Providencia
Quebraleña
San Francisco de Alfarcito
Barrancas
Rinconadillas
Olaroz Chico
Susques
Aguas Blancas
Cerro Negro
Rangel
Tres Pozos
Pozo Colorado
San Miguel de los colorados
Huancar
Cóbres
Ojo del Salar
Esquina de la Guardia
Matancillas
Ojo del Salar
Pastos Chicos
El Moreno
Lipán
Sepulturas
Puesto Sey
Olacapato
Olacapato Chico
Apu Tuzgle
Apu Chañi
San Antonio de los Cobres
San Salvador de Jujuy

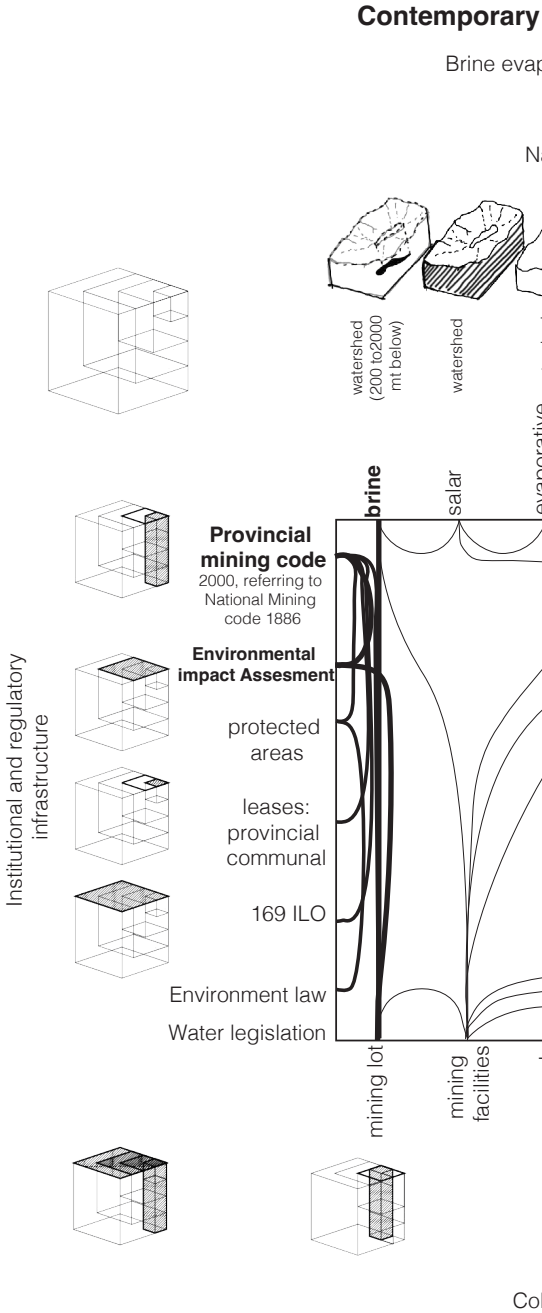
Chapter 3

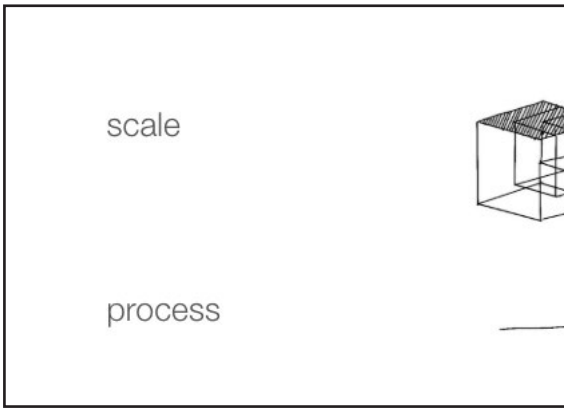
Landing and Territorial Organisation:
unveiling and exposing processes in tension

General Conclusion: Contrasting Extractive and Andean ontologies territorial organisation:

As a conclusion of the analysis of the territorial organisation of the two ontologies present in the Puna de Atacama case study reveals the layered and complex relationships that structure the region's socio-environmental dynamics. Contemporary lithium mining has a powerful impact on institutional and regulatory infrastructures, as well as on natural capital and the long-standing cultures of production and reproduction that sustain local livelihoods. These impacts are not only material, but also ontological, challenging diverse worldviews and modes of territorial engagement.

In order to preserve, mitigate and meaningfully mediate the consequences of extraction, there is an urgent need for a reimagined institutional and regulatory framework. Such a framework must engage with multiple scales and cultural processes and acknowledge the legitimacy of local knowledge systems and forms of environmental stewardship. Only through an inclusive, multi-scalar approach that can negotiate between industrial extraction and local life-worlds can sustainable and equitable futures be built in the Puna de Atacama.

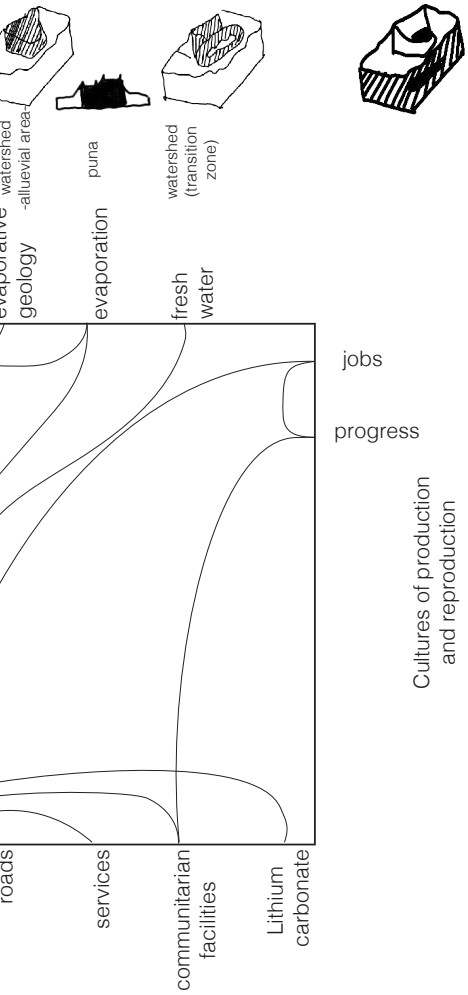




lithium mining process

oration mining process

atural Capital

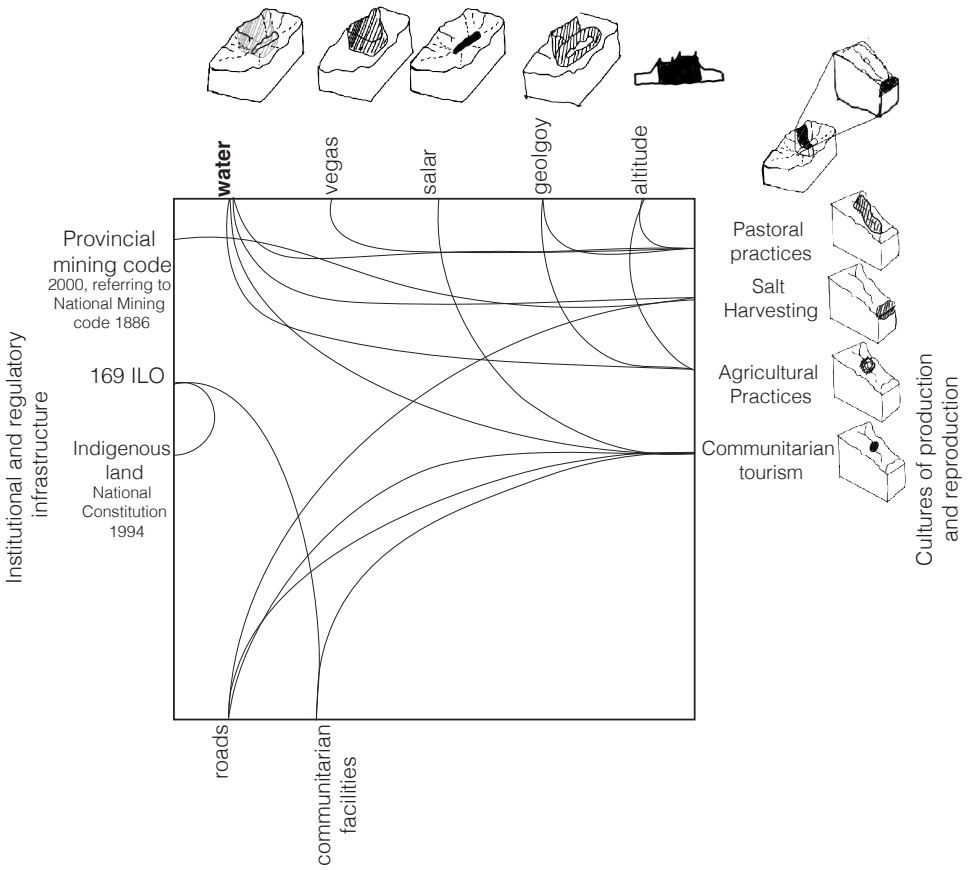


llective Capital

Ancient local processes and practices

Salt Harvesting, Pastoral practices,
small scale agriculture

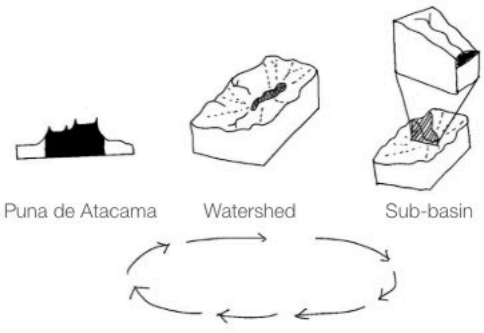
Natural Capital



Collective Capital



Poligonal governance,
thin superficial areas,
and linear process



Natural scales,
cyclical and relational
process

CHAPTER 4
RESEARCHING GOVERNANCE AND AGENCY: LOGICS OF NEGOTIATION

This chapter builds on Karen Barad's theory of agential realism, which reframes agency not as a property possessed by subjects or objects, but as something that emerges through intra-actions-the relational processes through which entities co-constitute one another. In this view, agency is distributed and relational. Complementing this perspective, the chapter also draws on Stuart Elden's understanding of territory as political technology, where territory is not a static container of power or space, but a product of historically situated practices, including the techniques, tools and calculations used to measure, regulate and make decisions about land. For Elden, these techniques are not neutral but deeply political, shaping the very possibilities of governance and agency. Taken together, these frameworks allow for an analysis of how governance operates through technologies of mediation, and how agency is both enabled and constrained by the material-discursive assemblages that define and produce territory. It is guided by sub-research questions 3 and 4:

SRQ3: How has the agency of local communities historically evolved, and what forms does it take in current decision-making processes regarding territorial governance?

SRQ4: What are the mechanisms, instruments, and practices through which the shaping of territory is negotiated in the context of the Salar de Olaroz and Laguna de Guayatayoc?

"Mining brings progress for entrepreneurs, mifortune for communities"

"Water is sacred. Water is a right. Let's recover the sovereignty of water"



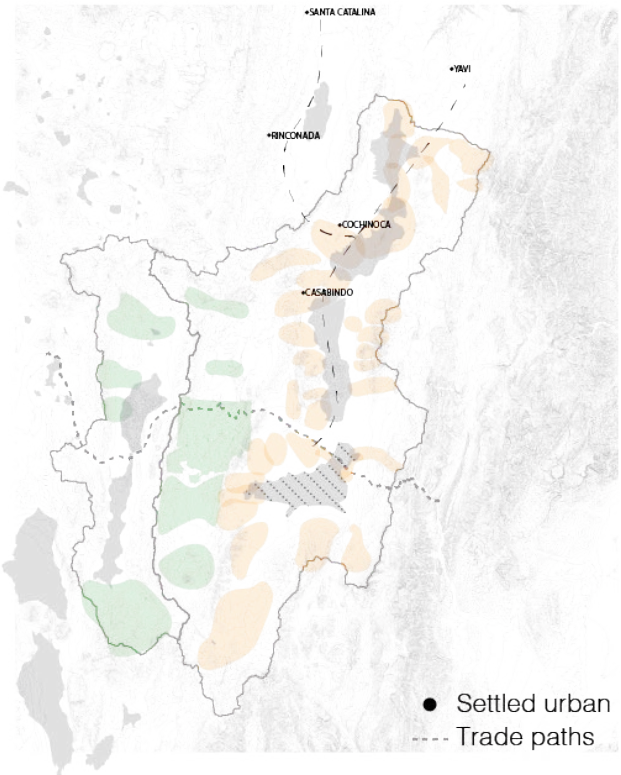
Salinas Grandes communitarian Tourism point
/ Author, 2025

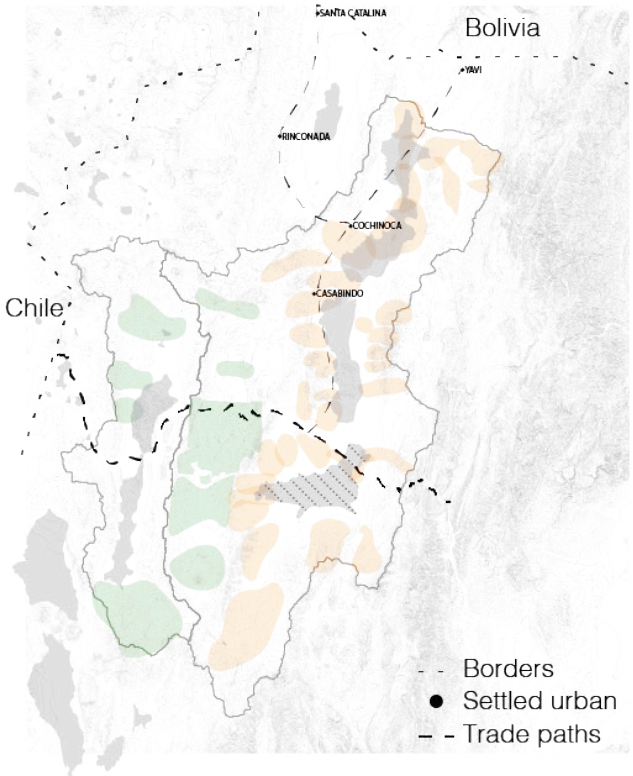
Chapter 4

Researching governance and agency
Logics of negotiation

Tracing local communities agency in decision making

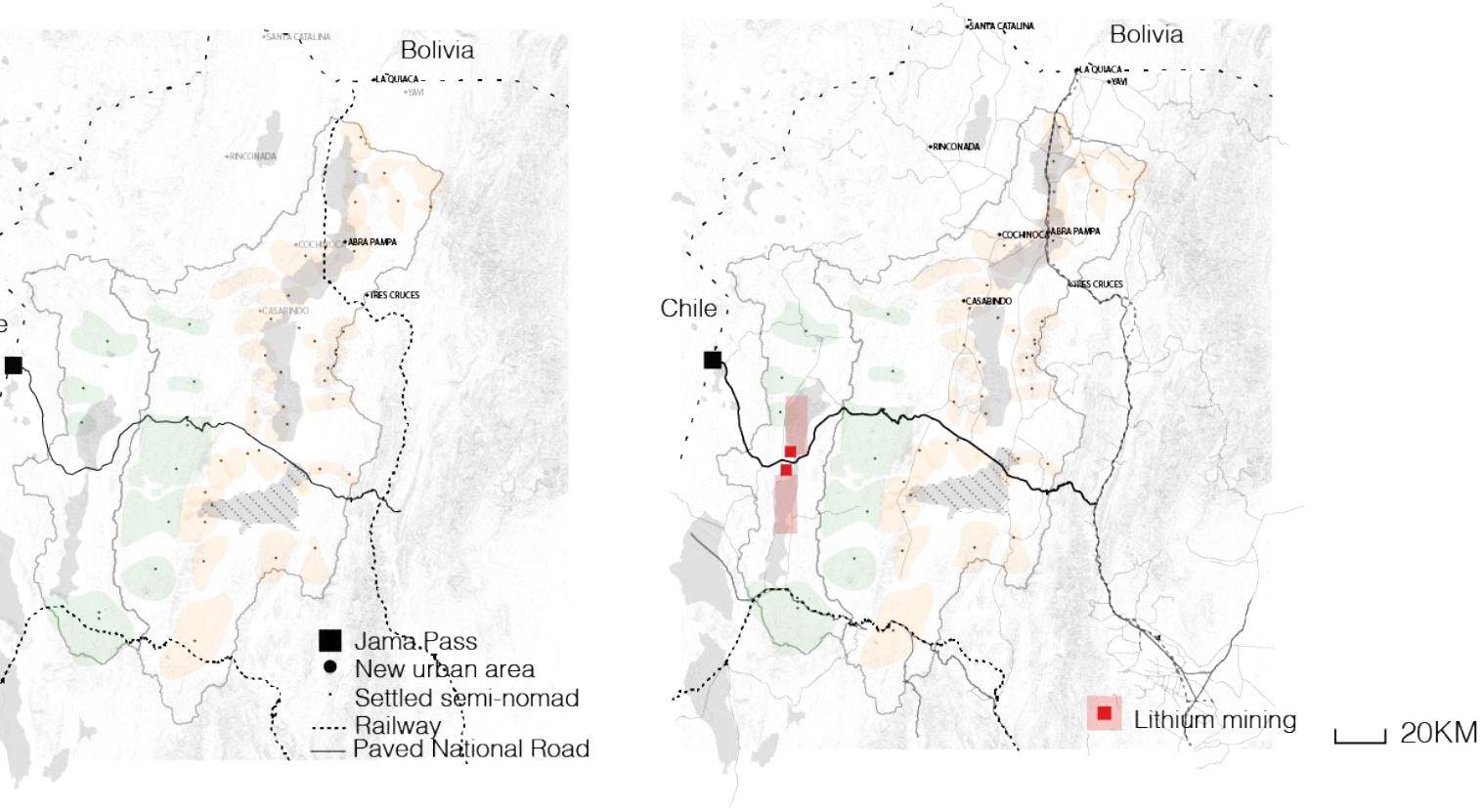
The Kolla and Atacama communities have matained a profound and evolving relationship with their ancestral lands for millennia. During the pre-Hispanic period, they developed adaptive practices such as salt harvesting, agriculture and regional trade. These were organised around communal land systems and a relational worldview of the territory.
However, colonialism imposed external governance structures, dispossessed communities of their lands and forced them into exploitative labour, particularly in salt mining. Indigenous systems such as the ayllu and communal water use were undermined.
With the formation of nation states, the ancestral territory was divided between Argentina, Chile and Bolivia. National policies such as land taxes and leases further marginalised the communities, leading to armed uprisings such as the Rebellions of Abra de la Cruz and Quera in the 1870s. Despite repression, these actions demonstrated the significant indigenous resistance to dispossession.





In the 20th century, modernisation and extractivism — railways, mining and centralised development — disrupted local economies and intensified migration. The Malones de la Paz in the late 1990s and early 2000s marked a pivotal moment in the peaceful reclamation of land, as communities across the Puna mobilised to reclaim territories through legal action and non-violent occupation. These actions helped to raise awareness and pushed the state towards land regularisation agreements, although implementation has been slow and many communities still do not have their land ownership papers.
In the 21st century, lithium extraction has brought new challenges, threatening water sources and exacerbating territorial conflicts.

In response, the Mesa de Pueblos Originarios de la Cuenca de Salinas Grandes y Laguna de Guayatayoc was formed to demand prior consultation and defend communal rights. To do so, they elaborated the KACHI YUPI “huellas de sal” proposing an alternative protocol of prior consultation.
Their legal and political actions, which have reached national courts and international bodies, continue a long history of territorial defence based on environmental justice and indigenous autonomy.



Chapter 4

Researching governance and agency
Logics of negotiation

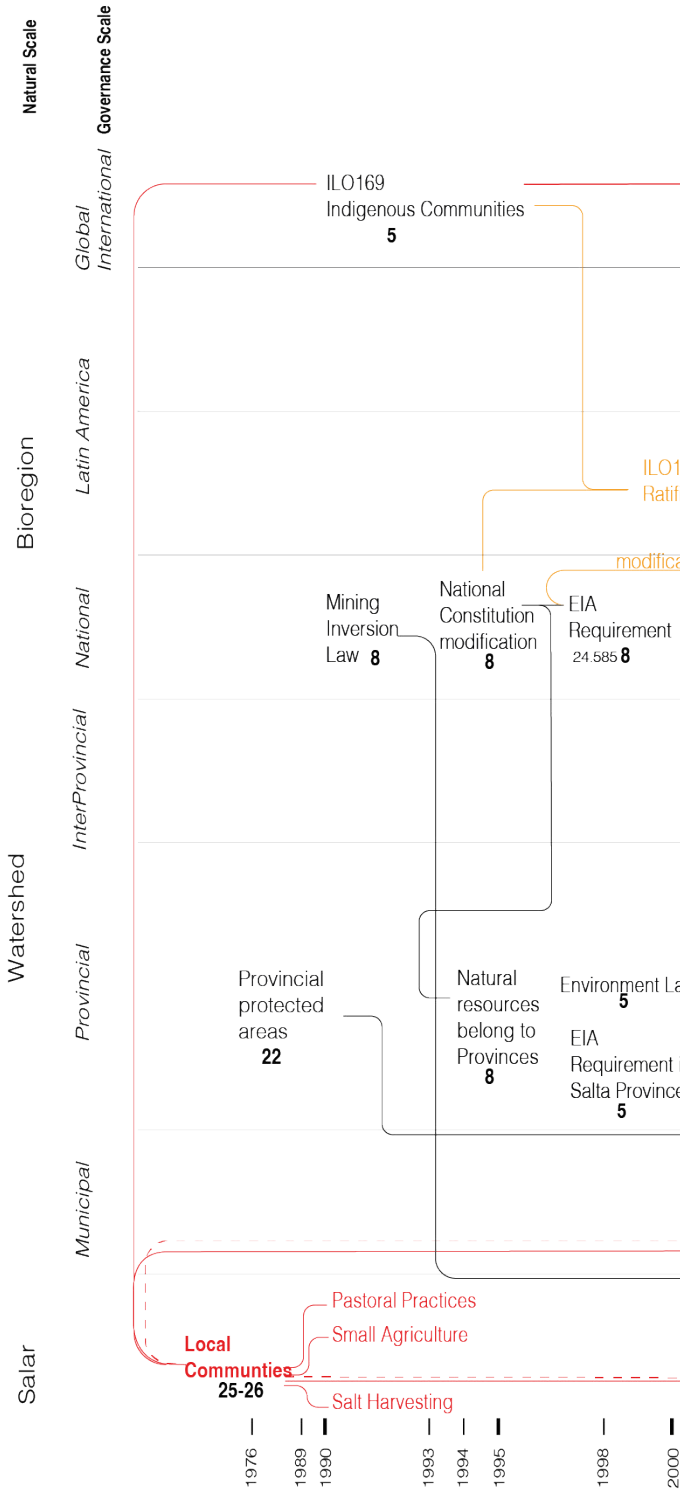
Agency map

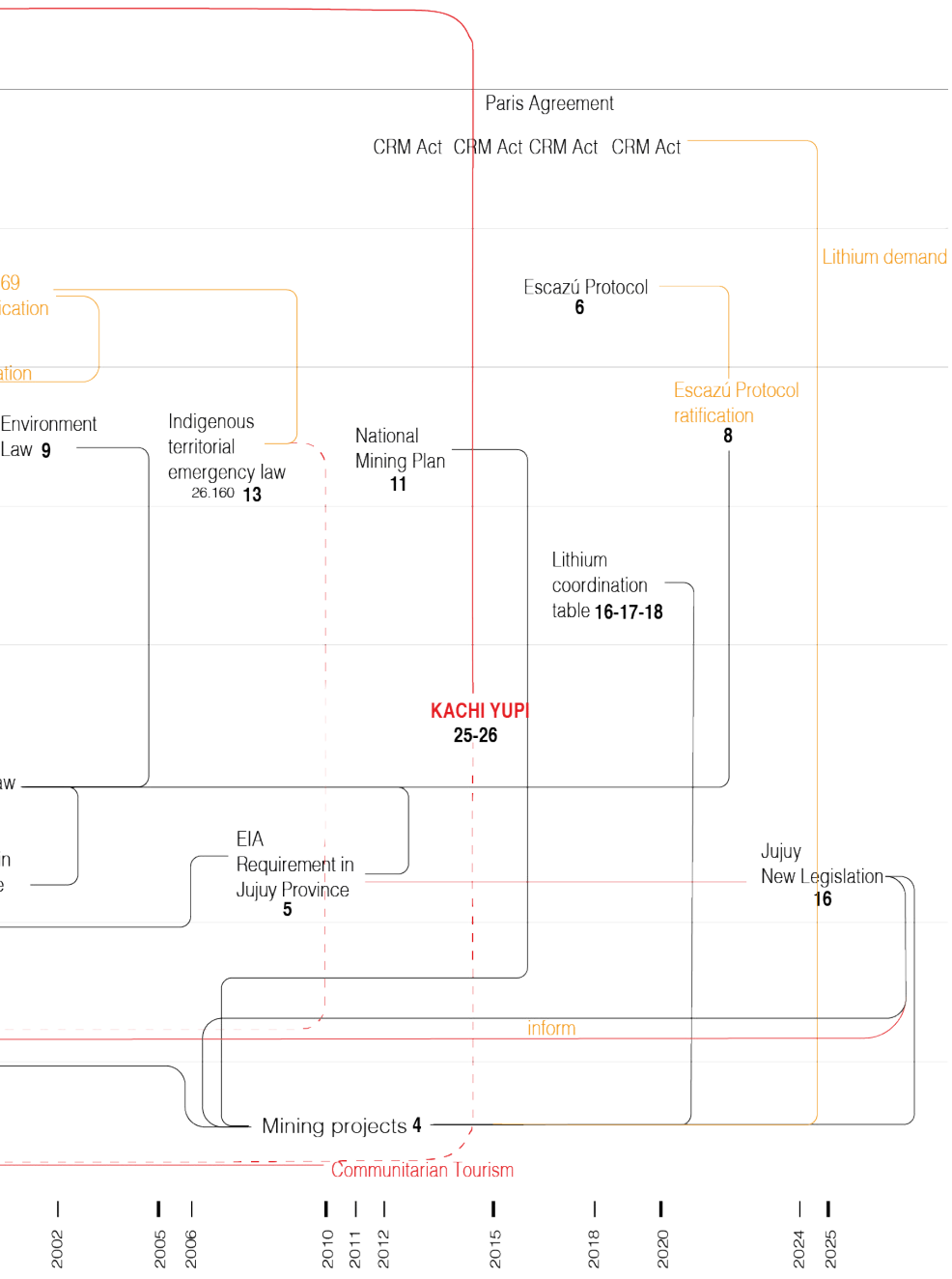
In light of the historical context and territorial agency of local communities in the Puna de Atacama and considering Argentina's lack of a specific regulatory framework for lithium mining, (which results in overlapping and fragmented regulations), I developed an agency map, inspired by the representational methodology proposed by Daher (2024). This map identifies and connects documents, practices, and actions across temporal and spatial scales, while situating key stakeholders to reveal the complex governance dynamics.

According to the Argentine National Constitution, natural resources located both on the surface and in the subsoil are owned by the State (Argentine Civil and Commercial Code, Law 26.994, Articles 235 and 236). Certain natural resources, such as minerals and water, may be granted for private use and benefit under the legal figure of imperfect domain, which confers conditional or time-limited ownership rights (Civil Code, Articles 1946 and 1964–1969). This is why these are referred to as mining concessions rather than ownership titles.

Although regulated by provincial authorities given Argentina's federal structure these concessions remain subject to national legislation, including the National Mining Code (1886) and the National Regime for Environmental Management of Water (Law 25.688). The General Environmental Law (Law 25.675, 2002) also mandates Environmental Impact Assessments (EIAs) before any mining activity begins, and every two year during operations. These assessments must describe project characteristics and identify potential socio-environmental impacts.

In terms of Indigenous rights, the 1994 constitutional reform granted precedence to international human rights treaties, such as the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP, ratified in 2007) and International Labour Organization's Convention 169. Both instruments recognize the right to Free, Prior, and Informed Consent (FPIC), which is central to Indigenous participation in decision-making (ILO, 1989; UN, 2007).





Stakeholders

1.EITI

2.Wetlands International

3.Global Citizens

4.Mining Companies

5.International Labour Organisation

6.CEPAL

7.UNASUR

8.ArgentinaNational Government
9.Environment Ministry
10.Academic Instituitions
11. National Mining Ministry
12.Wetlands International Argentina
13.INAI
14.FARN
15. National Environment Ministry

16.Jujuy Government
17.Salta Government
18.Catamarca Government
19.EIA Consultancies

20. Provincial Mining Ministry

21.Academic Instituitions

22. Provincial Environment Ministry
23. Water Secretary
24. Indigenous Ministry

4.Mining Companies

25.Atacama Indigenous communities

26.Kolla Indigenous communities

27.non-humans

entailing
local communityagency
not operative

In practice, mining companies are also expected to secure a social license to operate, particularly in areas considered vulnerable.
The Escazú Agreement (ratified under Law 27.566) further strengthens public participation and access to environmental information, complementing Laws 25.675 and 25.831. At the international level, mechanisms like the Critical Raw Materials List (European Commission, 2023) and the Critical Raw Materials Act do not carry regulatory weight in Argentina but signal the strategic importance of lithium globally, shaping political priorities and potentially influencing local regulation.

Although Indigenous communities have historically maintained a continuous relationship with their territories, they have, in recent decades and in response to extractive pressures, developed alternative livelihood strategies. One such approach is community-based sustainable tourism, which allows them to share their practices and cosmovisions, diversify income, and resist dependency on mining employment. This is evident in communities such as Pozo Colorado and Tres Pozos, linked to salt harvesting, and El Moreno and San Francisco de Alfarcito, which preserve knowledge in agriculture, herding, and weaving.
In conclusion, it is evident that state regulatory structures prioritise extraction, often limiting community involvement to procedural compliance. Public participation is reduced to minimum legal requirements, such as those tied to Environmental Impact Assessments, which are supposed to include FPIC under ILO 169, but are often perceived by communities as insufficient.
Although the legal framework is oriented to prioritise mining development, as a conclusion, it can be said that due to the legal gaps and interrelation with, for example, the ILO 169, there are legal tools like the EIA that can be shaped to include local communities participation.
In response to mining exploration in Salinas Grandes, the Indigenous communities developed a consultation protocol outlined in a legal document called Kachi Yupi, which symbolically mirrors the natural cycle of salt harvesting.

Kachi Yupi Protocol

Though the protocol is not legally operative within national regulatory frameworks, it offers a powerful framework rooted in Indigenous territorial logic. The process unfolds in six phases:

1. Preparation (tool-making and knowledge-building),

2. Design (constructing pools and initial meetings),

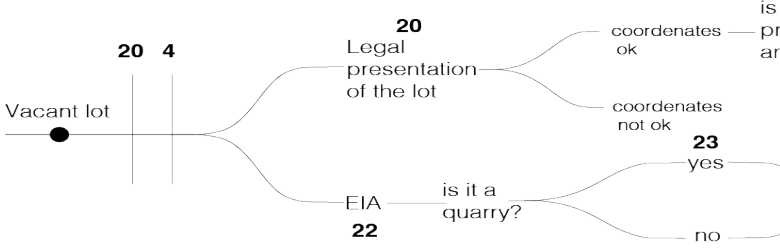
3. Development (salt nurturing and information-sharing),

4. Maturation (crystallisation and internal deliberation),

5. Decision-making (harvesting and approval),

6. Follow-up (drying and monitoring).

This analogy conveys how consultation is understood not as a bureaucratic procedure, but as a living, collective, and respectful process, aligned with the temporal rhythms, relational ethics, and ecological cycles of the land.



Furthermore, to understand why the shortcomings of the consultation process, it is essential to examine the mining concession system itself (fig.1). Based on fieldwork records, this process is highly linear: starting with an unpaid conces-sion application, followed by the publication of the mining lot polygon, and various institutional interventions, regarding provincial protected areas and a hydrological intervention aligned with conventional mining (only addressed if the mining exploration-concession is about a quarry). A public hearing with communities occurs only shortly before approval. It can be said that al-though an EIA is submitted at the beginning and updated biannually, it only considers arbitrarily defined areas of influence and fails to assess broader hydrological, ecological, or cultural systems such as watersheds, despite their relevance to Indigenous territoriality.

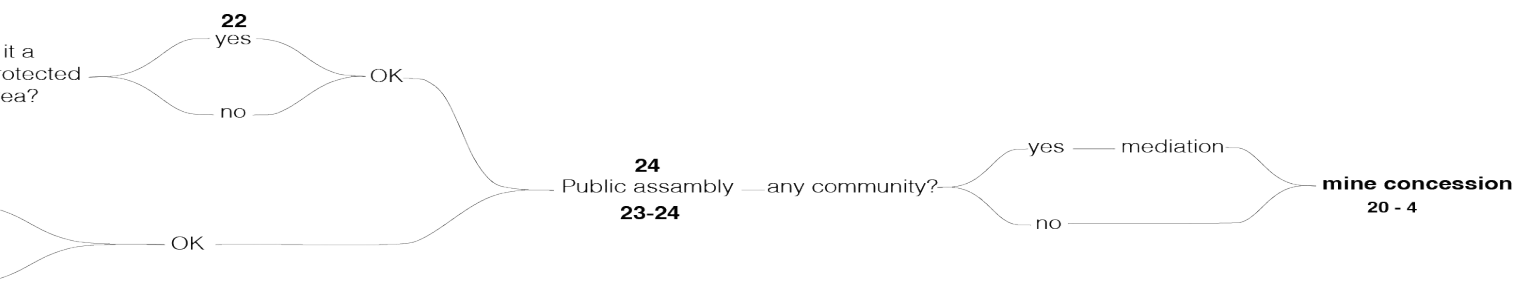


fig.1

CHAPTER 5
HOW ARE WE READING THE TERRITORY?

Having understood the history of governance in the Puna de Atacama, and having concluded in Chapter 3 the lack of coordination and the relationship between regulatory and institutional infrastructures and natural capital, and having seen in Chapter 4 how the complex web of governance derives from and is contained in the EIA, this chapter is guided by the following research sub-question:

Srq5: How is the territory interpreted, measured, and represented? Which knowledge and tools are taken into account in the production of territorial knowledge?

Although various disciplines work together with the territory of the Puna de Atacama both to protect it and to promote mining,their responses often remain fragmented, each addressing isolated aspects without fully capturing the systemic relationships, scales of impact, or long-term preservation needs. Categories such as soil, water, people, and non-humans are commonly used to organize knowledge and action, appearing both in Environmental Impact Assessments and in the approaches of academics and NGOs working to defend the region.
During this chapter I will unfold the disciplines and methods used for the Enviromental Impact Assesment



Salt Flower in Salinas Grandes
Author, 2025.



Pozo Colorado
Author, 2025.

Chapter 5

How are we reading the territory?

Dissecting Enviromental Impact Assesments

An Environmental Impact Assessment (EIA) is a technical-administrative process through which the potential environmental impacts, both positive and negative, of a project are evaluated before it is authorized for execution. In this process, a territorial baseline is established, which defines the pre-existing conditions of the environment. This baseline is crucial because it sets the parameters against which future impacts will be measured, serving as a key reference for evaluating the changes induced by the project.

Framed by an understanding of the EIA as a political technology that produces both territory and knowledge, this analysis is structured through a series of analytical columns that help examine what is measured, with what tools, by whom, and at what scales. These columns also identify problems or abstractions present in the EIA and propose alternative or expanded scales of analysis shifting toward levels of interpretation more aligned with real natureculture systems.

Column	How does it contribute?
Dimension	Identifies key analytical blocks that include the entire system: soil, water,non-humans and people. Related with natural capital -abiotic and biotic and cultures of production and reproduction.
EIA Category	Recovers the technical categories used in EIAs (geology, hydrology, etc.). Highlighting the fragmentation of the territory.
Discipline – Actors	Identifies the scientific and professional knowledge that operates in each category, from an analysis of the EIA and the EIA consultancies,-showing how technical authority is produced in the EIA. Raises the question: who has the agency to define what constitutes impact?
Tools / Methods	Describes the technical tools (models, maps, indicators). Reveals the languages and devices that mediate the relationship with the territory.
Current Scales of Implementation	Shows the scales at which the analysis is currently applied (mining lot, sub-basin, etc.), revealing a trend towards spatial ffragmentation
Measurement – Information	Exposes what type of data is produced and for what purposes (e.g., quantity of water vs. symbolic quality of water). Allows to see how impacts are defined in a reductive way.
Problems / Abstractions	Describes the ontological and epistemic limitations of conventional EIAs: reductionism, ignorance of relationships, invisibility of indigenous knowledge, lack of territorial scale.
Possible Scales	Introduces the possibility of thinking about other levels of analysis that align better with real natureculture systems (watershed, ancestral territory, network of relationships).

