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Governing Data in Modernity/Coloniality: Astronomy Data in the Atacama Desert and the Struggle for Collective Autonomy

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<u>Declaration</u>

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Abstract

In recent years, different actors in Chile have portrayed the vast volumes of astronomy data produced by international observatories in the Atacama Desert as a unique opportunity for scientific and economic development. Research, policy and corporate initiatives have been put into place to leverage this situation. In this thesis I examine the governance of this data by developing a framework based on collective autonomy.

Unlike the paradigms of openness and sovereignty, collective autonomy speaks to long-standing concerns related to social justice in Latin America that took shape in parallel with European colonialism. This framework builds upon decolonial thinking and mobilised groups in the region, situating the analysis in the context of a capitalist modern/colonial world system. Collective autonomy also draws on post-Marxism, foregrounding dissenting voices and examining the changing positionalities of the parties involved. In analytical terms, I approach interviews, field notes and policy documents from a discursive-material perspective sensitive to the role of both meaning and matter.

The empirical chapters explore three different spheres. First, I look at the implementation of data-intensive research and examine how the articulation of a new positionality by local actors favours an obedient stance in knowledge generation. After that, I turn to the economy and trace emerging meanings of development, extractivism and the state as actors make sense of what is going on with astronomy data. Finally, I connect the expansion of data infrastructure in Chile with the long-standing threat to Indigenous worlds cultivating balanced modes of existence in the territory.

As this thesis shows, collective autonomy introduces previously ignored concerns and changes the actors, scales and aims at stake in the governance of data. Furthermore, this framework aims to depart from the precepts of capitalist modernity and, instead, supports decoloniality and the flourishing of multiple worlds.

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<u>Acknowledgements</u>

This thesis has been written under exceptional circumstances. The Covid-19 pandemic, the unprecedented social uprising in Chile and the upsurge of the Black Lives Movement in the United Kingdom are but examples. These events make this section especially relevant since without the unconditional listening and support from my supervisors, colleagues, family and friends I simply would not have managed to keep going.

First of all, I am deeply grateful for the support from my supervisors Alison Powell and Nick Couldry. Many of the ideas I put forward here emerged from rich and generative conversations held with them. Even at the worst moments of the pandemic, they provided me with valuable feedback and were able to contain my anxiety despite them having their own responsibilities. I feel deeply influenced by the way Alison and Nick understand media and communications: as a moving target crucial for constructing a just society. Alison believed in me and this project even before it took its current shape. I feel particularly inspired by Alison's capacity to build supportive communities in which each person's interests and ideas are put to the service of a collective endeavour, an approach I expect to follow in my own academic practice. Nick's support has also been fundamental. His sharp observations allowed me to put into words what I really wanted to express and to develop my own voice. Nick reached out in crucial moments such as the deadly London winter in 2021 and introduced me to researchers and activists that allowed me to conceive this thesis as part of a broader collective effort.

The Department of Media and Communications at the LSE has offered me an intellectual home that pushed me to strive for relevant, rigorous and critical research. I am particularly thankful for the community of supportive people that makes up the department, many of whom have become long-lasting friends. I will miss the enriching and challenging doctoral seminars, the casual encounters in the kitchen and many other situations that ended up becoming part of my everyday life. I am grateful to Lilie Chouliaraki, who provided me valuable and in-depth feedback on early versions of this project. I also appreciate the support of Seeta Peña Gangadharan and Sonia Livingstone and the conversations we had on the joys and perils of British academia. César Jiménez-Martínez, João Carlos Magalhães, George Maier and Svetlana Smirnova have been excellent colleagues and mentors who heard my fears and concerns in the first years of the PhD. Zoë Glatt, Kat Higgins, Ludmila Lupinacci and Rodrigo Muñoz-González are not only colleagues but also true friends, comrades and even family. You are present in the best memories I hold of these crucial years of my life. I feel your achievements and defeats as if they were my own, and I am sure that you also feel the same. I would also like to express thanks

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Abbreviations

The following table contains the abbreviations and acronyms that are mentioned in this thesis on more than one occasion.

AI	Artificial Intelligence
ALeRCE	Automatic Learning for the Rapid Classification of Events
ALMA	Atacama Large Millimiter/submillimeter Array
ANT	Actor-Network Theory
ARC	ALMA Regional Centre
AWS	Amazon Web Services
CASSACA	Chinese Academy of Sciences South America Center for Astronomy
Chi2AD	China-Chile Astronomical Data Center
ChiVO	Chilean Virtual Observatory
CONICYT	Commission for Scientific and Technological Research
CORFO	Chilean Economic Development Agency
CYBERSYN	Cybernetic Synergy
DMA	Discursive-Material Analysis
DO	Data Observatory
DT	Discourse Theory
LSST	Legacy Survey of Space and Time
R&D	Research and Development
STS	Science and Technology Studies
Sysadmin	System Administrator
UAI	Adolfo Ibáñez University
UTFSM	Santa María Technical University

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1. Introduction

> It is clear that the stars that look at us in the South are different
>
> from those that look at the people who live in the North.
>
> To look at the night light of the South is a unique experience,
>
> a learning now difficult to put into practice in the city
>
> thanks to the urban glare.
>
> Silvia Rivera Cusicanqui (2018, p. 90)

A new imaginary of the Atacama Desert in the north of Chile has been emerging over the last decade. Besides its reputation as the driest non-polar region and the largest provider of copper, this area is now becoming known as one of the most significant sources of digital data worldwide. As a consultancy firm estimated in 2017, the international astronomical observatories constructed and under construction in this location are expected to produce 16.5 Petabytes (PB)[1] per year by 2021, a magnitude comparable to that of social media platforms (as cited by Ministry of the Economy, 2019b). At present, scientists, engineers, policy makers and members of the private sector in Chile are thinking big about the opportunities afforded by this situation, mobilising resources, envisioning policies and putting into place research initiatives to leverage such vast volumes of data for national scientific and economic progress. In their view, astronomy data can transform the country into 'the Silicon Valley of data science' (Ibsen & Cossio, 2017, 32:50). Just like the area on the West Coast of the United States, Chile could become a privileged global node of innovation by excelling in the emerging form of expertise focused on the management and processing of data. Furthermore, actors expect that the data produced in the Atacama Desert will ignite technological development in different regions of the country. One of the ideas circulating in scientific and corporate circles is to construct farms of data centres in Patagonia, the southern cape of the continent, where the observatories could store their data in an energy-efficient way thanks to this area's cold temperatures. In short, as the CEO of a local technology company expressed it to me, for Chile astronomy has come to represent 'the goose that lays the golden eggs', with the golden eggs being, of course, the data produced by the international observatories.

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[1] A PB equals approximately 1,000,000 Gigabytes (GB).

But the dominating optimism in Chile with regards to astronomy data did not come out of the blue. The way local actors have been thinking about it resonates with widespread claims about the potential benefits brought about by 'datafication', i.e., the increasing transformation of phenomena into digital data (Mayer-Schönberger & Cukier, 2013, p. 78).[2] As pundits, magazines and international organisations have argued, the capacity to identify previously hidden patterns and develop predictive models permitted by the processing of vast volumes of data can increase the efficiency and productivity of organisations operating in a broad range of spheres. Not only this: in 2017 the British magazine *The Economist* asserted that data had become 'the new oil', a metaphor that transformed it into a key economic resource (*Economist*, 2017). But the advantages of datafication go beyond the economy, as illustrated by the United Nations' expectation that this phenomenon will help advance climate action and the protection of human rights, among other Sustainable Development Goals (United Nations, 2020, p. 9). Furthermore, such promises are not restricted exclusively to so-called developed countries. In theory, everyone everywhere can take advantage of the benefits of datafication, or at least this is how the notion of 'data-driven development', formulated by the World Economic Forum (2015), conceives of it. Certainly, 'deficits' in terms of access, control and capabilities might keep the Global South from leveraging the unique opportunities afforded by the abundance of data, but the introduction of measures such as public-private partnerships are expected to set countries on the right course for thriving in this new context.

In contrast to the enthusiasm shown by different groups in Chile, many critical intellectuals and mobilised groups in Latin America would prefer to approach the bold claims surrounding datafication with caution, to say the least. In their view, since the invasion of the Spanish and Portuguese empires in the fifteenth century, this region has been subject to the imposition, and in some cases later internalisation, of seductive discourses promising the capacity to catch up with the most advanced societies of the world. The Christian salvation and the civilizational mission are two historical examples, but, without a doubt, 'development' constitutes the most appealing narrative nowadays, managing to endure seven decades after its original formulation by the United States government (Escobar, 1995). This experience has inspired a profound critique from scholars interested in the region. For them, the lack of critical reflection in the adoption of templates of progress developed elsewhere, in some cases with tragic

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[2] Recent work has tended to approach datafication in relation to personal data, but here I follow earlier proponents that had a broader understanding in mind and included scientific data (Mayer-Schönberger & Cukier, 2013).

consequences such as genocides and the erosion of the Earth, connects directly with the world order that emerged with European colonialism more than five centuries ago.

In this thesis I build upon decolonial thinking emerging from Latin America to identify connections between discussions on how to govern vast volumes of data and long-standing planetary and domestic power dynamics. To do so, I turn to 'autonomy', a concept with few rivals when it comes to encapsulating the trajectory and current situation of struggle in Latin America. Emerging over the last three decades among Indigenous communities—from the Zapatistas in the north to the Mapuche in the south—and non-Indigenous social movements, autonomy rejects the imposition and uncritical adoption of designs developed on the basis of other contexts. In its search for alternatives, autonomy strives for sustaining ways of thinking and doing that do not rely on the accumulation of resources by a few, gender violence, racialised forms of classification or the transformation of land into an economic asset. In the formulation by Colombian anthropologist Arturo Escobar (2018), and as I explain extensively in chapter two, autonomy emerges as a response to the harms brought about by 'coloniality'. Coloniality is another key concept in the region, used to designate the power structure that outlived historical colonialism (Quijano, 2007). Autonomy, thus, is a way of challenging a world order that took form five centuries ago and that still shapes who produces what, who is entitled to generate legitimate knowledge and whose ecosystems can be sacrificed for sustaining ways of living elsewhere. Thinking of the case of astronomy data in Chile, in this thesis I ask to what extent can autonomy help approach discussions regarding the governance of data in a way that acknowledges datafication's entanglement with coloniality. Additionally, I also wonder whether autonomy can provide an alternative to the dominant paradigms of openness and sovereignty, and to speak to the needs and visions in Latin America rather than those of the United States and China, the two role models in the field (*Economist*, 2018). A challenge for this aim is that to a considerable extent autonomy has been formulated on the basis of territorial-based communities, which is why here I also draw on post-Marxist political theory, calling the resulting approach 'collective autonomy'.

My proposal for bringing to bear autonomy grows out of the observation made by scholars and activists from both the North and the South that, despite the narratives of disruption and innovation that usually accompany datafication, its deployment relies to a great extent on colonial dynamics and asymmetries. As Nick Couldry and Ulises Mejias (2019) argue, datafication is giving rise to 'data colonialism', a social order based on the appropriation of the life of individuals in a way that resembles what historical colonialism did with faraway lands, their resources and the populations inhabiting them. Building upon Couldry and Mejias, Paola

Ricaurte (2019) affirms that this social order does not only rely on the appropriation of personal data since, for example, records of natural phenomena can also become valuable commodities in and of themselves. Inspired by Latin American critical thinking, these authors affirm that data colonialism also encompasses a rationality 'compelling us to believe there is no other way to imagine the world unfolding and becoming known to us' (Couldry & Mejias, 2019, p. 203), a view that 'leads to the expulsion of human beings from the social order, denies the existence of alternative worlds and epistemologies, and threatens life on Earth' (Ricaurte, 2019, p. 351). In the next chapter I delve into the arguments mobilised by data colonialism authors, but suffice to say for now that their insights suggest that there are grounds for thinking that the possibilities and constraints faced by actors seeking to take advantage of astronomy data in Chile respond to power dynamics that have constituted long-standing concerns in Latin America. The notion of collective autonomy I am proposing precisely seeks to illuminate how these dynamics play out in practice.

1.1. Context: Chile and the Latin American Trajectory

As I suggested earlier, this thesis interrogates the debate over data governance from the perspective of the Latin American trajectory. The fact that the notion of coloniality emerged in relation to this region is not a coincidence. The choice of the term 'discovery', usually employed to name the arrival of Christopher Columbus in the fifteenth century, is telling of the position that the European invaders attributed to the Americas in the geopolitical imaginary: one in which the experience of the peoples inhabiting these lands did not count. The very use of the terms 'America' and 'Latin America' speaks to this hierarchy since this is not how inhabitants referred to this region before 1492. For this reason, at the moment some Indigenous groups are privileging the name 'Abya Yala', which stands for 'land in full maturity' in the language of the Kuna-Tule people (Muyolema, 2001). Along these lines, the widespread imaginary of Latin America as 'a vast territory and a resource of cheap labor, full (sic) natural resources, exotic tourism, and fantastic Caribbean beaches waiting to be visited, invested in, and exploited' (Mignolo, 2005, p. 96) represents a form of coloniality as well since it renders invisible the knowledges and ways of living present in the region.