Dimension	EIA category	Discipline - actors	Tools / Methods	Cur im
Environment	Geology and seismicity	Geology, Seismology, Geotechnical Engineering	Seismic risk mapping, core sampling, fault analysis	Minin
soil	Geomorphology	Physical Geography, Geomorphology, Earth System Science	Slope stability, terrain classification, erosion modeling	Minin
water	Hydrology	Hydrology, Environmental Engineering, Physical Geography	Surface water modeling, water balance studies	Minin
	Hydrogeology	Hydrogeology, Groundwater Science	Aquifer models, pumping tests, drawdown curves	Mining in t
	Hydrochemistry	Geochemistry, Environmental Chemistry	Brine chemistry, contamination thresholds, trace element analysis	Mining in t
non-human	Biology	Biology, Ecology, Conservation Science	Biodiversity surveys, indicator species, ecological value metrics	Minin
people	Cultural	Anthropology, Indigenous Studies, Cultural Geography, Environmental Humanities	Oral histories, ritual mapping, participatory workshops	Comm the r registe
	Socioeconomic	Sociology, Economics, Human Geography, Political Economy, Development Studies	Livelihood assessments, cost-benefit analyses, statistical surveys	Co c m

rent scales of plementation	Measurement - information	Problems / Abstractions	Possible scales
g lot boundaries	Mineralisation - soil type	Reduces the land to a geotechnical substrate abstracting geological formations from the socio-environmental systems they underpin	**Region - zones**
g lot boundaries	Soil quality	Treats soil as fragmented landforms; abstracting ecological and cultural feedbacks they interact with	**zones**
g lot boundaries	Water quantity	Omits basin interconnections and hydrosocial and biological relations.	
lot - somewhere the watershed		It often treats groundwater as a closed system, overlooking how those hydrological shifts affect surface ecosystems, traditional land uses, and the social fabric of local communities	**watershed - subbasin-microbasin**
lot - somewhere the watershed	Water quality - *Industrial standards*		
g lot boundaries	Composition, abundance	Tend to isolate biological variables, overlooking abiotic factors as salinity shifts due to brine extraction or geomorphic alterations that can affect habitat structure over time.	**Micro**
munities close to mining lot, legal ered communities		Culture treated as static or symbolic without integration with geophysical or ecological data missing a broader understanding of the location in a watershed or the relationship with other activities.	**Cultural proposed, negotiated scale**
mmunity unit, onventional easurement	*Jobs, income, infrastructure development*	Focuses on market values excluding livelihood autonomy and mutual parenting care networks	

Chapter 5
How are we reading the territory?

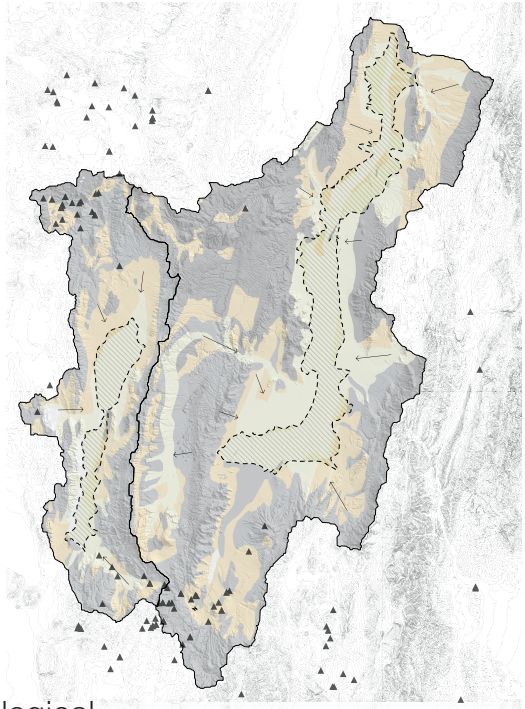
One of the key conclusions drawn from the Environmental Impact Assessment (EIA) analysis is that the territory is interpreted in a fragmented way. This fragmentation is evident in both how impacts are measured and the interdisciplinary coordination — or lack thereof — when establishing the baseline. The territory is analysed at different scales, yet without coherent or integrated logic. Although the EIA involves multiple disciplines, ranging from geology and hydrology to biology and anthropology, their contributions remain largely compartmentalised, which limits a holistic understanding of the territory.

This analysis revealed the need for tools capable of addressing the territory's complexity and layered nature. As part of this process, I developed a set of maps that I consider essential for understanding the underlying dynamics—some were compiled from existing sources, some were modified and some were created from scratch. These maps not only served as tools for analysis, but also as instruments for the iterative exploration and refinement of hypotheses.

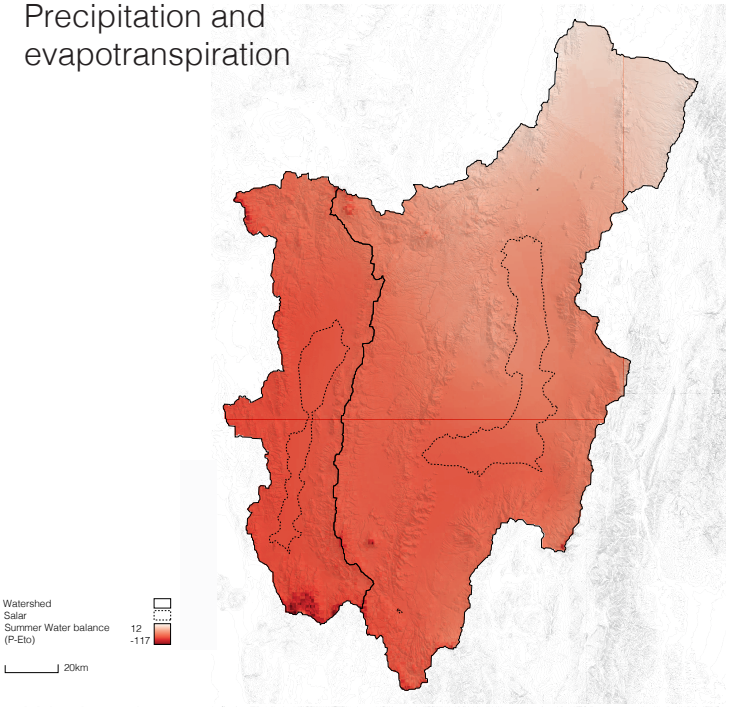
The creation of these layers was not a one-time process, but rather unfolded progressively throughout the entire investigation. This involved continuous iteration and adjustments, as well as the incorporation of new information and the development of additional layers as needed. Available datasets for the region are limited, often incomplete and difficult to access. Due to the area's unique characteristics, I had to interpret certain parameters unconventionally, particularly those related to water cycles and evaporation. Diagrams and the intersection of various data layers were fundamental to interpreting the data and deriving meaning from it.

Adopting a research-by-design approach, these mapping layers culminate in Chapter 8, where they provide a framework for proposing and testing possible futures for the territory.

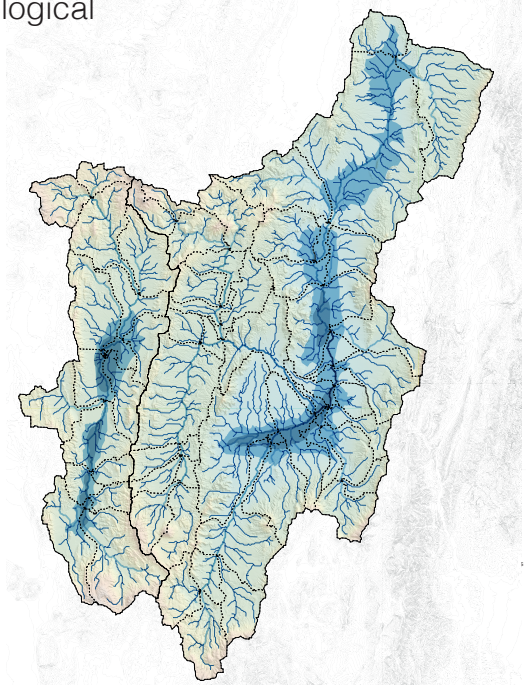
Soil



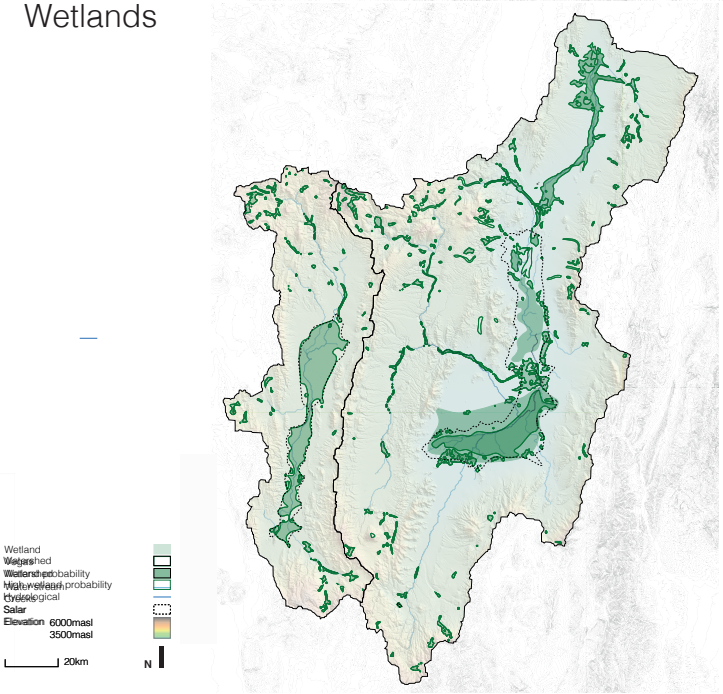
Precipitation and evapotranspiration



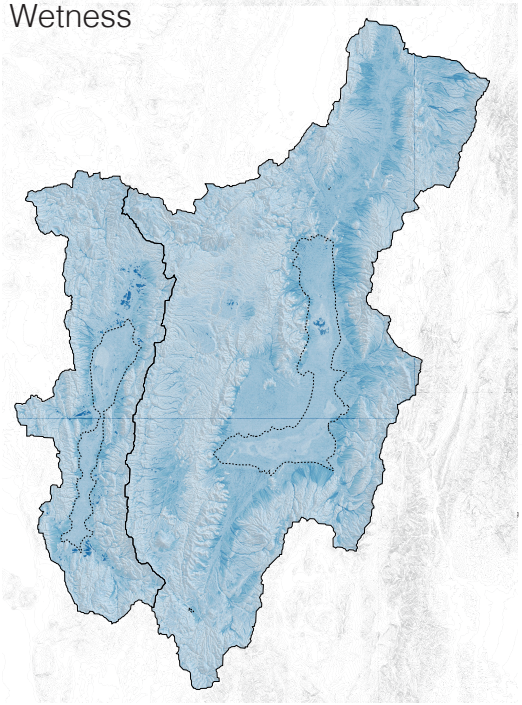
Water-Hydrological



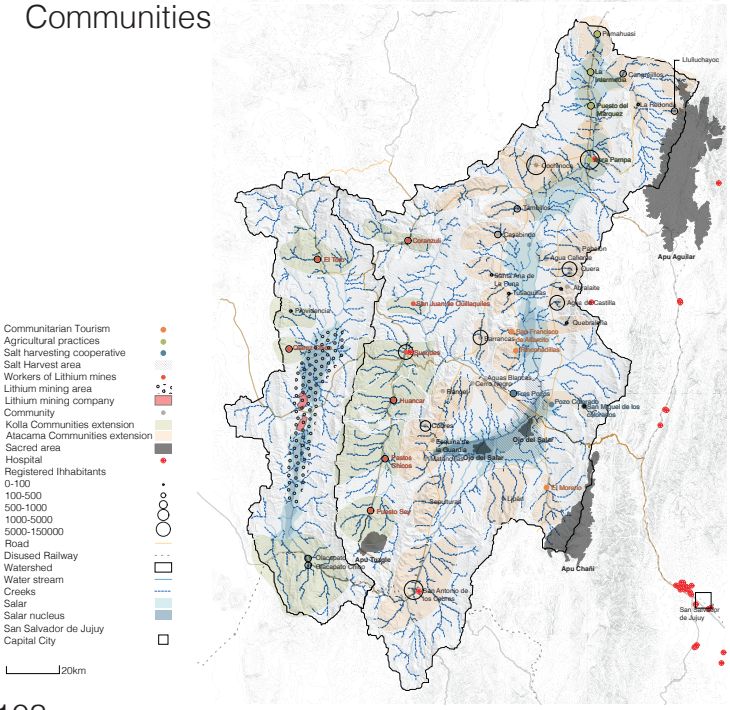
Wetlands



Topograpgic Wetness index



Communities



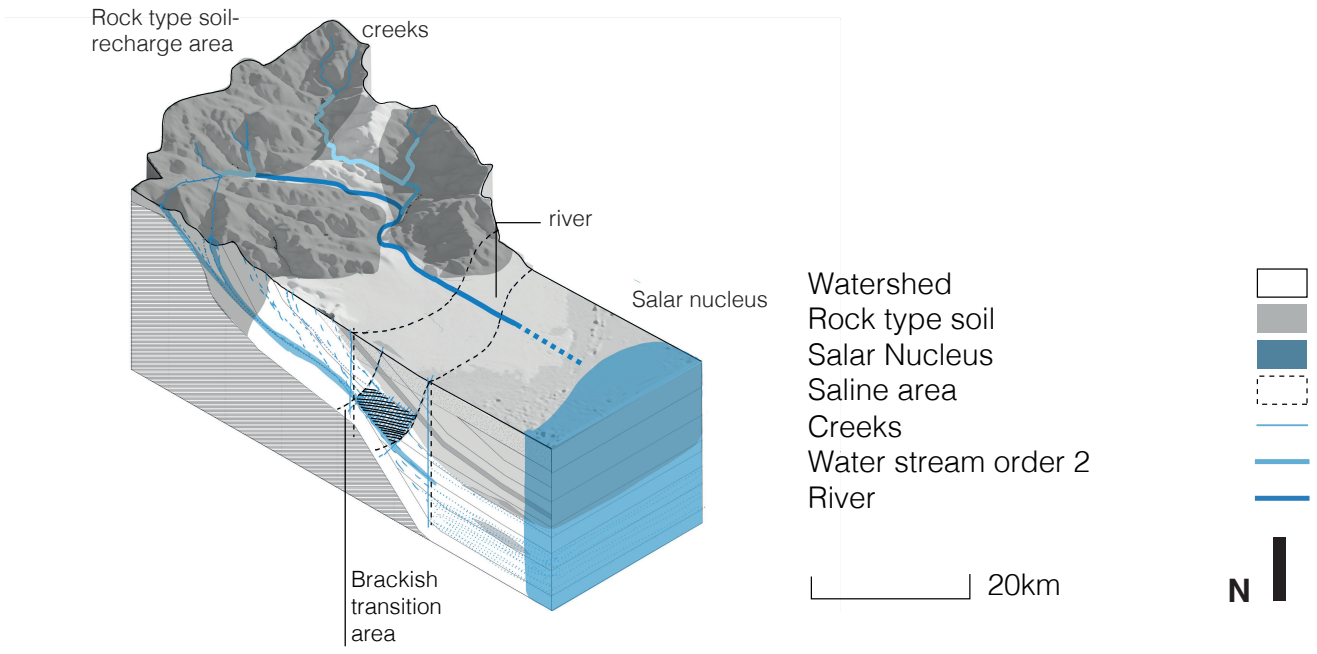
Chapter 5

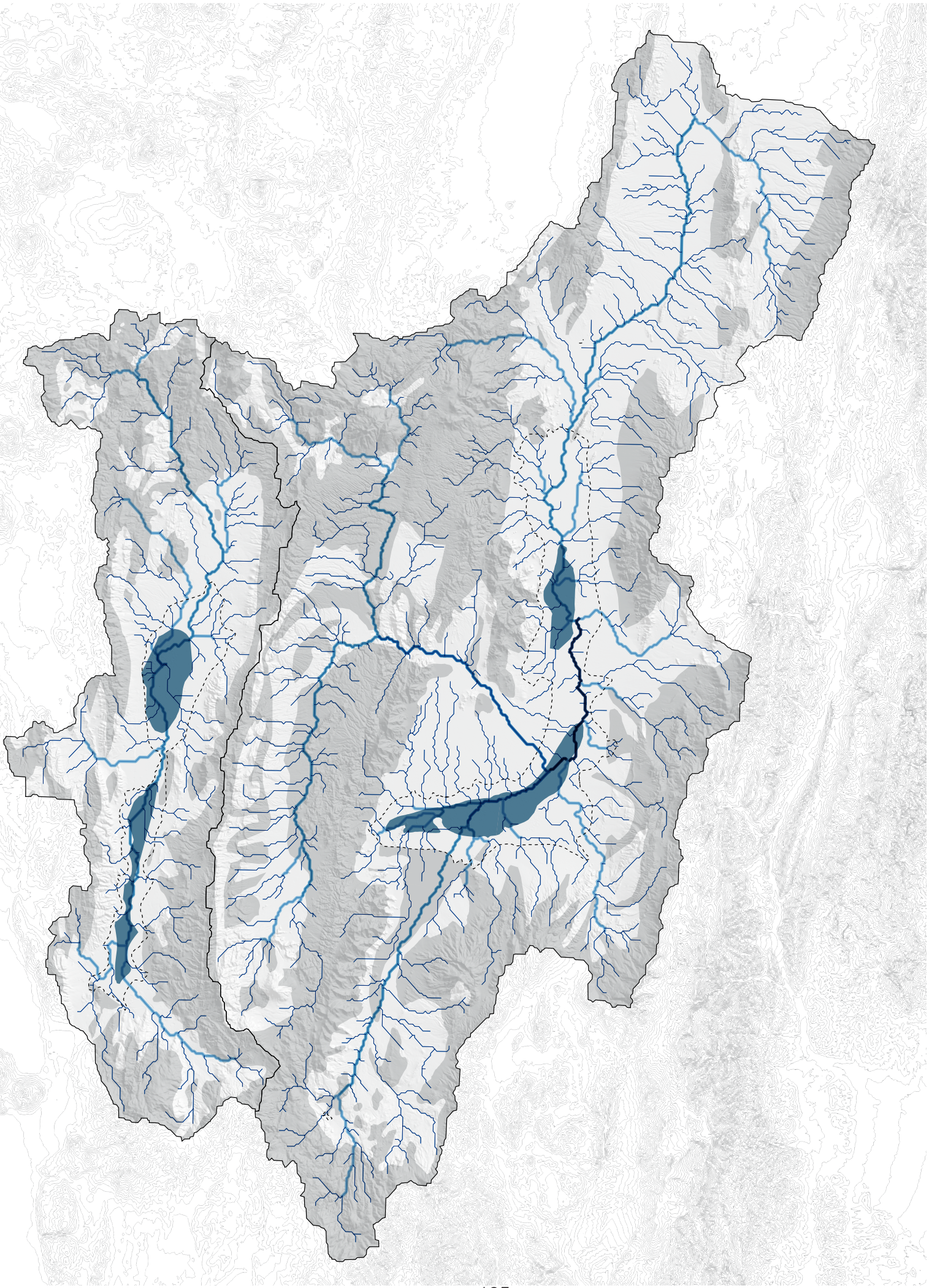
How are we reading the territory?

Soil-Water

In order to understand groundwater recharge in arid and semi-arid regions, it is necessary to integrate hydrological analysis with soil and rock type classification, since the structure of the soil and the geology of the area fundamentally influence the movement and retention of water. Soils such as Aridisols and Inceptisols, which are commonly found in alluvial cones and plains, generally have a higher porosity, allowing infiltration. However, their recharge potential is often limited by the high evaporation rates that are typical of these climates. This causes a significant amount of infiltrated water to be lost before it can reach aquifers (Levick, L, et al 2008). Conversely, rocky soils with low porosity at higher elevations produce limited infiltration, but concentrate surface runoff into creeks and ephemeral streams. These watercourses act as focused recharge pathways, transporting water downslope and facilitating groundwater replenishment through fractures and permeable zones within the bedrock.

This emphasises the vital role of creeks in rocky landscapes as key agents of watershed recharge, which is often more significant than the recharge potential of more porous, but evaporation-prone, soils in lower-lying plains. Therefore, to accurately assess groundwater recharge processes, a comprehensive understanding of watershed dynamics must consider the interplay of soil type, geomorphology, and climate (Levick, L, et al 2008)





Chapter 5

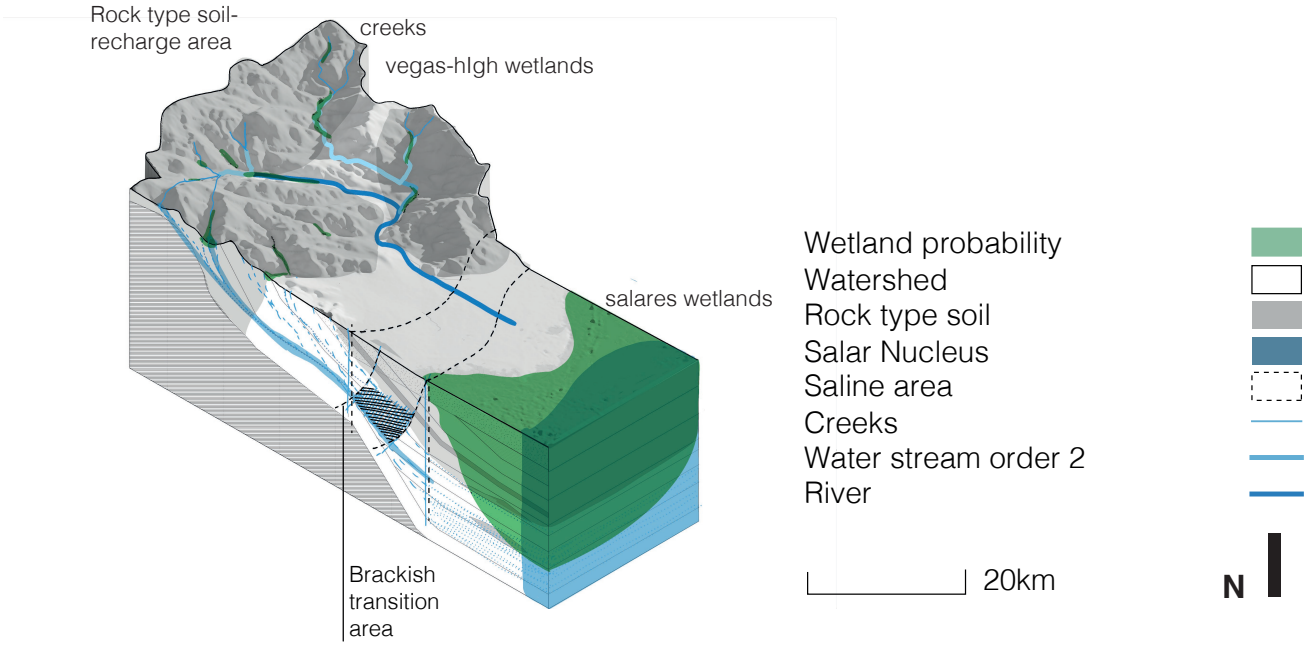
How are we reading the territory?

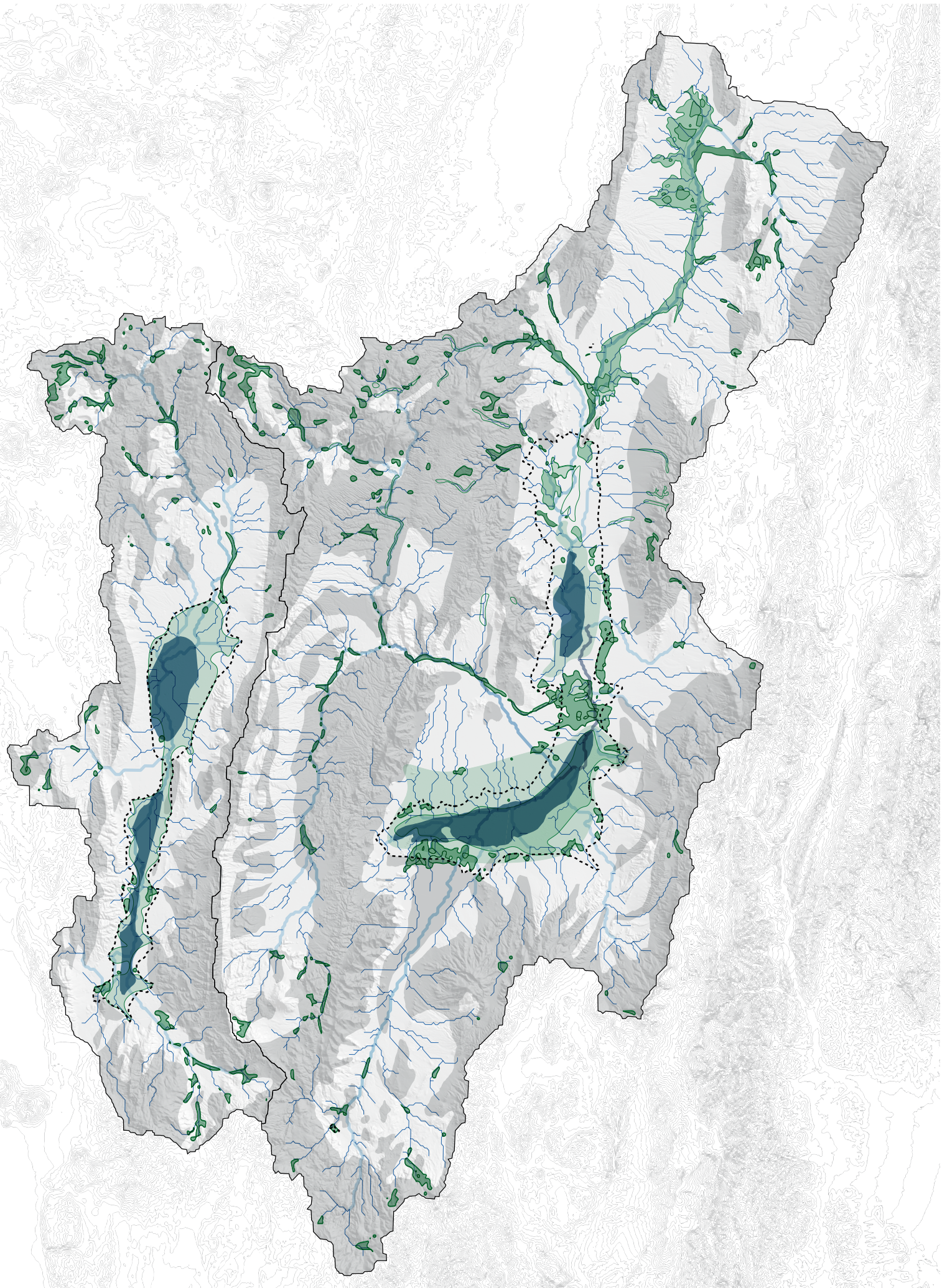
Wetland system: relation with geology and hydrology

In arid and semi-arid landscapes, wetlands tend to be scarce and are heavily influenced by local hydrology and geology. In these settings, wetlands found alongside creeks and ephemeral streams in hilly and upland areas — commonly referred to as vegas and bofedales — are sustained by groundwater discharge and surface runoff, despite the generally low porosity and high evaporation rates of the surrounding rocky terrain. These wetlands support unique ecological communities and act as vital freshwater reservoirs in high-altitude environments (Squeo et al., 2006).

In contrast, salares characterise the lower plains as saline wetlands, where evaporative concentration leads to salt accumulation. These terminal basins receive limited inflows and often reflect the complex interplay between groundwater and surface water in arid conditions. Salars are important habitats for organisms adapted to living in salt flats and represent the final sinks for hydrological and solute fluxes in the watershed (Risacher et al., 2003).

Therefore, wetland systems in arid regions exhibit a dual pattern: upland vegas and bofedales act as zones for the recharge of freshwater and as biodiversity hotspots, while salars dominate the plains as saline wetlands shaped by evaporation and solute concentration. Understanding this spatial and functional distinction is essential for the conservation of wetlands and the sustainable management of water in dry mountain and desert landscapes (Squeo et al., 2006)



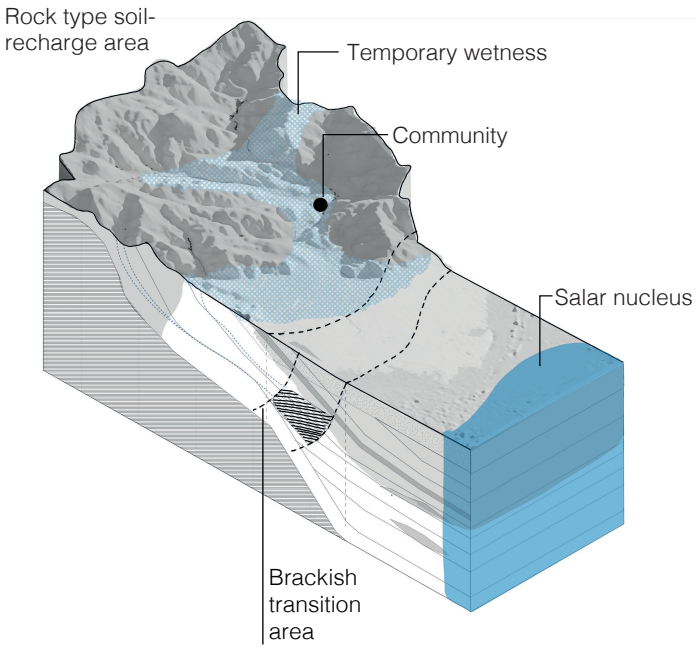


Chapter 5

How are we reading the territory?

Topographic Wetness Index- Soil

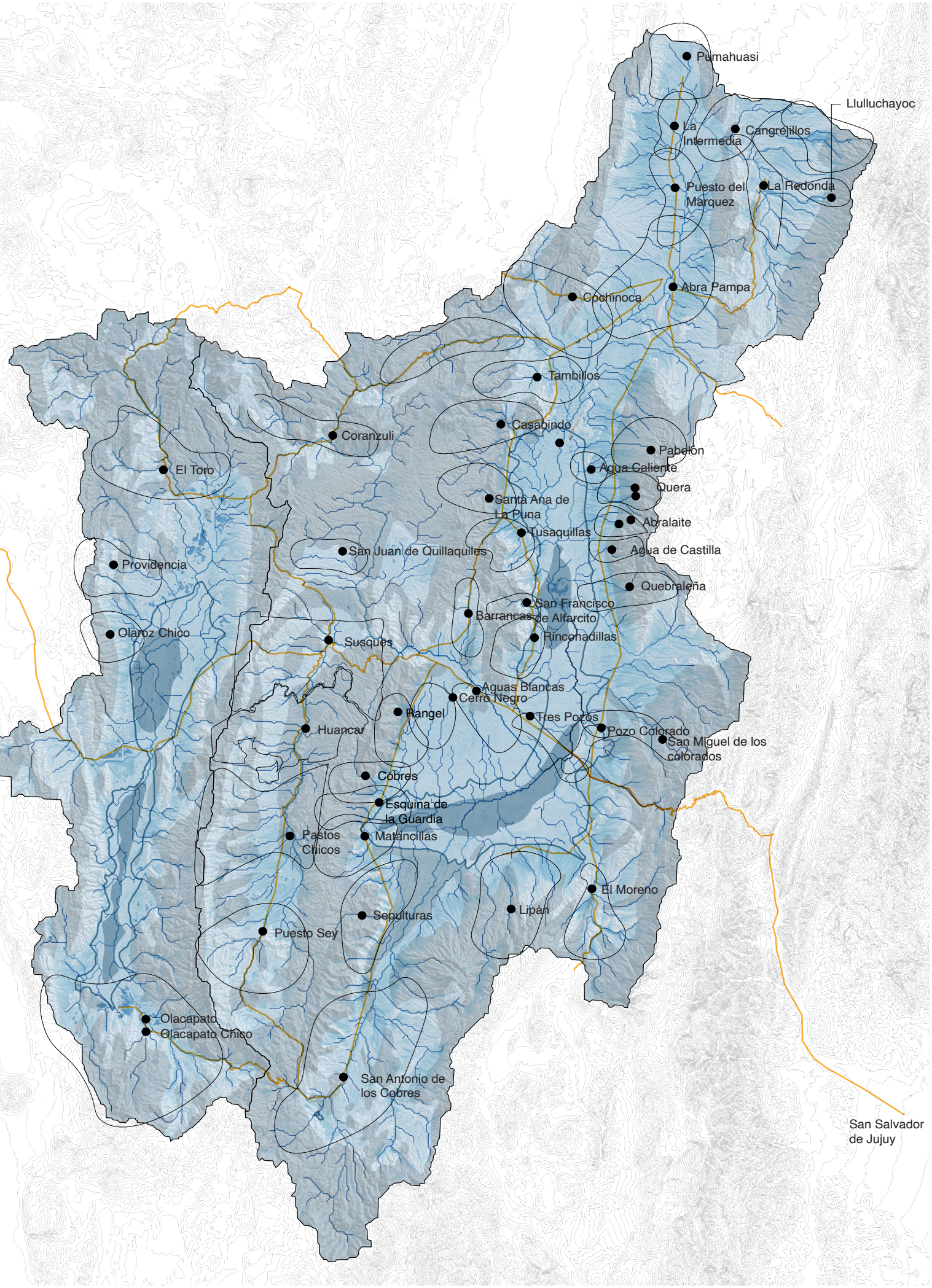
The combined analysis of the Topographic wetness index and soil classifications with local communal spatialities, reveals that community dynamics and settlements tend to concentrate in basins with higher moisture availability, while saline areas are generally avoided. Furthermore, the TWI, together with hydrological analysis, shows how spatial organization and movement are shaped by the presence of water channels and moisture-rich areas



Watershed
Rock type soil
Salar Nucleus
Saline area
Topographic Wetness Index
< 5-Low wetness
15 High wetness
Community
Road

20km

N

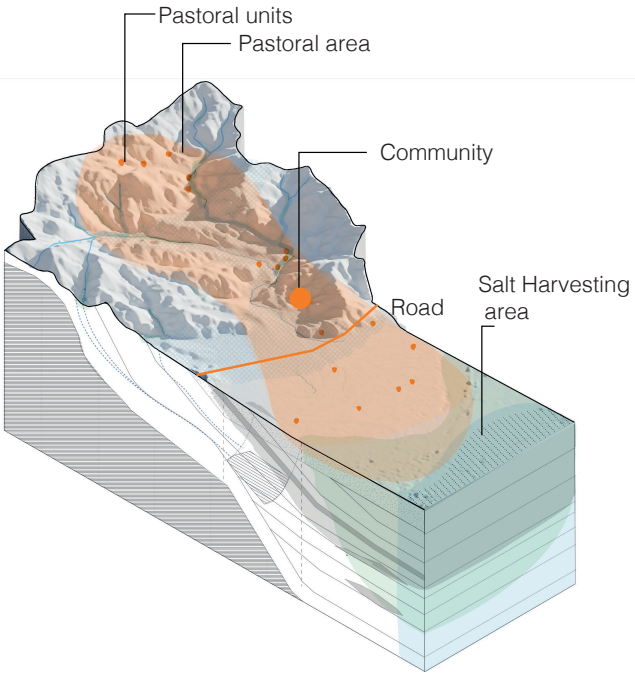

Pumahuasi
Llulluchayoc
La Intermedia
Cangrejillos
Puesto del Marquez
La Redonda
Abra Pampa
Cochinoca
Tambillos
Casabindo
Coranzuli
Pabellón
El Toro
Agua Caliente
Quera
Santa Ana de La Puna
Abralaite
Tusaquillas
San Juan de Quillaquiles
Agua de Castilla
Providencia
Quebraleña
San Francisco
Barrancas
de Alfarcito
Rinconadillas
Olaroz Chico
Susques
Aguas Blancas
Cerro Negro
Rangel
Tres Pozos
Huancar
Pozo Colorado
San Miguel de los colorados
Cobres
Esquina de la Guardia
Pastos Chicos
Matancillas
El Moreno
Lipán
Sepulturas
Puesto Sey
Olacapato
Olacapato Chico
San Antonio de los Cobres
San Salvador de Jujuy

Chapter 5

How are we reading the territory?

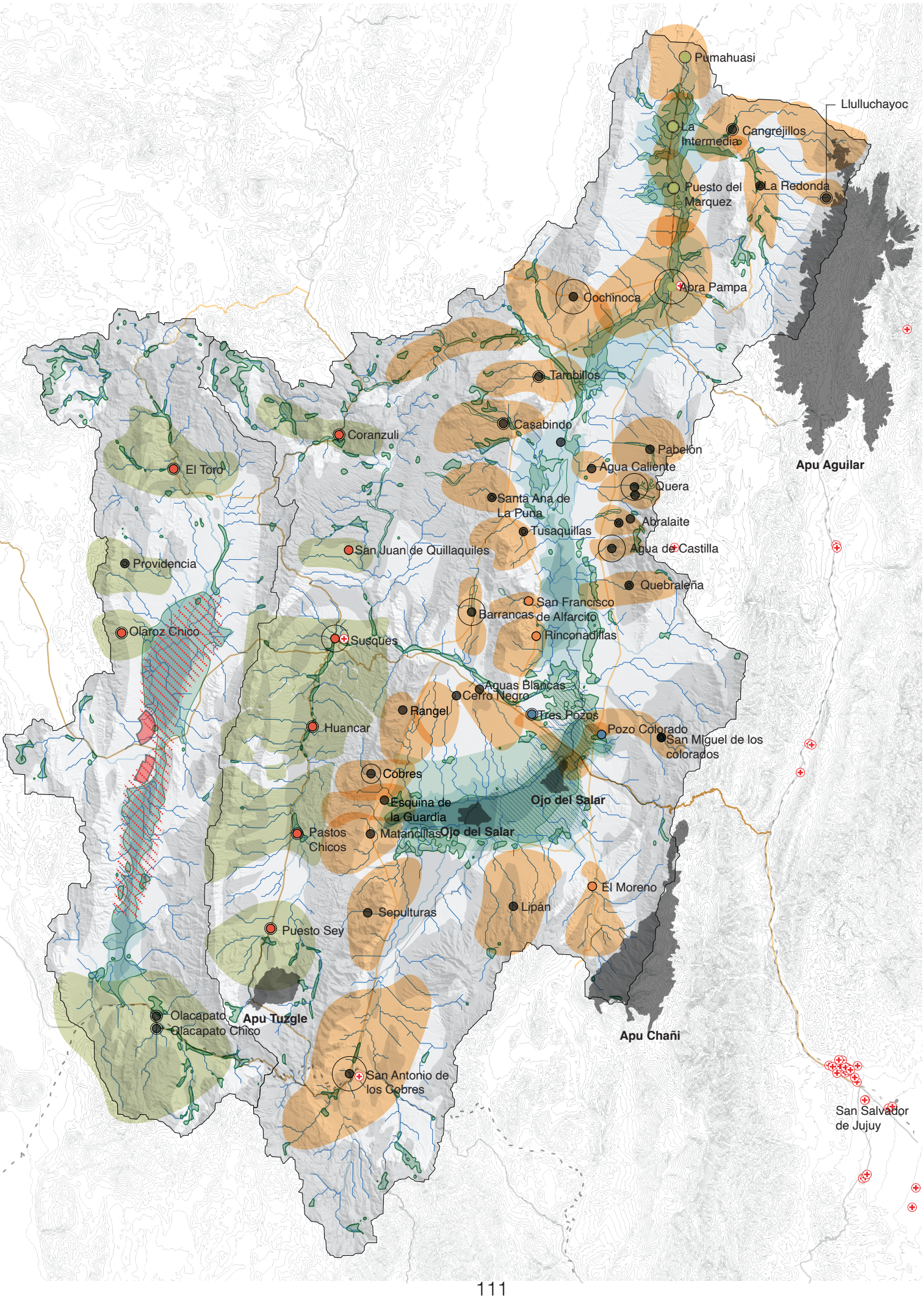
Local communities and the biophysiscal

Local activities are closely intertwined with the territory. These include salt harvesting in the salina and pastoral movements that follow the availability of water sources such as channels, vegas, bofedales and other high-altitude wetlands. While it is difficult to map these complex and fluid dynamics, literature reveals strong associations between sacred and natural elements, such as mountains, salares, ojos de salar and highland wetlands, that structure and guide local spatial practices.



Communitarian Tourism
Agricultural practices
Salt harvesting cooperative
Salt Harvest area
Workers of Lithium mines
Lithium mining area
Lithium mining company
Community
Kolla Communities extension
Atacama Communities extension
Sacred area
Hospital
Registered Ihhabitants
0-100
100-500
500-1000
1000-5000
5000-150000
Road
Disused Railway
Watershed
Water stream
Creeks
Salar
Salar nucleus
Wetland
Rock soil
San Salvador de Jujuy
Capital City

20km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Llulluchayoc
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Cangrejillos
Puesto del Marquez
La Redonda
Abra Pampa
Cochinoca
Tambillos
Casabindo
Coranzuli
Pabelón
Agua Caliente
Apu Aguilar
El Toro
Quera
Santa Ana de La Puna
Abralaite
Tusaquillas
Agua de Castilla
San Juan de Quillaquiles
Providencia
Quebraleña
San Francisco de Alfarcito
Barrancas
Olaroz Chico
Susques
Rinconadillas
Aguas Blancas
Cerro Negro
Rangel
Tres Pozos
Huancar
Pozo Colorado
San Miguel de los colorados
Cobres
Esquina de la Guardia
Ojo del Salar
Pastos Chicos
Matancillas
Ojo del Salar
El Moreno
Lipán
Sepulturas
Puesto Sey
Olacapato
Olacapato Chico
Apu Tuzgle
Apu Chañi
San Antonio de los Cobres
San Salvador de Jujuy

CHAPTER 6
SYNTHESIS: exposing

In a deeply complex territorial context where multiple scales of conflict and socio-environmental tensions converge with the steady advance of extractive frontiers, there is also a growing sense of hopelessness and difficulty in clearly grasping the problems.
The fragmentation of information, the dominance of technical discourse and the disconnect between territorial stakeholders and decision-makers contribute to this paralysis.

In response, an opportunity-based perspective was adopted, not as a naive proposal, but as a critical tool to identify fractures in the dominant model and generate transformative responses.

Viewing opportunities as spaces of contestation and redefinition enables us to imagine new forms of agency, emerging regulatory frameworks, multiscalar articulations and ways of inhabiting territory that affirm alternative life projects.
This approach does not deny conflict; rather, it recognises conflict as a fertile condition for envisioning non-extractive and decolonial futures.

Problems identified in the analysis

The analysis reveals a series of interconnected problems that are rooted in the historical marginalisation of the Atacameño-Kolla communities, as well as their exclusion from territorial governance. Despite their deep cultural and ecological ties to the land, these communities have been systematically excluded from decision-making processes, particularly those relating to resource extraction. The impacts of evaporite mining, especially on water systems, ecosystems and social dynamics, remain largely unmeasured, which reinforces a fragmented understanding of the territory. This issue is further exacerbated by the absence of legislation specific to evaporite mining, resulting in a regulatory gap that permits extractive activities to proceed without the implementation of targeted safeguards. Furthermore, the territory is managed at different institutional and spatial scales, lacking an integrated approach that considers the relationships between different uses and their impacts.

The way territory is viewed, managed, and measured is largely confined to mining cadastres and, subsequently, to environmental impact assessments, which are closely interrelated. In other words, the representation of territory aimed at enabling rapid management results in a simplification of socionatural processes, thereby deepening power asymmetries in favor of extractive exploitation.

Opportunities

Despite the urgency and complexity of the context, there are emerging opportunities for transformative change.
The absence of specific legislation for evaporite mining provides an important opportunity to develop regulatory frameworks that reflect the unique socio-environmental dynamics of these territories.
There is a growing willingness among various stakeholders, including state institutions, researchers and civil society, to explore preservation strategies .
Communities are actively demanding inclusion in governance processes. Furthermore, the territory's connection to the global lithium market places it at the heart of wider discussions on energy transitions and environmental justice, providing leverage to promote non-extractive and decolonial approaches grounded in local perspectives.

Challenges

A central challenge lies in creating an integrated vision of the territory that considers environmental, cultural and political factors. This requires the technical coordination of data and policies, as well as an ethical commitment to preserving natural and social heritage, including local knowledge systems, water basins and ancestral practices.
Another challenge is redistributing decision-making power to ensure that the voices of historically marginalised groups, particularly the Atacameño-Kolla communities, are meaningfully represented in the shaping of their territories future.

From exposing to proposing

In the search for an answer to the research question: How can a territoriality of brine extractivism on the Andean plateau be achieved with a distributed agency over the territory for a truly ecologically, politically and economically sustainable future? And after developed the research, it became clear that political technologies (Elden, 2010) and agential cuts(Barad,2007) not only represent and establish the ways in which the territory is operated and represented, but also reveal themselves as devices of power.

These devices operate through closed, projective representations that abstract (Scott, 1999) and stabilize what is actually in motion, shaping not only how the territory is seen but also how it is managed and exploited. Rooted in colonial, extractivist, and disciplinary logics, these dominant technologies fragment reality and filter what can be perceived, measured, or acted upon depicting the territory as timeless, conflict-free and disembodied limiting our ability to grasp what is truly present and unfolding.

This raises the question:
How can we speak of distributed agency or nature-culture preservation when the tools and processes through which territory is read, governed, and regulated systematically exclude the presence and knowledge of local human and non-human actors?

In this context, decolonising territorial governance requires us to question not only extractive practices, but also the epistemic and technological infrastructures that sustain them.

If local communities,along with the ecological entities they relate to, are not part of the narrative or the frameworks that shape territorial decisions, how can they hold meaningful agency in shaping their own futures?

CHAPTER 6
INTENTIONS AND PROPOSE

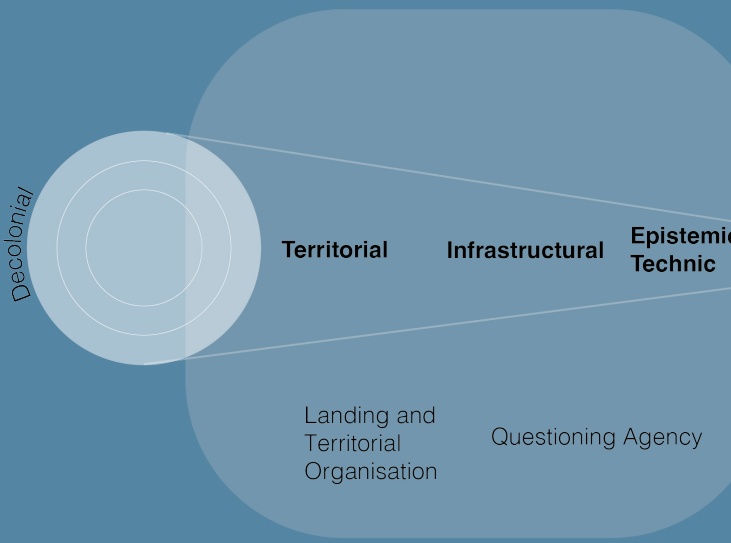
So, guided by the last SRQ6: What forms of intervention could be proposed to enable equitable negotiation processes and spatial justice among diverse territorial actors?

If local communities,along with the ecological entities they relate to, are not part of the narrative or the frameworks that shape territorial decisions, how can they hold meaningful agency in shaping their own futures?

That lead to the need of finding ways of shaping political tecnologies to represent local communities. Having researched how territorial technologies such as mining cadastres and Environmental Impact Assessment (EIA) baselines fragment and stabilise space and time to serve extractive logics, the urgent need to imagine other representational forms becomes clear. These forms must be flexible, processual and responsive to the living, transforming nature of territory. These are representations not intended to dominate, but to engage with territorial ways of being.

This also requires acknowledging the limitations of my own attempts to map. As explored in Chapter Five, the atlas was an attempt to reveal alternative layers and articulate interdisciplinary perspectives. However, it remains static and is unable to fully grasp the multiscalar, temporal and relational dynamics at play. Informed by “the how” I frame my propose as a re reading of tge territory through processes and representations.

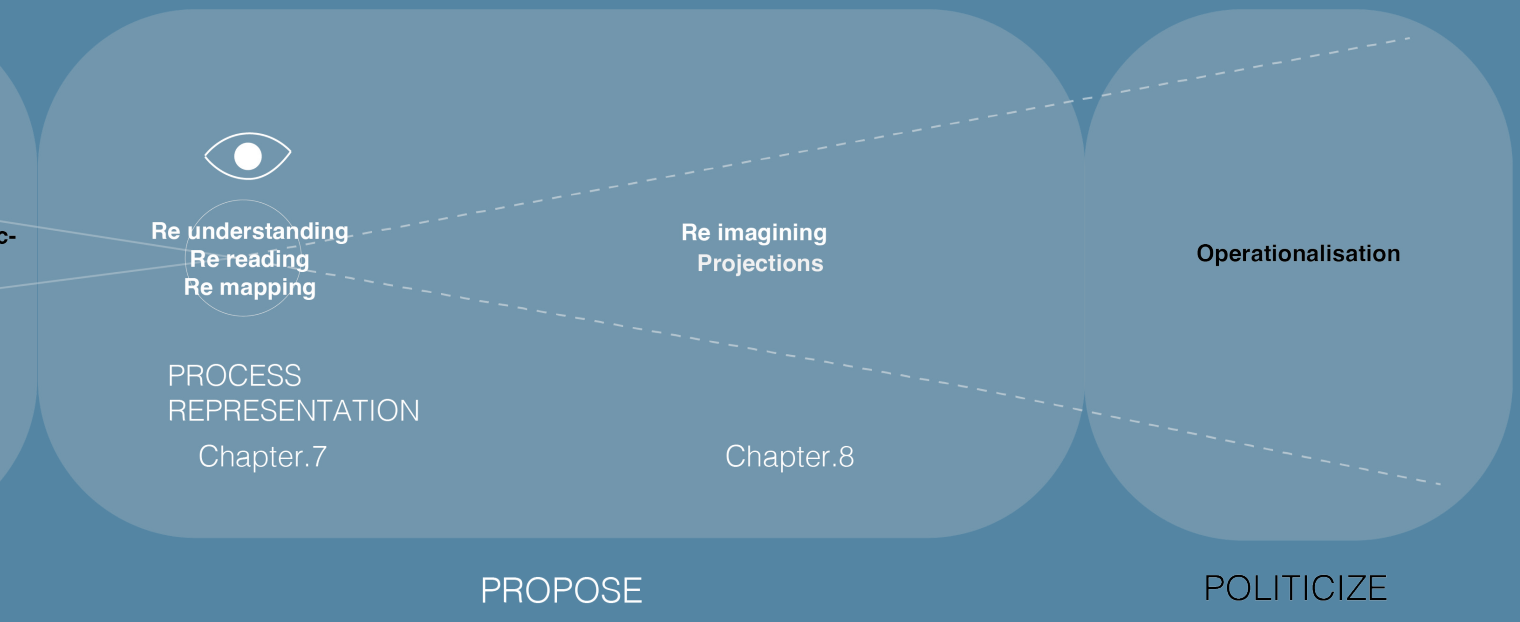
The How:
Informed by the dual permission- respect mode of living that is the core of Andean Ontologies and by how contemporary thinkers such as Arturo Escobar (2017), Marisol de la Cadena (2023),have changed the way we understand representation as no longer seen as an act of fixing meaning or enclosing reality. Instead, it is seen as a form of engagement, as staying with the trouble (Haraway, 2016) and following the ever-changing, contested and interconnected nature of place. and must be open to time and conflict and capable of adapting to the uneven rhythms and ontological plurality of territorial life. The focus is not on representing in order to know or control, but rather on responding, relating, and remaining affected by what is still in formation.



EXPOSE

In Chapter 7, I propose a methodology : a possibility for re-reading and re-interpreting territory through an approach that encompasses both process and representation, which can inform the atlas proposed in Chapter 5. This methodological pairing challenges the simplifications imposed by dominant territorial technologies, such as conventional cadastral systems and Environmental Impact Assessments (EIAs). Rather than reducing territory to static, extractable units, this approach encourages a more contextualised, relational and temporal engagement with territorial life.

Chapter 8, anchored in the discipline of urbanism, expands this proposal towards reimagining. It explores how this re-reading of the territory can inform planning and design and tools for envisioning alternative spatial futures, enabling more equitable forms of negotiation and decision-making.

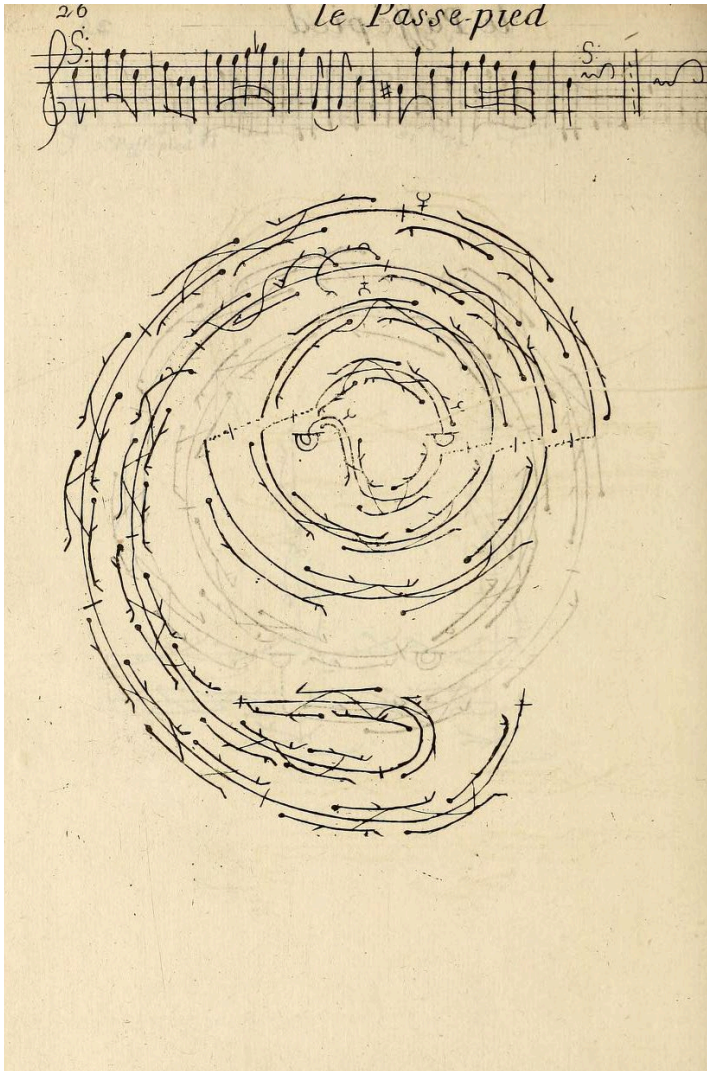


CHAPTER 7
TESTING A PERSPECTIVE OF HOW WE SHOULD READ THE TERRITORY

Guided by the intersecting disciplines of Environmental Impact Assessment (EIA), territorial analysis, and the pursuit of an ecology of knowledge, this chapter outlines a preliminary exploration of a transdisciplinary methodology. This approach places local perspectives at the center, grounded in the Andean principle of permission and respect, which is essential for defining contextually relevant working scales. It seeks more situated, respectful, and inclusive ways of understanding and representing territory.

The chapter outlines a methodological shift and describes the core steps of the proposed approach developed through informed assumption testing via literature review, mapping exercises, and a fieldwork visit to the community of San Francisco de Alfarcito.It woth mention that it was not tested on site due to the length of the research.
It concludes with reflections on the methodology's relevance and potential applications in future territorial practices.
At the heart of the proposal is a scalar and dialogical process through which territories are conceptualised.Local communities are recognized not as passive subjects of study, but as co-producers of knowledge and co-definers of meaningful scales for analysis and action, working together with different disciplines.

This reorientation marks a shift from disciplinary and sectoral models toward a spatial, relational approach rooted in nature-culture scales. These become operative units for producing context-sensitive knowledge grounded in the lived realities of the territory.
By engaging multiple disciplines in dialogue—each with distinct modes of intervention and scalar logics—the methodology supports more integrated territorial analysis. This opens the possibility for shared understandings and distributed agency in shaping more inclusive and responsive forms of territorial governance.



A Dance Recorded in Notation.
Feuillet, 1700 “Choreography, or the
Art of Describing the Dance”



Children folding a paper airplane
in San Francisco de Alfarcito
Author, 2025.

Chapter 7

Testing a perspective of how we should read the territory

The working scales proposed in Chapter 5 and informed by the tensions between scales discussed in Chapter 3 (particularly those arising from local impacts and territorial processes) are used here as a foundation for developing a multi-scalar understanding of territory. This process actively involves local communities as key dialogue partners in recognising nature-cultural scales.

The methodology brings together actors from diverse disciplines and local communities to co-define a consensual scale for territorial analysis and mapping that reflects both technical knowledge and lived experience.

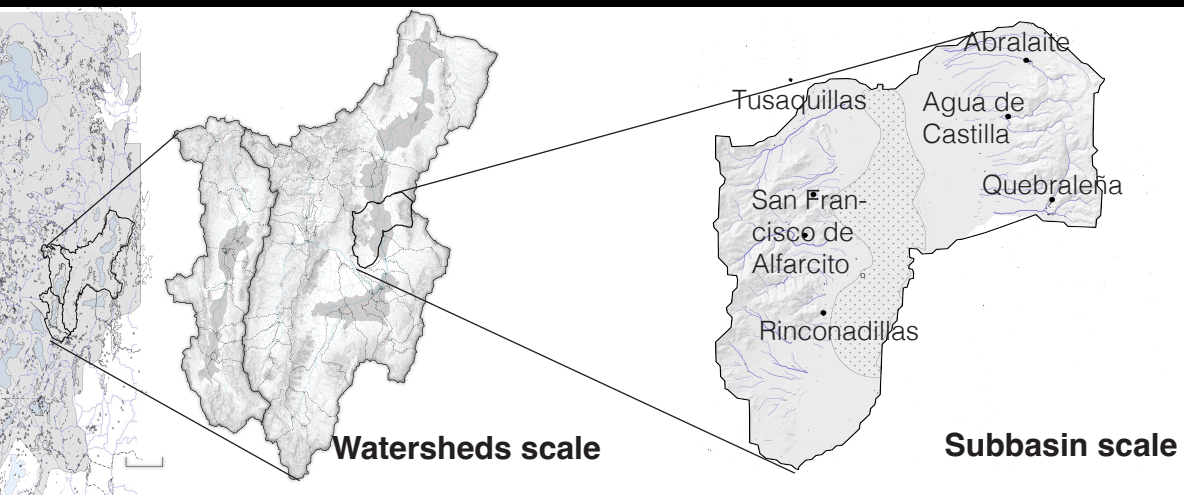
In the case of San Francisco de Alfarcito, the analysis began at the regional level. After recognising historically and culturally significant relationships with the surrounding Olaroz-Cauchari and Salinas Grandes–Laguna de Guayatayoc watersheds, a sub-basin scale was identified.

	Category	Current Disciplines-actors	Proposed possible Relational spatial Disciplines-actors
soil	**Geology and Seismicity**	Geologist, Seismologist	Urban Planner, Environmental Lawyer, Political Scientist
	Geomorphology	Geomorphologist	Landscape Architect, Cultural Geographer, Urbanist
water	**Hydrology**	Hydrologist	Community Water Management Experts, Ecologists, Urban Planner
	Hydrogeology	Hydrogeologist	Local Knowledge Experts, Hydrochemist
	Hydrochemistry	Hydrochemist	Environmental Health Specialist
Non-humans	**Biology**	Ecologist, Biologist	Ethnobiologist, Urban Ecologists
people	**Cultural**	Anthropologist, Cultural Geographer	Heritage Specialist, Linguist
	Socioeconomics	Sociologist, Economist	Political scientist
	Spatial		**Urban Planning, Urban Design, Landscape design, Geography**
			scale



Seismicity	Structure		x	stratugraphy lithology		Mineralisation - soil type
Physiogeographic characteristatio n				geoforms		Soil quality
	watershed delimitation	sub basin delimitation	morphometry and network analysis - characterization of rivers and streams			Water quantity
			Identifications of aquifre types			
						Water quality
			x			Composition, abundance
	ancestral heritage - cultural practices					
Governance scales - provinces	Governance scales - provinces		x			

Region	watershed	subbasin	cultural proposed-negotiated scale	zones	micro basin	micro scale
local communities						

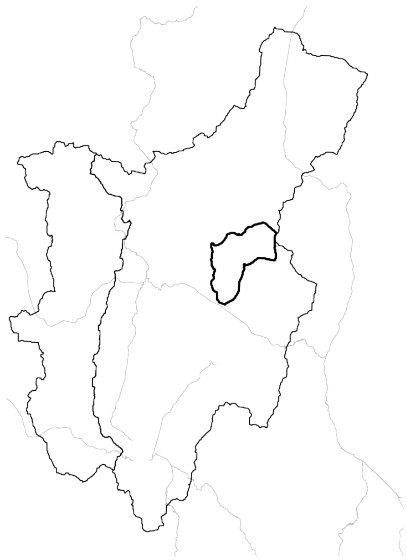


Chapter 7

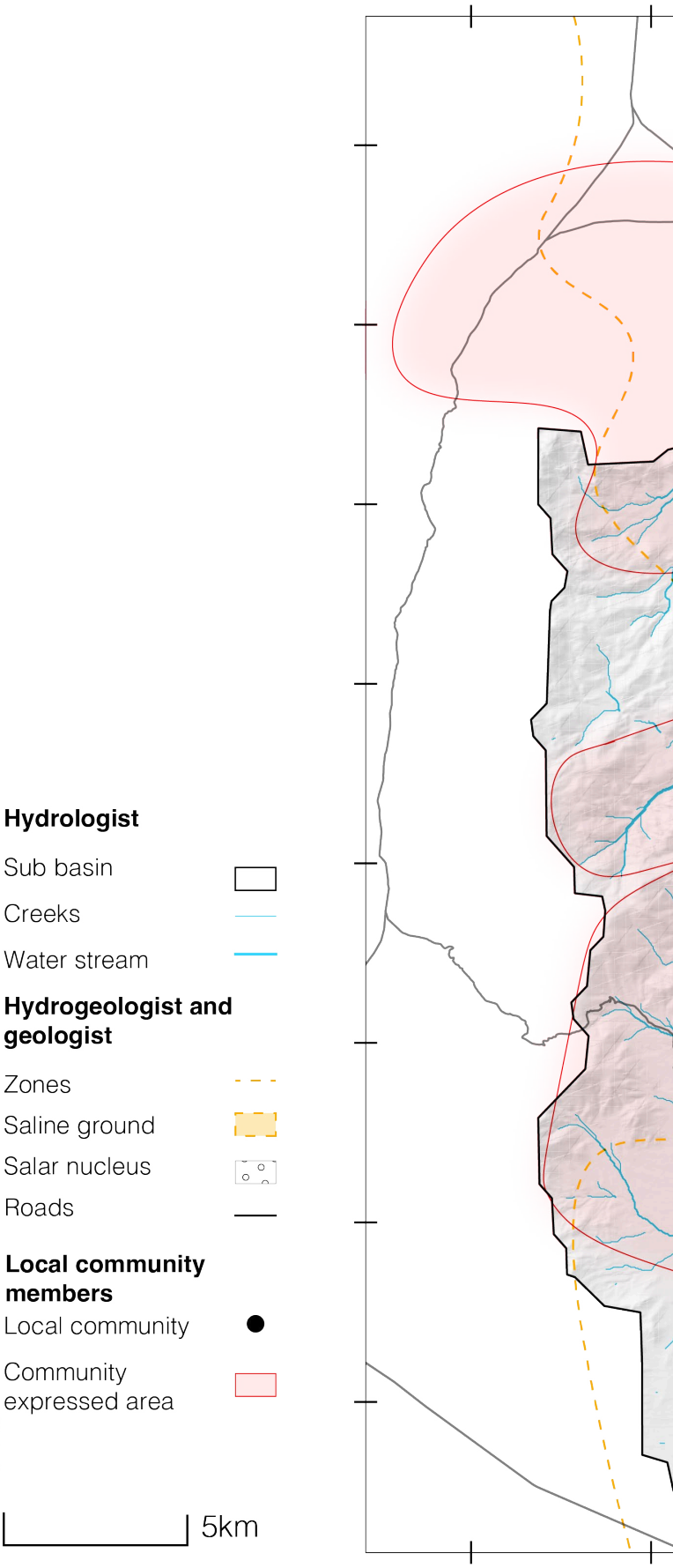
Testing a perspective of how we should read the territory

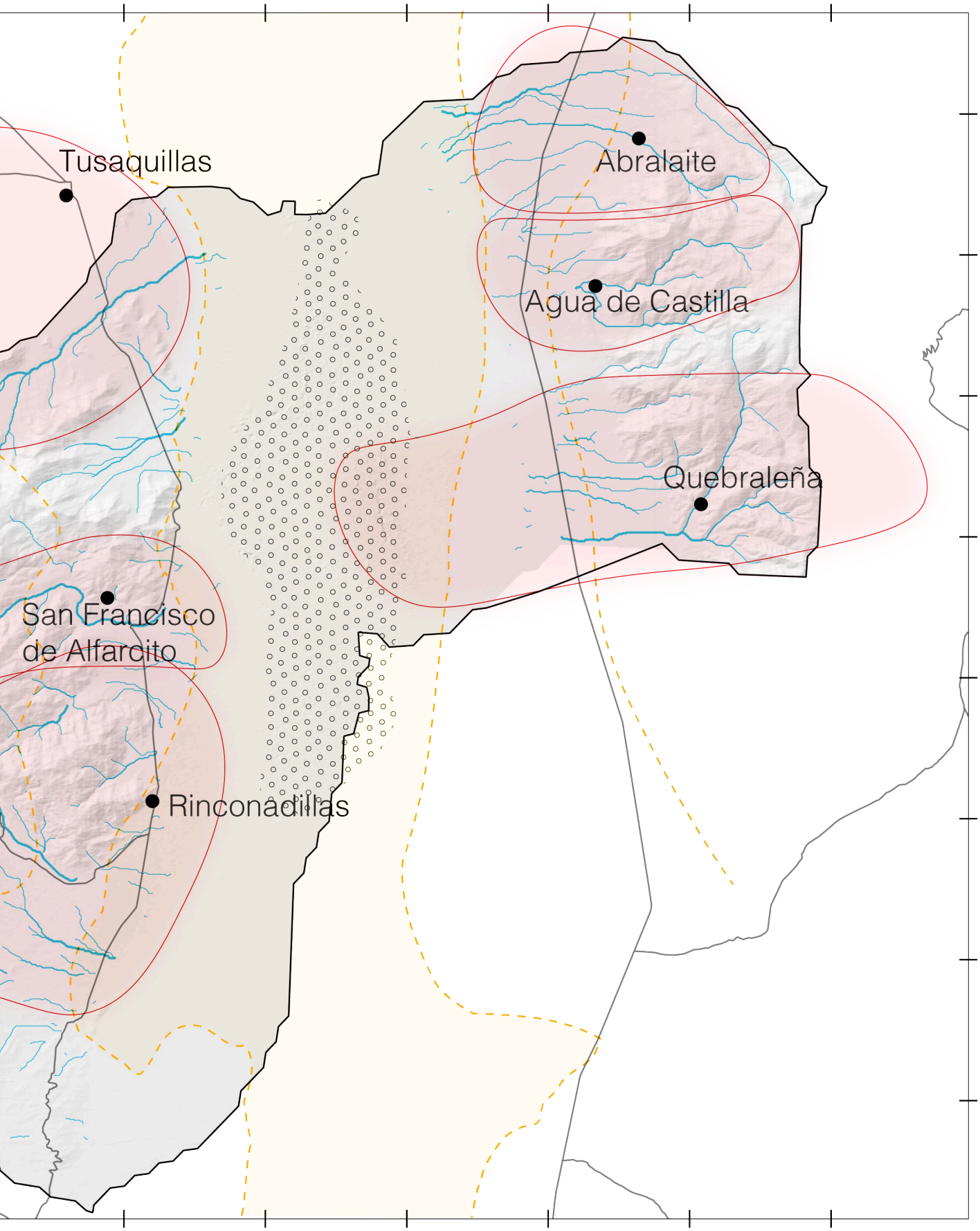
Sub basin approach

At the sub-basin scale, local communities are invited to participate actively in the decision-making process by sharing their spatial knowledge and identifying areas of interest and use. Specialists from various disciplines collaborate in this process: geologists contribute information on soil types and geomorphology, including soil structure and porosity; hydrogeologists provide insight into salinity levels and recharge zones within the sub-basins; hydrologists map micro-basins and surface water flows; and biologists, working alongside hydrologists, help to identify wetland areas and zones of high biodiversity.
Co-mapping is used as a tool for transdisciplinary dialogue, enabling each stakeholder to share, interrelate and spatially express their knowledge. This collaborative approach fosters an integrated understanding of the territory from multiple perspectives.



Salinas Grandes y
Laguna de Guayatayoc



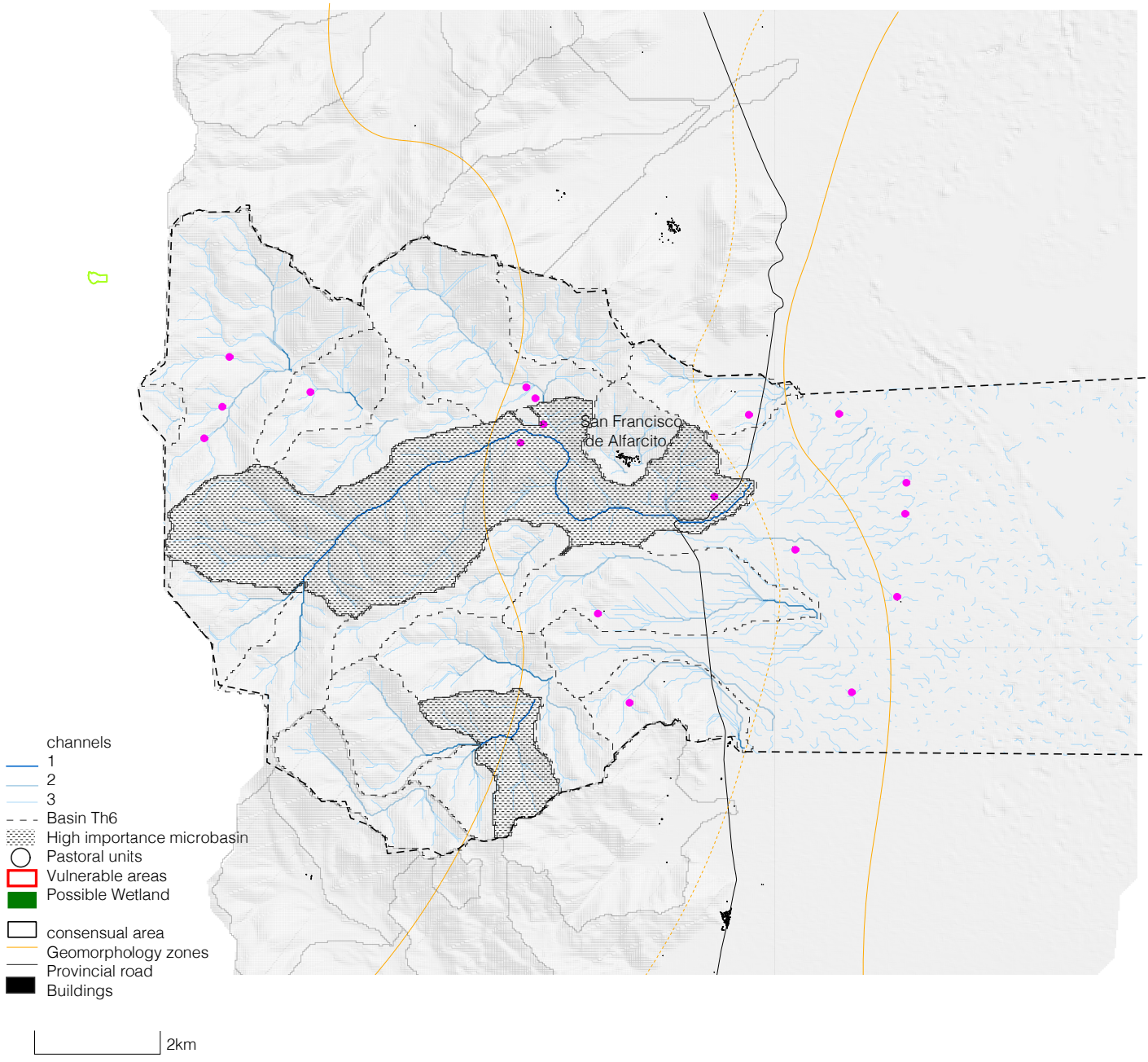

Tusaquillas
Abralaite
Agua de Castilla
Quebraleña
San Francisco
de Alfarcito
Rinconadillas

Chapter 7

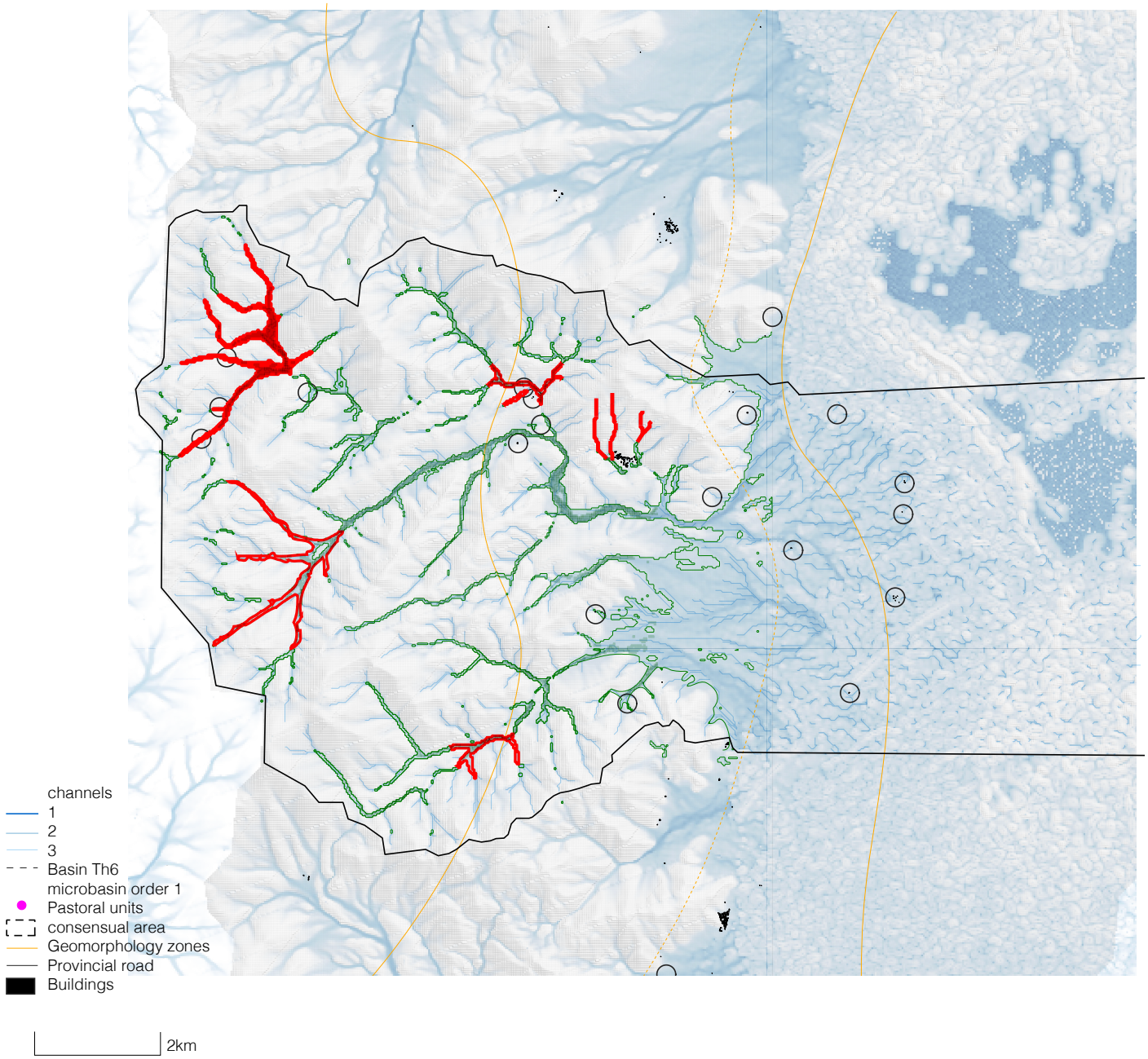
Testing a perspective of how we should read the territory

Consensus area: Cultural proposed negotiated area

Focusing on the area of use proposed by the community of San Francisco de Alfarcito, as defined by pastoral units and micro-basin boundaries, the collaborative process also considered saline and non-saline zones, recharge areas and sensitive ecosystems. Based on this, a consensual working area was delineated, enabling the identification of vulnerable zones and priority areas.