For some, Chile might not be the best choice for making claims about Latin America. Chilean themselves have tended to emphasise their exceptionalism with respect to other countries of the region (Larraín, 2001, p. 162). Many Chileans consider that, in contrast to some of their neighbours, they hold predominantly European traits, an assertion that ignores the historical and current role of Indigenous and Afrodescendant groups. When it comes to geography, the relative

isolation of the country—with the Pacific Sea on the west and the Andean mountains on the east—and its relative cold weather are usually mentioned as distinctive attributes. This exceptionalist narrative was exacerbated in the nineties in light of the country's growing reputation as an economically dynamic and politically stable one. In the wake of Augusto Pinochet's dictatorship (1973-1990), democratic governments registered growth rates of almost 7% for a decade and reduced the poverty rate to 3.7%[3] (World Bank, n.d.). Furthermore, in 2020 Chile ranked first in the region in the UN's Human Development Index, and just above Croatia globally (United Nations Development Programme, 2020). I myself grew up in a post-dictatorship Chile, constantly hearing remarks emphasising Chile's historic and current detachment from the critical political and economic situation of other Latin American countries. From this angle, Chile would represent an exception rather than the rule in the region.

Despite the above, further examination indicates that the Chilean trajectory echoes many of the patterns that have marked Latin America. In economic terms, the positive figures do not rest on industrialisation but rather on economic growth based on the export of natural resources (Observatory of Economic Policies, 2020). Such an 'extractivist' pattern has persisted since the independence of the country (1818) despite efforts by many governments in the twentieth century to transform the state into a promoter of industrialisation. For example, in the seventies Salvador Allende's democratic socialist government introduced radical reforms in order to assert economic sovereignty, including the nationalisation of strategic industries such as copper mining from foreign capital. The practical challenges spurred by this shift led to the design of CYBERSYN (Cybernetic Synergy), an innovative networked computing system aimed at enabling a decentralised management of state industrial production (Medina, 2011). Nevertheless, the state-led push for industrialisation was drastically put to an end in 1973. Supported by US intelligence and corporations, Augusto Pinochet's *coup-d'etat* gave way to a violent civic-military dictatorship that lasted for 17 years. This regime hired a group of economists, known as the 'Chicago Boys' due to their training at the University of Chicago, that transformed Chile into 'a brutal neoliberal experiment carried out in the periphery' (Harvey, 2005, p. 9). Radical market reforms were imposed with the purpose of 'freeing' the economy, favouring an export-led type of growth that ushered in deindustrialisation (Ffrench-davis, 2016). Despite some adjustments, the democratic governments from 1990 onwards kept in place Pinochet's *laissez faire* approach to international trade. As of today, copper represents 42% of net exports, almost half of which leaves Chile with little or no processing (Observatory of Economic Policies, 2020). Importantly,

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[3] Measured as incomes of less than US$5,5 per day.

the extractivist character of Chile's economy is tightly linked to environmental damage. There are 95 socio-environmental conflicts in active or latent status in the country, a third of which affect Indigenous territories (National Institute of Human Rights, 2018).

Besides extractivism, another shared pattern between Chile and Latin America has been the historical subordination of the Indigenous population to the visions and interests of the mestizo—a mix between European and Indigenous—population. Before the Spanish invasion, almost five centuries ago, a rich set of worldviews inhabited the Chilean territory, including, but not limited to, the Aymara in the Andes, the Mapuche in the centre and the south, and the Kawéskar in Patagonia (Bengoa, 2004). From the colonial period onwards, these groups have been subject to military actions and economic dispossession, even though, thanks to their resistance, their ways of thinking and doing have endured to this day. A particularly tragic period took place between the end of the nineteenth and the early twentieth centuries, when the expansion of the Chilean state to new territories led to the extermination of entire communities (Bengoa, 2004, p. 22). In 1881, the Chilean army took over the Wallmapu, the area inhabited by the Mapuche people in the south of Chile that the Spanish empire never managed to cross. Particularly relevant for this thesis are the Lickan Antay communities inhabiting the Atacama Desert since they have had two territorial conflicts with an astronomical observatory. Throughout the twentieth century, the state carried out a process of 'Chilenisation' that implied the disappearance of some Lickan Antay cultural patterns such as their Kunza language (Bengoa, 2004, p. 22). Despite this, the Lickan Antay communities have seen a resurgence of their identity over the last three decades. This process has allowed them to engage in struggles such as the one they are currently holding against the water-intensive form of lithium extraction (Gundermann & Göbel, 2018).

More recently, Chile's alleged exceptionalism has been publicly questioned in the context of the unprecedented social uprising that took place in 2019. On 8 October neoliberal billionaire president Sebastián Piñera affirmed that Chile was a 'true oasis' with a stable democracy and a growing economy in the middle of a 'convulsed Latin America' (Baeza, 2019). Ten days later, his words resurfaced in the media as millions of people took to the streets across the country to denounce long-standing inequalities and a governing elite disconnected from the reality of ordinary citizens (Contardo, 2020). Since then, many of us who participated in student and other types of protests since the return to democracy have seen a previously marginalised critical narrative gaining prominence in the public sphere. Under this new light, rather than an oasis, the history and current situation of Chile does not differ so much from that of its Latin American neighbours; this narrative depicts a country incapable of ensuring the well-being of the people

and of putting a stop to a centuries-old history of racial, gender and sexual discrimination and environmental harm. On a more optimistic note, many people expect that the constituent process triggered by this social uprising will make it possible to construct a more equal, inclusive and democratic country (Cociña et al., 2021).

In contrast to attempts to present Chile as an exception on the continent, its current configuration echoes many of the patterns that have marked the Latin American trajectory. The endurance of extractivism and the violence against Indigenous peoples are two examples, but other aspects such as environmental damage and gender violence also speak to the type of dynamics that have inspired the emergence and circulation of the notion of autonomy in the region. Whether there is any connection between the case of astronomy data and these dynamics, and the extent to which autonomy can help identify such intersections, constitute central questions in this thesis.

1.2. Case Study: The 'Data Tsunami' in the Atacama Desert

The case of astronomy data in Chile is unusual; few other countries host such a sophisticated machinery producing what has been termed a 'data tsunami' (Barba et al., 2008, p. 24)[4]. But despite its singularities, this case provides a unique vantage point for the study of datafication since it encapsulates in a single setting important patterns underpinning this phenomenon. First, this case brings together many of the actors involved in the expansion of datafication. International scientific organisations, technology companies, research teams, policy makers, activists and Indigenous communities have sought to participate in or have been drawn to the discussion. Second, the gaps between researchers based in Chile and their colleagues from the Global North speak to the planetary inequalities in terms of access and skills underpinning datafication and that to a large extent overlap with the ones that emerged with European colonialism (Couldry & Mejias, 2019, p. 103). From a broader perspective, however, there is much more going on beyond simplistic narratives that formulate the problem in terms of 'gaps' between so-called 'data-poor' and 'data-rich' groups (e.g., World Economic Forum, 2015, p. 8). Instead, the case of astronomy data in Chile reveals that multiple and entangled power dynamics are at play, as becomes evident when attending to, for example, the conflicts between the state

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[4] Other regions hosting mega observatories are South Africa, Spain and Hawaii. When it comes to other scientific disciplines, the particles accelerators Large Hadron Collider (LHC) on the Franco-Swiss border and the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) in Jordan also produce vast amounts of data.

and the Lickan Antay Indigenous communities affected by the construction of an observatory. As this example shows, the complex set of planetary and domestic hierarchies shaping the implementation of datafication cannot be reduced to ready-made categories. For this reason, the case of astronomy data in Chile can shed light on the complex dynamics underpinning datafication.

In historical terms, the relationship between local actors and the international observatories are not free from coloniality. As someone from Santiago who did not know any astronomers, before undertaking this study it did not occur to me to wonder about potential power dynamics taking place in this field. However, as Javiera Barandiarán (2015) shows, international hierarchies criss-cross the history of astronomy in Chile. In the early 1960s, the Chilean state put a series of incentives on the table to attract the construction of foreign astronomical observatories.[5] Besides the outstanding conditions for observation afforded by the Atacama Desert,[6] since then scientific organisations have enjoyed diplomatic immunity as well as tax, labour and environmental exemptions. Initially, the agreements with the observatories did not include any tangible benefit for local actors. However, the situation started to change in 1968, when the US Association of Universities for Research in Astronomy (AURA) granted the University of Chile 10% of the assignable viewing time in its observatories. Three decades later, in 1997, the state renegotiated its agreements with the European Southern Observatory (ESO), expanding the 10% of observation time to all the mega observatories in the country,[7] albeit requiring half of such observations to be carried out in collaboration with ESO members. Currently, foreign scientific organisations also provide funds for local research and in some cases for local communities. As a result of these policies, at the moment Chile hosts around 70% of the world's terrestrial observational infrastructure, with 19 observatories operating and under construction in the country by predominantly United States and European organisations, but also from other countries such as Japan and Canada (Guridi et al., 2020, p. 6).

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[5] In strict terms, the history of international observatories in Chile began with the construction of the US Naval Observatory in the mid-nineteenth century (Silva, 2020). However, it was only in the sixties that the Chilean state adopted a more proactive attitude towards the matter.

[6] According to Guridi et al. (2020, p. 1), five conditions transform the Atacama Desert into a privileged site for astronomical observations: (1) its dryness, (2) the lack of urban and radio pollution, (3) the thin air present in high altitude, (4) the reduced number of clouds and (5) the lack of atmospheric turbulences.

[7] This number corresponds to 15% in the case of Hawaii and 20% in the case of Spain (Barandiarán, 2015, p. 153).

Besides the difficulty of negotiating equally beneficial agreements, other aspects of the presence of the international observatories in Chile also speak to North-South asymmetries. Since the sixties, the state has donated 1,720 square kilometres to European and US organisations (Barandiarán, 2015, p. 154), with such transfers involving Indigenous ancestral territories and lands under the control of a local university. In addition to this, the costly investment by foreign scientific organisations and the tax exemptions enjoyed by the observatories appear as problematic when considering that some of the surrounding communities still have basic unmet needs. For example, while ESO's Paranal has a swimming pool with tropical plants sustained through a humidity system (ESO, 2002), around 42% of the rural population in the same Antofagasta region does not have regular access to water (National Institute of Statistics, 2017). Last but not least, and as Patricio Guzmán's documentary *Nostalgia for the Light* shows, the sophisticated questions and technologies underpinning the mega observatories contrast with enduring efforts by relatives of victims of human rights violations to find the bodies of victims who were disappeared in the Atacama Desert during Pinochet's dictatorship.

Two astronomical mega observatories are particularly relevant in this thesis. One of them is the Atacama Large Millimeter/submillimeter Array (ALMA), which is located in the Antofagasta Region, in the core of the desert. Inaugurated in 2013, ALMA is made up of 66 radio antennas and is under the control of a consortium with representatives from North America, Europe and East Asia (ALMA, n.d.-b). This observatory is one of the most famous in Chile and has a solid record of collaborations with local researchers on aspects such as self-maintenance systems and, certainly, astronomy data. During my fieldwork I was based in the offices of the Chilean Virtual Observatory (ChiVO), a local initiative working on the standardisation and archiving of ALMA data. Even so, ALMA's history of collaborations contrasts with two conflicts that it has had with the Lickan Antay Indigenous groups living close to its operations site. These conflicts arose in relation to the concession of lands by the state (2002) and the expansion of ALMA's gas pipelines (2016). Another relevant actor in this thesis is the Vera C. Rubin Observatory, which hosts the Legacy Survey of Space and Time (LSST). The LSST is mainly funded by public and private sources from the United States—including contributions by technology businessmen Charles Simonyi and Bill Gates (LSST, 2008)—and is currently under construction in the Coquimbo Region, on the southern skirts of the desert. The LSST is expected to produce 20 Terabytes (TB)[8] of raw data per night, some of which will be shared in an almost real-time stream of approximately 10 million alerts (Gnida, 2019). For this reason, this

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[8] A TB equals 1,000 Gigabytes (GBs).

observatory has been frequently associated with 'big data',[9] being mentioned as an example of datafication in the book that coined the term (Mayer-Schönberger & Cukier, 2013, p. 7). The LSST has drawn the attention of local researchers interested in processing such amounts of data. For example, the Automatic Learning for the Rapid Classification of Events (ALeRCE) team is seeking to become one of the LSST's community brokers.[10]

The excitement over the opportunities afforded by astronomy data in Chile connects with older concerns held by scientists and policy makers in relation to the benefits brought about by the construction of the observatories. Certainly, there is a shared optimism regarding the impact of the observatories on local research. Over the last decades, the Chilean astronomy community has gained international prestige, increased the productivity and impact of its research (Cortes et al., 2018), and grown from 39 academics in 2005 to 163 in 2019 (Chilean Astronomy Society, 2019). However, more contested is the assessment of the benefits of astronomy outside research, especially when it comes to industrial development. Even though astronomy has been heralded as a driver of development in the Global South (Office of Astronomy for Development, n.d.), so far local actors have not managed to participate in the stages of design and construction of the observatories, making it difficult to ensure skill and technology transfer to local industry (Barandiarán, 2015).[11] Against this backdrop, some actors consider that the vast volumes of data produced by the observatories in Chile can turn the tide. In particular, it is considered that investing in data science can strengthen local companies due to the general-purpose character of this form of expertise. The Data Observatory (DO) public-private partnership launched in 2019 with participation from the Ministries of the Economy and Science, Amazon Web Services (AWS)[12] and Adolfo Ibáñez University (UAI) aims at materialising these ideas, aspiring to generate 'a new pole of development in data science' (Ministry of the Economy, 2019a, para. 1).

The fact that the type of data at stake concerns observations of the sky can be particularly enlightening for studies on datafication in at least two ways. First, because astronomy data is one

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[9] The term 'big data' gained popularity around 2012 and encapsulates a broad range of claims regarding the opportunities afforded by the increasing volume, velocity and variety of data (boyd & Crawford, 2012).