Following the mapping and identification of wetlands, which are valued as both biodiversity hotspots and sacred spaces that are critical to water recharge, efforts were made to pinpoint relational nodes for documentation, representation and protection. One outcome of this process was the identification and analysis of the queñoa forests (Polylepis spp.), which were recognised as areas of significant ecological and cultural importance. These forests are considered sacred transition zones — spaces of life and death, places where wood is gathered, and homes to endangered endemic species.



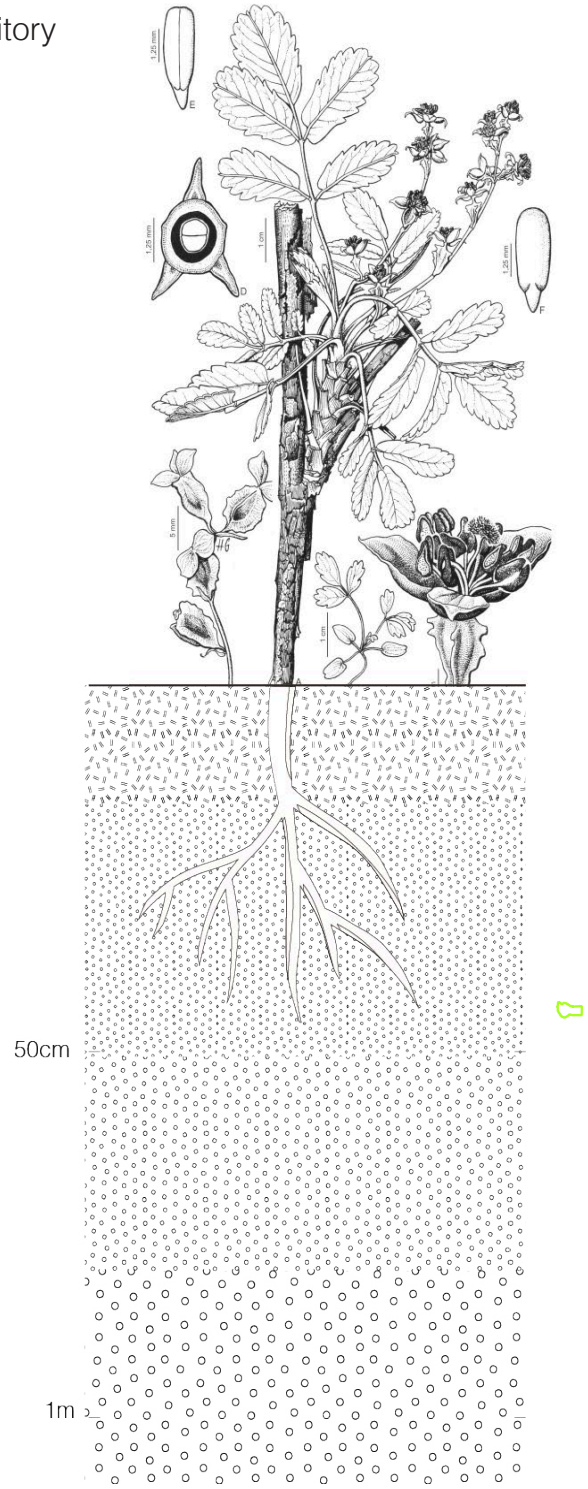
Chapter 7

Testing a perspective of how we should read the territory

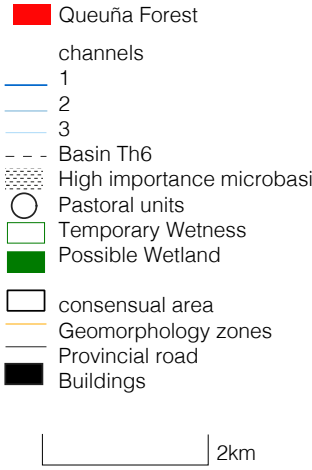
Nano scale

One outcome of the participatory territorial mapping process can be the identification and analysis of queuña forests (Polylepis spp.) as areas of ecological and cultural significance. Often located near winter pastoral units on the upper slopes of hills, these forests are considered by local communities to be sacred transition zones : spaces associated with the passage between life and death, wood collection (Julian et al., 2021) and the presence of endangered endemic species.

Understanding the microscale dynamics of queuña forests, including their soil preferences (by geologists), water needs and ideal habitat conditions (biologists), enables their spatial distribution to be mapped effectively. When linked to broader hydrological and cultural data (e.g. soils, geoforms, water streams, sacred areas), this knowledge enables the methodology to be replicated in other territories. This enables new priority sites to be identified for monitoring, protection and conservation, in line with nature-culture preservation principles.

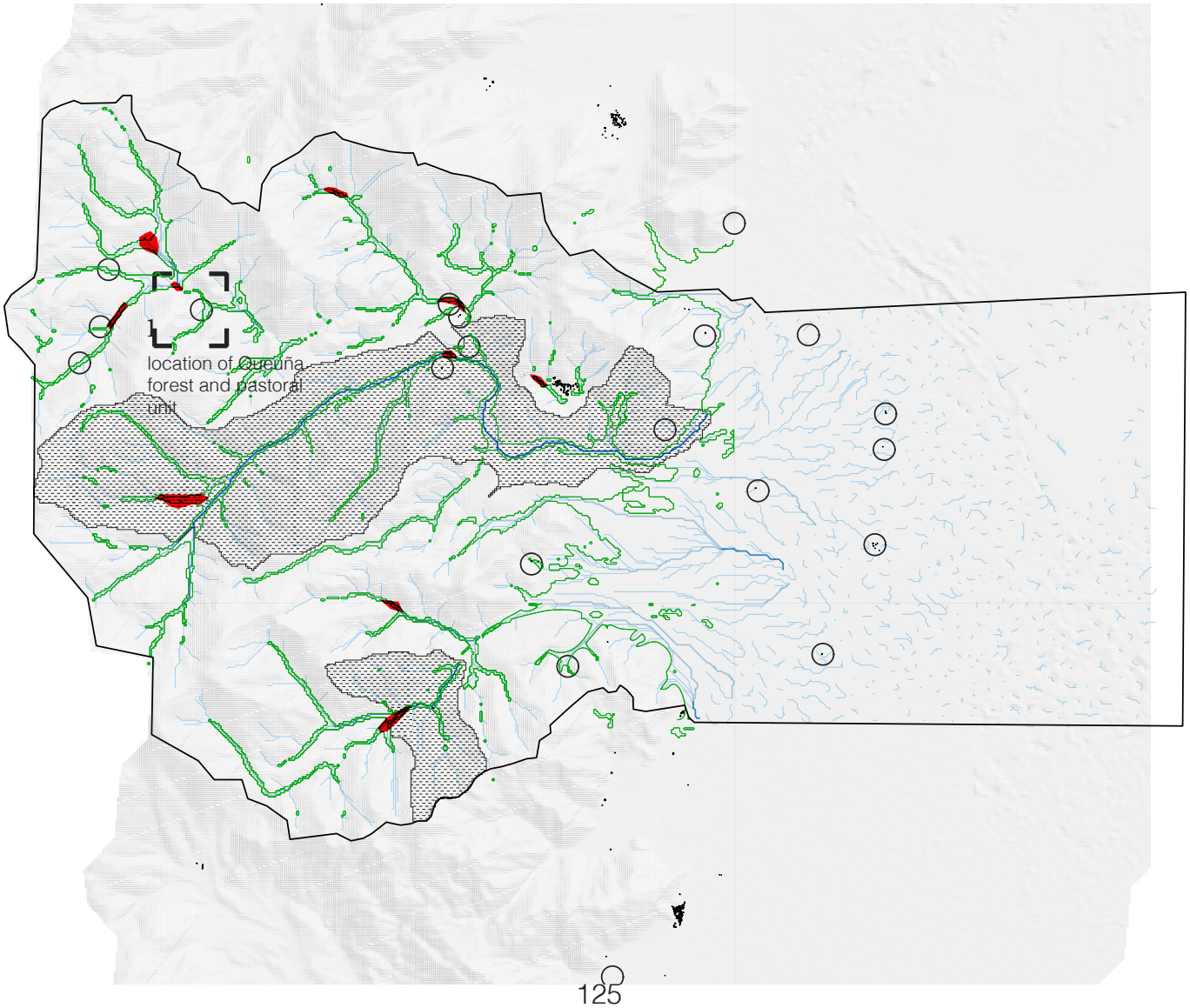


img :Hunziker, A. T. edited with soils by author.



For Andean communities, queuñas form part of an interrelated kosmos-corpus-praxis worldview (Julian et al., 2021):
Kosmos: Queuñas are symbolic of life-death cycles and are linked to spiritual significance.
Corpus: They provide essential resources such as fallen wood while communities ensure the care and renewal of these forests.
Praxis: Queuñas are used sustainably for fuel and materials in everyday life.

Ecologically, Polylepis forests are typically found between 3,500 and 5,200 m.a.s.l. (IUCN), growing on steep, shallow-soil slopes often unsuitable for other trees (Bellis et al., 2014). Although generally small (3–8 m tall), some queuñas can reach 15–20 m in height and up to 2 m in trunk diameter. Their roots, often 30–50 cm deep, thrive in well-drained areas. Because of their ecological functions, they are often referred to as 'water-sowing' trees—they retain and filter rainwater, contributing to the formation of water sources and the regulation of hydrological cycles. These forests also help generate microclimates that mitigate extreme temperature changes, reduce frost incidence, and act as wind barriers. Such conditions support agroforestry systems where tubers and cereals can be grown. Additionally, queuña forests serve as refuges for numerous animal and plant species, enhancing local biodiversity (Fjeldså, 2004).



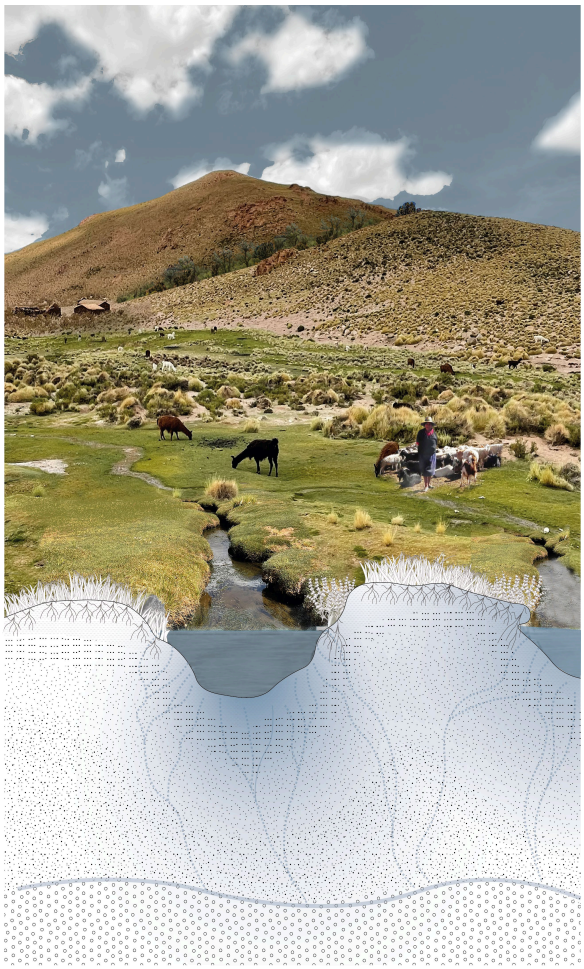
Chapter 7

Testing a perspective of how we should read the territory

Relational Nodes

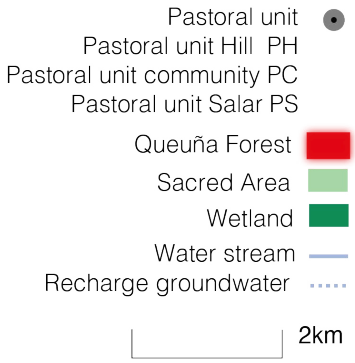
This methodology allows for an representation of the territory from below, considering the relationships, knowledge and experiences that arise from everyday practices and connections with ecosystems. Rather than imposing a homogenising external view, it seeks to identify relational nodes where disciplines, practices and forms of knowledge intersect in places that are significant to local communities and in areas that are biologically, geologically or hydrologically complex.

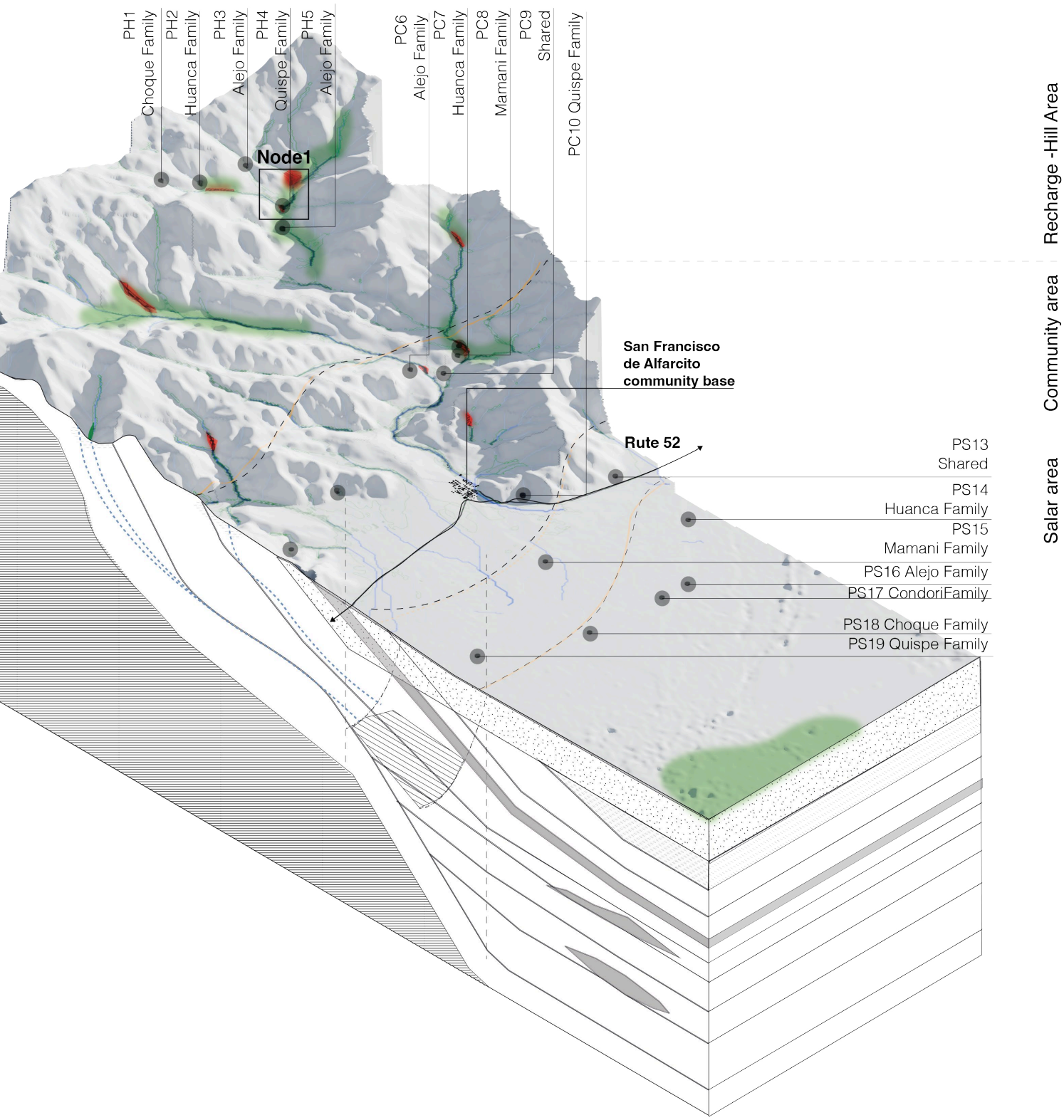
According to the definitions provided by the communities themselves, these nodes may include sacred sites, vulnerable zones, and key areas for care, observation, and situated practices. By focusing on these points of convergence, the methodology promotes a more nuanced and sensitive interpretation of the territory while enabling actions aimed at its preservation, rehabilitation and sustainable management.
Family names in isomeric graphic are assumptions, It is a representation of what it can be.



1. vega, pastoral unit and queuña forest






PH1
Choque Family
PH2
Huanca Family
PH3
Alejo Family
PH4
Quispe Family
PH5
Alejo Family
Node1
PC6
Alejo Family
PC7
Huanca Family
PC8
Mamani Family
PC9
Shared
PC10 Quispe Family
San Francisco
de Alfarcito
community base
Rute 52
PS13
Shared
PS14
Huanca Family
PS15
Mamani Family
PS16 Alejo Family
PS17 CondoriFamily
PS18 Choque Family
PS19 Quispe Family
Recharge -Hill Area
Community area
Salar area

Conclusion:

This methodology is not intended to be a technical manual, but rather a flexible, ethical and contextualised guide designed to support territorial processes through respect, active listening and political commitment. It is geared towards co-constructing knowledge with communities, recognising the plurality of knowledge and promoting transformative forms of action with the aim of representing on space important areas that should be visibilised and protected according each local community.

Although the methodology is based on critical analysis and the identification of existing opportunities, it remains a preliminary framework that needs to be tested and adapted in practice. As a first step, this proposal outlines a set of core principles to guide implementation.

Prior listening and consent: Every process begins with explicit permission, mutual respect, and sensitivity to local rhythms, languages, and practices.
Critical reading of power and conflict: Understanding territorial dynamics requires analysing the historical and structural forces that produce inequality, domination and resistance.
Dialogue of knowledges: This involves promoting horizontal exchanges between local, ancestral, technical, and scientific knowledge without reproducing epistemic hierarchies.
Constant return and validation: Processes and findings must be shared with communities for review, validation and autonomous use.
Action projected from the territory: Interventions should emerge from local dynamics rather than external agendas in order to strengthen territorial struggles and identify areas that are vulnerable or valuable and in need of protection.

Distributed agency as an ethical and political horizon: This approach redistributes the power to imagine, decide and act among multiple human and non-human actors, enabling collective, situated and plural forms of territorial governance.

Core principles:

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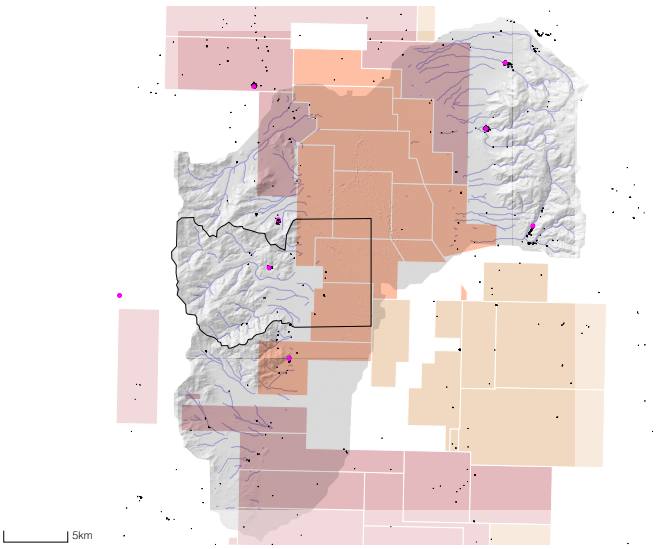


Application:

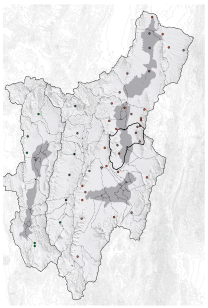
This methodology can be used in a variety of contexts and by different actors, while always remaining grounded in its ethical, situated and non-extractivist approach:

Mapping and representation of community territories, particularly in the ones in dispute with extractive industries.

Identifying zones vulnerable to climate and anthropogenic processes in order to promote mitigation and ecological regeneration actions.

Environmental impact assessments: This approach can be integrated into evaluations carried out by communities, governments or companies as a communication tool to assess possible and actual impacts.

EIA



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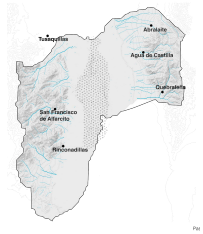

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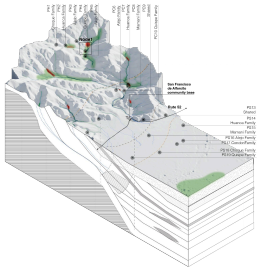

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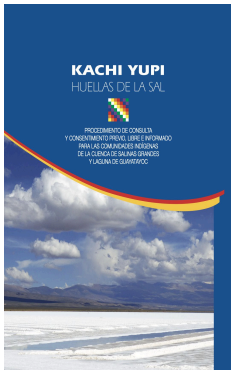
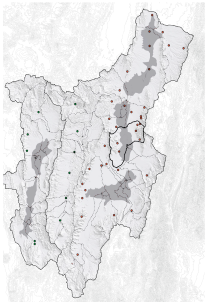
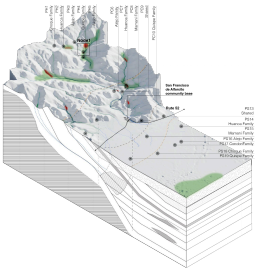








CHAPTER 8
PROJECTIONS

Imagination is the first political act in envisioning possible futures. Building on the research process, information gathered and critical analyses developed in Chapters 3, 4 and 5, as well as the methodology and atlas proposed in Chapters 6 and 7, this chapter focuses on formulating possible territorial alternatives. These alternatives are an integrated, multi-scalar response to the opportunities identified throughout the research. The chapter argues that alternative mapping of the territory, which acknowledges its natural and cultural processes, offers the possibility of envisioning a different form of territorial organisation.

Design guidelines and a territorial organisation proposal will therefore be established, accompanied by specific, feasible projects that seek to rethink the relationships between extractivism, territory and community. This will lead to an 'inverted mining cadastre' and the application of the proposed methodology for a localised evaluation of mining impacts.

The overarching goal is to generate tools that empower local communities and non-human entities, thereby fostering critical and transformative engagement with ongoing territorial processes.





Drawing by Catriel, a children of San Francisco de Alfarcito representing his land.
author 2025

Evaluation
ethodology. Situated
EIA

Chapter 8

Projections

Guidelines for territorial and natureculture management in Andean watersheds and salares

1. Watershed as a Design Scale Element

Guideline: Consider the watershed as the fundamental element in territorial design, integrating and preserving recharge areas as essential components of the natural and cultural water system. Implement zoning, infrastructure, and impact assessments based on hydrological scales to ensure system sustainability.

Action: Establish high preservation areas to protect recharge zones and maintain the integrity of the natural and cultural system.

2. Recognising Salares Complex Natucultural Wetlands

Guideline: Understand salares not merely as physical bodies but as wetlands with integrated ecological and cultural complexity requiring a natucultural management approach.

Action: Establish medium preservation areas to conserve the ecological and cultural value of the salt flats, promoting sustainable management.

3. Prioritising Spatial Autonomy of Communities (High Andean Spatialities)

Guideline: Recognise Andean communities as autonomous spatial entities linked to ecological, cultural, and hydrological systems, considering practices as semi-nomadism, beyond viewing them solely as urban settlements.

Action: Design territorial policies and plans that guarantee the spatial and cultural autonomy of communities.

4. Identification and Preservation of Sacred Areas

Guideline: Identify and preserve sacred areas as elements of high cultural and spiritual significance, granting them special protection.

Action: Establish high preservation areas for these sites, preventing any interventions that may affect their integrity.

5. Promotion and Articulation of Local Activities and Practices

Guideline: Identify and strengthen traditional local activities for their development and preservation, valuing practices such as: salt harvesting,community-based tourism,local agriculture.

Action: Spatial Identification and articulation and Implementation of support programmes to revitalise and promote these practices, ensuring their cultural and environmental sustainability.

6. Delimitation and Rehabilitation of Socially and Environmentally Degraded Areas Due to Lithium Mining in Olaroz Cauchari

Guideline: Recognise and delimit socially and environmentally degraded areas caused by lithium mining, including assessment of social impacts on communities and mine workers.

Action: Promote local ecological and social rehabilitation practices to mitigate these impacts.

7. Promotion of Vertically Integrated Green Corridors

Guideline: Create green corridors connecting highlands, wetlands, and valleys to foster biodiversity, facilitate species movement, and maintain ecological and hydrological flows.

Actions: Connect fragmented ecosystems vertically across altitudes.
Integrate corridors with territorial and transport infrastructure, with special attention to critical crossings.

8. Identification of areas for specific mitigation- integration-articulation projects

Identification of areas for specific projects that can foster integration and preservation of natural systems, enable community linkage, and mitigation of current and future mining activities.

9. Proposal for a New Mining Cadastre Based on Hydrological Delimitations

Guideline: Develop a mining cadastre considering hydrological divisions to restrict mining in sensitive areas, particularly salt flats as wetlands.

Recommendation: Avoid lithium mining in salt flats due to uncertainties about their hydraulic capacity and environmental impacts.

Alternative:
Delimit mining lots within hydrological sub-basins, establishing mining areas indivisible between concession holders.
Mark areas of direct influence to assess cumulative impacts within the same watershed.
-Incorporate these criteria for mining management and regulation, ensuring protection of water resources and associated ecosystems.

Chapter 8

Projections

Suggestion Plan for natureculture preservation

Based on the research, adopting a watershed-based approach to design promotes an understanding of the area through natural rather than political boundaries and views communities as High Andean spatialities rather than urban centres.

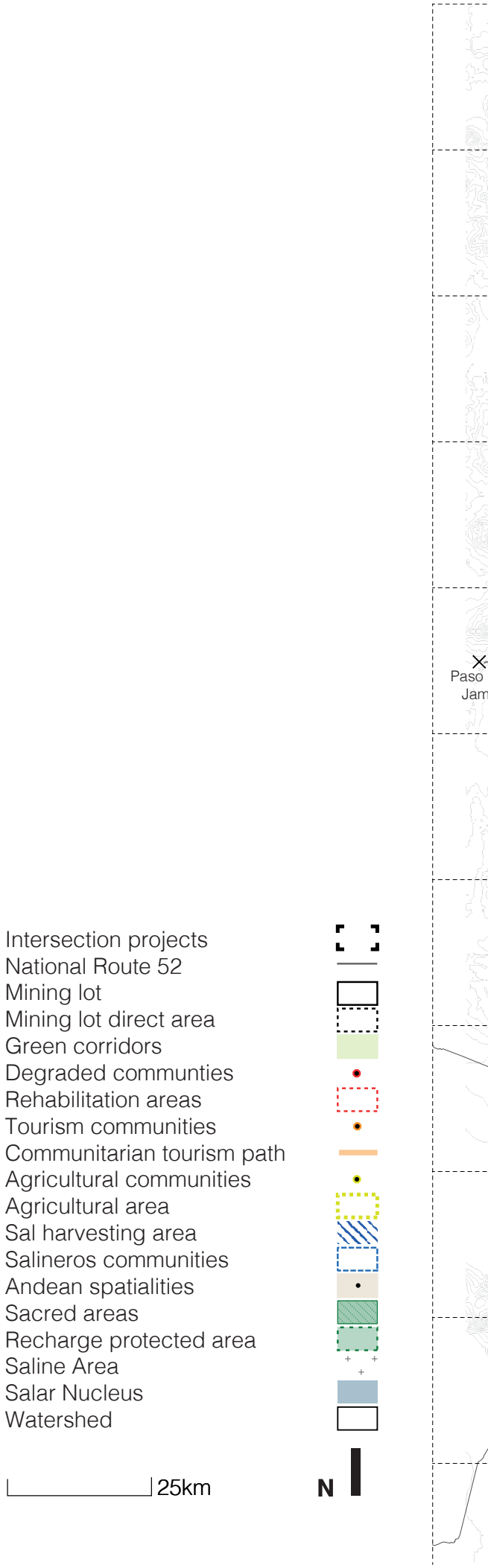
High preservation areas include upper basin zones such as sacred APU hills, wetlands and catchment areas. Sites of local heritage, such as salt harvesting, community tourism and a community agriculture zone north of Laguna de Guayatayoc, are also included. These areas are earmarked for preservation and enhancement.

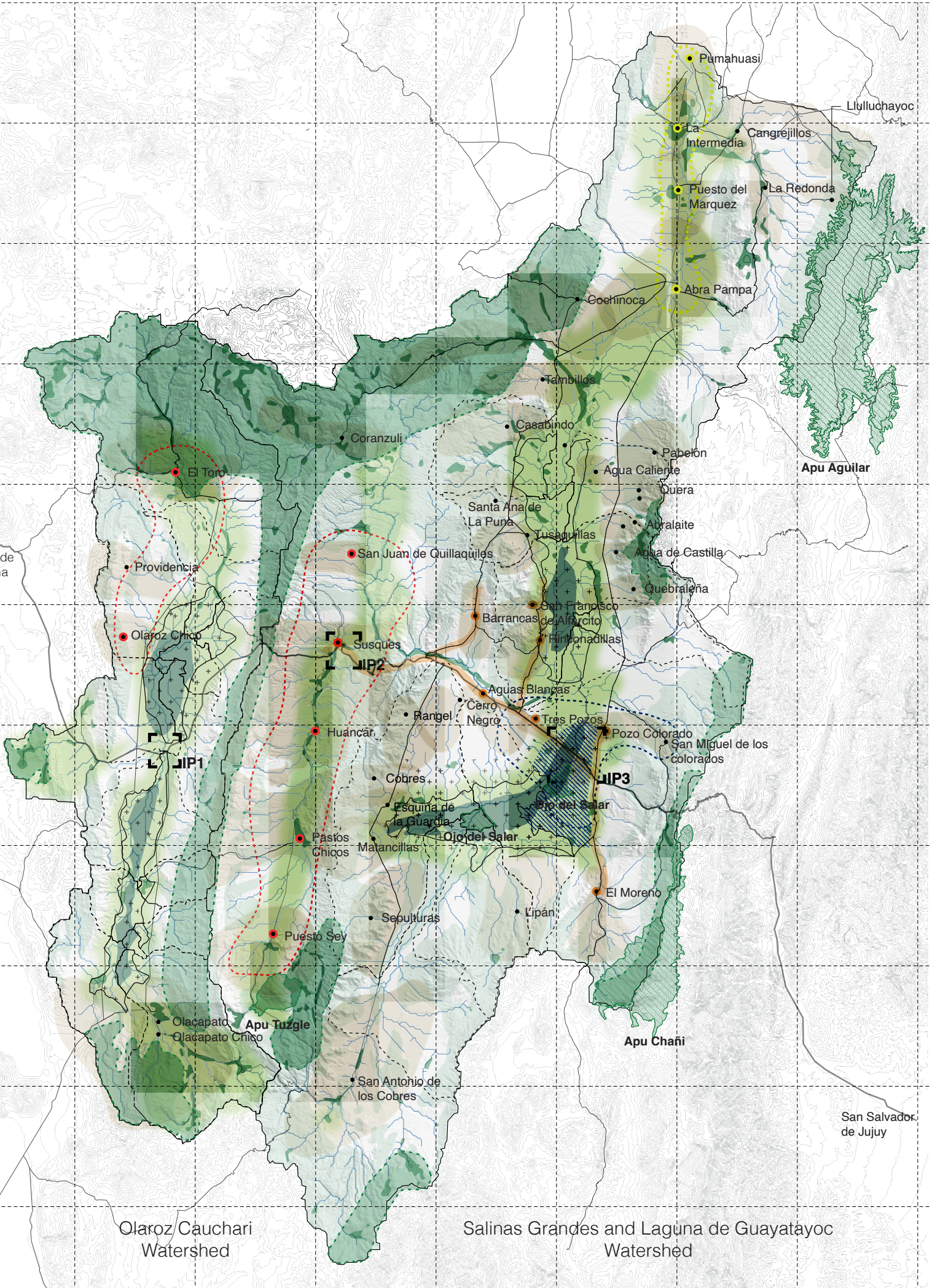
Vertical green corridors connect vulnerable ecological zones to promote biodiversity.

Regarding the salares, lithium extraction is discouraged due to their wetland status and uncertain mining impacts. Instead, mining plots are defined by hydrological sub-basins, creating indivisible zones with defined influence areas, which will be used to manage the cumulative impact of mining across concessions within the same watershed.

For the current mining operations at Olaroz Cauchari, rehabilitation zones are proposed at Olaroz Chico and El Toro. Urgent co-mapping and conservation plans are being developed in collaboration with local communities.

Finally, targeted projects are required for vulnerable areas at the intersections between corridors and National Route 52.





Olaroz Cauchari Watershed

Salinas Grandes and Laguna de Guayatayoc Watershed

Chapter 8
Projections

Specific Projects- Route 52 current situation

Historically, Route 52 has connected the territory by crossing the Andean highlands. It has served as a vital infrastructural and symbolic link across this challenging and unique landscape. Today, it functions as a bioceanic corridor (Fig1), linking the Pacific and Atlantic coasts via the high Andean plateau. Notably, it is the only fully paved route in the area, making it the main artery for vehicular movement, particularly for industrial and logistical operations associated with the extractive sector. Since the beginning of lithium mining in the region, Route 52 has seen a sharp rise in traffic, particularly heavy goods vehicles, raising concerns about rapid transit, structural degradation and the fragmentation of fragile ecosystems and community territories. This intensification of infrastructure aligns with Svampa's (2019) description of the consolidation of logística del saqueo: a logistical model of dispossession that reorders territories around the needs of global capital while marginalising socio-environmental concerns.

Simultaneously, roadworks and upgrades along the corridor prioritise efficiency and extractivist interests, often disregarding the region's complex socio-environmental fabric. As Gudynas (2013) argues, such interventions reflect the logic of neo-extractivism, imposing territorial simplification and ecological sacrifice zones under the guise of development. In this context, Route 52 is adopted as both a physical connector and a strategic axis for analysing and proposing territorial alternatives that resist extractivist logics, prioritise ecological integrity and empower communities to shape their own spaces.