[10] Community brokers 'ingest, process, and serve astronomical alerts from Rubin Observatory and other surveys to the broader scientific community' (LSST, n.d., para. 1).

[11] There have been exceptions to this, as is the case of the development of Band 1 receivers for ALMA by the Department of Astronomy at the University of Chile (ADDERE, 2012).

[12] AWS is the world's biggest provider of cloud infrastructure (Synergy Research Group, 2021). Cloud infrastructure points to 'a system for producing, storing, analyzing, and distributing data, information, applications, and services [that] enables on-demand self-service access to information and services delivered over global networks' (Mosco, 2014, p. 6).

of the driving forces behind the growth and development of the logistics that, following Couldry and Mejias (2019, p. 39), provide the conditions of possibility for data colonialism. A study shows that astronomy is between five and ten years ahead of the industry when it comes to data-related developments in aspects such as processing and visualisation (as cited by DO, n.d., para. 17). Furthermore, the vast amounts of data produced by the observatories make this discipline a spearhead in the growth and expansion of data infrastructure, pushing the construction and improvement of components such as fibre optic cables and data centres in different latitudes of the planet. In this way, and just as many of the assumptions and the architecture of the internet took shape in a scientific context, examining astronomy provides a glimpse into dynamics that might become mainstream in the future. In addition to the logistic dimension, looking at astronomy and not personal data raises critical questions regarding who has the capacity to make claims about the value of datasets. According to Mayer-Schönberger and Cukier, 'in the age of big data, *all* data will be regarded as valuable, in and of itself' (2013, p. 100, emphasis in the original). As I describe in chapter four, one of the biggest challenges for local actors has been to figure out whether such a statement applies to astronomy data, a scientific resource that experts have regarded as 'worthless' (McCray, 2017, p. 244). For these reasons, looking at astronomy data might illuminate concerns associated with datafication that have been overshadowed by the emphasis on the prediction and control of human behaviour afforded by personal data.

1.3. Intervention: Advancing Decoloniality

The type of intervention pursued in this research is well captured in this chapter's epigraph by Aymara/Bolivian thinker Silvia Rivera Cusicanqui. In it, the different skies that are possible to observe from the Southern and the Northern hemispheres, which are among the factors that have attracted scientific organisations to Chile, operate as a metaphor for epistemological contours, suggesting that things look different in the South. The latter is not because people living in the South have special powers but because it is from this location that it is possible to see coloniality with more clarity (Mignolo, 2007a, p. 495). From this standpoint, the destruction of Indigenous worlds and the erosion of the Earth do not look like mere temporal accidents but rather as part and parcel of the project of modernity. It is important to note that Rivera Cusicanqui's metaphor works in geographical terms since it attends to the North-South distinction that emerged after the Cold War; but it is also possible to think of it in terms of different 'Souths' made up by the multiple forms of hierarchisation brought about by modernity that are also at work in the North (Milan & Treré, 2019). This thesis takes up Rivera Cusicanqui's

call and approaches data governance in a way that includes actors and sites that have not been central so far in the discussion.

In line with the above, this thesis engages with 'decoloniality' in discussions regarding how to govern vast volumes of data. Decoloniality constitutes a horizon rising from the realisation that, despite their crucial contribution, the processes of formal political independence and decolonisation—in the nineteenth century in most of Latin America—were insufficient for breaking with the structures restraining the autonomy of the former European colonies. Thus, decoloniality asserts that undoing coloniality requires attending not to politics or the economy in isolation but instead to an entangled matrix that, in addition to these two dimensions, comprises *epistemological* decolonisation (Maldonado-Torres, 2016, p. 36). In particular, decoloniality emphasises the need to de-link from designs such as development that are presented as universally valid and to foreground the knowledges stemming from geographies and bodies that have been deemed as inferior under modernity. Because of this, decoloniality is a condition for transitioning from a *uni*-verse, where a single world is imposed over the rest, towards a *pluri*-verse in which no particular world has privilege over other ones. As the Zapatistas would say, decoloniality opens up a 'world in which many worlds fit' (Zapatista Army of National Liberation, 1997, section III, para. 4). Following this logic, the stance I adopt in this thesis does not aim at 'making room' for the Latin American experience in established data governance frameworks but rather at building an alternative framework in dialogue with the critical knowledges and experiences of struggle in Latin America.

Inspired by decoloniality, this research challenges some common-sense ideas in academia regarding social research. First, I draw on a rich tradition in Latin America that has questioned the dichotomy between theory and praxis. As decolonial thinkers Catherine Walsh and Walter Mignolo ask: 'Are you not doing something when you theorize or analyze concepts? Isn't doing something praxis? And from praxis … do we not also construct theory and theorize thought?' (2018, p. 7). A combination of theory and praxis permeates the different chapters of this thesis, as is the case when I draw on the experience of Zapatista communities in order to conceptualise autonomy. In addition to this, this thesis advances an 'undisciplined' (Walsh et al., 2002) type of research. The notions of 'disciplines' and 'fields' that emerged with Western academia compartmentalise knowledge, impeding the addressing of complex entanglements that make up coloniality. Herein, I bring together insights from sociology, political economy, media communications, political ecology and anthropology as well as political theory, science and technology studies, infrastructure and information studies in order to provide a holistic and nuanced portrayal of the case of astronomy data in Chile. The same can be said of the

methodological approach I propose, which draws on different disciplines and fields to propose a hybrid discursive-material lens capable of grasping the complexity of the phenomena studied. Finally, this thesis considers reflexivity as a necessary and urgent dimension of research. As Rivera Cusicanqui (2012, p. 102) observes, I can declare ambitious goals such as advancing decoloniality, but whether I am successful in this enterprise also depends on my positionality in the world system as well as the broader institutional context in which I am carrying out this research.

In sum, this thesis interrogates what it means to advance decoloniality in the study of data governance and the extent to which collective autonomy serves this purpose. This ambition sets as a condition privileging a theory- and praxis-inspired, undisciplined and reflexive research. Due to this, this thesis might look different to other research examining the same or similar objects of study. However, as Arturo Escobar states, one of the goals of decoloniality is precisely 'to craft new forms of analysis, not to contribute to already established (eurocentric)[13] systems of thought, no matter how critical these might be' (2007, p. 191). The type of thinking I undertake in this thesis moves in this direction, formulating an approach to the governance of data that, based on the Latin American experience, questions the extent to which existing frameworks can speak to contexts that do not fit with the European trajectory. Furthermore, it proposes autonomy as an alternative path aligned with theories and praxes otherwise.

1.4. Structure of the Thesis

In the two following chapters I develop a conceptual framework and propose a series of methods to study the case of astronomy in Chile from the perspective of collective autonomy. In them, I flesh out in more detail some of the terms I have referred to in this chapter, such as data governance and coloniality.

More specifically, in **chapter two** I propose the concept of collective autonomy as an overarching analytical approach to study the politics underpinning the deployment of datafication in Chile. This chapter kicks off with a literature review of the discussion surrounding data governance. After referring to the dominant frameworks of openness and sovereignty, I argue that these have not addressed the criticism emanating from work on data colonialism. The notions of

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[13] Eurocentrism does not mean that Europe is the only centre of power but that, even under the current multipolar world order, the dominant rationality draws paradigmatically on the particular historical experience of Europe. The notion of development reproduces this form of Eurocentrism since it seeks to replicate the economic, political and cultural transformations that took place in Europe.

autonomy and the capitalist modern/colonial world system circulating in Latin America are proposed to incorporate such concerns. Finally, I address some of the gaps encompassed by decolonial thinking for the purpose of this study by turning to the concepts of the political and subject positions as developed by post-Marxist authors Ernesto Laclau and Chantal Mouffe. Having delineated the conceptual framework, I formulate the research questions underlying this thesis.

After developing the conceptual framework, in **chapter three** I spell out the methods employed for the analysis. Here I put forward a hybrid discursive-material approach to account for the heterogeneity of the modern/colonial world system and the different ways in which data interacts with society. Inspired by work on ethnographic anthropology, I refer to some of the adjustments I undertook during my fieldwork in order to scale up this research and incorporate different spheres—scientific research, economic policy making and territorial struggles—in the analysis. After that, I describe the process of data collection—interviews, participant observation and documents—and provide procedural information regarding the analysis. Aspects concerning validity are also discussed as a means to open this study to scrutiny to a broader range of audiences. Finally, I draw on feminist thinkers in order to undertake reflexivity, discussing how my positionality and the institutional scaffolding underlying this thesis might have shaped the insights provided and permitted or constrained fulfilling its political goals. My understanding of critique and how this thesis takes into account the growing popular distrust in the sciences in the West are also covered here.

The following chapters have an empirical character and discuss the stakes of the governance of astronomy data in three spheres: scientific research, economic policy making and Indigenous territorial struggles.

Chapter four explores the shifts and responses ushered in by the implementation of data-intensive research in Chile. The protagonists in this case are astronomers,[14] engineers and astroinformaticians[15] working for Chilean institutions and the settings are predominantly universities and the offices of the international astronomical organisations. My concern here revolves around the calls by local actors for adopting a 'collaborative' positionality as the best

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[14] When I refer to 'astronomy' and 'astronomers' in this thesis I am also including 'astrophysics' and 'astrophysicists'. There are some differences between these two disciplines in principle, but in practice they overlap since almost all astronomy research involves the use of physics (National Radio Astronomy Observatory, 2020).

[15] Astroinformatics is a sub-discipline of informatics focused on the management and analysis of astronomy data (Borne, 2010).

means to catch up with the shifts in the discipline. The partnership of ChiVO with different international actors is employed for analysing the materialisation of such positioning in practice. The argument I advance is that the quest for establishing collaborative relations is favouring an obedient stance in knowledge generation produced by the dis-embedding of the data producers from any context, the erosion of local ties, the obscuring of asymmetries and data conformism. The problem of this obedience is that it impinges upon the capacity of local actors to conduct research attuned to the needs and visions of the local context.

In **chapter five** I trace efforts to construct a data economy in Chile. To do so, I focus predominantly on policy makers and introduce Indigenous activists living close to the ALMA observatory. Governmental offices in Santiago and the Atacama Desert become part of the settings involved. After analysing the transformation of astronomy data into the 'missing piece' of Chilean development, I refer to the emergence of three different articulations of extractivism as actors make sense of the operations of the observatories in Chile. While the technoscientific and competitive understandings tend to dis-embed extractivist dynamics from the world system, the ontological understanding is much better able to acknowledge the historic and patterned character of this phenomenon. Not coincidentally, the latter articulation is being formulated by Lickan Antay activists affected by the construction of ALMA. I finish this section by looking at the DO public-private partnership and the changing role of the state in times of datafication. In particular, I focus on the neglect and exclusion of local experiences underlying astronomy and astronomy data policies.

In the last empirical chapter, **chapter six,** I describe the way the expansion of data infrastructure in Chile can threaten the cultivation of worlds based on a relational coexistence in the territory. The Atacama Desert and Chilean Patagonia appear in this chapter as actors in and of themselves. In this case, I undertake a comparison of the imaginaries of territory held by policy makers and members of the private sector, on the one hand, and Lickan Antay Indigenous activists affected by the construction of ALMA, on the other. The first imaginary I identify, and that I call assetised, focuses on spotting geophysical features from the environment that can operate as resources for attracting external investment in infrastructure. By contrast, the relational imaginary approaches territory as part of a unitary whole enabled by a balanced coexistence, giving rise to an ethics of interdependence and care. My argument is that, whereas the assetised imaginary connects with modernity's threat to Indigenous worlds and the erosion of the Earth, the relational one is much better positioned to imagine the governance of data infrastructures in a way that is compatible with the cultivation of worlds otherwise.

Finally, in the **conclusion** I recap the observations made in the previous chapters and argue that collective autonomy not only changes the *content* but also the *terms* of the conversation on data governance. This framework changes the content by introducing previously ignored concerns, advocating a disobedient, post-extractivist and relational approach. Additionally, a holistic reading of the empirical chapters lays bare that collective autonomy also changes the terms of the conversation, by which I mean the actors, scales and aims that are usually taken into consideration in the discussion. In this final chapter I also argue that attending to histories of struggles such as the one encompassed by collective autonomy can contribute to challenging the logic of technological hypes promoted by the technology industry and that is also permeating academia. Finally, I discuss the contribution of this thesis for relevant scholarly debates, its implications outside academia and its limitations. My final words are dedicated to reflecting on the context in which this study took place, which is one that communities and social movements in Latin America identify in the form of a civilizational crisis.

2. Conceptual Framework:
Data Governance from the Perspective of Collective Autonomy

2.1. Introduction

As I argued in the introduction of this thesis, one of the main stakes in the case of astronomy data in Chile seems to be to find out how to think about the governance of such data in a way that speaks to the histories and particularities of the local context. To address this challenge, in this chapter I lay out a conceptual framework that proposes collective autonomy as an analytically and politically fruitful vantage point from which to examine the intersection between datafication and long-standing concerns in Latin America. The understanding of collective autonomy I delineate here brings together concepts emanating from decolonial thinking and post-Marxism, two theoretical bodies that have inspired political struggles in Latin America but that so far have tended to remain unconnected with regard to discussions about science and technology.

The chapter proceeds as follows. First, I situate my research in relation to discussions about the principles orienting the governance of large volumes of data. After reviewing two of the most influential perspectives in the field—openness and sovereignty—I argue that these have not managed to integrate the profound critique put forward by research on data coloniality. Drawing on decolonial thinking, I look at autonomous thought and praxis emerging in Latin America as an analytical and normative standpoint to think about data governance in the context of a capitalist modern/colonial world system. After that, I turn to Ernesto Laclau and Chantal Mouffe's post-Marxist notions of the political and subject positions in order to apply autonomy to the case of astronomy data in Chile and, potentially, other contexts as well. Before finishing, I refer to some of the tensions aroused by the combination of decolonial thinking and post-Marxism.

2.2. Governing Data Under Data Coloniality

2.2.1. A Power-Sensitive Take on Governance

Over the past decade, a broad range of actors have wondered about the principles that should orient the control, archiving, access and use of large volumes of data. Sparkled by the growing process of quantification of phenomena known as datafication, the questions posed by international organisations, governments and companies regarding the governance of data usually

pursue two goals. On the one hand, they seek to untap the 'hidden value' (Mayer-Schönberger & Cukier, 2013, p. 104) that can be derived from the production, aggregation and reuse of large volumes of data. A source of inspiration for this aim stems from influential magazines and international organisations that have sold the idea that big data can revolutionise scientific research (C. Anderson, 2008), become the 'new oil' (*Economist*, 2017) and usher economic growth into developing countries (World Economic Forum, 2015). On the other hand, discussions on the governance of data aim at addressing some of the geopolitical and privacy risks associated with datafication. This aspect became particularly relevant in the wake of the Snowden Revelations, an episode I refer to later in this chapter.

Looking at its current use, 'governance' constitutes an elusive concept whose genealogy and circulation can encompass politically problematic assumptions, especially with regard to its colonialist and neoliberal undertones. On the one hand, the colonialist origins of governance stem from a report by the World Bank in 1989 that explained the alleged lack of development of Africa as a 'crisis of governance', an assertion that echoes cosmopolitan ideals employed by some European empires to justify their rule in faraway lands (Pagden, 1998). On the other hand, the neoliberal underpinning of the term is associated with its understanding as a 'collaborative' form of rule-making in which the state privileges soft and indirect regulation and acts as a 'partner' of different 'stakeholders' (Estupiñán Serrano, 2016). Despite its apparent benefits, this understanding has made it easier for the private sector to gain autonomy and influence in the public sphere. For these two reasons, the employment of governance can constitute a fruitful analytical tool for decentring the role of the state in analyses of power, but at the same time runs the risk of justifying rather than critically interrogating the asymmetries between the actors at stake.

In light of its problematic ideological baggage, the term governance is approached with critical distance in this thesis. In particular, the way I understand 'data governance' is close to Micheli et al., who define it as 'the power relations between all the actors affected by, or having an effect on, the way data is accessed, controlled, shared and used, the various sociotechnical arrangements set in place to generate value from data, and how such value is redistributed between actors' (2020, p. 3). Unlike approaches concerned with technical or regulatory aspects in and of themselves, Micheli et al.'s definition is anchored in social sciences' and critical data studies' interest in the hierarchies and asymmetries engendered and reinforced by datafication. As for the case of astronomy data in Chile, this definition makes it possible to understand that debates and policies on matters of access, use and value do not only have a functional dimension—for example, fostering productivity—since they have a direct bearing upon the

reproduction or disruption of the existing social order. Another strength of this definition is that it is broad enough to incorporate not only personal but also different types of data. This advantage is of the uttermost importance for this thesis since here I deal with astronomy data, but more broadly it also allows for acknowledging that the questions and challenges emerging in relation to datafication have also been informed by developments and imaginaries from the field of science and technology (Edwards, 2010). However, there is an important distinction between Micheli et al.'s approach and my own. Whereas they envision the parties involved as actors operating within sociotechnical infrastructures, I also approach them as subject positions, namely as non-fixed identities located within a power structure, as I will explain throughout this chapter.

The way I approach data governance in this thesis is both analytical and normative. On the one hand, it is analytical because the definition I am providing orients my study towards the observation of the assumptions and practices surrounding the control, access and use of data and their attendant power dynamics. In this sense, it invites us to examine how a broad range of debates and decisions materialise empirically, expanding the epistemological emphasis of the first wave of responses to the popularisation of big data (e.g., boyd & Crawford, 2012). On the other hand, this approach to data governance holds a normative aim inasmuch as it seeks to intervene in discussions about the 'models' (Smichowski, 2019) that should orient the governance of data. This type of normative intervention echoes a long-standing tradition of engaged social research in Latin America inspired in struggles for social justice and of which decoloniality is but an example. Additionally, the two currents of thought I discuss in this chapter—decolonial thinking and post-Marxism—would advocate approaching academic research as a source of social transformation rather than as a mere description of the outside world. Such an approach has become increasingly urgent as datafication expands across the planet, a phenomenon that is calling for an interrogation of the suitability of established frameworks and envisioning alternative futures.

As I said, the approach to data governance I am proposing puts power relations at the centre of the analysis. However, studies have shown that datafication has become entangled with multiple spheres of social activity, which makes it necessary for this study to specify the types of dynamics to be studied. In the next section I narrow down the scope of my inquiry by referring to a body of work looking at the coloniality of data.

2.2.2. Linking Data and Coloniality

Claims about datafication, 'Artificial Intelligence' (AI) [16] and other data-intensive technologies tend to highlight the alleged innovative and unprecedented character of such developments. This widespread narrative has been challenged by a body of work on what I refer to here as 'data coloniality', which has outlined disturbing connections between these developments and the patterns of power that emerged with European colonialism and that structure domestic and planetary relations to this day. This literature is particularly relevant for the case of astronomy data in Chile, which, as I explained in the introduction, is marked by the presence of international and transnational actors, and has affected an Indigenous community cultivating a mode of existence that emerged before the Spanish invasion.

The discussion on the relationship between data and coloniality was triggered by observations over the similarity between the large-scale extraction of personal data carried out by technology companies and the European nations' accumulation of wealth at the expense of the livelihood of the peoples and the territories in the colonies. In the view of Thatcher et al. (2016), the political economy underlying datafication relies on a form of 'accumulation by dispossession' (Harvey, 2004) through which capitalism constantly expands its reach in temporal and spatial terms. From this angle, 'data colonialism' represents a metaphor to depict the process through which the commodification of the life of individuals serves the technology industry's interests. Following a similar logic, Shoshana Zuboff (2019) argues that 'surveillance capitalism' constitutes a new form of capitalist economic order in which human life becomes a raw resource for business models based on the prediction and manipulation of users' behaviour. Zuboff sees datafication as engendering major economic structural transformations and takes a predominantly pessimistic tone, as when she affirms that the 'information civilization shaped by surveillance capitalism will thrive at the expense of human nature and threatens to cost us our humanity' (2019, p. 347).

Building upon the above works, Couldry and Mejias expand the argument and propose data colonialism as a way to capture the 'emerging order for the appropriation of human life' (2019, p. xiii) brought about by datafication. For them, this emerging order does not constitute a metaphor but rather a new structural phase in the history of both capitalism and colonialism. Rather than a quantitative change, they conceive of datafication as inaugurating a new type of social order based to a large extent on the extraction of value from ordinary social interactions.

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[16] Artificial Intelligence (AI) points to a concept, an academic field and an industry that emerged in the fifties and that focuses on the development of autonomous computing systems (Katz, 2020).

Importantly for the goal of this thesis, Couldry and Mejias argue that data colonialism also brings about a 'new era of coloniality' (2019, p. xi), a statement that they support by relying on historical parallels not only with the political economy but also the rationality that made possible European colonialism. Drawing on Peruvian sociologist Aníbal Quijano, Couldry and Mejias consider that datafication also encompasses a totalising rationality capable of foreclosing alternative modes of knowing the world. Due to this, they advocate an 'epistemological decolonisation' (2019, p. 202) that rejects the assumption that 'the continuous collection of data from human beings is a rational way of organizing human life' (2019, pp. 203–204). Crucially for this thesis, Couldry and Mejias's two-fold argument suggests that, just as European colonialism, datafication is grounded on both an extractivist political economy and a series of universalising assumptions of an epistemological character.

Another relevant proposal is that of Paola Ricaurte, for whom datafication constitutes an 'economic model based on epistemic dominance' (2019, p. 351). In her view, datafication reconfigures a broad spectrum of areas and dimensions of human life, including the economy, the political system, knowledge, being and sensing, nature and sociotechnical systems (2019, p. 354). An important point for this thesis is Ricaurte's emphasis on the fact that not only international organisations and transnational technology companies are pushing for the implementation and expansion of datafication but also local states and companies, engendering a form of coloniality that is 'produced internally, internationally, and transnationally at the systemic, community, and personal levels' (2019, pp. 356–357). In an observation that echoes insights that I discuss in the empirical chapters, datafication gives rise to a form of 'internal colonisation' when states become key clients of big technology companies and exclude the voices of Indigenous people from the discussion.

Further works on data coloniality have demonstrated that international organisations (Isin & Ruppert, 2019; L. Taylor & Broeders, 2015) and the humanitarian sector (Halkort, 2019; Madianou, 2019) can also emerge as important actors deploying datafication in a way that reinforces colonial hierarchies. A shared observation in these works is the sense of contradiction produced by the contrast between the optimistic promises associated with the production and management of data and the problematic, and in some cases decidedly negative, outcomes of datafication. Even though data-oriented initiatives might seek to empower subjects such as refugee groups, they also 'rework and revitalize' (Madianou, 2019, p. 10) historical hierarchies and inequalities. For example, big data development programmes tend to encourage the involvement of profit-oriented and technically powerful technology companies in the definition and pursuit of societal horizons (L. Taylor & Broeders, 2015), opening up questions about the

real capacity of subalternised subjects to come up with alternatives in tune with their own knowledges and experiences. Research has shown that the field of AI is following similar patterns of coloniality, serving the imperialistic purposes of the United States (Katz, 2020) and drawing on a Eurocentric and individualistic notion of rationality (Mhlambi, 2020).

This thesis shares the main concern expressed by research on data coloniality since it also acknowledges the profound links between datafication and the power structure that emerged with European colonialism. Furthermore, I embrace the idea that datafication encompasses multiple dimensions and spheres, including but not limiting to knowledge generation and the economy. However, this thesis also departs from these works in at least two ways. Perhaps the most obvious observation is with respect to the type of data at stake. I consider that there is a need to look at scientific data more closely since, as Latin American intellectuals have long argued (Fals Borda, 1971; Varsavsky, 1969), scientific research has constituted a central historical locus of coloniality in and of itself. Another difference is that, rather than focusing on transnational companies or international organisations, in this thesis I look at the implementation of datafication by data-poor scientific groups and governments, which can be located in the South and the North. When approached from this perspective, the focus shifts towards an interest in the reasons why those who are not at the top of the data hierarchy—because they do not produce or control large volumes of data or lack the capabilities required to leverage this data—might opt for internalising rather than challenging the assumptions of those at the top. At the same time, the approach I take in this thesis de-centres the role of transnational companies and makes it possible to examine power dynamics between domestic actors such as scientific communities, policy makers and communities affected by datafication.

Despite the relevance of the points raised by work on data coloniality, the debate on data governance has not yet managed to incorporate this critique into its agenda. In the next section I show that the main arguments and models circulating in this field have tended to rely on notions of openness or sovereignty that are not apt for the task.

2.2.3. The Limitations of Openness and Sovereignty

Considering the above discussions, I proceed to examine the extent to which two of the most influential frameworks of data governance—'open data' and 'data sovereignty'—can address the points made by critics of data colonialism. A caveat before proceeding concerns the type of data at stake. On the one hand, openness has been primarily put forward in relation to scientific and government data, but here I mainly refer to proposals regarding the former. On the other hand, initially discussions on data sovereignty tended to focus on personal data, but more

recently proposals from regions such as China (Normile, 2018) and Europe (e.g., Gaia-X, 2020) have taken a broader approach encompassing industrial, scientific and other types of data.

Open data is one of the most influential frameworks of governance. A widespread definition of 'open' is all data that 'can be freely used, modified, and shared by anyone for any purpose' (Open Knowledge Foundation, n.d., para. 4). The case for open data draws on liberal principles and conjugates at least three types of arguments: *functional* ones pointing to an increased productivity and innovation through reuse; *ethical* ones portraying sharing as an act of justice; and *epistemic* ones emphasising the importance of public scrutiny for the generation of knowledge. In practice, openness is enacted through a series of technical configurations— standards, protocols, formats—, legal regimes and policy initiatives (Borgman, 2015, p. 39). In the sciences, open data is advocated as an opportunity to reduce the gap between wealthier and poorer scientific communities, especially those in the Global South (International Science Council, 2015, p. 7). For example, a study suggests that granting access to the data produced by the astronomical observatories is especially beneficial for low GDP countries (Peek et al., 2019, p. 5). Archives, concludes this article, 'unite a broader group of researchers in the scientific process by providing common open data to the entire astronomical community' (2019, p. 5). Open data still wields a great degree of influence more than a decade after its initial formulation, with governments around the world working to this day on the implementation and perfectioning of policies aligned with this framework (State of Open Data, 2021)

Criticism against open data responds to two classes of arguments. The first one points to its reification of accessibility, which obscures the actual barriers faced by communities to employ this data for their own purposes (Bezuidenhout & Chakauya, 2018). In other words, the wide availability of data does not imply that all the groups have the same technical capabilities to use it or a clear idea on the way this data could help them attain their goals. As evidence reveals, due to the unequal distribution of capabilities and technical equipment, opening up datasets can end up 'empowering the empowered' (Gurstein, 2011) rather than fulfilling the promise of equality. The second criticism is that openness tends to assume that data is objective and neutral without interrogating its built-in exclusions and hierarchies. The natural sciences are not innocent of this issue since data and its infrastructure 'do not simply support research, they fundamentally change the practices and organisation of research—the questions asked … who is conducting the research and how they operate as researchers' (Kitchin, 2014, p. 24). Even if the data is made available, this does not grant that its format and content necessarily align with the needs and views of different groups since these groups might need or want to, for example, work with datasets addressing different concerns in the first place (Johnson, 2014). In light of these limitations, open

data would constitute a problematic point of departure for addressing the power dynamics denounced by data coloniality.