On the right, a photographic path produced during fieldwork accompanies this analysis, visually tracing the infrastructural and territorial transformations observed along Route 52

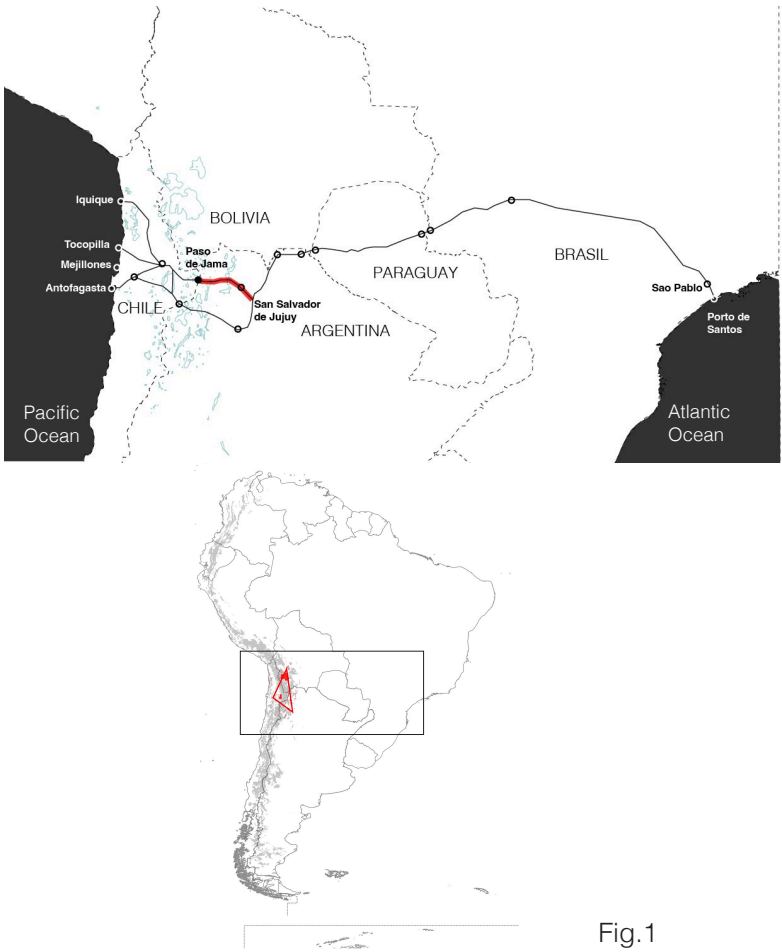


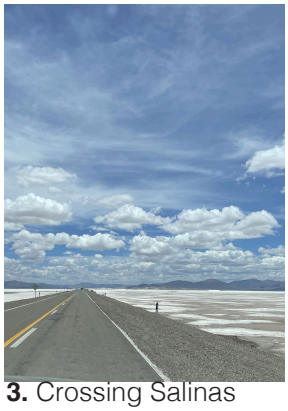
Fig.1



1. Crossing Cuesta de Lipan to arrive to Salinas Grandes



2. Salar Transition area arriving to Salinas Grandes



3. Crossing Salinas Grandes



4.Metering gas station built 2025



5. Electric line along the route



6. Several trucks along the route.



7. The Susques community is undertaking various new buildings and infrastructure.



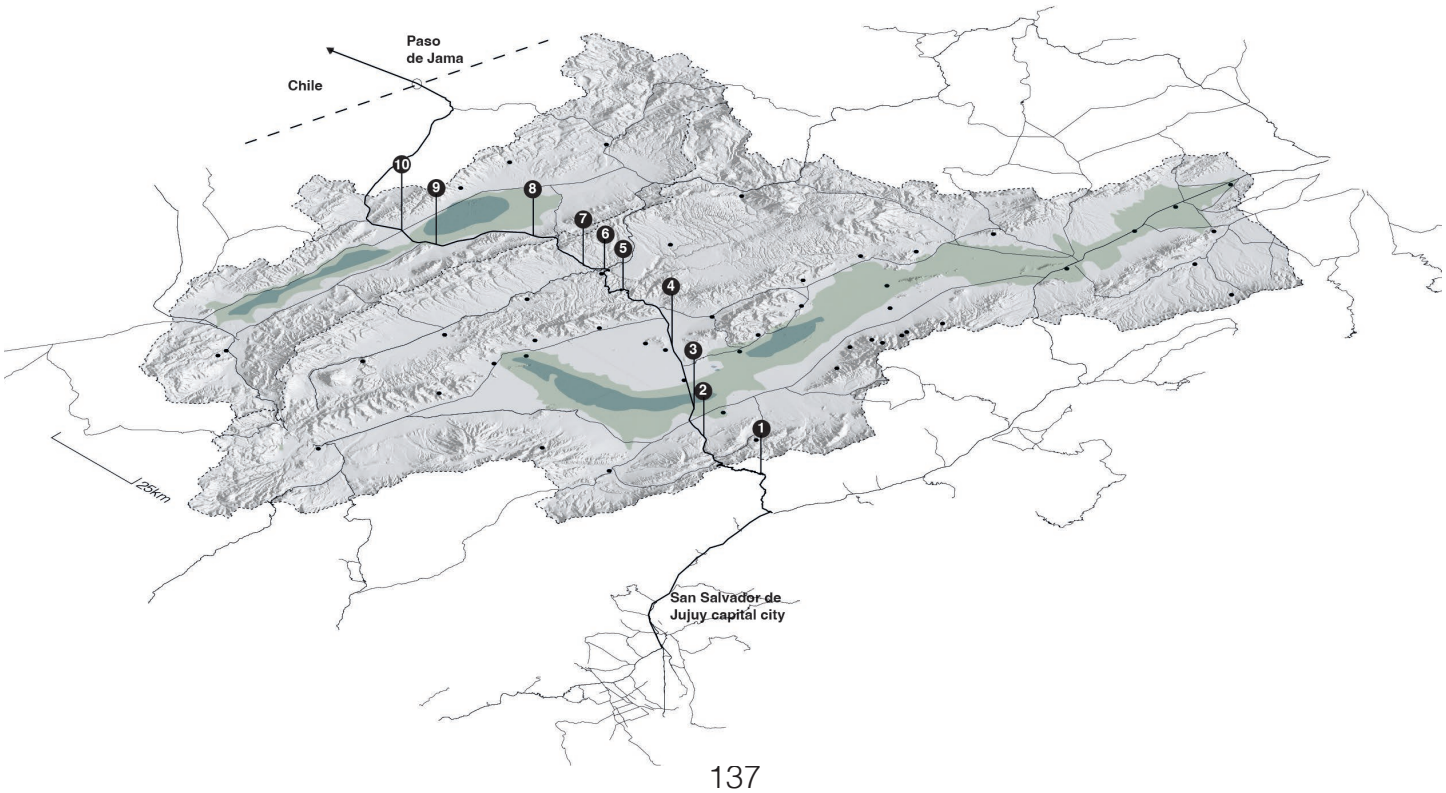
8. High andean vega interrupted by road



9. Landscape fragmentation



10. EXAR mining facility entrance, with drainage infrastructure



Chapter 8
Projections

Specific Projects- Route 52 current situation

Each site lies at a critical intersection with existing or potential green corridors, linking ecological systems, such as soils, wetlands and hydrology, with the knowledge, practices and uses of local indigenous communities.

The overarching objective is to transform Route 52 from a fast corridor used for transporting lithium and facilitating international trade into a slower route that promotes ecological continuity, cultural inclusion and a deeper respect for the landscape's complexity.
The interventions take a simple, low-impact approach, focusing on restoring natural water dynamics and protecting wetlands. Designed to be minimal and locally appropriate, the interventions are grounded in community participation and ancestral knowledge

Loss
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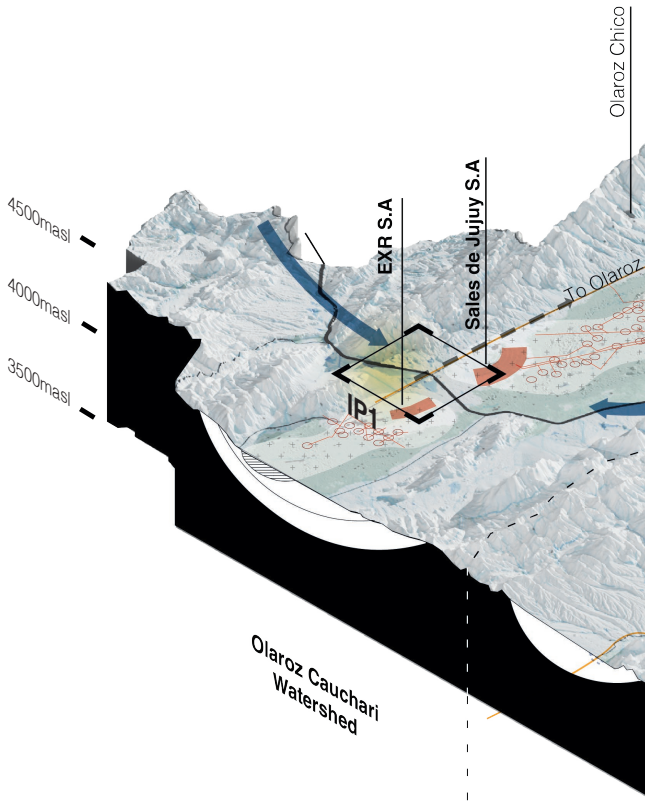
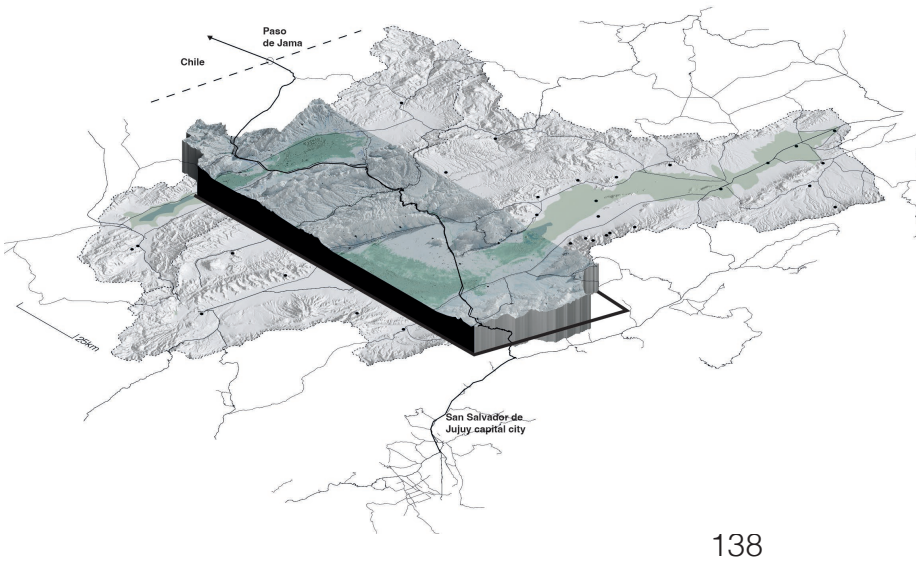
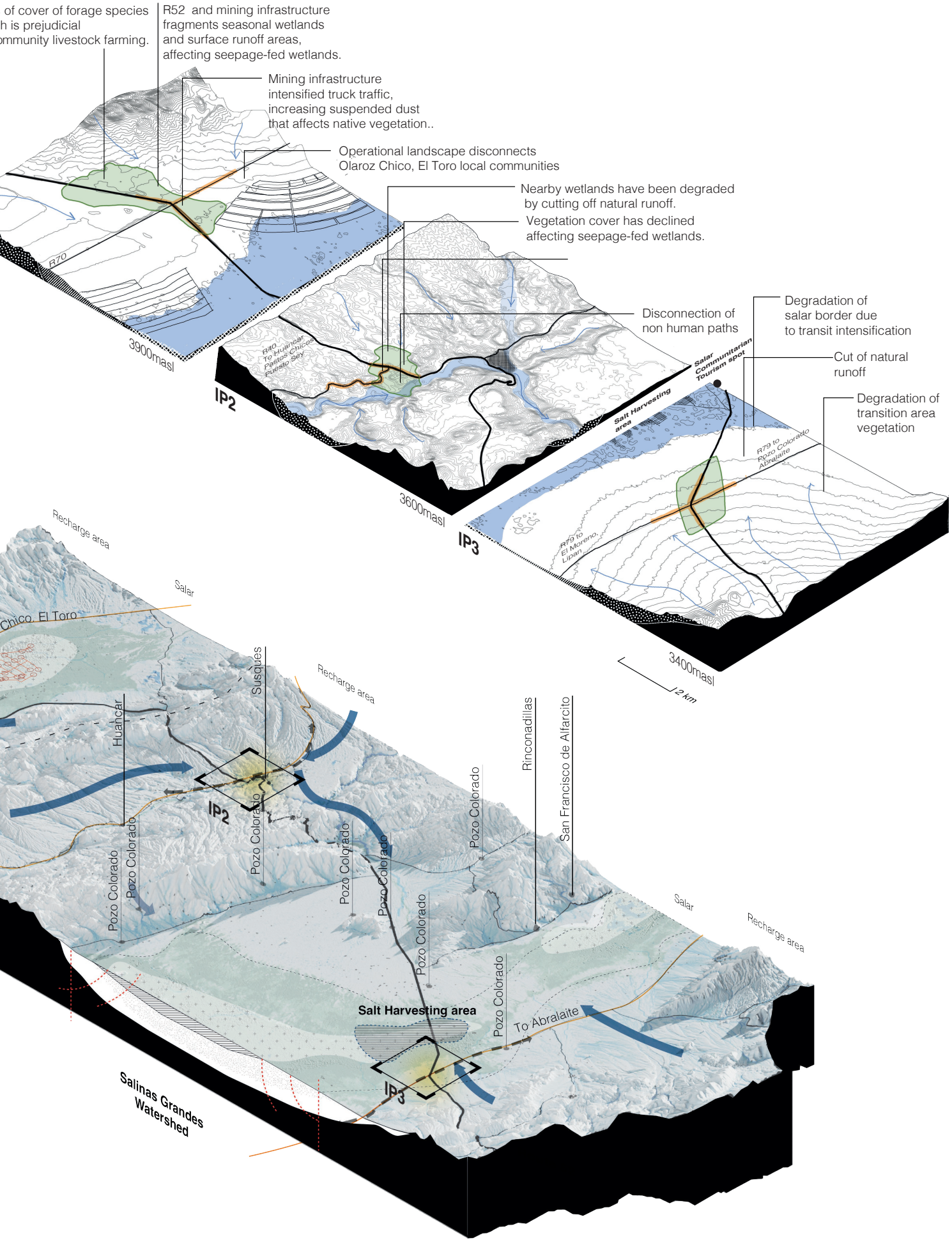
to co








of cover of forage species
h is prejudicial
ommunity livestock farming.
R52 and mining infrastructure
fragments seasonal wetlands
and surface runoff areas,
affecting seepage-fed wetlands.
Mining infrastructure
intensified truck traffic,
increasing suspended dust
that affects native vegetation..
Operational landscape disconnects
Olaroz Chico, El Toro local communities
Nearby wetlands have been degraded
by cutting off natural runoff.
Vegetation cover has declined
affecting seepage-fed wetlands.
Disconnection of
non human paths
Degradation of
salar border due
to transit intensification
Cut of natural
runoff
Degradation of
transition area
vegetation
R70
3900masl
IP2
3600masl
IP3
3400masl
2 km
Salar
Communitarian
Tourism spot
Salt Harvesting
area
R79 to
Pozo Colorado
Abralaite
R79 to
El Moreno,
Lipan
R40
To Huancar
Pastos Chicos
Puesto Sey
Recharge area
Salar
Chico, El Toro
Susques
Huancar
Recharge area
IP2
Pozo Colorado
Pozo Colorado
Pozo Colorado
Pozo Colorado
Pozo Colorado
Pozo Colorado
Pozo Colorado
Rinconadillas
San Francisco de Alfarcito
Salar
Recharge area
Salt Harvesting area
To Abralaite
IP3
Salinas Grandes
Watershed

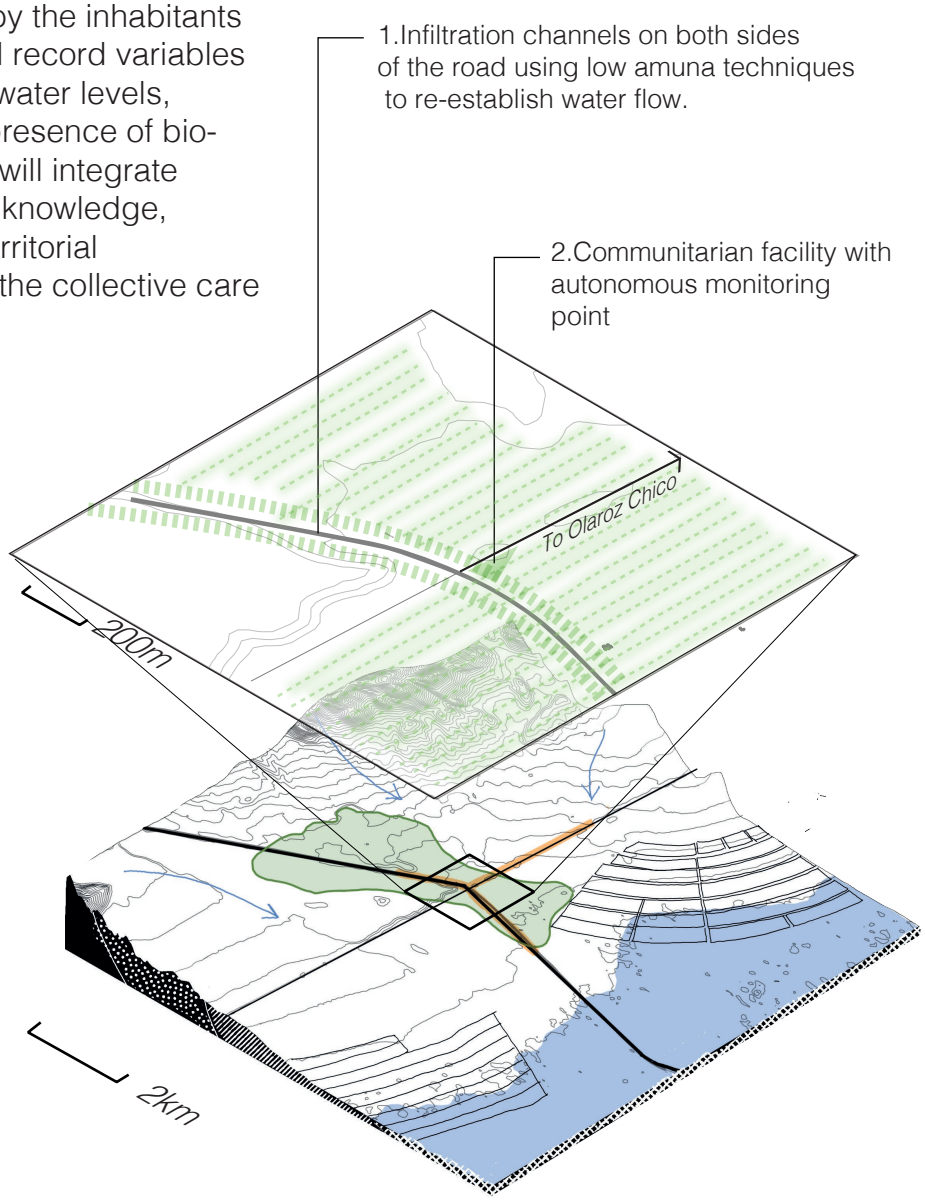
Chapter 8

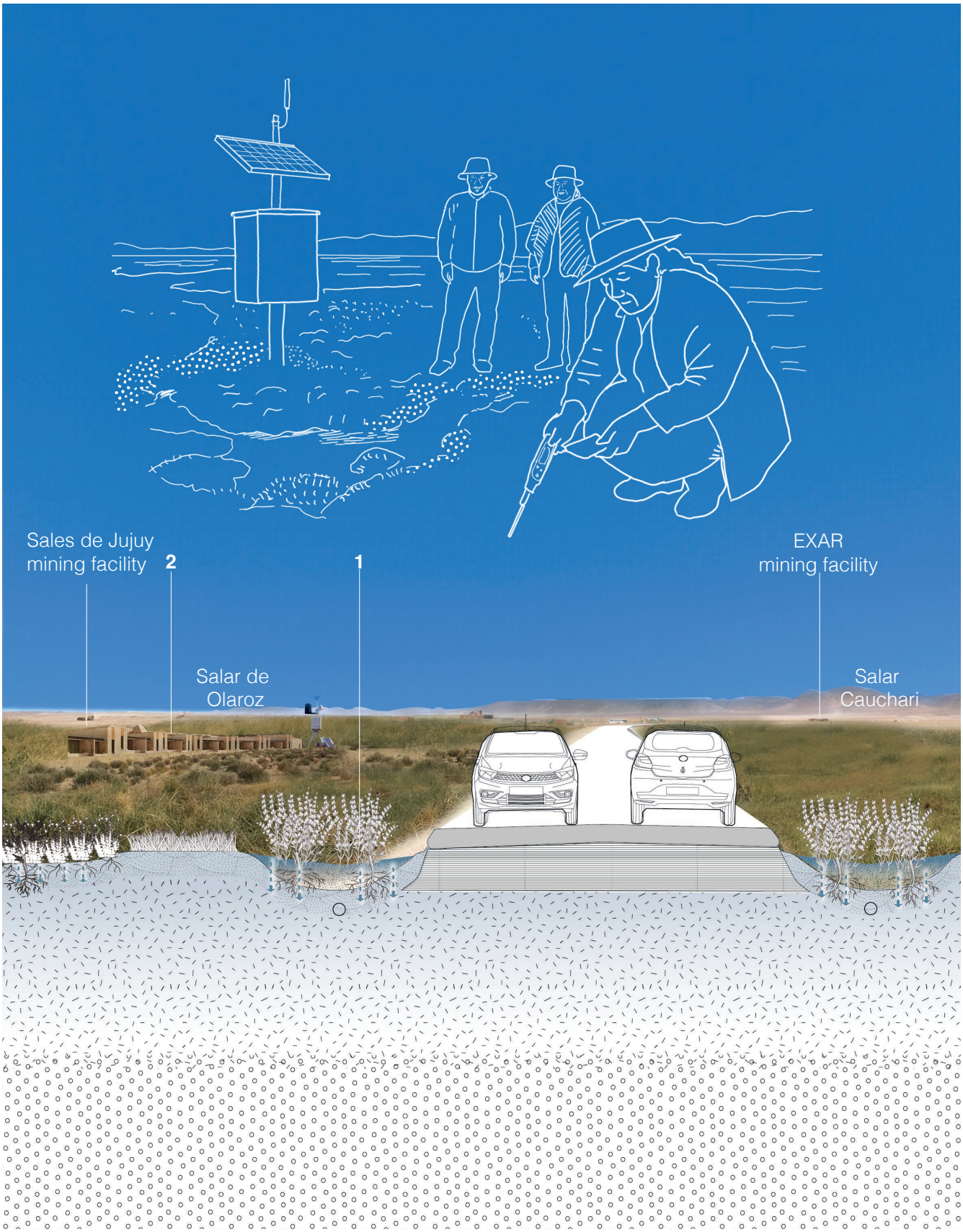
Projections

Intersection Project 1:

To strengthen the green corridor proposed in the master plan, the recovery of infiltration channels and soil moisture patterns is proposed, through the implementation of infiltration strips arranged perpendicular to the surface runoff. These strips will integrate adapted ancestral techniques, such as micro-qochas designed to capture and redistribute runoff water during the rainy season.

Along the roadside, micro-retention basins and vegetated strips will be laid out with native species tolerant to dust and salinity, contributing to both erosion control and improvement of the local microclimate.
A key component of the project is the construction of a community environmental monitoring station, managed by the inhabitants of Olaroz Chico. This node will record variables such as water quality, groundwater levels, vegetation evolution and the presence of bio-indicator species. The station will integrate technical know-how and local knowledge, promoting context-sensitive territorial governance oriented towards the collective care of the landscape.



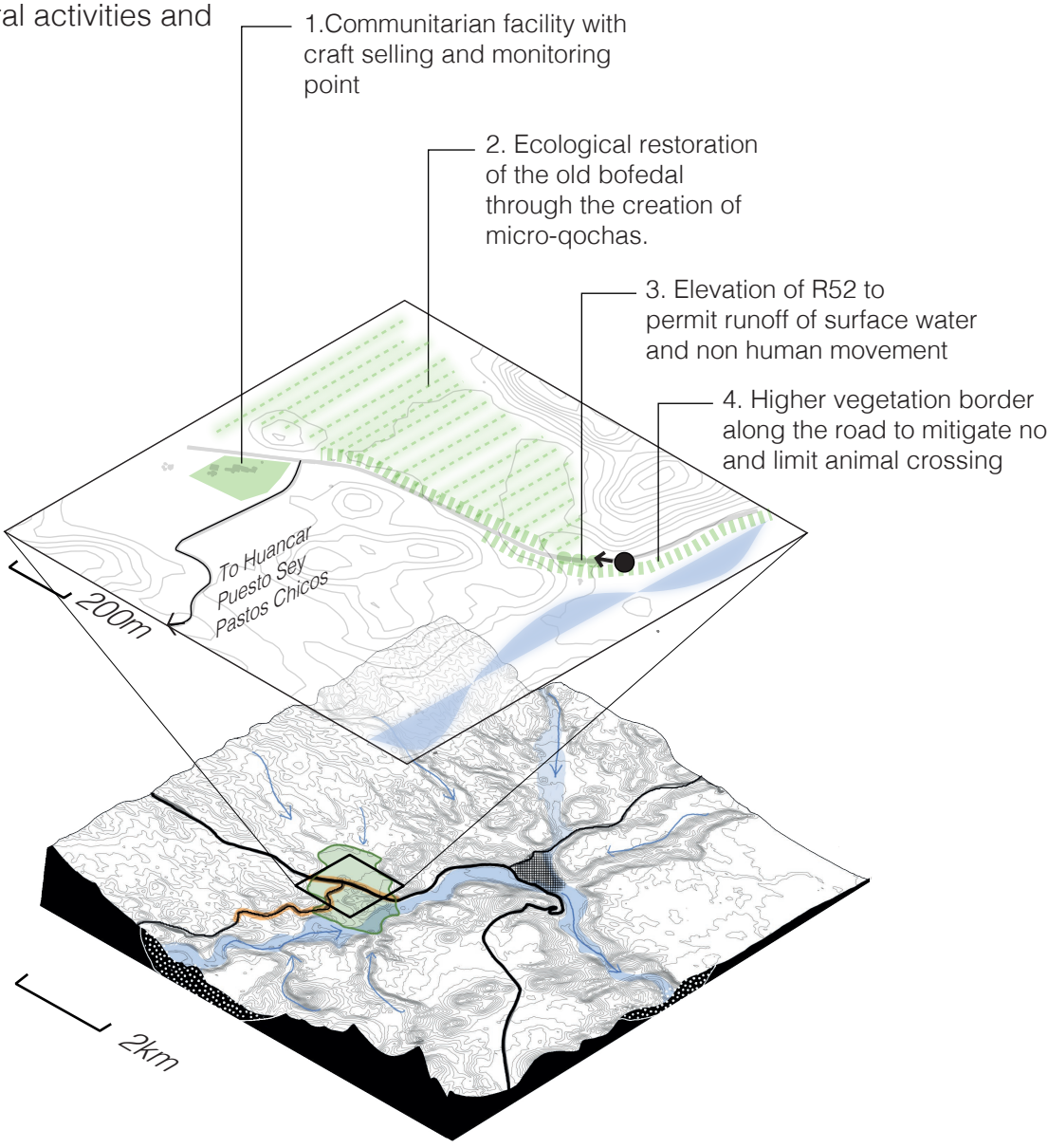

Sales de Jujuy
mining facility
2
1
EXAR
mining facility
Salar de
Olaroz
Salar
Cauchari

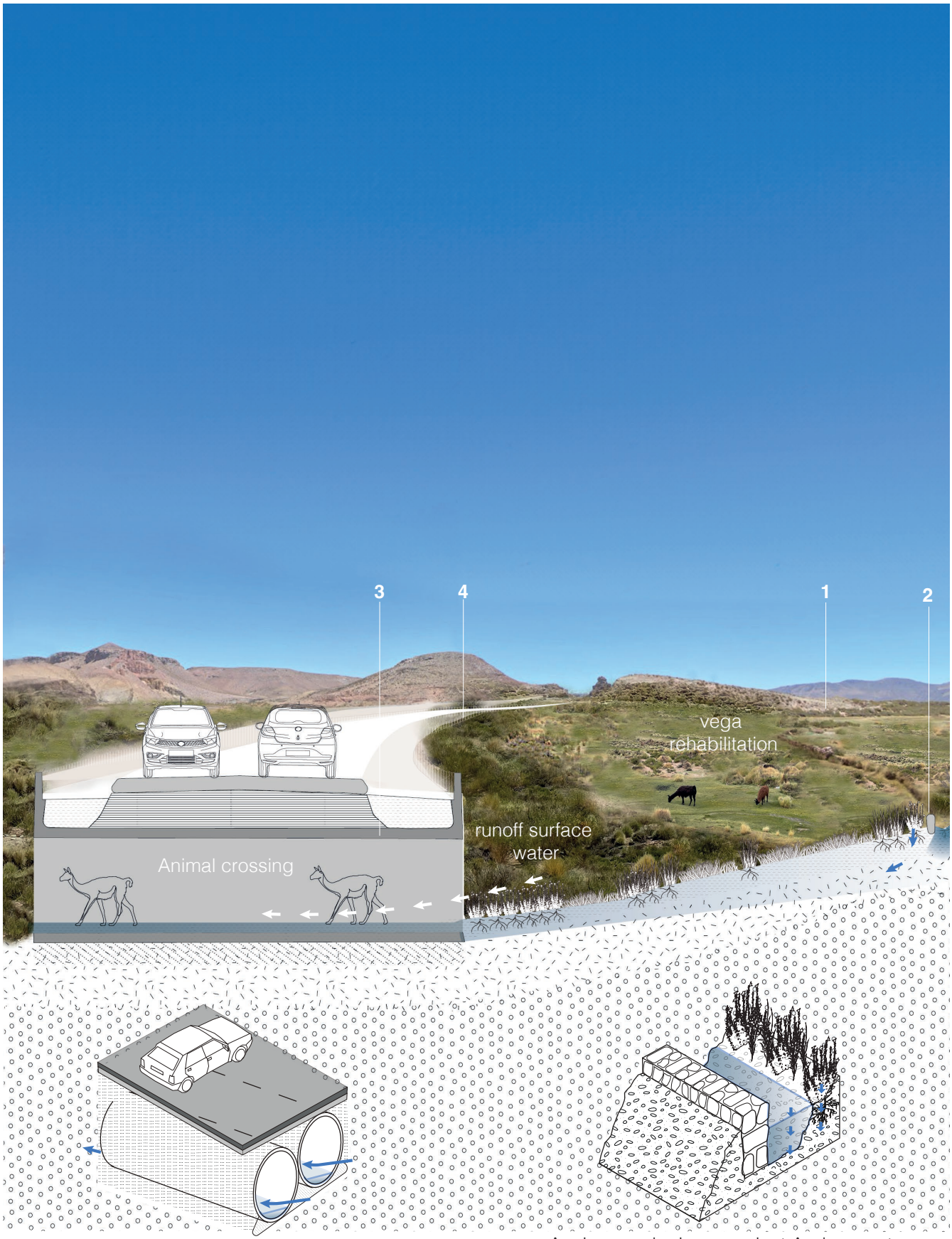
Chapter 8

Projections

Intersection Project 2:

At the junction with Route 40 in Susques, the focus of the intervention is on rehabilitating the vegas within the watershed's recharge zone, an area that is vital for sustaining the local water cycle. The intervention will also strengthen the connection with the nearby communities of Huáncar, Puesto Sey, and Pastos Chicos. Retention ponds will be constructed to restore natural infiltration and regulate surface water runoff.
A section of Route 52 will be raised to enable surface water to flow beneath the road and allow wildlife to pass through, using simple prefabricated culverts.
A new community hub will also be established at the Route 40 junction to support local trade, artisan markets, cultural activities and knowledge exchange.





The proposed elevation of Route 52 incorporates durable precast concrete culverts, which offer benefits such as rapid installation, high structural strength, and long-term durability. These culverts help reduce habitat fragmentation by preserving the natural slope of the terrain.

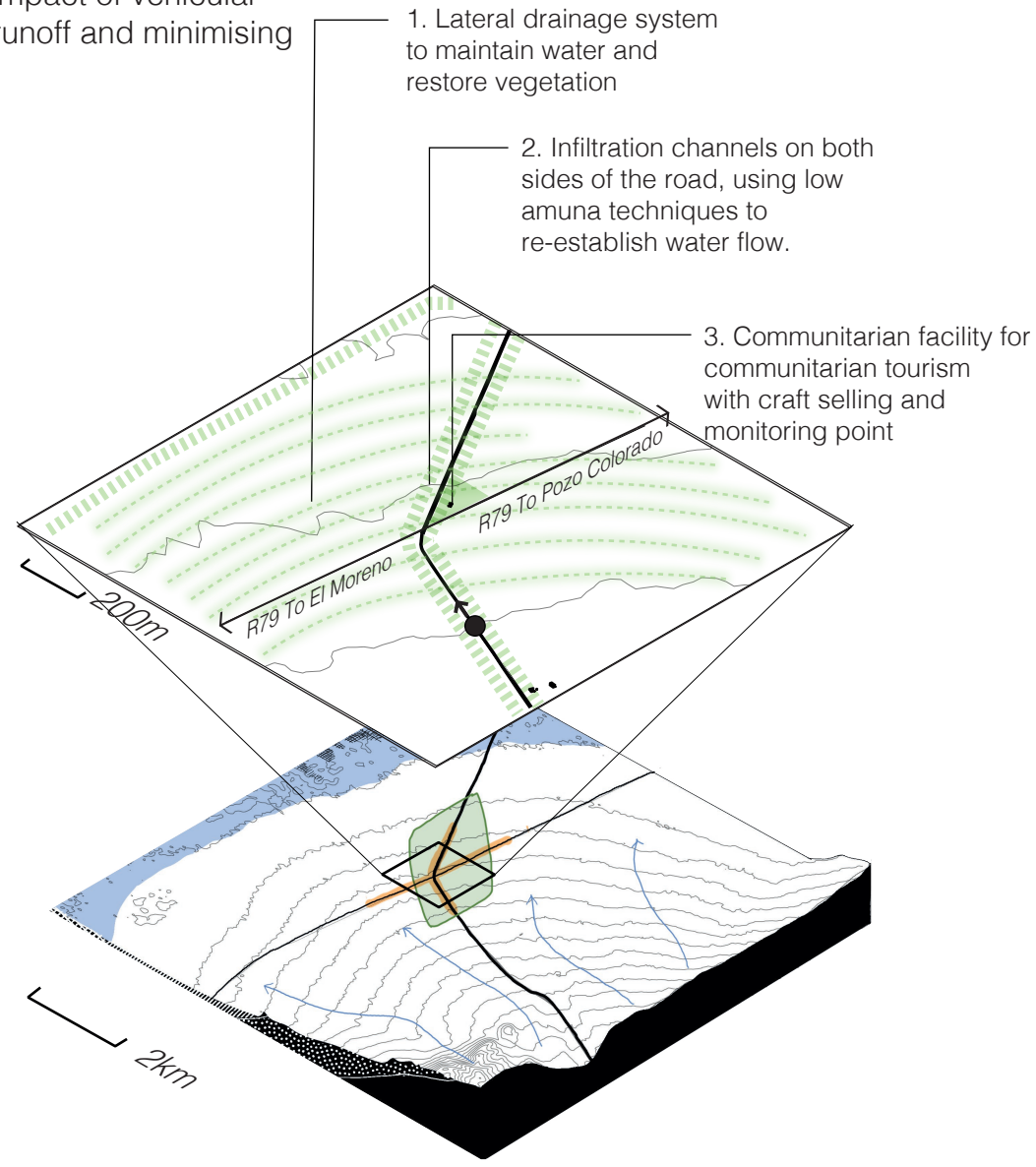
A micro qocha is an ancient Andean water management technique that consists of a small, hand-built depression or pond designed to capture and retain rainwater or meltwater, promoting infiltration, soil regeneration, and sustaining life in high-altitude landscapes.

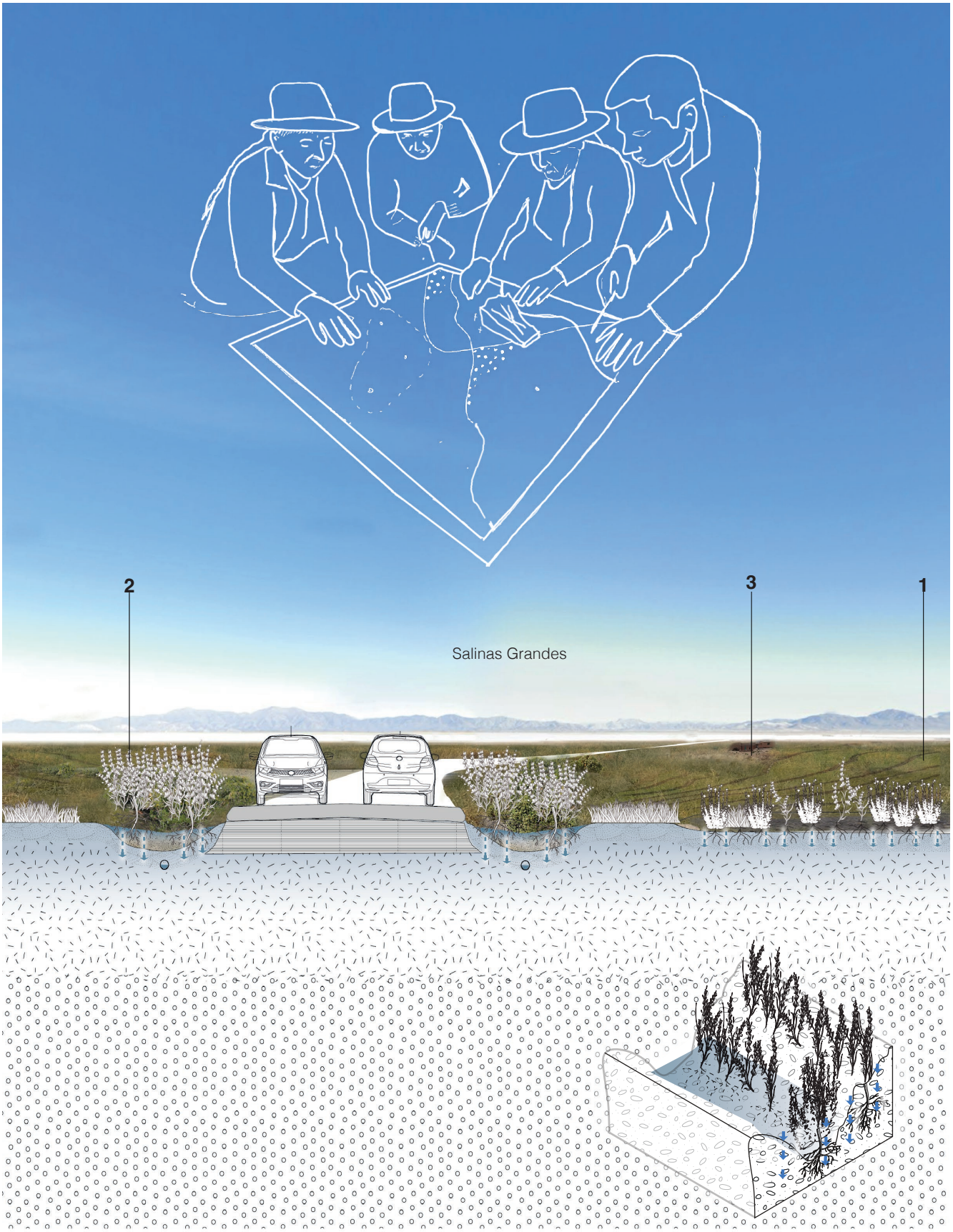
Chapter 8

Projections

Intersection Project 3:

The project aims to safeguard the ecological and symbolic boundaries of the Salinas Grandes salar at the edge of the transition zone towards El Moreno and Pozo Colorado. To achieve this, ecological buffers and a lateral drainage system will be implemented to capture runoff, restore native vegetation and recover soil moisture in the transition area.
In order to reduce pressure on the salar, tourist access will be relocated to a designated viewpoint which has been developed in collaboration with local communities. The facility may also incorporate an autonomous environmental monitoring point to support long-term stewardship of the site.
The lateral drainage system along Route 52 will mitigate the environmental impact of vehicular traffic by reducing surface runoff and minimising edge erosion.



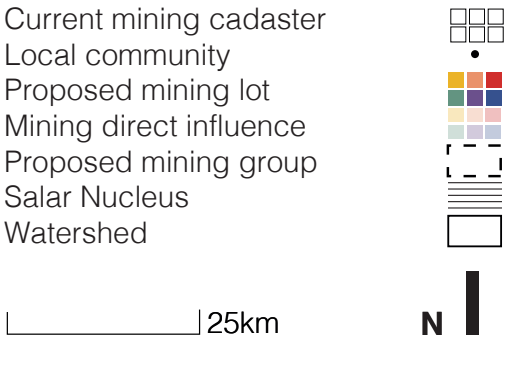

2
3
1
Salinas Grandes

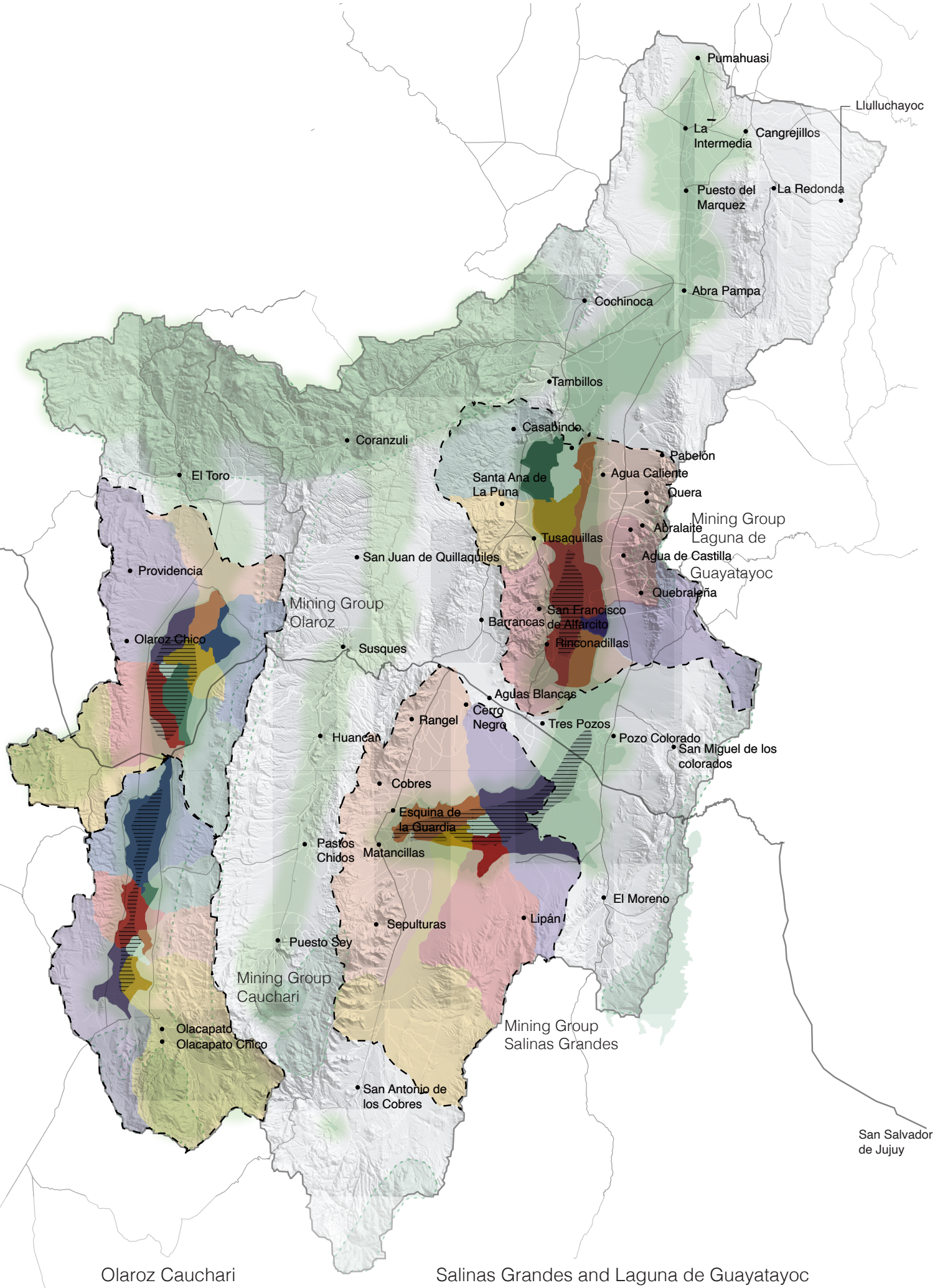
Chapter 8

Projections

Inverted mining cadaster -

Guided by Guideline 9, which recommends developing a mining cadastre based on hydrological divisions to protect sensitive ecosystems, particularly salt flats that are considered wetlands, this proposal acknowledges that a total mining ban in the region is currently unrealistic.
Instead, it advocates redefinining mining boundaries within the saline zones of Salinas Grandes and Olaroz-Cauchari based on hydrological analysis and previously defined sub-basins. Mining lots would be assigned according to watershed logic and would be delimited by sacred sites and local productive zones dedicated to traditional salt harvesting.
Each mining lot would also include a clearly demarcated zone of influence whose cumulative environmental impact would be assessed as part of the Environmental Impact Assessment baseline. Particular attention should be given to areas of high preservation, especially in the Olaroz-Cauchari basin, where hydrological vulnerability is most pronounced.
Local communities must play a central role in interpreting these zones of influence and participating in the evaluation and monitoring processes to ensure that mining regulation responds to both hydrological integrity and territorial rights.





Olaroz Cauchari

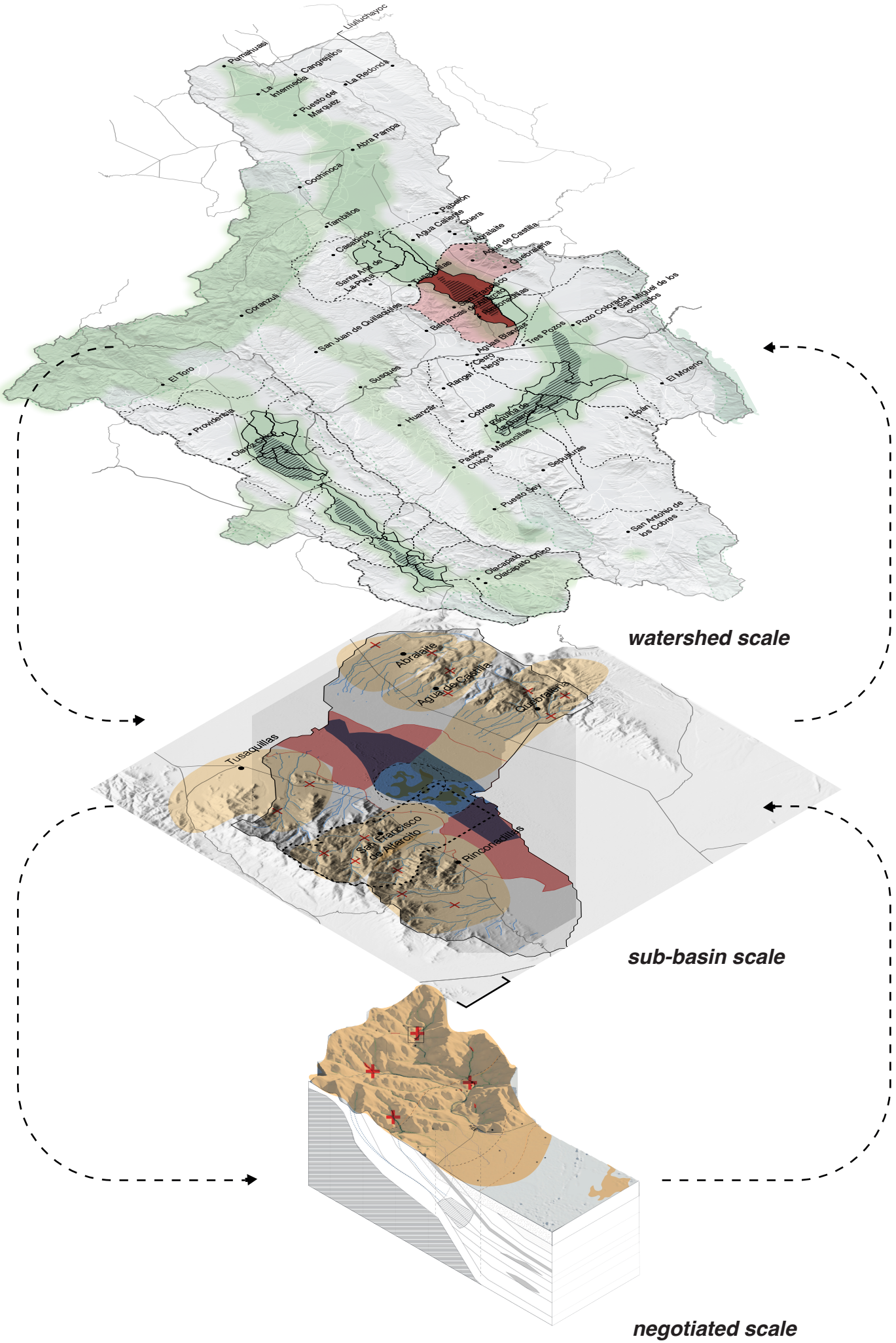
Salinas Grandes and Laguna de Guayatayoc

Chapter 8

Projections

Re-Landing

Using the methodology and steps previously proposed in Chapter 7, this process does not impose a static model. Instead, it unfolds as a translation of the territory by a constant fed of information between scales and actors, granting agency to both human and non-human actors in the decision-making process regarding the permitting or restriction of mining activities. Spatial representation, therefore becomes a form of language through which these negotiations take place, and can be done in relation to territorial implications.


Llulluchayoc
Pumahuasi
Cangrejillos
La Intermedia
La Redonda
Puesto del Marquez
Abra Pampa
Cochinoca
Tambillos
Pabellón
Agua Caliente
Quera
Abralaite
Agua de Castilla
Quebraleña
Casabindo
Santa Ana de La Puna
Tusaquillas
San Francisco de Alfarcito
Rinconadillas
Batrancas de Alfarcito
Coranzuli
San Juan de Quillaquiles
Aguas Blancas
Tres Pozos
Pozo Colorado
San Miguel de los colorados
El Toro
Susques
Cerro Negro
Rangel
El Moreno
Providencia
Huancar
Cobres
Esquina de la Guardia
Lipán
Olaroz Chico
Pastos Chicos
Matancillas
Sepulturas
Puesto Sey
San Antonio de los Cobres
Olacapato
Olacapato Chico
watershed scale
Abralaite
Agua de Castilla
Quebraleña
Tusaquillas
San Francisco de Alfarcito
Rinconadillas
sub-basin scale
negotiated scale

Chapter 8

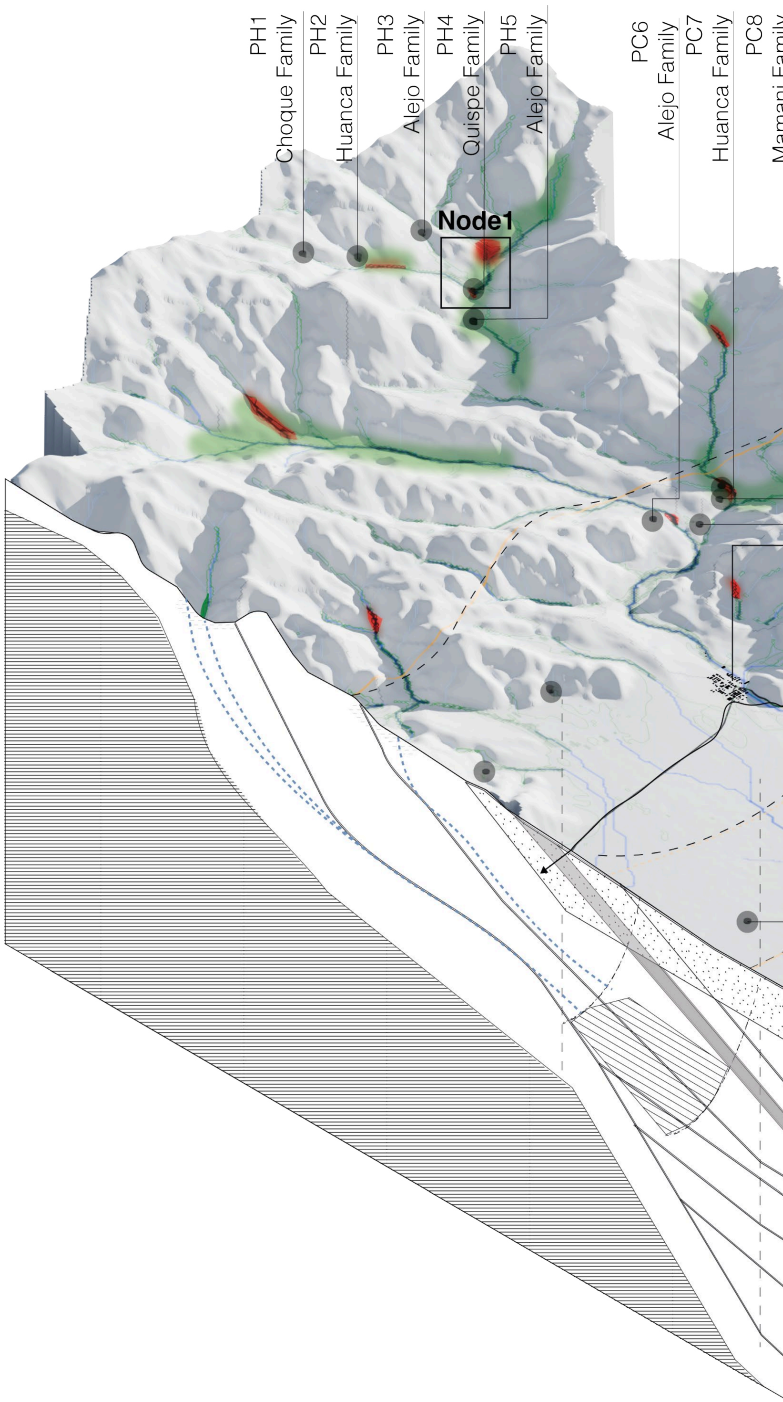
Projections

Proposed EIA baseline

In this context, establishing a new Environmental Impact Assessment baseline allows for fairer and more context-sensitive forms of territorial governance. Rather than relying solely on externally defined technical indicators, this baseline is based on measurements and decisions informed by natural cycles and local calendars. This acknowledges the seasonal rhythms that structure the territory's ecological dynamics, social life and collective responsibilities.

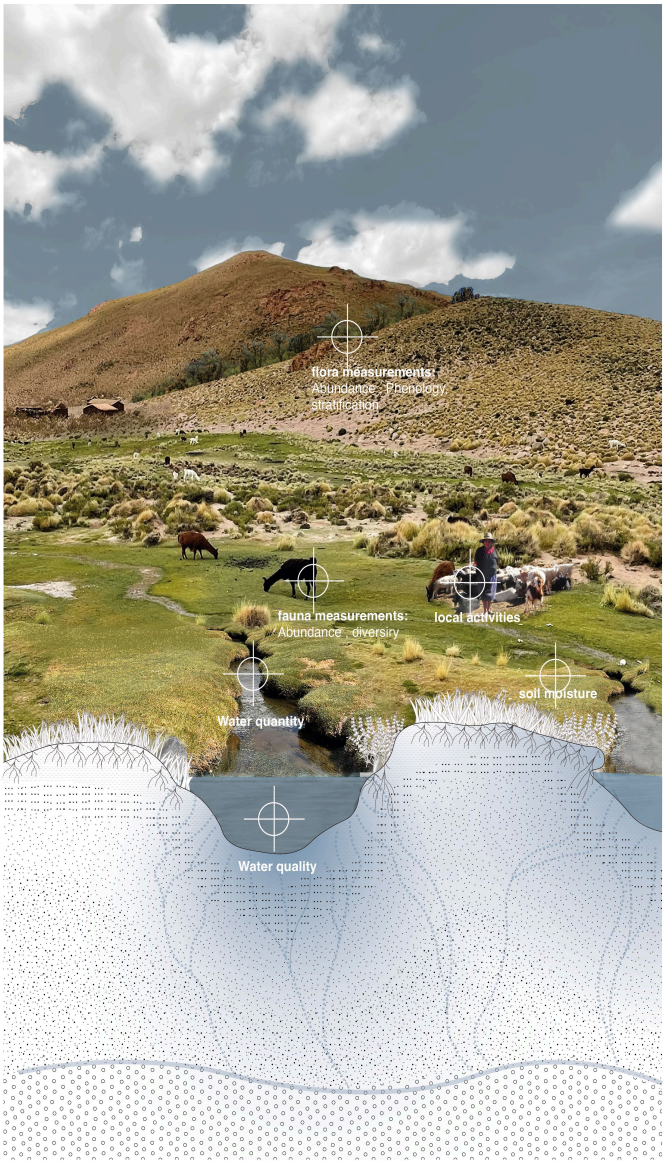
The co-definition of this baseline through participatory processes allows for the identification of key nodes, or contact zones, which are areas of heightened ecological, social and spiritual significance. These are not only zones of potential environmental impact, but also sites of profound relational value where local knowledge, memory and spiritual practices converge. Participatory measurements therefore extend beyond the biophysical to include social, cultural, and spiritual dimensions, which are often overlooked in conventional assessments.

This approach reframes the EIA baseline as a living, situated process capable of adapting to the region's plural ontologies and territorial dynamics. In this context, spatial representation becomes a tool for dialogue and negotiation rather than enclosure or abstraction, supporting collective decision-making around the permitting, restriction or transformation of extractive activities in fragile and contested territories.





Measurements and decisions made according to natural cycles and local calendars.



Recharge -Hill Area

Community area

Salar area

PC9
Shared

PC10 Quis

San Francisco
de Alfarcito
community base

Rute 52

PS13
Shared

PS14
Huanca Family

PS15
Mamani Family

PS16 Alejo Family

PS17 CondoriFamily

PS18 Choque Family

PS19 Quispe Family

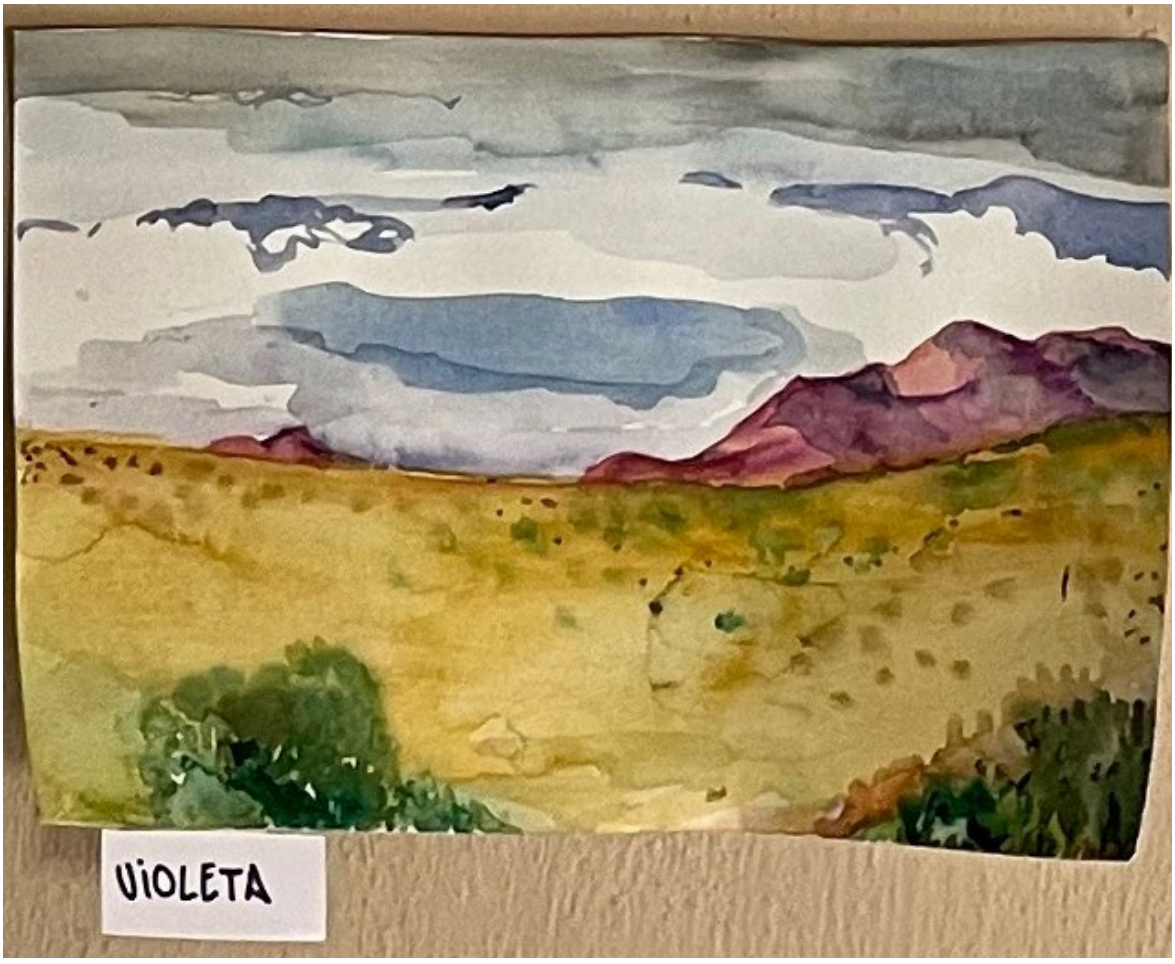
Co-definition of nodes- contact zones, to measure in participatory measurements according to vulnerable zones.

CHAPTER 9
STRATEGY

Adopting a relational and co-created approach to reading the territory enables us to move beyond fragmented methods by embracing an integrated perspective that recognises the interdependence and agency of actors, knowledge systems and ecosystems. Building on the research findings and identified opportunities and following the politicize step, an opportunities -project is proposed as a situated response to the case study. This opportunity-project comprises a series of strategic initiatives operating at multiple scales and combining top-down and bottom-up approaches with a strategic horizon of transforming the way the territory is perceived, managed and inhabited, promoting a relational, nature-cultural and multi-actor view.

Through the articulation of communicative, methodological and governance strategies, it seeks to promote a new territorial understanding based on natureculture, multi-stakeholder linkages and the co-production of knowledge and it supports a nature-cultural, multi-actor paradigm for territorial transformation.

This chapter unfolds through an analysis of stakeholders, the formulation of strategic actions, and the description of possible projects and the explanation of a digital platform.



Drawing by Violeta, a children of San Francisco de Alfarcito representing her land.
author 2025

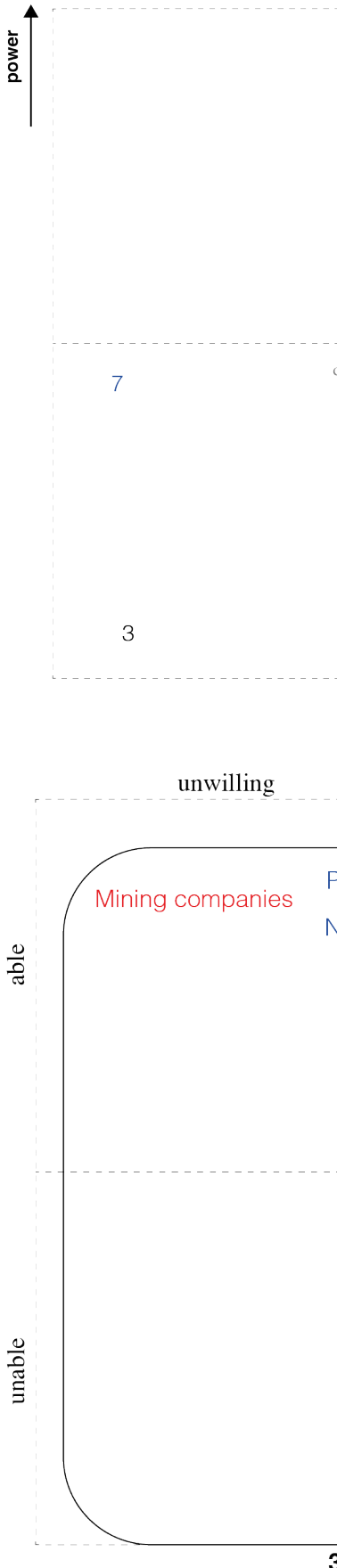
Stakeholder analysis and proposed actions

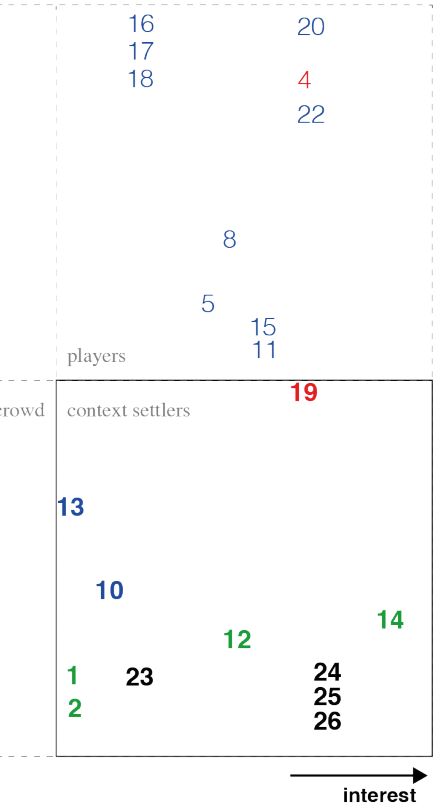
After completing the agency map and literature review, I identified several actors operating at different scales and positioned them within the Power-Interest Matrix (Johnson and Scholes, 1999) to assess the real possibilities for interaction. Given the urgency of the issue, I chose to prioritize engagement with the most interested stakeholders. Among these, I used the Willing–Unwilling Matrix to define targeted actions aimed at promoting natureculture preservation, involving both local communities and non-human actors:

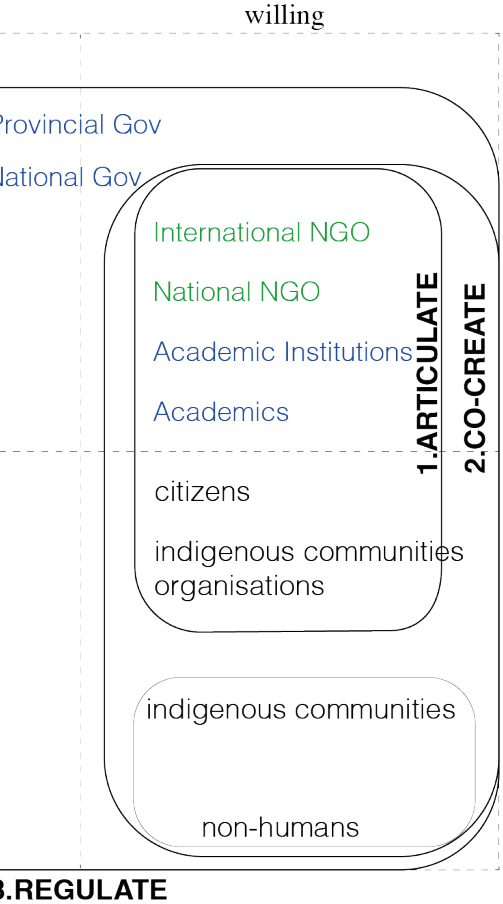
1-Articulation of willing stakeholders – Facilitating collaboration and communication among stakeholders already motivated to act.

2-Co-creation of knowledge and regulatory tools –Using the developed methodology to develop shared understanding and tools and areas with local communities.

3-Regulation of impacts and actions – Implementing mechanisms to monitor and control mining activities.







Public
Private
NGO
General

Global International

1.EITI

2.Wetlands International

3.Global Citizens

4.Mining Companies

5.International Labour Organisation

Latin America

6.CEPAL

7.UNASUR

National

8.ArgentinaNational Government
9.Environment Ministry
10.Academic Institiutions
11. National Mining Ministry
12.Wetlands International Argentina
13.INAI
14.FARN
15. National Environment Ministry

InterProvincial

16.Jujuy Government
17.Salta Government
18.Catamarca Government
19.EIA Consultancies

Provincial

20. Provincial Mining Ministry
21.Academic Institiutions
22. Provincial Environment Ministry
23.Local Citizens

Municipal

4.Mining Companies

24.Atacama Indigenous communities

25.Kolla Indigenous communities

26.non-humans

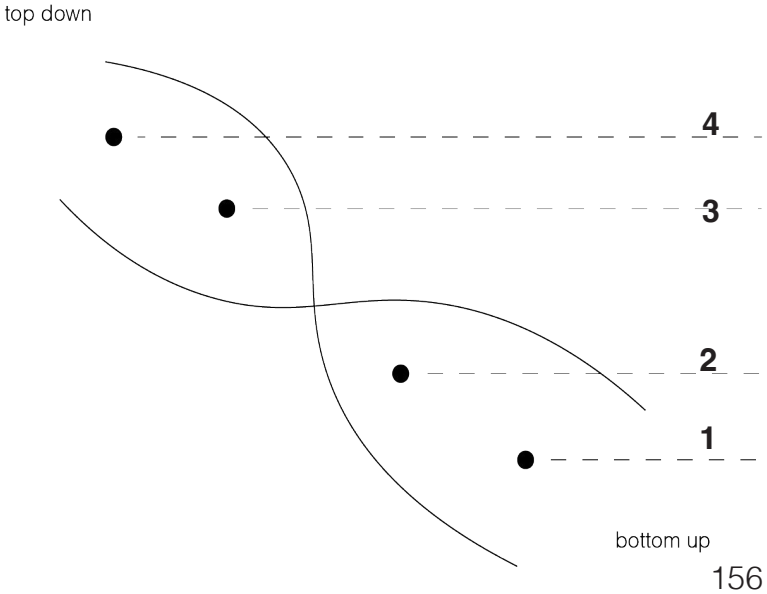
Chapter 9
Strategy

The opportunities project:

In recognition of the urgency of action and the complexity of territorial dynamics, this research proposes the Opportunities Project: a flexible framework designed to identify and realise new opportunities for more inclusive and collaborative forms of governance. Rather than relying on a fixed model, the project builds on existing institutional processes and the openness found in regulatory grey areas, such as the current lack of a comprehensive legal framework for lithium. It also builds on the willingness of various actors to engage at different stages of cooperation. Adopting both top-down and bottom-up strategies, it engages provincial governments, public institutions and ministries in coordination with mining companies from above, and fosters interdisciplinary and cross-sector collaboration among communities, researchers, NGOs and other committed stakeholders from below.

By working within and alongside existing systems and recognising the opportunity to reimagine roles and relationships, the project establishes alternative pathways for territorial decision-making. To achieve this, four interrelated pilot initiatives are proposed:

1.Digital Platform for Communication and Territorial Networking
2. Mapping, Co-creation of Information, and Rehabilitation of Vulnerable Areas
3.Relational Environmental Impact Assessment (Relational EIA)
4.Implementation of a Natureculture Protection Plan



4. Implementation of a nature culture protection plan.

-Specific objective: To identify and protect landscapes, practices and knowledge that integrate the ecological and cultural value of the territory.Institutionalising the relational approach through policies and plans.

-Instruments: Protected areas, areas to be rehabilitated, new mining cadastre, agricultural areas, community tourism areas, salt harvesting areas.

3. Relational EIA (Environmental Impact Assessment with Relational Approach)

Specific objective: To implement an assessment methodology that considers not only biophysical impacts, but also socio-ecological, affective and cultural relationships.
Changing the way the impact of projects on the territory is assessed and institutionalising a common language and process.

Approaches: Dialogue of knowledges, active participation, non-conventional indicators.

2. Mapping actions, co-creation of information and rehabilitation-protection of vulnerable areas through a network of actors.

-Specific objective: Restore degraded areas through participatory processes and sensitive to the territorial fabric.
-Actions: Co-definition of relevant areas, endemic species areas, cultural reactivation, community appropriation of spaces.

1. Digital platform for communication and territorial networking

-Specific objective: To make visible the actors, practices and knowledge of the territory and to create networks of exchange and collective action.Communication tool, narrative construction and networking.To embody the change of perspective in concrete interventions.

-Main functions: Communication, interactive map linking actors and disciplines, repository of knowledge, repository of actors.

The opportunities project feasibility

As this project has developed into both a conceptual perspective and a set of territorial tools, its real-world feasibility and implementation phases must be assessed specifically for each individual case. Nonetheless, as an informed and strategic approach, I have proposed an organizational structure that outlines potential pathways for action.

Nature culture protection plan:

Implementing development plans requires coordination at multiple levels of governance. In the case study area, for example, coordination is required between various ministries (environment, mining and water resources) and provincial governments. In the current context in Argentina, which is characterised by a discourse of 'development and mining urgency' and an extremely neoliberal national government, I suggest that these governance gaps present a potential opportunity. However, the feasibility of such coordination remains low.

Relational EIA (Environmental Impact Assessment with Relational Approach)

As shown in this research, the proposed methodology can inform a situated perspective. While formally changing laws and regulatory frameworks to adopt it may be unfeasible in the current political context, it can nonetheless be integrated into existing procedures through graphic elements, by advocating for the inclusion of specific spatial scales and interdisciplinary inputs.
Moreover, it can be used by communities—such as those involved in Kachi Yupi—as a tool for the spatial representation of practices, memories, and temporalities.
Can be as an expansion and deepening of the principles outlined in Kachi Yupi, contributing to the communities ongoing processes of territorial self-determination.