Principles of openness held sway in debates about digital technologies and the internet for decades. In the 2010s, however, notions of sovereignty gained currency in international debates and national policies. A fundamental prompt for this was the revelation by Edward Snowden of the global programme of surveillance conducted by US intelligence agencies with the participation of large technology companies (MacAskill & Dance, 2013). Against this backdrop, the conception of sovereignty that emerged in Western modernity came in handy to advance a more active role for nation-states in the regulation of the storage and circulation of data (Couture & Toupin, 2019). This approach constituted a direct opposition to the maxim of internet freedom advocated by the United States, with governments such as China and Russia adopting measures to strengthen the role of national jurisdictions in the control of the data infrastructure within their geographical boundaries (Polatin-Reuben & Wright, 2014). By this time, Brazil had achieved a great deal of global leadership by promoting multistakeholder instances of internet governance (Hurel & Rocha, 2018). In some cases, the rationale behind sovereignty-inspired initiatives does not only convey security goals since the development of technical capabilities and infrastructure has become central for productive-economic national strategies. More recently, the industrial-focused case for sovereignty has gained currency in Western liberal democracies such as Germany (Pohle & Thiel, 2020).

Most of the criticism of the above formulation has come from actors who have opted for re-signifying sovereignty in a way that can challenge its underlying state-centrism. Along these lines, the term data sovereignty has also been discussed in relation to Indigenous rights, cities, social movements and individuals (Couture & Toupin, 2019). However, Stephane Couture and Sophie Toupin point out that these reformulations have not necessarily undertaken a profound reflection on the assumptions, practices and techniques that have historically accompanied sovereignty. In their words:

> While digital sovereignty might currently be trendy and somewhat useful, many of the issues discussed are usually addressed without reference to colonialism, imperialism, and a critique of sovereignty itself. So the question is then: what is to be gained and to be lost in the use of sovereignty when thinking about the digital? (Couture & Toupin, 2019, p. 2319)

The limitation identified by Couture and Toupin in relation to sovereignty is especially concerning from the perspective of coloniality. In Latin America, intellectuals, social movements and Indigenous communities have denounced sovereign forms of exercising power due to, among other reasons, their detrimental consequences for the sustainment of Indigenous ways of living and complicity with extractivism and gender violence. For example, drawing on the case of systemic rapes to women and children in Latin America, Argentinian anthropologist Rita Segato argues that sovereign power has as a condition of possibility 'to annihilate equivalent attributions in others and, above all, to eradicate the power of these as alterity indexes or alternative subjectivities' (2010, p. 74). Rather than generative, sovereignty supports a hierarchised take on power that, from the perspective of the Latin American experience, impinges upon the possibility of coexistence between peoples sustaining different ways of thinking and doing. The very genealogy of the term derives from the Latin word 'superanus', which points to 'over' or 'superior' and illustrates the contrast between sovereignty's implicit theory of power and more bottom-up and horizontal models such as the notion of autonomy I discuss here. Certainly, to some extent sovereignty seems to respond to claims on data coloniality since it has sought to challenge the hegemony of countries such as the United States. However, paraphrasing Walter Mignolo (2018, p. 130), this principle can be seen as an attempt to change the *content*—who holds power—but not the *terms*—the type of power exercised—of the conversation.

In sum, the assumptions underlying openness and sovereignty transform these principles into problematic alternatives for thinking about data governance in a way that acknowledges the criticism made by work on data coloniality. In the rest of this chapter I explain the notion of autonomy that has emerged in Latin America over the last decades and argue that it can provide a theoretically and politically fruitful vantage point from which to overcome the limitations posed by existing frameworks. Before that, though, I discuss the capitalist modern/colonial world system as formulated by decolonial thinkers in order to contextualise the emergence of autonomy in the region and describe the planetary and domestic power dynamics in which I situate my inquiry.

2.3. Autonomy in a Capitalist Modern/Colonial World System

2.3.1. The Capitalist Modern/Colonial World System

There have been several formulations of autonomy in history, but, as Arturo Escobar agues (2018), in Latin America it constitutes a response to the harms produced by what

intellectuals in the region call the 'heteropatriarchal capitalist modern/colonial world system'. This term emerged in relation to the historical and political experience of the region and designates the 'historical-structural heterogeneous totality' (Grosfoguel, 2007, p. 217), or 'ensemble of processes and social formations' (Escobar, 2007, p. 185), shaping the 'present organization of life' (Lugones, 2007, p. 187) on a planetary scale. In historical terms, this world system took shape in parallel with the Spanish and Portuguese invasion of the Americas in the sixteenth century and has prevailed to this day even after the formal independence of most of the countries in the region in the early nineteenth century. Below I unpack this theoretically rich concept since it constitutes the context in which I propose to situate the study of data governance.

The 'capitalist' and 'world system' parts of the term stem from discussions held in the register of Marxist political economy that dominated Latin American critical thinking in the sixties and seventies (Grosfoguel, 2000, 2011). In contrast to models relying on unilinear stages of development like modernization theory, dependency theorists such as Raúl Prebisch affirmed that the 'underdevelopment' of some societies is not the product of their backwardness but rather the consequence of a planetary system of exchange that benefits 'developed' countries. For Immanuel Wallerstein, this structure took shape in the fifteenth century, when Europe's invasion of the Americas inaugurated a world economy with capitalist contours for the first time in history. This world economy was and still is characterised by a distribution of labour in which a 'periphery' extracts raw materials and a 'core' processes these materials and appropriates the surplus-value derived from their exchange. Certainly, these frameworks are more complex than the outline I am making here, but this brief description suffices to point out some foundational features of decolonial thinking: a focus on capitalism, structural critique, historical analysis and, above all, the suspicion that, far from benefitting the rest of the world, models developed in light of the European experience tend to reinforce the existing hierarchies (Maldonado-Torres, 2016, p. 72; Mignolo, 2011a, p. 276). These ideas are still influential in Latin America, as is the case of political economists denouncing the 'extractivism' taking place in the region (Gudynas, 2015). As I describe in chapter five, the attempt to overcome Chile's alleged peripheral status in the world economy has been central in the debate over astronomy data.

The 'modernity/coloniality' part of the term, which I briefly referenced in the previous chapter, comes from the work by Aníbal Quijano. After the Cold War, Latin America experienced profound shifts such as the mobilisation by Indigenous people in the five hundredth anniversary of the so-called discovery of the Americas and a growing influence of the Latin American Subaltern Studies group, which had a literary and cultural focus (Maldonado-Torres, 2016, p. 75). In parallel with these shifts, Quijano developed the concept of 'coloniality of

power', or more simply coloniality, to describe the heterogeneous and historical 'power structure' (2007, p. 168) that outlived European colonialism and that represents 'the most general form of domination in the world today' (2007, p. 170). Modernity and coloniality, Quijano argued, are co-constitutive, two faces of the same coin, hence the use of 'modernity/coloniality' (Mignolo, 2018, p. 139). This means that processes such as enslavement or the destruction of the Earth are not mere anecdotes but rather constitutive features of modernity, conditions of possibility for it. Crucially, this power structure has been kept in place not only thanks to a capitalist distribution of labour but also due to racial, gender and sexual forms of domination, the subordination of nature to culture and the idea that a single rationality, namely the European one, holds universal validity (Quijano, 2000, 2007, 2013). The latter point is fundamental since it implies that, after being violently deprived of their own cultural patterns, vast segments of the population in Latin America internalised this rationality and transformed Europe into the mirror through which they would look at themselves.

Quijano's work also signalled a way out of modernity/coloniality. In particular, he advocated 'de-linking' from Eurocentred and universalist rationalities. In his words: 'It is necessary to extricate oneself from the linkages between rationality/modernity and coloniality, first of all, and definitely from all power which is not constituted by free decisions made by free people' (2007, p. 177). For Quijano, the problem is not the idea of rationality itself but rather the assumption that a particular rationality, i.e., the European one, holds a universal status. Thus, whereas decolonisation points to political and economic independence, *decoloniality* incorporates a particular concern for epistemology. In the view of Argentinian linguist Walter Mignolo (2009), decoloniality necessitates acts of not only civic but also 'epistemic disobedience' aimed at unmasking the concealed interests and visions of the knowing subject. In this way, decoloniality invites 'to make visible, open up, and advance radically distinct perspectives and positionalities that displace Western rationality as the only framework and possibility of existence, analysis, and thought' (Walsh, 2018, p. 17).

The incorporation of 'heteropatriarchy' stems from Latin American feminists who sought to overcome Anibal Quijano's blind spots regarding the role of gender and sexuality in the configuration of the modern/colonial world system. For Rita Segato, patriarchy not only depicts 'a gender relation based on inequality' (2016, p. 18) but also 'the pillar, foundation and pedagogy' (2016, p. 16) of *all* forms of power and violence, representing a crucial and co-constitutive element of the dominant world system. Since the modern/colonial gender system has gone hand in hand with what María Lugones calls a 'compulsory and perverse' (2007, p. 206) heterosexualism, a more complete depiction would speak of *hetero*patriarchy. Even if

heteropatriarchy underlies many of the power dynamics I discuss in this thesis, it nonetheless does not constitute a central point in the analysis. One of the reasons for this is because this aspect was not particularly salient in the empirical data, with an exception being the concerns I heard regarding the lack of women in the astronomy community that I address in the next chapter. Therefore, in this thesis I mainly refer to 'the modern/colonial world system', although in some cases I add 'capitalist' to foreground the role of political economy in the phenomenon at stake.

More recently, approaches stemming from political ecology, anthropology and ecofeminism have also revealed the anthropocentric character of the modern/colonial world system, where 'nature' has been deemed as the mere background of 'culture'. In dialogue with the ontological turn in the social sciences (Law, 2011), Mario Blaser, Marisol de la Cadena and Arturo Escobar (Blaser & de la Cadena, 2018; Escobar, 2018) have approached environmental and territorial conflicts not as battles over resources (as in political economy) or as incompatible visions about nature (as in political ecology) but as 'ontological' conflicts pointing to profound disagreements regarding *what exists*, the type of entities that make up reality and the relationship between them—in other words, as divergences about the very *worlds* societies and communities are part of. For example, in some Indigenous worlds mountains and rivers can become relevant actors in political discussions. Challenging the modern/colonial dichotomy between nature and culture, many Indigenous worlds are based on 'relational' philosophies in which the entities that make up reality depend on each other. Under this view, decoloniality necessarily implies striving for the 'pluriverse' I introduced in the first chapter so as to ensure the peaceful coexistence of worlds. Such socio-environmental concerns have become especially relevant in the context of the 'terricide', a term coined by Mapuche activist Moira Millán (2020) to depict the criminal operation threatening all dimensions of existence underlying the worlds of the Mapuche and other Indigenous peoples.

Most of the intellectuals participating in discussions regarding the heteropatriarchal capitalist modern/colonial world system belong to a group of researchers known as the 'modernity/coloniality programme', whose members are predominantly based in Latin America and the United States. This group has the work of Aníbal Quijano as its unifying element, and aims at putting forward 'an other (sic) way of thinking that runs counter to the great modernist narratives (Christianity, liberalism, and Marxism); it locates its own inquiry in the very borders of systems of thought and reaches towards the possibility of non-Eurocentric modes of thinking' (Escobar, 2007, p. 180). Despite their theoretical and political differences, this group's observations on epistemology, gender and sexuality, political economy and political ecology have contributed to unearthing the complex matrix of entangled and mutually constitutive hierarchies

that make up the modern/colonial world system. This programme constitutes the main theoretical source of this thesis, which is why herein I privilege citations from these authors. Even though in many cases their arguments echo concerns raised by Western thinkers such as Karl Marx and Michel Foucault, they do so in a way that reformulates their arguments from experiences and trajectories that differ from the European one.

A recurrent target of decolonial thinkers has been development, a political horizon and economic template envisioned to replicate the trajectory of Europe across the planet (Escobar, 1995). Proposed by the United States in the fifties to keep Latin America from the influence of communism, development operates as a 'seductive narrative' (Kothari et al., 2019a, p. xxi) in the South that draws on science and technology in order to tackle problems created by modernity/coloniality itself. Development programmes are usually designed and executed by experts, assume a unilinear vision of progress and put a strong emphasis on financial- and industrial-driven growth. A broad range of mobilised groups across the planet have expressed their opposition to development over the last decades, laying bare its connection with 'ecological collapse, land grabs, oil wars, and forms of extractivism' (Kothari et al., 2019a, p. xxiii) as well as the 'loss of rural livelihoods and urban poverty' (Kothari et al., 2019a, p. xxiii). For Mexican activist and sociologist Gustavo Esteva, development constitutes a 'tool of domination and control' (Escobar & Esteva, 2020, p. 112) whose endurance has transformed it into 'an obsession, an addiction, a pathological mania' (Escobar & Esteva, 2020, p. 112). In view of this, it is not surprising that development has become one of the rationales behind the expansion and implementation of datafication worldwide, as research (L. Taylor & Broeders, 2015) and the case of astronomy data in Chile suggest.

The discussion over development makes it possible to clarify the position of this thesis with respect to the notion of the 'Global South' that is frequently employed in academic and international circles. At first glance, this term points to the geographical location that concentrates most of 'underdeveloped' or 'developing' societies. From a decolonial perspective, however, the North-South distinction represents a manifestation of the modern/colonial 'global linear thinking' (Mignolo, 2011b, p. 174) that appropriates and hierarchically classifies the world on the basis of geographical (North/South and West/East), chronological (advanced/backward) and racist (whites at the top) criteria. Besides the risk of reproducing linear thinking, the notion of the Global South becomes problematic when considering that, due to internal inequalities and hierarchies, it is possible to identify 'Norths in the South' and 'Souths in the North', not least when speaking of datafication itself (Mann & Daly, 2019). Furthermore, the use of this category runs the risk of homogenising multiple and divergent experiences, collapsing the diversity of modes of existence

on the Earth into a single tag. Despite this, in some cases the Global South can also point to the location from which alternative futures are being forged and, as Milan and Treré (2019) argue, a source of resistance in times of datafication. Against this backdrop, I employ this term only occasionally and with extreme caution. Accordingly, this thesis should not be understood as a study of 'datafication in the Global South' but instead as one whose observations might resonate with other experiences in both the South and the North in which the implementation of datafication is rendering visible the patterns of power encompassed by the modern/colonial world system.

Summing up, the capitalist modern/colonial world system is conceived of in this thesis as a historical-structural pattern of power shaping but not determining planetary and domestic relations in times of datafication. This structure manifests through three analytical dimensions: distribution of labour (political economy), universal rationalities (epistemology) and the imposition of a single world (ontology). The three empirical chapters of this thesis examine each of these dimensions, with chapter four referring to epistemological power dynamics under data-intensive research, chapter five looking at the political economy of data extractivism and chapter six focusing on the ontological character of the territorial conflicts spurred by the expansion of data infrastructure. In addition to these dimensions, the modern/colonial world system encompasses different forms of social classification, predominantly racial, gender, sexual, geographical ('North' versus 'South') and class. An important note in this regard is that, inspired by decolonial thinking, this study addresses the connection between epistemology and datafication in a broad way, i.e., not only with respect to the methodological particularities of data-intensive research (Kitchin, 2014, p. 128) but also in relation to the assertions about scientific and economic progress accompanying discussions about the governance of large volumes of data.

Having delineated the capitalist modern/colonial world system, it is now easier to explain why I turned to Latin American decolonial thinking rather than to postcolonial theory[17] and critical race theory. Developed by authors such as Edward Said and Gayatri Chakravorty Spivak in light of the experience of the Middle East and Southeast Asia, postcolonial theory has been highly influenced by post-structuralist literary analysis and has tended to focus on the period of time known as the European Enlightenment. In some cases, these emphases have come at the

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[17] In this thesis I also refer to 'postcolonial contexts' and 'postcolonial states'. In these cases I am not referring to a body of theory but rather to societies or groups that achieved formal political independence after being European colonies.

expense of an acknowledgement of the historical role of capitalism in the configuration of planetary power structures (Grosfoguel, 2002, p. 214). Such an omission would leave outside the analysis dynamics that, in light of work on data coloniality, might be critical for this study such as extractivism. Furthermore, putting forward an alternative political horizon has been outside the interest of postcolonial theory so far. By contrast, decolonial thinking has developed notions such as decoloniality and autonomy that aligns with a rich tradition of engaged research in the region. As Walter Mignolo would say, Latin American decolonial thinking encompasses both an *analytic* of coloniality—what it is and how it operates—and a *programmatic* of decoloniality (Mignolo, 2007a). In addition to postcolonial theory, another alternative would have been to rely on critical race theory. Decolonial thinking and critical race theory share some similarities. For example, the notion of 'white supremacy' encompasses a 'political, economic and cultural system' (C. I. Harris, 1993, p. 1714) that equates to some extent to coloniality. However, Latin American decolonial thinking's macro and transnational approach, two aspects not thoroughly developed by critical race theory (Meghji, 2020), is particularly relevant to understand the case of astronomy data in Chile and the full scope of datafication.

In the next section I explore Latin American autonomous thought and praxis, which acknowledges political economy, epistemology and ontology and provides this study with an engaged and normative orientation. However, the context in which this notion has emerged does not necessarily resemble the particularities of the case of astronomy data in Chile. Thus, in the following section I also look at some of the limitations of approaching the governance of data from this perspective.

2.3.2. *Autonomous Thought and Praxis in Latin America*

Arturo Escobar (2018) proposes that the autonomous thought and praxis emerging in Latin America over the last decades can serve as a foundation for the design of 'worlds otherwise', namely not responding to the precepts of capitalist modernity/coloniality. In his view, autonomy constitutes one of the transformative post-development alternatives put forward from the margins of the modern/colonial world system along with other proposals such as *buen vivir* [living well] in Latin America and *Ubuntu* in Sub-Saharan Africa (Kothari et al., 2019b). Echoing this move, in this thesis I draw on autonomy in order to explore the issues and power dynamics present in governance of astronomy data in Chile that have been overlooked by the approaches based on openness and sovereignty.

An important note before proceeding is that the notion of autonomy is not new in discussions about data coloniality, but the way I approach it differs from previous formulations.

In particular, Nick Couldry and Ulises Mejias draw on autonomy in order to foreground what they consider to be one of the most violent implications of data colonialism: an 'invasion of the basic space of the self on behalf of an external power' (2019, p. 155). In genealogical terms, autonomy is composed by two Greek words: 'auto' that stands for 'self' and 'nomos' for 'law' (Couldry & Mejias, 2019, p. 162). Whereas philosophers such as Hegel, as well as Couldry and Mejias themselves, approach the 'self' in relation to the individual, the notion of autonomy circulating in Latin America takes collective entities as its point of departure. In addition to the different 'selves' at stake, the Latin American formulation differs from the European one inasmuch as the former conceives of autonomy as a response to the harms engendered by modernity/coloniality and the latter as a feature of modernity.

Autonomy emerged with strength in Latin America in the nineties, when the end of the Cold War prompted the reactivation of previously repressed political antagonisms. The sources of inspiration for this formulation stem from different places, including the Zapatista movement in Chiapas, Mexico,[18] Mapuche communities in Chile, mobilised women and social uprisings in urban areas (Dinerstein, 2015, p. 63; Escobar, 2020, p. 34). For Escobar, communities living under different forms of modern/colonial occupation regard autonomy as 'an attempt to construct an altogether different form of rule anchored in people's lives, a struggle for liberation and a new type of society in harmony with other peoples and cultures' (2018, p. 172). Because of this, autonomy constitutes a 'horizon guiding political practice' (2018, p. 173) that has as a central focus enabling the pluriverse. Autonomy points to the capacity of communities to self-determine their own ways of being as well as their beliefs, practices and tools—in other words, to extricate themselves from universalisms and extractivist logics so as to cultivate worlds otherwise. In the context of a profound civilizational crisis, autonomy represents the 'cutting edge of thought' (Escobar, 2020, p. 45), a knowledge developed by communities dealing with modernity/coloniality to reclaim the capacity to imagine and enact alternative futures.

The notion of autonomy circulating in Latin America does not equate to self-sufficiency since it acknowledges that societies, communities and territories do not exist in isolation. Instead, communities are understood as continuously co-produced with the human and other-than-human actors that make up the environment they inhabit. As Escobar explains, autonomy acknowledges interdependence and openness to change in both principle and practice, which is why it 'does not mean autarky or isolation; on the contrary, autonomía requires dialogue with other peoples, albeit

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[18] The Zapatistas' autonomy is anchored in their Indigenous experience, but they consider that their philosophy can also apply to non-Indigenous groups (Esteva, 2011, p. 124).

under conditions of greater epistemic and social equality' (2018, p. 181). The point underscored by autonomy, thus, is that the changes engendered by these relations cannot be imposed or implemented in situations of military, extractivist or epistemic occupation, when modern/colonial hierarchies become the only valid ones. Instead, these changes must be the product of a process in which communities freely decide how to react to external triggers.

Even if this specific terminology is not employed in this thesis, a productive way to get a grasp on autonomy is to look at the distinction made by Gustavo Esteva (2015, p. 143) between the forms of regulations he calls 'heteronomy', 'ontonomy' and autonomy. Heteronomy is the situation in which change is imposed externally. This phenomenon is frequent in a capitalist modern/colonial world system since, for example, certain rationalities such as development are seen as universally valid and therefore uncritically adopted. Ontonomy, on the other hand, describes the cases in which the existing costumes and cultural traditions are kept in place. The prefix 'onto' is employed in reference to the ontology of some non-modern societies whose social order seeks to attain an alignment with the natural or cosmological order of things. Finally, autonomy reflects the situation that occurs 'when the conditions exist for changing the norms from within' (Escobar, 2018, p. 172). In this case, changes prompted by external triggers are not uncritically adopted or rejected but rather collectively examined in light of the needs and visions of the local context. Because of this, autonomy is a dynamic process that 'might involve the defence of some practices, the transformation of others, and the veritable invention of new practices' (Escobar, 2018, p. 172). An important caveat when it comes to these different modes of social regulation is that complete autonomy is impossible since what tends to occur in practice is an interplay between autonomy, ontonomy and heteronomy (Escobar, 2018, p. 178).

There are at least two points raised by autonomous thought and praxis that can change the way data governance is usually discussed. Approaching data governance from the perspective of autonomy de-centres issues of control, access, management and use and calls for a careful examination of how modernity/coloniality shapes the processes through which datafication is implemented, adapted, negotiated or rejected. Of particular interest in this regard is how the location of the actors developing and implementing datafication within the world system inform their symbolic and material possibilities to shape datafication based on the needs and views of the local context. In the context of this thesis, this process of implementation is explored in relation to data-intensive research, the formulation of economic development programmes and the expansion of data infrastructures across Chile. Second, autonomy acts as a reminder that change is a complex dynamic in which communities and societies do not simply 'choose' whatever alternative they prefer. In that sense, autonomy takes into consideration but also advocates

resisting the symbolic and material constraints posed by the modern/colonial world system with the goal of expanding the horizon of available alternatives.

My proposal to examine scientific research and technological development from the perspective of autonomy builds upon and expands previous works on science and technology in Latin America. Informed by a combination of science and technology studies (STS) and postcolonial theory, a significant body of research in the region has sought to challenge rigid notions of centre and periphery by emphasising the ingenuity of local actors (Medina et al., 2014, p. 10). Particularly influential for this line of research has been Michel Callon, Bruno Latour and other authors' Actor-Network Theory (ANT), which has contributed to replacing unilinear and deterministic models with an emphasis on movement, adaptation and, above all, translation (e.g., da Costa Marques, 2005). In addition to foregrounding the agency of local actors, my proposal of observing scientific and technological development from the perspective of autonomy adds an additional analytical layer by incorporating an emphasis on the bearing of local dynamics upon the broader structure of capitalist modernity/coloniality. Thanks to this, and echoing another relevant line of research in the region (Kreimer & Vessuri, 2018, p. 26), autonomy makes visible the way planetary structures also shape local dynamics. In other words, compared to STS-informed research in Latin America, autonomy not only interrogates whether the so-called periphery can make science and innovate but also takes into consideration the structural import of the science and innovation carried out in the so-called periphery, asking about the extent to which local practices can open up worlds that do not follow the precepts of modernity/coloniality.

2.3.3. Communality/Territoriality and its Limitations

As Escobar explains, communities in Latin America tend to accompany claims about autonomy with concerns about 'communality' and 'territoriality'. Because of this, the triad 'autonomy-communality-territoriality' makes up the 'political-theoretical anchor' (Escobar, 2020, p. 38) of Indigenous, Afrodescendant and peasant communities seeking to overcome different types of occupation. Below I argue that incorporating communality and territoriality in the analysis can bring to the fore implications of datafication ignored by the existing frameworks, but also that these terms are not capable on their own of addressing some of the particularities of the case of astronomy data in Chile.

The emphasis on communality responds to the acknowledgement that one of the effects of the capitalist modern/colonial world system has been and still is the destruction of ways of living based on a harmonious coexistence between human and other-than-human actors. Seeking to address this issue, the term communality points to not only a form of social organisation based

on collaboration and reciprocity but also, more broadly, to 'a theory and practice of interexistence and interbeing' (Escobar, 2018, p. 175). Thus, '[t]he communal is not a set of things, but an 'integral' fluidity' (Guerrero Osorio, 2019, p. 131) in which people, animals, plants, inert objects and the planet are part of an interdependent whole. Going back to points I made earlier, the relational assumptions and practices underlying communality explain why autonomy does not equate to autarky; in communality there is no existence in isolation but only interexistence. The focus on communality connects autonomy with other relational philosophies such as *Ubuntu* developed by communities in Sub-Saharan Africa and that, as Sabelo Mhlambi proposes, can help tackle the 'subjugation and dehumanization' (2020, p. 18) brought about by data coloniality.