While Kachi Yupi establishes the framework for Free, Prior, and Informed Consent from an Indigenous perspective, the Relational EIA further strengthens this approach by incorporating scales, mapping, and territorial dimensions. It not only assesses biophysical impacts but also takes into account the socio-ecological, emotional, and cultural relationships that communities maintain with their land.
By emphasizing territorial scales, mapping practices, and the interconnectedness of different ecological zones, this methodology ensures a more holistic and localized evaluation of impacts. It institutionalizes a common language of dialogue, knowledge sharing, and active participation, offering a framework that respects and reflects Indigenous worldviews while reshaping the way development projects are assessed and understood within the broader territorial context.

Mapping actions, co-creation of information and rehabilitation-protection of vulnerable areas through a network of actors and Digital platform for communication and territorial networking

In light of the complex political context, the wide range of stakeholders, both within and beyond the territory, and the fragmented information, I believe that representation and critical mapping are the most urgent actions to take. In line with this research, I propose creating a digital platform for communication and territorial networking as a first step. Initially, this platform could be used to communicate the spatial impacts of mining, visualise the presence of various disciplines operating in the territory and map the distribution of stakeholders. It could then evolve into a tool for interdisciplinary mapping and spatial coordination within the Puna de Atacama, helping to consolidate dispersed knowledge, increase visibility and promote transparent, collaborative forms of territorial governance.

Chapter 9
Strategy

Digital platform for communication and territorial networking

Webpage: www.eltriangulodelitio.com

This digital platform has been developed in response to the fragmented information encountered during the literature review, the increasing number of researchers studying the impacts and local practices in the region, and the urgent need for interdisciplinary approaches. The platform is the result of a politicised engagement with the territory — a call to action in the face of extractivist expansion — and a critical reflection on the role of academic disciplines in shaping how we intervene in, represent and act upon the land.
The platform aims to serve as a unified space in which to communicate and highlight the relationships between disciplines working on and with the territory in a contextualised and responsive manner. It also seeks to foster meaningful connections between academic, technical and community-based knowledge, with the broader goal of collectively imagining fairer and more liveable futures.
Given the complexity of the biophysical matrix, the diverse local practices that configure the territory, and the documented impacts of brine-based lithium extraction, the territory has been organised into three interconnected zones: the ssalar, the community, and the vega.
This spatial structure is intended to articulate and bring into dialogue the multiple studies, practices and knowledges that emerge from each of these areas.
The platform's primary objective is to propose other approaches to interpreting and narrating the territory by developing critical cartography, narrative, and conceptual tools that facilitate the visualisation of relationships, conflicts, and alliances from a spatial and interdisciplinary perspective.

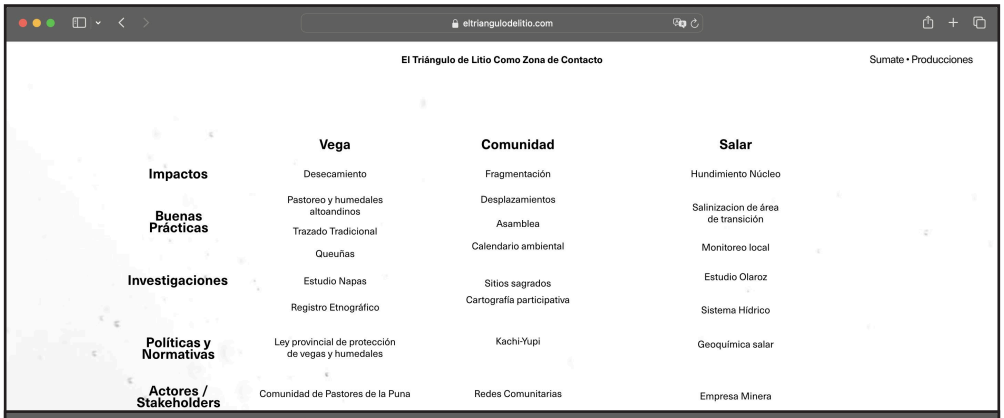
Platform structure

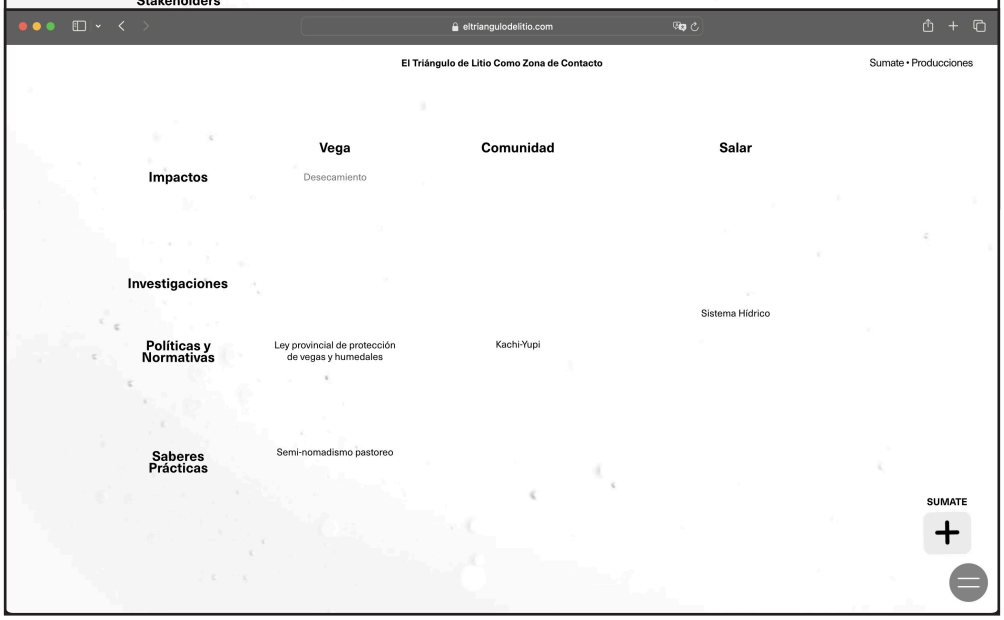
1. Communication Component:
This is a visual representation of a relational node or contact zone where different actors, disciplines and activities converge. The aim is to spatialise interaction and reveal entanglements.

2. Knowledge Matrix:
Taking inspiration from the Feral Atlas by Anna Tsing (https://feralatlas.org/), this section operates as an evolving repository that compiles and interrelates documents, disciplines, stories, articles and testimonies. It encourages open collaboration and the co-production of situated knowledge.

3. Upcoming development:
An interactive map allowing users to locate actors, research and knowledge production across different hydrological basins, fostering an eco-territorial perspective at multiple scales.


eltriangulodelitio.com
El Triángulo de Litio Como Zona de Contacto
Sumate • Producciones
¿Por que dividimos el territorio en 3 zonas?
A partir de los impactos observados, los estudios existentes y las actividades cotidianas de las comunidades, propongo dividir el territorio en tres zonas interrelacionadas, que nos permiten leerlo de forma más clara, situada y sensible, reconociendo su carácter natucultural:
Salar: el núcleo de extracción, donde se encuentra la salmuera y se realizan las actividades mineras, así como la cosecha de sal.
Vega: las zonas húmedas de altura que rodean a los salares, fundamentales para el ciclo del agua, la biodiversidad y el pastoreo.
Comunidades: los espacios donde desarrollan sus actividades sociales las poblaciones locales, con formas propias de producir, cuidar y relacionarse con el territorio.
Estas tres zonas no son compartimentos estancos. Al contrario, funcionan como nodos relacionales, donde se cruzan saberes, disciplinas, escalas y formas de vida.
La riqueza de compartir información y experiencias está en poder interrelacionarlas, para entender mejor el territorio y pensar colectivamente futuros posibles.
Etnobiología


eltriangulodelitio.com
El Triángulo de Litio Como Zona de Contacto
Sumate • Producciones
Vega
Comunidad
Salar
Impactos
Desecamiento
Fragmentación
Hundimiento Núcleo
Buenas Prácticas
Pastoreo y humedales altoandinos
Trazado Tradicional
Queuñas
Desplazamientos
Asamblea
Calendario ambiental
Salinizacion de área de transición
Monitoreo local
Investigaciones
Estudio Napas
Registro Etnográfico
Sitios sagrados
Cartografía participativa
Estudio Olaroz
Sistema Hídrico
Políticas y Normativas
Ley provincial de protección de vegas y humedales
Kachi-Yupi
Geoquímica salar
Actores / Stakeholders
Comunidad de Pastores de la Puna
Redes Comunitarias
Empresa Minera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El Triángulo de Litio Como Zona de Contacto
Sumate • Producciones
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Desecamiento
Investigaciones
Sistema Hídrico
Políticas y Normativas
Ley provincial de protección de vegas y humedales
Kachi-Yupi
Saberes Prácticas
Semi-nomadismo pastoreo
SUMATE

CONCLUSION

In response to the research question," How can a territoriality* of brine extractivism on the Puna de Atacama be achieved with a balance of power over the territory for a truly ecologically, politically and economically sustainable future?", This research concludesThis research concludes that the territorialisation of lithium mining in the Puna de Atacama must be approached from a spatial and territorial perspective.
In the context of a global ecological crisis where dominant responses tend to be technocratic and centred on the strategic extraction of so-called 'critical' raw materials, this thesis questions how the geographies of power continue to produce sacrifice zones in historically marginalised territories. From this standpoint, urbanism is positioned as a mediating and spatialising discipline capable of exposing and territorialising conflict, rendering uneven power relations visible, and proposing alternative ways of inhabiting and managing territories.

Using critical cartographies, multi-scalar readings of historically entangled nature-culture systems and an analysis of legal-regulatory infrastructures alongside the spatial and temporal distribution of actors (as explored in Chapters 3, 4 and 5), this research demonstrates how it is possible to propose alternatives that are grounded and multi-scalar with diverse territorial actors. While these proposals are small in scale, they may trigger systemic change and reinforce the agency of local communities — both human and non-human.

Rather than offering set solutions, this thesis proposes a change of perspective: one that considers practices in a spatial context, highlights the ways in which the territory is used and appropriated, and compiles a local catalogue of opportunities based on territorial experience. This research therefore provides a foundation for reimagining the Puna de Atacama through a critical spatial lens, as well as for reconsidering extractivism from within the territory itself.

The thesis concludes with the proposition that changing our perspective and decolonising our ways of seeing, while listening to the territory's multiple voices, will create new possibilities for negotiation and collective construction, offering pathways towards a more just and sustainable future.

Throughout the research, concrete outcomes emerged through the strategies of expose, propose and politicise, as detailed on page 162 .

FURTHER RESEARCH

This project adopted a central strategy of territorial negotiation, meaning that certain areas could not be fully explored. However, engaging with the region's complexity and identifying gaps in data and governance highlighted the urgent need for further research, particularly in areas that are often overlooked by traditional studies.

Key areas for future investigation within urban and territorial studies include:

- The reconstruction of historical land-use practices and cultural relationships in the Puna de Atacama.
- Analysis of hydrological basin dynamics to better understand water availability and vulnerability.
- Studies on the transformation of urban conditions in mining towns and surrounding regions.
- Continued documentation and spatial mapping of environmental impacts from brine extraction
- Spatial approaches to legal frameworks, analysing how laws (or their absence) shape territory, and how spatial tools can help to visualise, critique or reform regulatory gaps.

CONCLUSION

EXPOSE

Territorial

Infrastructural

Epistemic-Technic

Decolonial

Landing and Territorial Organisation

Questioning Agency

Thinking about a just negotiation

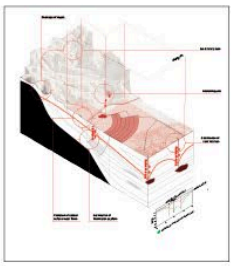
Transdiciplinar
Re understanding
Re reading
Re mapping

Communication and articulation throughout the territory

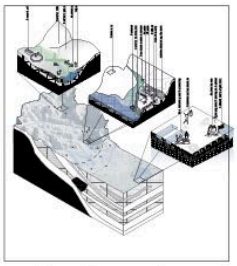
Outcomes

Conclusions on Territorial organisation

Territorialisation of ontologies and clashings



mining impacts



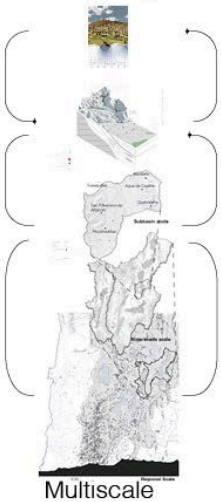
local practices

Critique of current regulations

Recommendation for Salta and Jujuy Provincial Governments

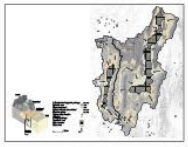
Process

Re understanding
Re reading
Re mapping



Multiscale trasdisciplinar **methodology** for readin and representing the territ

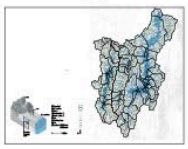
Representation



Soil



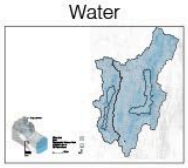
Evapora



Water



Wetlan



TWI



Commun

Atlas of Olaroz Caucha and Salinas Grandes an Laguna de Guayatayoc Watersheds

PROPOSE

POLITICIZE

Projections

Projections

Projections

Projections

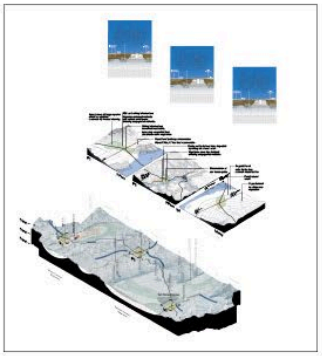
Projections

Re imagining

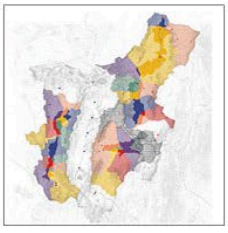
Design Guidelines for natureculture preservation in the Puna de Atacama

Territorial plan for Olaroz Cauchari Salians Grandes and Laguna de Guayatayoc Watersheds

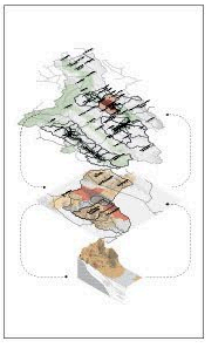




Opportunities of **design interventions** and proposals



Proposition of an inverted **mining cadaster**



Proposition of a landing of mining companies
Enviromental Impact Assesment baseline process

Operationalisation

Strategy for implementation: Opportunities of interventions

Digital platform
for communication and territorial networking

FINDINGS- RECOMMENDATIONS

General recommendations to the regulatory bodies of the provinces of Salta and Jujuy:

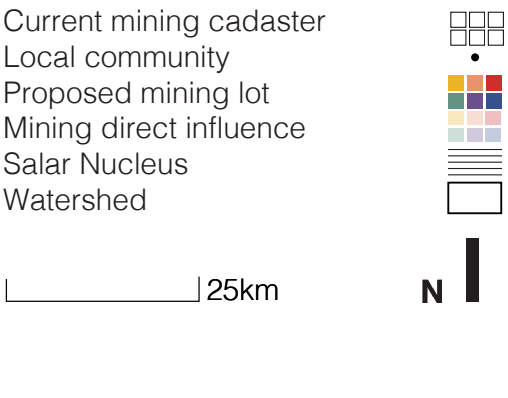
Recognise watersheds as the primary territorial unit.
Adopting the watershed as the fundamental unit for planning and managing lithium mining is recommended, moving beyond political-administrative boundaries and promoting an integrated territorial approach.

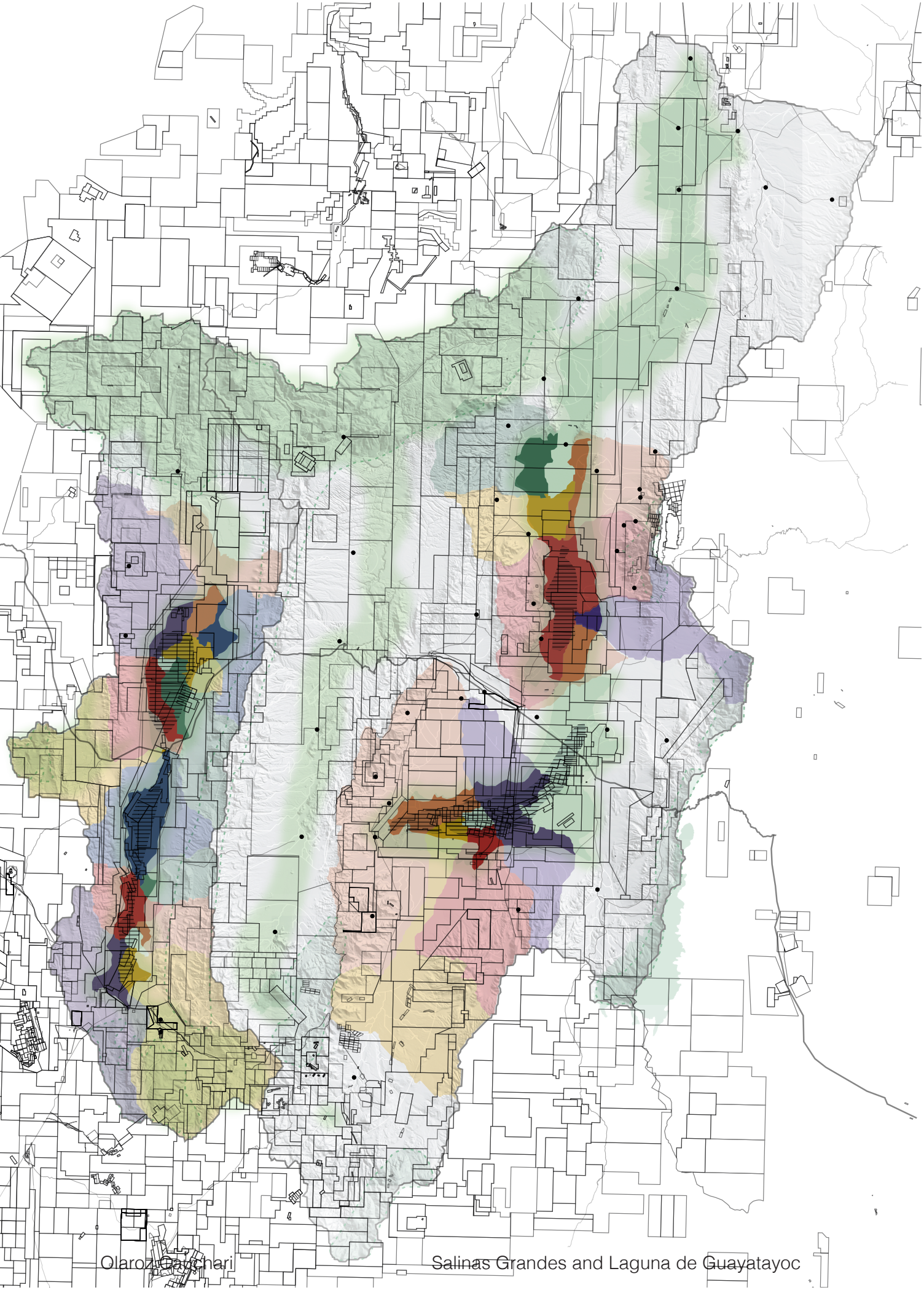
Unified water balance calculation:
A combined, interoperable registry system for groundwater pumping wells and water extraction is necessary at provincial and interprovincial levels.
This system should enable dynamic, up-to-date water balance calculations supported by geospatial tools that allow territorial visualisation and analysis.

Strengthening Environmental Impact Assessments (EIAs):
A biannual comparison of key environmental indicators against a well-defined baseline should be mandated. The assessment must be quantitative and spatial, including mapping the evolution of impacts over time.

Spatialisation of environmental impacts:
The spatial dimension must be incorporated into the evaluation, monitoring and management of environmental impacts through the use of geographic information systems (GIS) and related technologies.This includes the precise geolocation of activities, affected areas and sensitive zones, as well as the development of dynamic environmental risk and degradation maps.
Furthermore, harmonised spatial data standards and criteria should be adopted across provinces to ensure data interoperability and coordinated decision-making.

The strict inclusion of local communities during the mine concession process:
It is essential to establish regulatory frameworks that guarantee the full, prior and informed participation of indigenous communities in all stages of environmental assessment and decision-making processes.
This participation must extend beyond mere consultation to enable effective influence and co-management, particularly in territories that have been inhabited or used by these communities for generations.
Regulatory bodies must ensure that environmental procedures respect indigenous rights, cultural values and traditional knowledge, in line with national legislation and international instruments such as ILO Convention 169.





REFLECTION

On the relation between the graduation project topic, master trach and master programme:

My graduation project focuses on the spatial and environmental dynamics of evaporitic mining territories, specifically lithium extraction in South America. The core of the research lies in understanding how opportunities of negotiations can arise from a natureculture interpretation of the territory. This investigation is deeply rooted in the Urbanism track, as it engages with territorial planning, systems thinking, and multi-scalar interpretations. Moreover, the project, framed by Transitional Territories studio transdiciplinar approach,propose to push disciplinary confinement's boundaries by adding a diversity of perspectives. The project reflects the Urbanism track's emphasis on designing with complexity, operating across spatial scales, and synthesiz ing ecological, social, and infrastructural layers.

At the same time, the project aligns with the objectives of the MSc programme, which encourages research-driven design, critical reflection, and interdisciplinary integration. My work bridges spatial analysis, technical insight (e.g., hydrology, soil systems) trying to contribute to ongoing global debates around sustainability, climate transitions, and resource governance. The project aims to act as a lens through which to explore new forms of spatial intervention and critical situated territorial planning.

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

My research deeply influenced my design and recommendations by reshaping my entire approach to inquiry and presence within the territory. Engaging with the Indigenous communities of the Puna taught me that the world is not a passive object to be analyzed or mapped, but a living web of relationships (human and non-human)that demands respect, reciprocity, and listening. This realisation led me to question traditional, rigid research frameworks and instead adopt a more open, situated, and relational methodology. Rather than arriving with predefined methods or solutions, I learned to ask, to doubt, and to be taught by the territory itself. The how became central: how to arrive, how to move, how to inhabit. These were not logistical questions, but ethical ones about permission, respect, and positionality. This sensibility directly influenced the design of my recommendations: they were not imposed from outside but emerged from within the local rhythms, voices, and needs.Design became less about intervention and more about co-existence, support, and dialogue. In turn, the act of designing of trying to respond to real, situated needs reshped my research. It revealed gaps, tensions, opportunities and new questions I hadn't seen before. It compelled me to return to the field, to listen again, and to refine both my understanding and my approach. In this way, research and design formed a continuous loop of learning.

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

I assess the value of my approach by considering its ability to remain responsive, grounded and ethically engaged with the realities of the territory. In line with my ongoing reflections on methodology, I found it essential to reshape and reconsider the approach throughout the process. Rather than adhering strictly to predefined methods, I allowed the territory's needs and conditions to inform my approach

.This adaptive methodology was both challenging and necessary, particularly in a context characterised by the expansion of mining frontiers and the oversimplification of complex local dynamics. The political sensitivity of the topic meant that some in-person interviews were not possible. This forced me to reconsider not only my methods, but also the nature of knowledge production itself. Who speaks, when, and under what conditions?I also reassessed and restructured my theoretical framework, sub-research questions and analytical tools, particularly the analytical mapping processes, in order to respond more effectively to the information revealed by the territory. These adjustments were not a sign of the methodology's weakness, but rather its strength — its ability to evolve in dialogue with the complexity of the context.Ultimately, I value this approach because it does not isolate the researcher from the world, but rather places them within it and holds them accountable to the people and non-human entities with which they engage.

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

I assess the academic and societal value of my graduation project based on its ability to address urgent territorial, political and ethical issues in a critical and sensitive manner. From an academic perspective, the project challenges traditional research methodologies by proposing a more contextualised, relational and ethical approach. It contributes to the ongoing conversation about decolonial approaches, as well as the role of design and spatial practices, in contested territories. The project demonstrates how knowledge can be co-constructed with communities and territories rather than extracted from them.

Societally, the project seeks to amplify the voices of those who have been silenced or overlooked. By framing the territory as a living, relational space rather than a passive background, the project challenges dominant narratives of progress and development and suggests alternative approaches to seeing, engaging with and caring for places.

It also facilitates public discourse and reflection on how design and research can serve as tools for advocacy and collaboration rather than imposition.
Ethically, the project was guided by a strong commitment to respect, reciprocity and responsibility. It continually asked: Who speaks? Who benefits? Who is exposed? These questions were particularly important in a politically sensitive context, where certain forms of visibility could pose a risk to individuals or communities. Decisions about what to reveal, how to represent things and when to withhold information were made with great care and constant consultation. This approach reinforced the idea that ethics should be an ongoing practice, embedded in every stage of the research process.

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

Rather than through direct replication, I assess the value of the transferability of my project results through the adaptability of its core principles. The project is rooted in the situated approach to urbanism proposed by the Transitional Territories Studio, which was considered throughout the research. It offers an alternative perspective on how we understand and relate to territory, especially in contested or vulnerable contexts. The research's structure, including its lines of inquiry and relational methodology, can be applied in other geographies where extractive activities reshape landscapes and lives. Throughout the research process, I reflected on the Q4 elective 'Mine Lives' where we visited communities living around mine waste disposal sites in Johannesburg, and the whole area is about to be re-mined. While this context may requier the involvement of other disciplines,I see strong potential for my methodology to serve as a communication and reflection tool. It could facilitate the expression of local voices, spatial memories and beliefs, which are often excluded from official narratives and technical assessments.In this sense, the project transferability lies in its ability to foster alternative forms of representation, dialogue, and the co-creation of territorial knowledge.

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ANNEX

Atlas of Olaroz Cauchari Watersheds:
The atlas and datasets are available in the webpage www.eltriangulodelitio.com

Water
Soil
Urban
Wetlands
Topographic Wetness Index

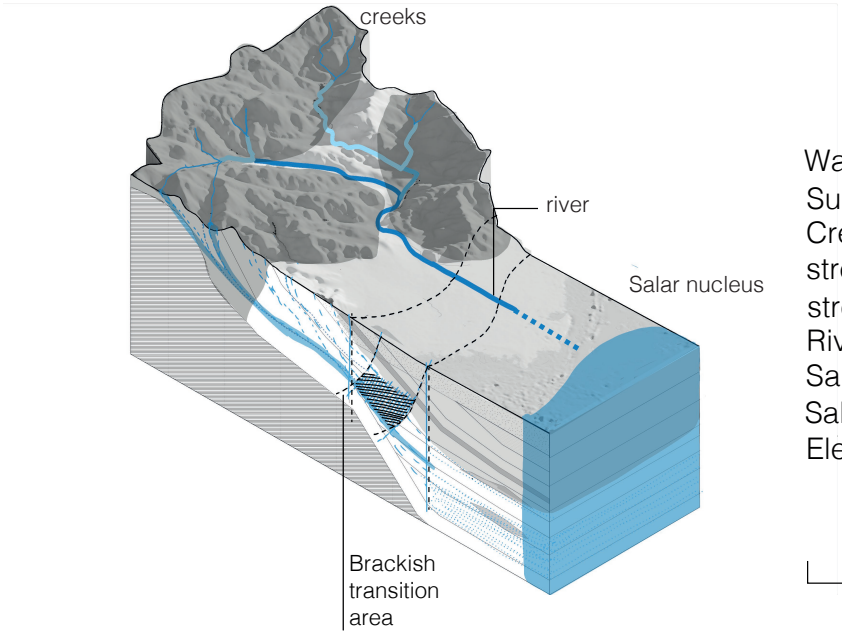
Other Drawings

Analytical mapping-counter mapping
Water

The salt flats are The Salar de Olaroz-Cauchari and the Salinas Grandes and Laguna Guayatayoc are closed watersheds that are located at high altitude and are considered fragile ecosystems.
There, water is a limited and key asset for survival (Izquierdo et al, 2018) and ecosystem functioning. In them are present, in a delicate natural balance, freshwater systems (with low salinity levels), and very salty waters (“brines”), as well as fossil waters - groundwater housed in confined aquifers for hundreds of years which is a non-renewable resource - and modern.(Sticco et al, 2018).
Due to lithium extraction processes, the geographical and ecological characteristics of the site, and the variability and inconsistency of available information, I decided to conduct my own hydrological analysis to contribute additional data for the area. It was absolutely necessary to have comprehensive information about the water cycle.

For this purpose, I used a SRTM Digital Elevation Model (DEM), which I processed using SAGA GIS Hydrological analysis within QGIS.
This information was cross-referenced with watershed data from the Argentinan National Centre of Hydric Resources(COHIFE,2022), HydroSHEDS (Lehner, B., Grill G, 2013), and scientific publications (Sticco et al, 2018).
The same methodology was applied to delineate sub-basins and micro-basins, although in those cases there were no records available for comparison.

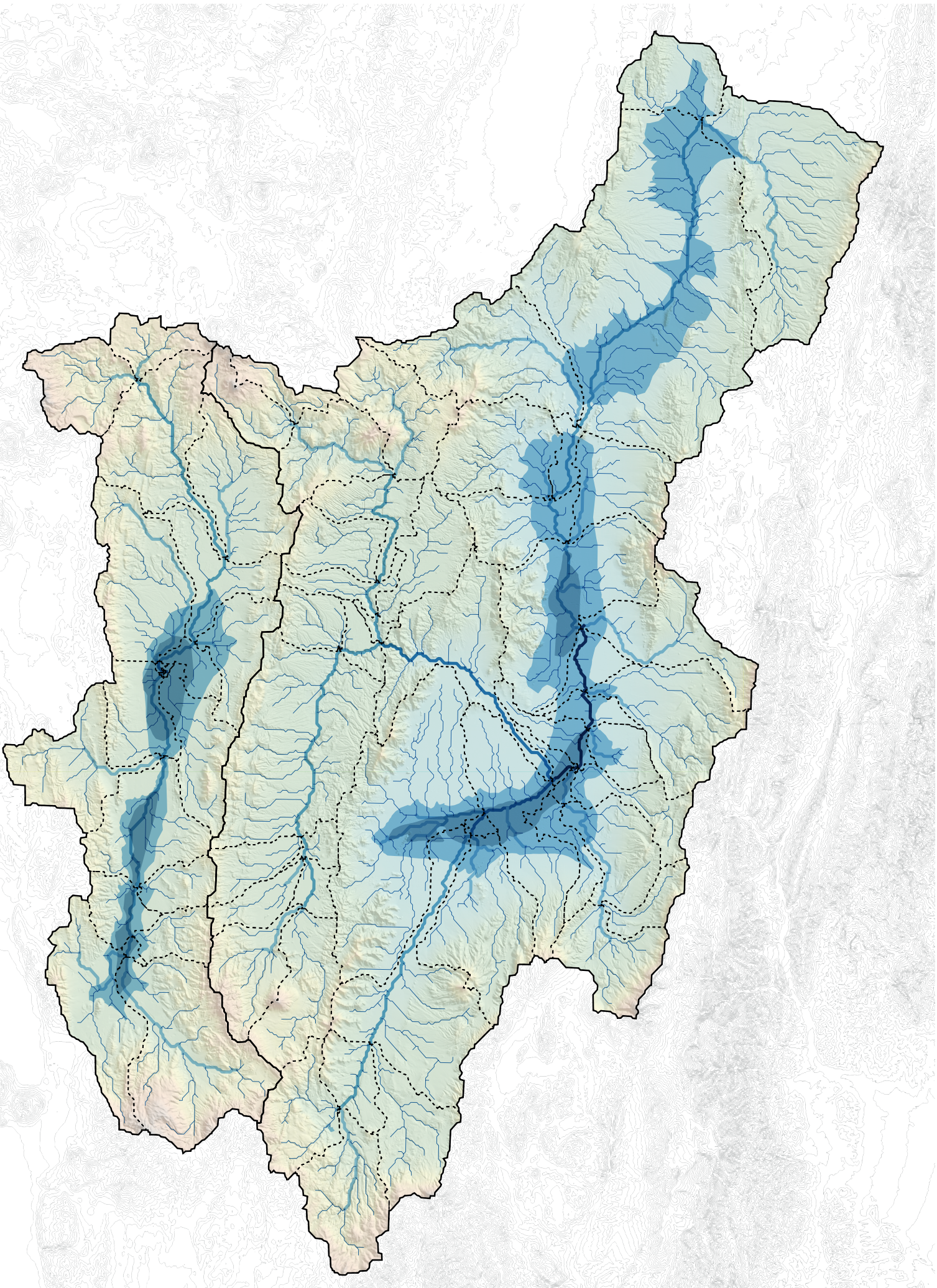
Salares and Salar nucleous were decided contrasting the hidrological map with geomorphology,hydrogeology and wetland probability layers.



Watershed
Sub basins
Creeks
stream order 2
stream order 3
River
Salar Nucleus
Salar
Elevation 6000masl
3500masl

20km

N



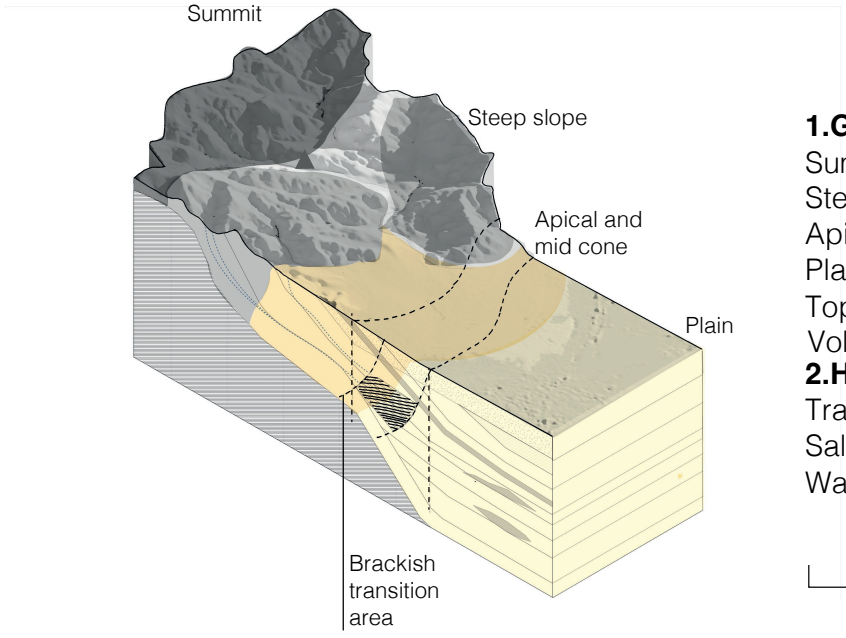
Analytical mapping-counter mapping
Soil

In the case of soils, the integration of information was more complex. I considered it essential to represent soil characteristics based on fertility and salinity, understanding these variables as key to interpreting human settlement patterns and land use. When comparing existing information for the area—such as Environmental Impact Assessments (EIAs) that referenced layers from INTA stating that the entire basin was classified as “non-arable land” (in agricultural terms)—I decided to cross-reference additional data sources.

For geological characteristics, I used a volcano database from Bertin et al. (2022), combined with a lithological layer by Gómez J. et al. (2019), which classifies rock types as volcanic, metamorphic, sedimentary, or plutonic. I contrasted them with the geological mpa of Jujuy Seggiaro-,et al 2015.
Additionally,for soils, I incorporated data from INTA that categorizes land according to geomorphological and soil characteristics (e.g., summit, apical, rocky outcrop, floodable areas, etc.) contrasted with Argentinan Soils Pereyra, 2012.