Territory, the third term of the triad, is tightly connected to communality since it designates 'the system of relations whose continuous reenactment re-creates the community in question' (Escobar, 2018, p. 173). Unlike in the case of deterritorialised societies, autonomy approaches the territory not as the passive background in which life unfolds but instead as an actor with the capacity to enable particular modes of existence. Furthermore, the territory is also the site where modern/colonial forms of extraction take place, coming to represent not only a geographical space but also the body of women and children (Segato, 2010) and even life itself in the case of datafication (Couldry & Mejias, 2019, p. 5). This understanding of territory subverts a term that in European modernity came to designate a bounded space subject to the sovereignty of the nation-state (Elden, 2010). In relation to this thesis, emphasising territory makes it possible to counter widespread narratives that present datafication as a process taking place in 'the cloud', instead underscoring the fundamental role of the relations that make up the territory for sustaining the infrastructure that make possible the production and processing of vast volumes of data in the first place. For example, the territory provides the mineral materials required to produce digital devices and the energy required to cool the highly energy-consuming data centres (Crawford, 2021). This notion figures prominently in chapter six, where I discuss the divergent imaginaries of territory held by policy makers and members of the private sector in Chile, on one side, and Lickan Antay Indigenous communities, on the other.

The triad autonomy-communality-territoriality calls for a profound interrogation of the role of the nation-state in overcoming the harms produced by modernity/coloniality. Among other reasons, the forms of organisation and philosophies underlying this triad opposes sovereign forms of exercising power and the establishment of clear-cut boundaries between humans and the territories they are part of. This critical stance does not necessarily translate into an upfront rejection of the state as a potential site for social change but rather into an attempt to move beyond what the Zapatistas call the 'state illusion', or the vision of this space as *the* location of

revolutionary transformation (Dinerstein, 2015, p. 3). As Arturo Escobar puts it, '[a]utonomía is not achieved by "capturing the State" but by taking back from the State key areas of social life it has colonized' (2018, p. 173). This concern can be particularly pressing in Latin America since, as Rita Segato argues, 'due to their colonial origins, our States do not have the same relationship with the society and the territories they manage that the European States have with theirs… [Latin American States] cannot help reproducing the distanced and exterior type of relationship with what is administered' (2016, p. 104). Thus, an exploration of data governance based on the perspective of autonomy would necessarily question the role adopted by the state. Looking at the case of astronomy data in Chile, in chapter five I argue that the design of the DO public-private partnership provides a fruitful vantage point from which to explore this question.

Particularly relevant for this thesis are initiatives encompassing the governance of technology in Latin America that have mobilised the conceptual triad I am describing here. In particular, the autonomous telecommunication networks developed by Indigenous communities in Oaxaca, Mexico, since 2013 offer a paradigmatic case in point (Bravo, 2017). These networks cover around 50 villages and their development involved discussions in community assemblies, regulation advocacy and envisioning appropriate software and hardware solutions. As Loreto Bravo points out in her reflections about this experience, in the case of autonomy 'the construction of power is not based on the sovereignty of the people. Power emanates from the territory … where technologies play a role in strengthening that autonomy' (2017, pp. 126-127). Bravo's definition touches on some of the themes I have reviewed in this section, replacing the vocabulary of sovereignty (the people, the commons) with the that of autonomy (territory, communality) and putting the latter into practice for rethinking the governance of technology.

Despite the relevance of communality and territoriality, anchoring autonomy exclusively on these notions encompass two limitations that are particularly relevant for this thesis. The first one is that these concepts do not provide sufficient tools to explore the arguments and practices employed by a group to dismantle coloniality, i.e., to de-link, from coloniality in the first place. In other words, Escobar's notion of autonomy focuses on the worlds otherwise constituted by communities but does not put an emphasis on the more antagonistic acts through which they reject or keep at bay the expansion of modernity/coloniality. Drawing on Ana Cecilia Dinerstein, I would argue that such an account of autonomy does not extend much on autonomy's crucial 'negative praxis' (2015, p. 10), which is the one oriented to the rejection of existing power structures. As the Zapatistas say, autonomy encompasses both *rebellion* and *resistance*: 'Our rebellion is our NO to the system, our resistance is our YES to an "other" possible way' (as cited in Walsh, 2018, p. 47). As I put it in the next section, an autonomous approach to data

governance requires acknowledging not only communality but also 'conflictuality'. In the case of this thesis, foregrounding autonomy's negative praxis can be crucial for identifying fresh narratives and practices of criticism against datafication.

The second limitation of communality/territoriality is that these notions have been predicated on anthropological studies of place-based communities. Because of this, some questions need to be asked when it comes to geographically distant groups, such as the scientific and technical communities that have been key in the development of the planetary data infrastructure (Edwards, 2010). These actors' group ties are less bounded, more heterogeneous and interconnected with other memberships, which sets a different scenario from the one studied by authors such as Escobar and Esteva. As for autonomy, these groups complicate the notions of 'external' and 'internal', making it hard to assess the power dynamics at stake. The risk in this case is to rely on notions of identity and community that would assume rather than interrogate who are the actors at stake and their position within the modern/colonial world system.

In the next section I look at Ernesto Laclau and Chantal Mouffe's concepts of the political and subject positions in order to address the gaps expressed above. Unlike Escobar's communal autonomy, what I call 'collective autonomy' foregrounds both the communal and the conflictual character of collective life and questions the positionality of the actors involved.

2.4. Approaching Autonomy Politically

2.4.1. Accounting for The Political

As I suggested earlier, for the Zapatistas autonomy involves 'one no and many yeses'—saying no to modernity/coloniality and yes to multiple forms of thinking and doing otherwise. In this section I turn to Ernesto Laclau and Chantal Mouffe's focus on conflictuality in order to shine a light on the negative praxis—the one 'no'—encompassed by autonomy. After that and independently, I look at these authors' reflections on collective identity formation for identifying the parties at stake in the governance of data from a non-essentialist vantage point.

Like Quijano's, the work by Argentinian and Belgian political theorists Ernesto Laclau and Chantal Mouffe emerged in parallel with the end of the Cold War and sought to open up questions obscured by orthodox Marxism's economic determinism and privileging of the category of class. However, Laclau and Mouffe's points of reference were not Indigenous communities but Argentinian populist politics and the rise of the feminist, gay and ecological social movements. As a whole, Laclau and Mouffe's proposal constitutes a multi-layered and

thorough theoretical framework informed by a number of currents of thought such as Marxism, linguistics, post-structuralism and psychoanalysis. In this section I will circumscribe the discussion to their take on 'the political', which is at the core of their proposal. Considering that the work by Laclau and Mouffe tends to be labelled 'post-Marxism' and 'discourse theory' (DT) (Mouffe, 2013, p. 130), this chapter mainly deals with the former and the next one with the latter, albeit in practice it is almost impossible to establish a clear-cut boundary between them.

Laclau and Mouffe's post-Marxist theory puts a great emphasis on the antagonistic aspect of social relations—on the fact that conflict criss-crosses collective life and that ignoring this aspect can be detrimental for social change. Addressing conflict is particularly relevant in the case of modern societies, where the conduct of public affairs does not rest on a shared moral order. Even though in many instances Laclau and Mouffe take politics—the field associated with political parties and the state—as their referent, their observations extend to any field of human activity. In fact, the very definition of the political points to 'the dimension of antagonism which … [is] constitutive of human society' (Mouffe, 2005, p. 9). As Mouffe explains, the political 'cannot be restricted to a certain type of institution ... [i]t must be conceived as a dimension that is inherent to every human society' (Mouffe, 1993, p. 3). For empirical studies in general, this understanding opens up the possibility 'to search for modes of the political in the most unexpected places' (Marchart, 2018, p. 12).

The philosophical grounds of Laclau and Mouffe's understanding of the political rests on French linguist Ferdinand de Saussure, for whom the meaning of a sign depends on its position within a broad system of signification (Marchart, 2018, p. 20). In other words, what something *is* (a dog) is derived from an opposition to what it *is not* (a cat) (Jørgensen & Phillips, 2002, p. 10).[19] The notion of the political emerges from the disturbing observation that such negative relationship both enables and threatens identities simultaneously.[20] Because of this, the identity of a subject or an object is always enabled by a 'constitutive outside', i.e., an exterior that emerges from the tension produced by signs that both put into question the existence of an inside and, at the same time, constitute a condition of possibility of it (Mouffe, 2000, p. 12). In the words of Mouffe: '[T]he condition of existence of every identity is the affirmation of a difference, the

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[19] This example does not mean that Laclau and Mouffe consider that there is an intrinsic opposition between 'dog' and 'cat'. In the next chapter I explain that a central aspect of DT is that such connections are always forged and sustained through articulatory practices.

[20] An identity is understood here in a broad sense, as what any object or subject is and is not.

determination of an "other"' (1993, p. 3). As political philosopher Oliver Marchart explains, given that this negative logic permeates all processes of intelligibility

> all social affairs are political in terms of being grounded, to a greater or lesser degree, by the political, that is to say: through instances of conflict, power, subordination, oppression, exclusion and decision as much as, of course, resistance, opposition, confrontation, association or consensus-building (Marchart, 2018, p. 12).

Along these lines, the political reminds the researcher that *all* claims and decisions have a political character inasmuch as they imply a rejection of alternatives, inevitably encompassing an act of exclusion. This is the case in even the most seemingly apolitical fields such as the sciences and, of course, data governance.

In the case of this thesis, factoring in the political translates into two analytical emphases. One of them is an attentiveness to disagreements and marginalised voices in the discussion over data governance. For post-Marxism, a close examination of such voices is fundamental since they reveal the political character of the social arrangements in place, making them subject to subversion and providing fresh sources of critique. A case in point in this thesis is the relevant role I grant to the view of Lickan Antay Indigenous communities, whose voices have been excluded not only from the conversation on astronomy data in Chile but also from the design of scientific and technology policies more generally (e.g., Ministry of Science, 2020). The second way in which the political manifests in this thesis is through a focus on attempts to fix certain views in order to present them as common sense, stifling or rendering invisible alternative ideas and practices. For example, in chapter five I look at the way local actors are transforming astronomy data into the 'missing piece' for development, as if investment in this resource would be the most obvious way of upgrading the Chilean economy. More broadly, incorporating a post-Marxist sensitivity in this study, and the notion of the political more specifically, aligns with the interest of decolonial thinkers of attending to criticism stemming from the border of modernity/coloniality, or 'the moments in which the imaginary of the modern world system cracks' (Mignolo, 2012, p. 23). When approached from this angle, the modern/colonial world system appears less as a monolithic and static structure and more like a formation subject to subversion and requiring constant adjustments in order to accommodate critique.

An important condition for approaching the political is to pay close attention to the dimension of 'the discursive', or to the constitution of the social order through dynamics of

meaning-making. This is because it is only when subjects make sense of phenomena—a process that takes place through discourse—that these acquire a political character. As Laclau and Mouffe explain, '[t]here is nothing antagonistic in a crash between two vehicles: it is a material fact obeying positive physical laws' (2014, p. 109). I underscore this point here since over the last decade a turn in social sciences emphasising 'the material'[21] has profoundly informed research on information and data (Dourish, 2017, p. 33). Even if in some cases material-oriented approaches have sought to incorporate the role of discourse, their theoretical and conceptual sources are not meant to foreground the political in empirical analyses and therefore have tended to leave aside a crucial dimension in the study of the endurance, transformation and contestation of power structures. As I propose in the next chapter, a comprehensive grasp of the politics of datafication requires a conceptual-methodological toolbox capable of acknowledging both the discursive and the material dimensions and the way they shape each other.

In this thesis I draw on Laclau and Mouffe's insights in order to infuse the analysis with a particular concern over the conflicts and disagreements surrounding the discussion on astronomy data in Chile. Such an emphasis, I argued earlier, can contribute to grappling with autonomy's complex, multilayered and, most of all, *political* character. As Chantal Mouffe would say, '[i]t is only when division and antagonism are recognized as being ineradicable that it is possible to think in a properly political way' (2013, p. 15). The notion of collective autonomy I propose here aims at thinking the case of astronomy data by addressing both communality and conflictuality.

2.4.2. Actors and Stakeholders as Subject Positions

In addition to the acknowledgement of conflictuality, I explained earlier that thinking about data governance from the perspective of collective autonomy requires a non-essentialist approach for identifying the actors—identities, groups, communities, territories, stakeholders or what have you—involved in the process. In modernity/coloniality, the boundaries between these actors are not always clear since they might not live within a specific geographical location or share a common moral order. Just to mention an example, this is the case of transnational research teams and networked activist groups that interact regularly without being physically in the same place nor sharing the same ideals of common good. In addition to this, it is crucial to take into consideration that the subjects implied by the capitalist modern/colonial world system

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[21] Like Carpentier (2017, p. 43), here I speak of 'the material' rather than 'materiality' in order to follow Laclau and Mouffe's vocabulary and to reject the idea that there is something akin to an essence that makes things 'thingly'.

might vary over time and materialise differently in specific spheres. As Stuart Hall replied to those who are nostalgic for binary understandings of the coloniser and the colonised: '[P]olitical positionalities are not fixed and do not repeat themselves from one historical situation to the next or from one theatre of antagonism to another' (1996, p. 244). The concept of 'subject positions' developed by Laclau and Mouffe (2014) can be particularly helpful for identifying the actors involved in the governance of data and the location of these subjects within the hierarchies of the modern/colonial world system.

The development of Laclau and Mouffe's theoretical framework had as one of its more important goals decentring the category of class so as to make room for a wider spectrum of social antagonisms. A relevant conclusion they arrived at is that analyses should not presume who are the parties at stake, and that in fact the political revolves to a large extent around establishing the boundaries and identifying the characteristics of the actors involved. The concept they use to designate these actors is that of subject positions, which are locations opened up by discourse and in relation to which subjects can or cannot identify. For Laclau and Mouffe (2014, p. 101), these locations create expectations about what subjects can and cannot do, providing them with 'behavioural instructions' (Jørgensen & Phillips, 2002, p. 43) that translate into concrete practices. It is important to note that subject positions are always allocated within a structure, which means that they distribute authority among subjects in a hierarchical way. For example, the subject position of the 'employee' is generally considered inferior to that of the 'boss'. One of the consequences of thinking about collective formations from this perspective is that it challenges the modern idea of the autonomous individual since the construction of identities always relies on the discursive resources available in a particular context (Jørgensen & Phillips, 2002, p. 41).