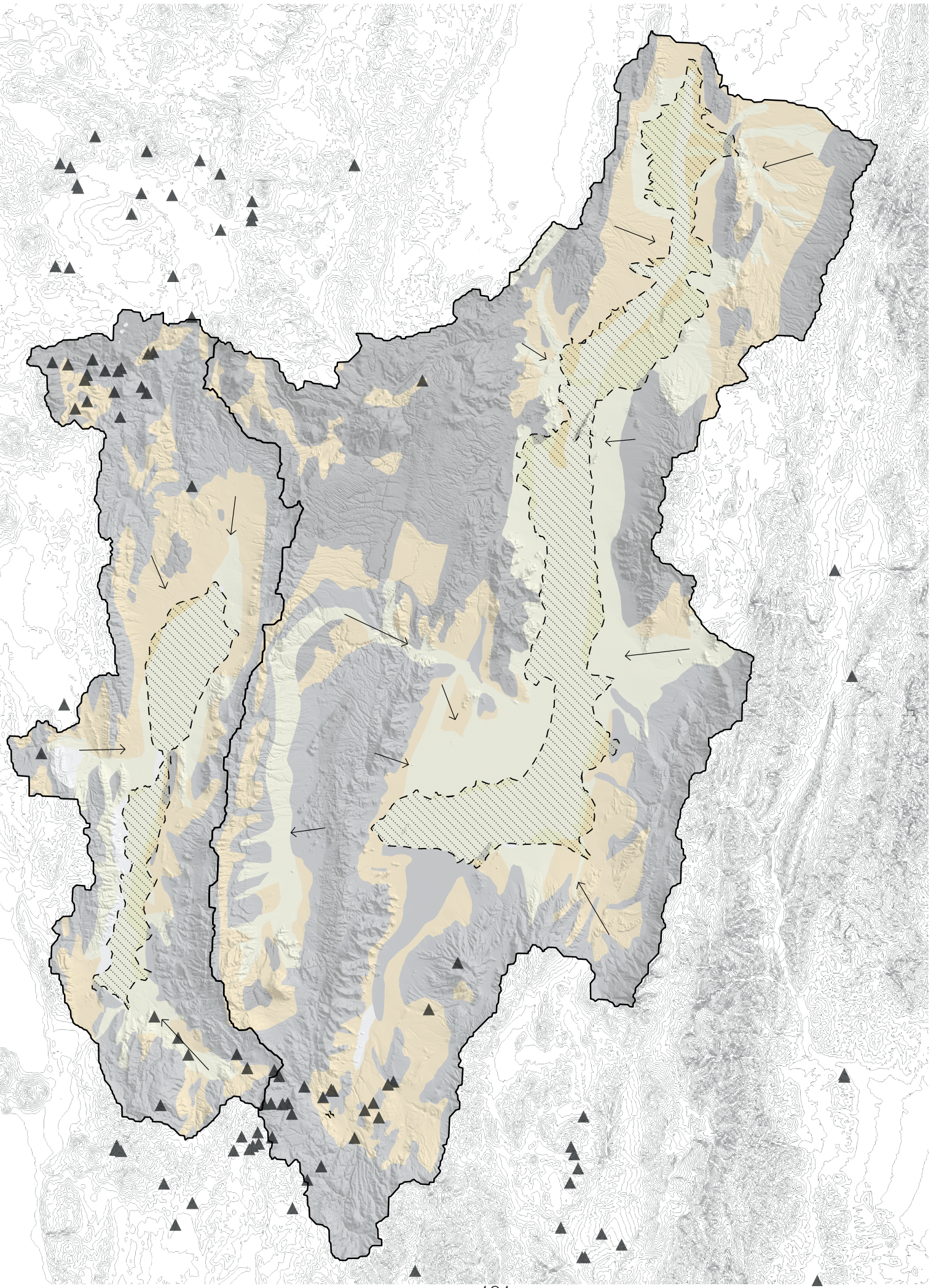
Given the unique features of the basins and salt flats—and the presence of transitional zones, saline areas, and freshwater systems—it was necessary to identify potential transition boundaries. As a reference, I used a study by Houston et al. (2011), which describes the characteristics of immature salars, such as Salinas Grandes, Laguna de Guayatayoc, and Olaroz-Cauchari. These boundaries were delineated using satellite imagery to interpret salinization patterns and were cross-referenced with geomorphological and soil-type layers.

Salares and Salar nucleous were decided contrasting the hidrological map with geomorphology,hydrogeology and wetland probability layers.



1.Geomorphology and geology porosity
Summit- rock <5%
Steep slope-rock <5%
Apical and mid cone-aridisol 25–35%
Plain-inceptisol 35–50%
Topography direction
Volcano
2.Hydrogeology
Transition area
Salar nucleus
Watershed

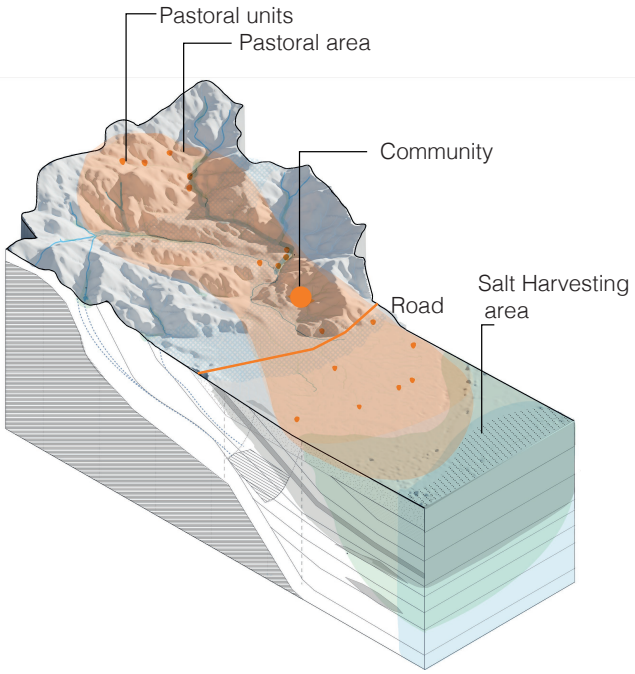
20km N



Analytical mapping-counter mapping Urban

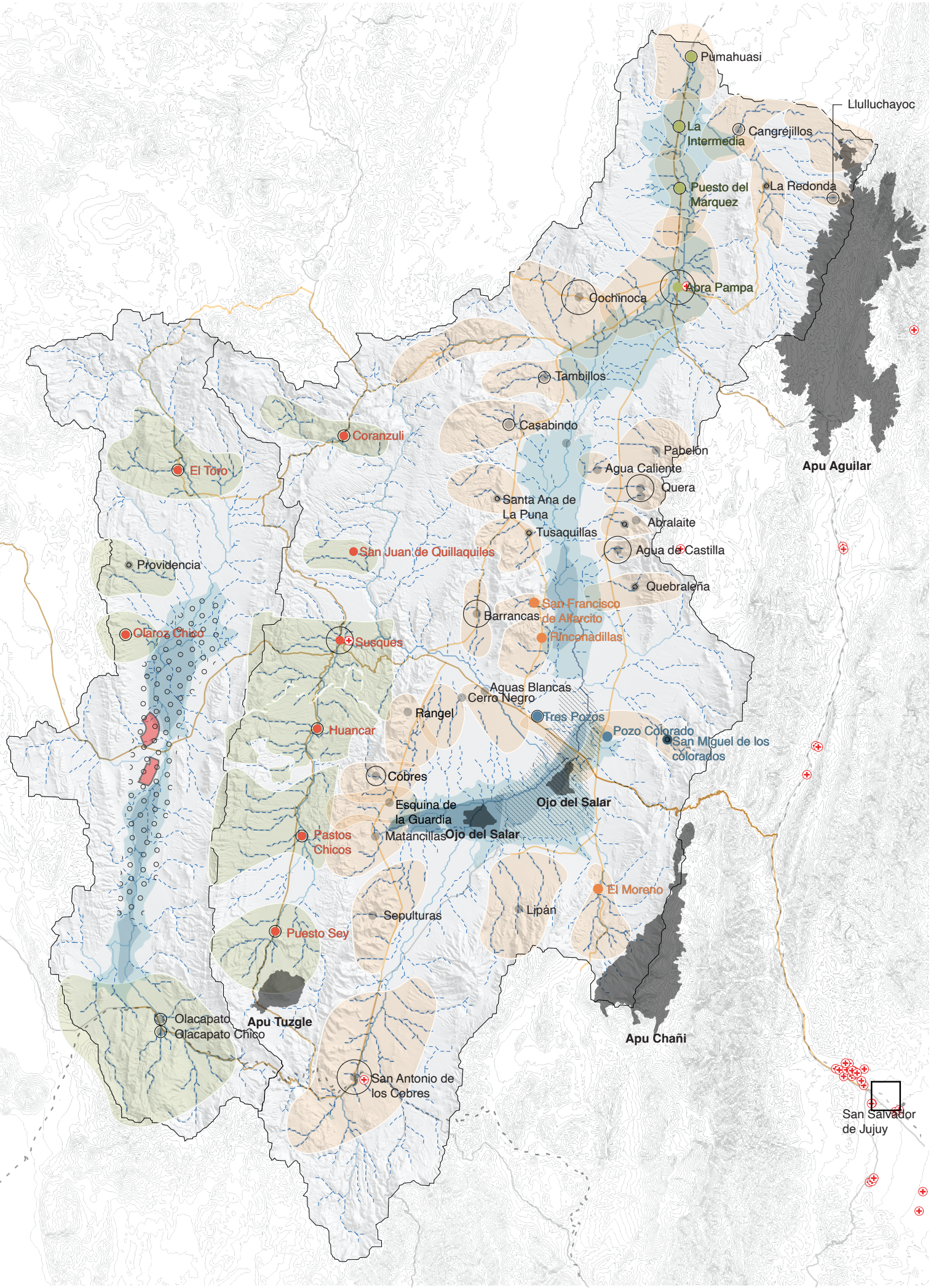
The area is crossed from east to west by National Route 52. Local communities are dispersed throughout the territory, typically located near watercourses, at the base of hills, or along roadsides. Historically, the urban morphology shifted from a scattered arrangement of dwellings clustered around the chapel to a more orthogonal layout with a defined organizing axis. The population ranges from approximately 30 to 400 inhabitants, according to the 2010 national census. During the research, it was found that available information on local communities was fragmented and partial. As a first step, I compiled the geographic points where communities are located using the “Human Settlements of the Argentine Republic” layer from public data provided by the Instituto Geográfico Nacional (IGN). To this base layer, I added population data from the 2010 census. Subsequently, I incorporated communities listed by the Ministry of Indigenous Affairs, including the identification of Indigenous groups (Kolla, Atacama).

Additional communities referenced in the Kachi Yupi document were also included. This information was cross-validated using satellite imagery, site visits, and newspaper reports Regarding basic services, data on schools and health centers was sourced from the Poblaciones.org platform of CONICET, specifically the layers created by Pedicino and De Grande (2022, 2024).
The map’s main contribution lies in documenting the land use practices of local communities, particularly identifying areas used for grazing and agriculture. These zones were mapped through a process of re-mapping and interpretation of pastoral practices, based on the work of Tomasi (2013) and Göbel (2002), supplemented with satellite and hydrological layers.



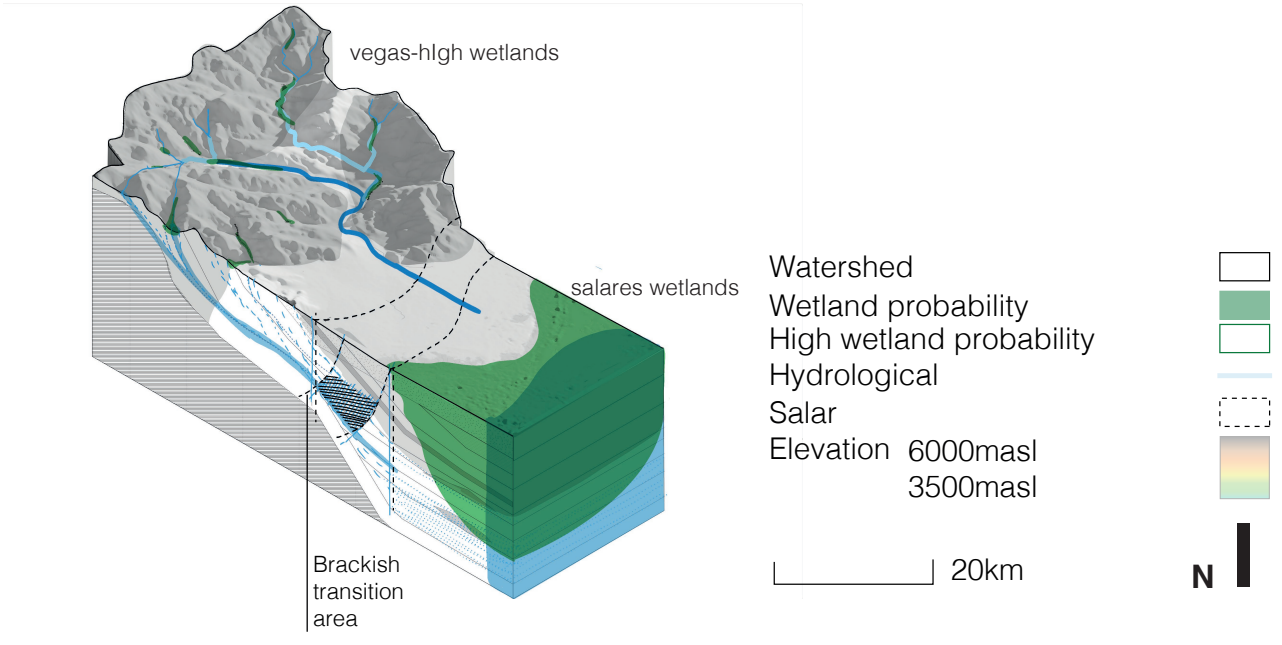
Communitarian Tourism
Agricultural practices
Salt harvesting cooperative
Salt Harvest area
Workers of Lithium mines
Lithium mining area
Lithium mining company
Community
Kolla Communities extension
Atacama Communities extension
Sacred area
Hospital
Registered Ihhabitants
0-100
100-500
500-1000
1000-5000
5000-150000
Road
Disused Railway
Watershed
Water stream
Creeks
Salar
Salar nucleus
San Salvador de Jujuy
Capital City

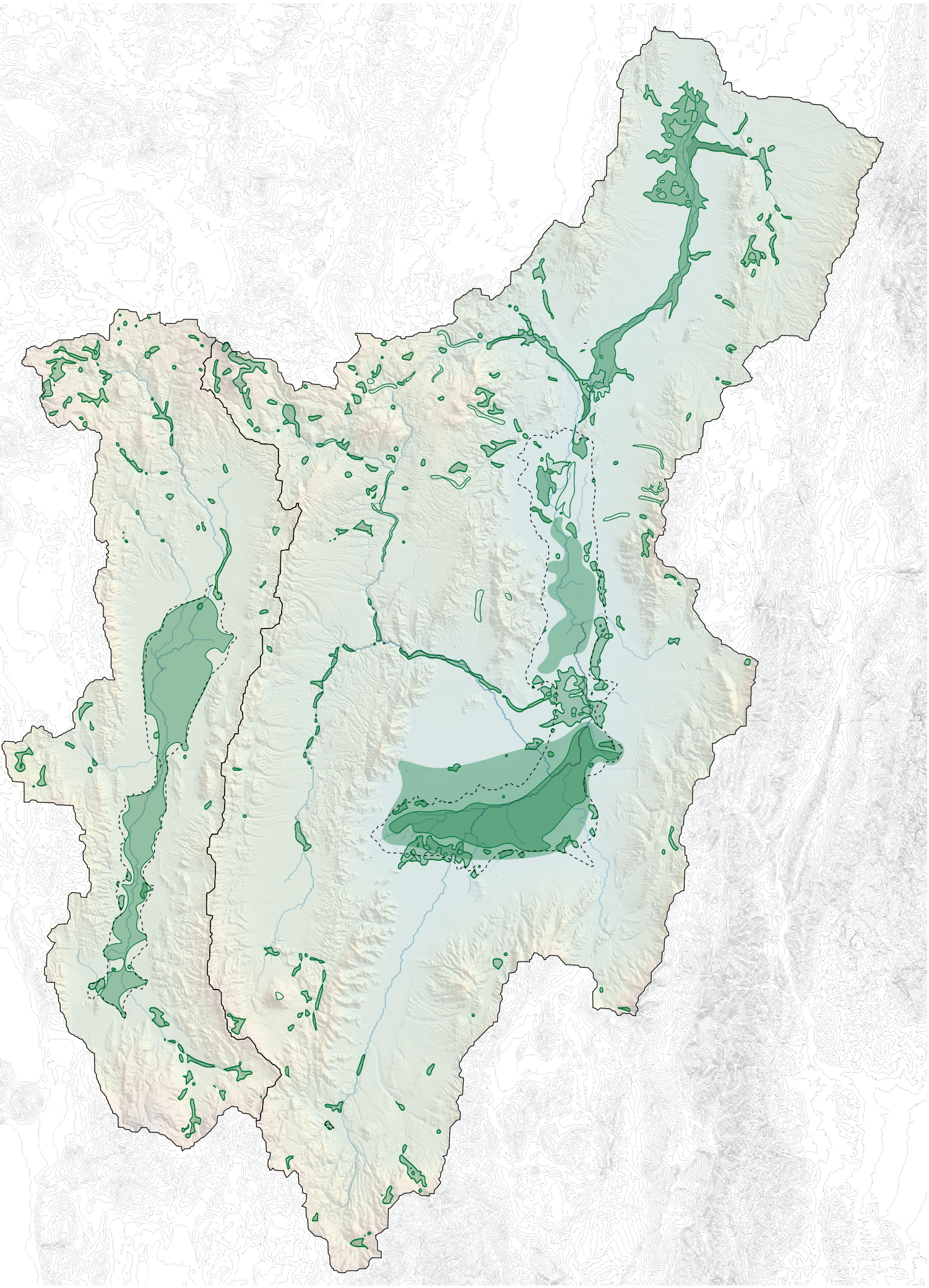
20km


Pumahuasi
Llulluchayoc
La Intermedia
Cangrejillos
Puesto del Marquez
La Redonda
Abra Pampa
Cochinoca
Tambillos
Casabindo
Coranzuli
El Toro
Pabelón
Agua Caliente
Quera
Apu Aguilar
Santa Ana de La Puna
Abralaite
Tusaquillas
Agua de Castilla
San Juan de Quillaquiles
Providencia
Quebraleña
San Francisco de Alfarcito
Barrancas
Rinconadillas
Olaroz Chico
Susques
Aguas Blancas
Cerro Negro
Rangel
Tres Pozos
Pozo Colorado
San Miguel de los colorados
Huancar
Cobres
Esquina de la Guardia
Ojo del Salar
Matancillas
Ojo del Salar
Pastos Chicos
El Moreno
Lipán
Sepulturas
Puesto Sey
Olacapato
Olacapato Chico
Apu Tuzgle
Apu Chañi
San Antonio de los Cobres
San Salvador de Jujuy

Analytical mapping-counter mapping Wetlands

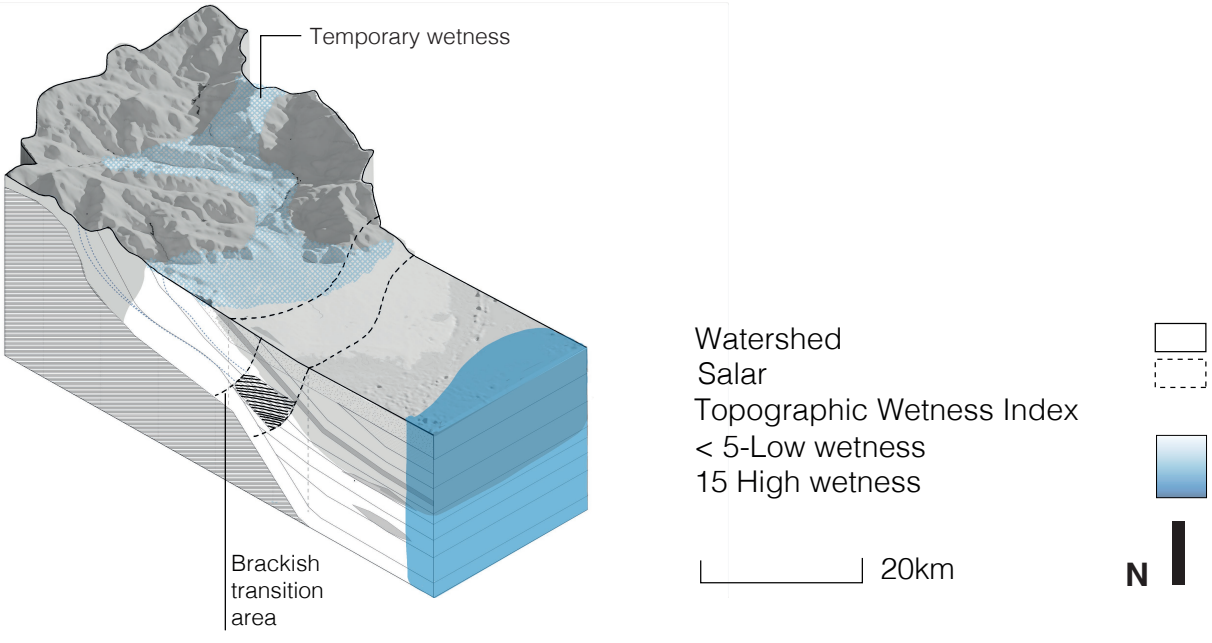
As a base, I used a spatial layer developed by the National Institute of Agricultural Technology (INTA) (Navarro et al. 2022), representing the potential distribution of wetlands in Argentina with a probability range of 70% to 100%. This data was cross-checked and validated using a Topographic Wetness Index (TWI) layer for more detailed, zoomed-in case areas.

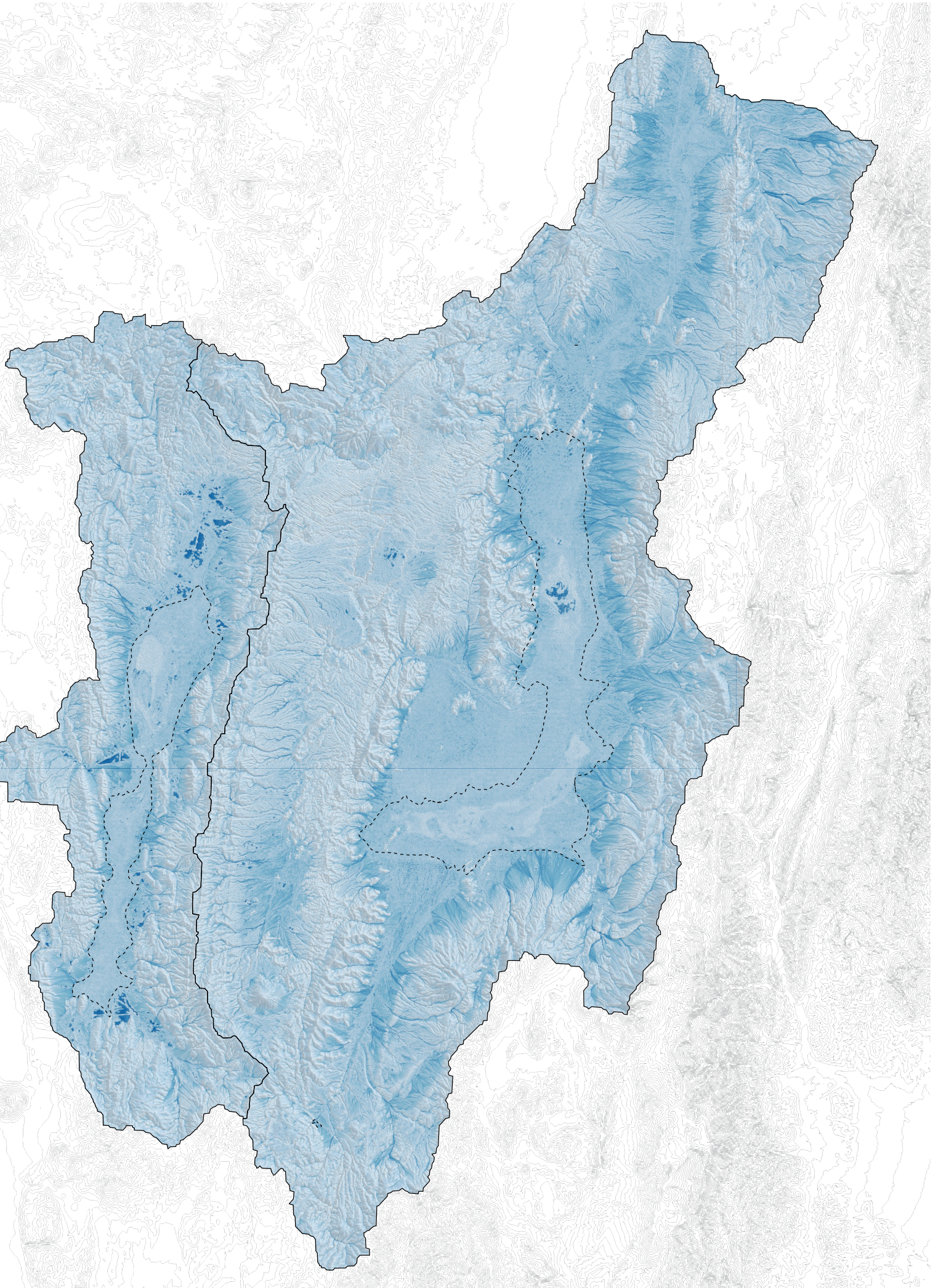




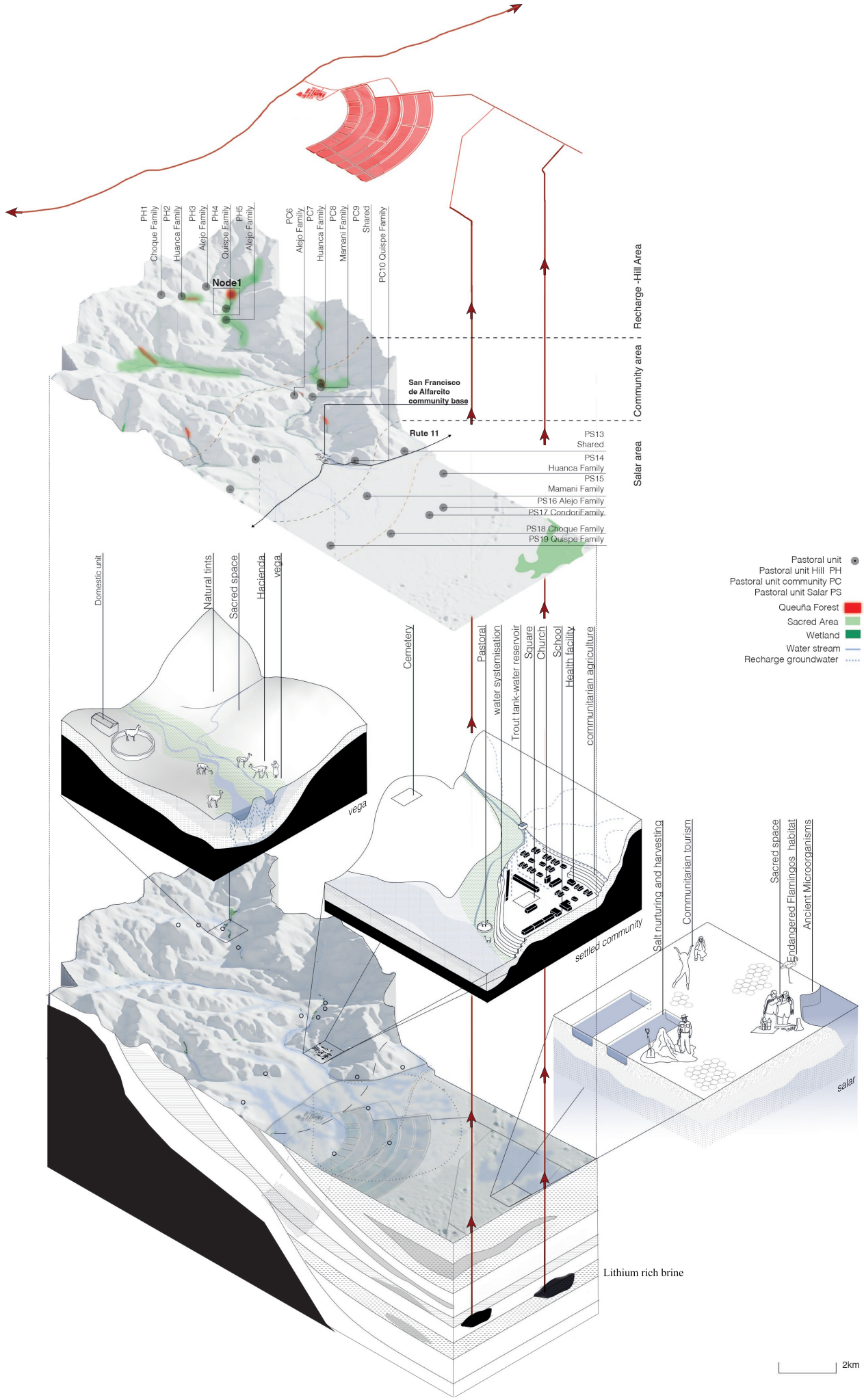
Analytical mapping-counter mapping Topographic Wetness Index

Continuing with the need to understand the water cycle at different scales, and given the detailed analysis of an arid area where evaporation plays a significant role, it was necessary to consider not only the hydrological analysis but also the permanent soil moisture. To achieve this, I developed a Topographic Wetness Index (TWI) using the same SRTM DEM base, processed with SAGA GIS within QGIS.

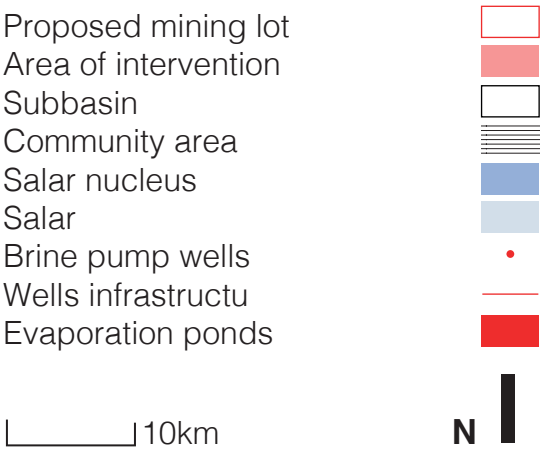


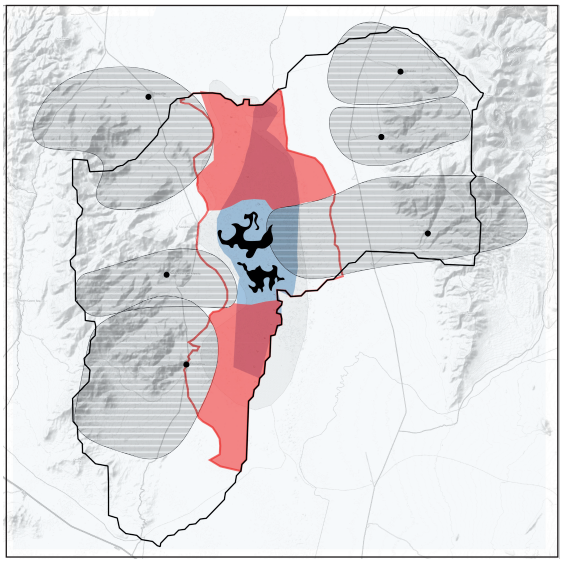


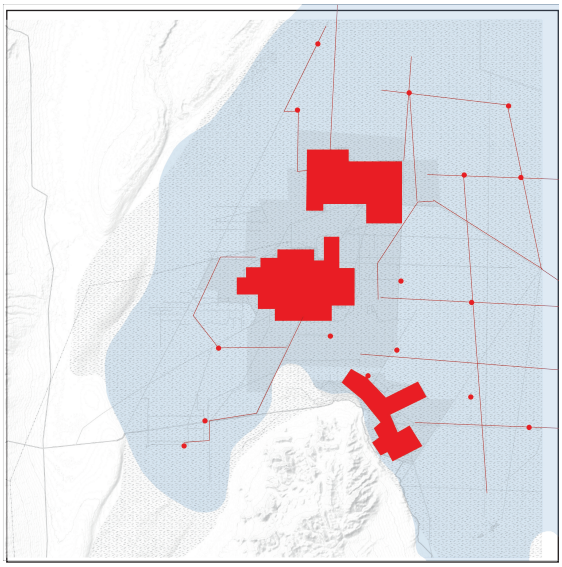
Landing


PH1 Choque Family
PH2 Huanca Family
PH3 Alejo Family
PH4 Quispe Family
PH5 Alejo Family
PC6 Alejo Family
PC7 Huanca Family
PC8 Mamani Family
PC9 Shared
PC10 Quispe Family
Node1
Recharge -Hill Area
Community area
Salar area
San Francisco de Alfarcito community base
Rute 11
PS13 Shared
PS14 Huanca Family
PS15 Mamani Family
PS16 Alejo Family
PS17 CondoriFamily
PS18 Choque Family
PS19 Quispe Family
Pastoral unit
Pastoral unit Hill PH
Pastoral unit community PC
Pastoral unit Salar PS
Queuña Forest
Sacred Area
Wetland
Water stream
Recharge groundwater
Domestic unit
Natural tints
Sacred space
Hacienda
vega
vega
Cemetery
Pastoral
water systemisation
Trout tank-water reservoir
Square
Church
School
Health facility
communitarian agriculture
settled community
Salt nurturing and harvesting
Communitarian tourism
Sacred space
Endangered Flamingos habitat
Ancient Microorganisms
salar
Lithium rich brine
2km

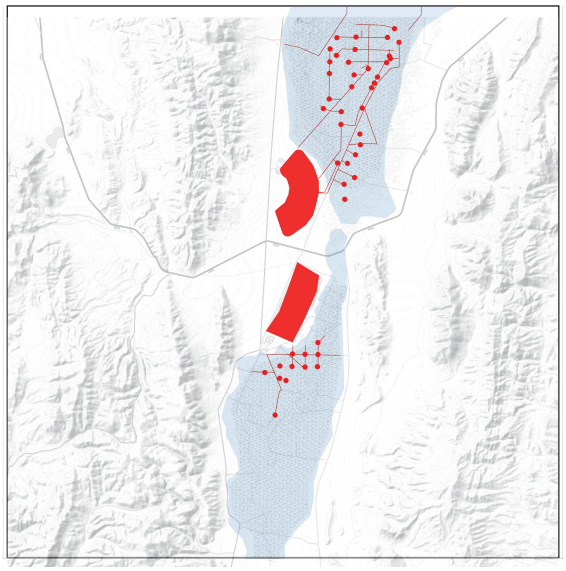
Scale of proposed mining lot in relation with other mining facilities



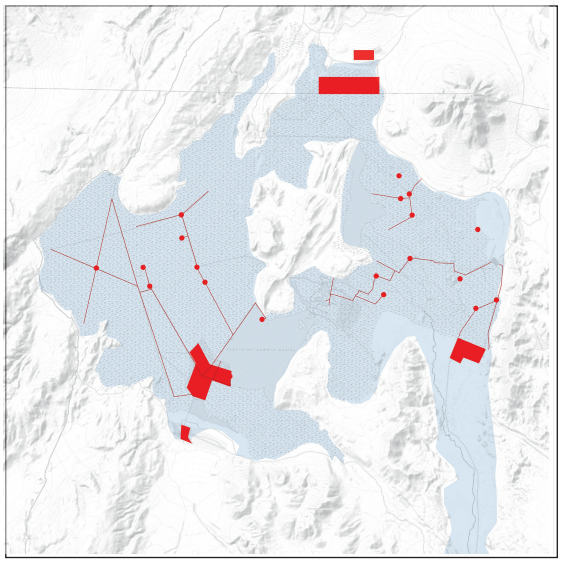




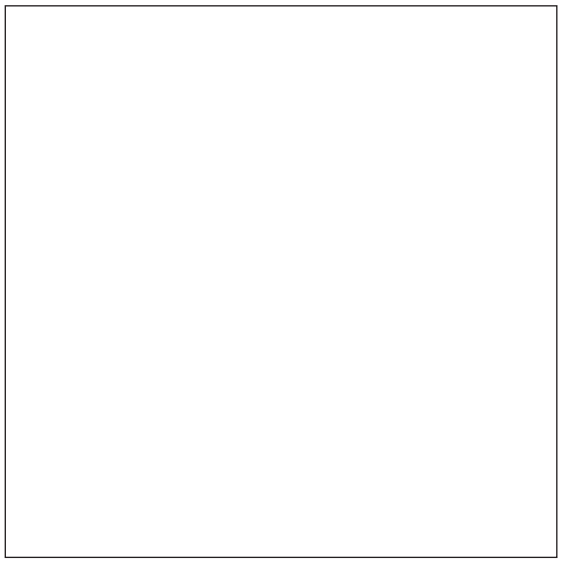
SQM mining in
Salar de Atacama

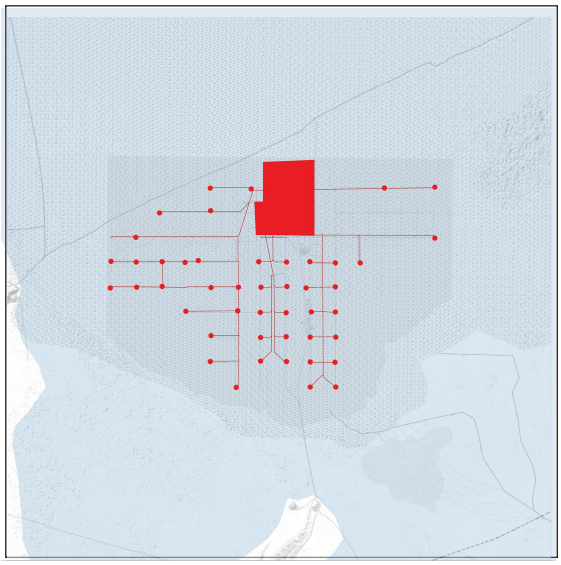


Sales de Jujuy S.A
EXAR S.A
in Olaroz Cauchari



Mining companies
in Salar del Hombre Muerto





Liothium mining
in Salar de Uyuni