However, the above does not mean that the alternatives available in a given context and the position adopted by subjects are entirely determined by the structure. Instead, and in line with post-structuralist theory, Laclau and Mouffe argue that identities and their boundaries are never entirely stable and always open for struggle and subversion. Subject positions encompass contradictions and, in practice, it is impossible to find subjects that perfectly match with them. Because of this, part of the politics surrounding subject positions revolves around a constant attempt to fix these identities. As per the old question in the social sciences between structure and agency, these observations leave Laclau and Mouffe in a middle point since they acknowledge that individuals and groups are not completely autonomous but also that they do enjoy some degree of freedom. Crucially, since the articulation of subject positions follow the rules of signification, their configuration is also criss-crossed by the political and therefore built on the basis of conflict and discord.

Two clarifications can be made regarding the concept of subject positions that are particularly relevant for this thesis. The first is that Laclau and Mouffe did not stress enough that not only the discursive but also the material can shape the construction of identities. In the case of datafication, this means that elements such as the distribution of labour, the affordances and protocols of technological infrastructures and the relationship between communities and the territory can also inform the process of identity formation. The second observation is that the acknowledgement of the political character of subject positions does not translate into the assertion purported by Laclau and Mouffe (2014, p. 104) that *all* identities are inevitably constructed in a hierarchical way, which would constitute an improper universalisation of the modern/colonial system of classification (Escobar, 2018, p. 92).

While Arturo Escobar anchored autonomy in communality and territoriality, I argued that the notions of the political and subject positions can contribute by foregrounding the conflictual character of autonomy and the complexity that can emerge when identifying the actors at stake. Having said that, a final observation is that the combination of these two bodies of work is not a free from theoretical and political tensions, especially when considering that Laclau and Mouffe proposed the concepts I reviewed here within a broader political project. I address this aspect in the next section.

2.4.3. Bringing Together Decolonial Thinking and Post-Marxism

The conceptual framework I am proposing builds upon decolonial thinking and post-Marxism, two bodies of theory and praxis that have inspired critical thinking and struggles in Latin America (Escobar, 2020, p. 31). As I argued earlier, these two sources of scholarship have different genealogies, and, although decolonial thinkers have occasionally built upon European theoretical bodies, post-Marxism has not been among their favourite ones. Against this backdrop, below I specify three points in which these two frameworks might diverge and argue that post-Marxism can still provide a solid theoretical support for decolonial thinking. Certainly, a central concern for authors such as Escobar would be the excessive focus by Laclau and Mouffe on the discursive, an aspect I develop at length in the next chapter. Nor do I discuss here the contradictions between decolonial thinking and Laclau and Mouffe's radical democracy (Conway & Singh, 2011) and its underlying emancipatory horizon (Mignolo, 2007b, p. 454), since these are not part of this conceptual framework.

First of all, it is interesting to note that even though both Escobar's and Laclau and Mouffe's frameworks are grounded in a relational understanding of the social—nothing exists in isolation but rather in relation to other entities and identities—they arrive at different conclusions.

Whereas Escobar's communality foregrounds the politics and ethics that arise from the realisation that life depends on a web of interdependencies, Laclau and Mouffe's conflictuality emphasises the negativity involved in any process of signification. In my perspective, this difference does not mean that one is right and the other is wrong. Instead, I see these two observations as complementary from both a philosophical and political perspective. Philosophically speaking, communality and conflictuality derive from observing the ontological grounds of the constitution of the social from the lens of the material (we cannot survive without others) and the discursive (the negativity underpinning the rules of signification). Rather than contradicting each other, these two dimensions can and should be approached as equally and mutually constitutive of the social order. Politically speaking, acknowledging both communality and conflictuality makes it possible to approach autonomy as a complex praxis that encompasses creation, positivity, reconstruction and generativity as well as negation, deconstruction and opposition (Dinerstein, 2015, p. 10). In other words, both communality and conflictuality are component parts of, and therefore conditions for, collective autonomy. While communality signals the characteristics of the world to be cultivated in autonomous conditions, conflictuality reminds us that in modernity/coloniality such worlds are constructed in opposition to forces generating occupation.

A second issue arises in relation to the old sociological debate between structure and agency. At first sight, the notion of the modern/colonial world system would seem to privilege analysis of structure and the reproduction of asymmetries. More recently, however, authors such as Arturo Escobar and Walter Mignolo have provided less deterministic accounts by arguing that, despite the expansion of modernity/coloniality almost all over the planet, some groups have managed to remain on the border of this world system by sustaining non-capitalist and non-dualist forms of existence. The very discussion on autonomy has as its aim foregrounding experiences of struggle of this type. Under this lens, studies on the capitalist modern/colonial world system get closer to the post-structuralist concern with unfixity and instability that inspires Laclau and Mouffe's work. It is not a coincidence that Mignolo (2012, p. 19) and Escobar (2020, p. 46) have been informed to a no small extent by post-structuralist philosopher Michael Foucault, who is also one of the sources of Laclau and Mouffe.

A final potential issue concerns the combination of decolonial thinking with theories and concepts that emerged in the West. Some might argue that bringing together autonomous thought and post-Marxism would imply compromising the commitment to de-linking from Eurocentric rationalities advocated by Quijano. In this respect, I would argue that post-Marxism is part of the 'Eurocentric critique' of modernity that emerged in the eighties and that, even though it helped uncover some of the harms produced by modernity, it did not take coloniality into account

(Mignolo, 2018, p. 151). However, this type of framework can still be helpful since, as Walter Mignolo argues, '[d]elinking requires that economic, political, philosophical, ethical, etc., conceptualization based on principles that makes the Bible, Adam Smith and Karl Marx *necessary* (because Western categories of thoughts [sic] have been globalized) ... but highly *insufficient*' (2007a, p. 459, emphases added). Taking up Mignolo's reasoning, I argue that post-Marxism constitutes an insufficient but nonetheless necessary framework for understanding the modern/colonial contours of datafication, especially when it comes to acknowledging the political dimension and shifting positionalities underpinning this phenomenon.

The above observations do not imply that the combination I am proposing is free from power dynamics. A recurrent issue in this regard takes place when some theories and concepts developed outside the West are asymmetrically bridged with Western ones, depoliticising issues raised by subalternised groups in a way that erases their urgency and relevance. Arturo Escobar considers that incorporating 'the categories, knowledges, and understandings of the communities themselves and their organizations' (2020, p. 33) becomes a crucial task for Latin American critical thinking since 'the epistemic structure of modernity (whether liberal, rightist, or leftist) has largely been erected atop the effective erasure of this crucial level of thought' (2020, p. 33). A requirement for an eclectic and horizontal approach, thus, is to ensure a dialogue based on a pluriversal politics and ethics in which no way of thinking is granted a superior status. As Achille Joseph Mbembe argues, what is needed is 'a horizontal strategy of openness to dialogue among different epistemic traditions' (2016, p. 37). In this chapter I have sought to advance such a type of dialogue, incorporating concepts stemming from post-Marxism in order to provide an account of autonomy that could speak to different contexts without sacrificing its commitment to the sustainment of worlds otherwise.

2.5. Research Questions

Having delineated the conceptual framework of this thesis, I address the following questions:

RQ1. What concerns overlooked by established paradigms emerge when examining the governance of astronomy data in Chile from the perspective of collective autonomy?

RQ2. Inspired by the case of astronomy data in Chile, what would be central elements of a framework of data governance based on collective autonomy?

Whereas RQ1 has a predominantly descriptive character, RQ2 has a more normative aim. Also, it is important to note that the notion of 'collective autonomy' I mention incorporates the two important analytical focuses I delineated earlier, namely situating this investigation in the context of the modern/colonial world system and paying attention to the political.

2.6. Conclusion

In this chapter I laid out a conceptual framework capable of bringing together discussions about data governance and data coloniality. In particular, I proposed to do so by turning to collective autonomy, an analytical and normative lens that draws on decolonial thinking and post-Marxism. Particularly relevant in this regard is that the notion of autonomy circulating in Latin America implies contextualising social relations in a capitalist modern/colonial world system, a concept depicting a power structure sensitive to the power dynamics and dimensions underlined by data coloniality scholars. My understanding of collective autonomy is informed by both decolonial thinking, which puts the focus on communality and territoriality, and post-Marxism, which underscores conflictuality and the non-fixed identity of the actors at stake. Since this combination is not free from theoretical and political issues, I finished by proposing pluriversal dialogue as a means to avoid reproducing Eurocentric hierarchies. After that, I formulated the three research questions underlying this thesis. In sum, the notion of collective autonomy I am putting forward makes it possible to reject preconstructed assumptions and practices accompanying developments such as datafication or AI, to interrogate whose interests and visions they serve and to figure out whether their implementation can still respond to the needs and visions of the local context.

The discussion I developed here touches on multiple fields of research, such as media and communications, critical data studies, information studies and political theory. This choice differs from previous studies on similar issues that have drawn on frameworks stemming from STS, a field that has provided fruitful tools to describe the role of science and technology in the configuration of the social and to overcome social theory's anthropocentrism. Furthermore, STS has benefited to a great extent from proposals that have combined it with postcolonial theories and concepts (W. Anderson, 2009; Philip et al., 2012), putting forward insights that resonate with some of the observations I provide in this thesis. Nevertheless, the limitations I pointed out in relation to the work on the translation of technology in Latin America show why STS would provide an insufficient theoretical foundation for this thesis—its emphasis on micro-level analysis and ethnomethodology has tended to overlook the role of macro structures that are fundamental

for decolonial thinking. This issue can become even more pressing in times of datafication, when the descriptive ethos and flat ontology of ANT—the most influential one within STS—can make it difficult to conduct the type of critique required to unravel the stakes of data coloniality (Couldry, 2020). Still, even if decolonial thinking and post-Marxism are privileged in this thesis, in the methodological and empirical chapters I occasionally draw on work developed in STS in order to take advantage of some of its insights.

The conceptual framework I proposed here brings in several analytical challenges, such as grasping the role of macro-level structures in particular settings and balancing between the agency of local actors and the influence of structures. Seeking to address these points, in the next chapter I delineate a hybrid discursive-material framework capable of examining the governance of data in a way that acknowledges the insights from both decolonial thinking and post-Marxism.

3. Methods:
Datafication and Coloniality Through a Discursive-Material Lens

3.1. Introduction

Whereas in the previous chapter I delineated the conceptual framework underlying this thesis, in this one I set out an analytical approach and a series of methods to empirically examine the governance of astronomy data in Chile from the perspective of collective autonomy. Such a task might sound straightforward, but the theoretical scaffolding and aims of this thesis introduce a series of challenges. First and foremost, it is necessary to take into consideration that the heterogeneous components making up the modern/colonial world system speak to dynamics pertaining to political economy, epistemology and ontology. Second, datafication constitutes an equally complex phenomenon that requires attending to its implications in spheres such as scientific research and the economy. In addition to these considerations, a thorough methodological framework would need to account for the particularities of the local context and acknowledge that as a researcher I am also part of the world system I am to analyse. The picture becomes even more pressing when noting that there are few similar studies on data governance from which to draw.

The framework I propose in this thesis is a hybrid one that brings together the analytical dimensions known as the discursive and the material and builds upon contributions from other disciplines such as anthropology and feminist theory. This approach differs from standardised notions of methodology based on pre-constructed alternatives (e.g., Creswell, 2007).[22] However, this choice does not translate into an 'anything goes' approach since here I acknowledge that each of the methods and theories discussed carries a different set of assumptions and histories that in some cases might enter into contradiction. The resulting hybrid and flexible methodological framework I develop here might offer a more complex account than established alternatives, but, as I argue throughout this chapter, this choice is necessary in order to provide nuanced answers to the research questions underlying this thesis. One of the ways in which I address this complexity is by providing a diagram (Table 2) summarising the steps undertaken in the analysis.

This chapter sets out a methodological framework capable of organising and operationalising theoretical and methodological debates held in a broad range of fields. To do so,

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[22] This approach echoes Ernesto Laclau's dismissal of 'the myth of methodology' in which the latter is seen as 'unified in an established and orderly system of procedures' (1991, para. 8).

I split the discussion into three main sections. In the first one I propose Nico Carpentier's (2017) 'discursive-material analysis' (DMA) as an overarching framework capable of interpreting the series of struggles over meaning, practices, technical affordances, productive arrangements and forms of relating to nature that I encountered in my fieldwork. This first section also clarifies the ontological and analytical foundations of this study and draws on ethnographic anthropology in order to address the politics of conducting fieldwork. In the second section, I turn to more procedural aspects of the analysis, describing the methodological adjustments I introduced in light of the particularities of the field and discussing matters concerning data collection, sampling, coding and validity. Finally, in the last section I take inspiration from feminist theory and address some of the tensions engendered by my positionality as a researcher and the type of critique underlying this thesis.

There are two important notes regarding the organisation of this chapter. First, discussions pertaining to ethics are spread throughout the sections, which means that aspects such as anonymity and positionality are addressed as they become relevant for the discussion. Second, the whole process is presented here in a linear way, but in reality it is the result of an iterative approach, which is one of the main features of qualitative research and that consists of a back and forth between the theoretical concepts and the empirical data (Carpentier, 2017, p. 15).

3.2. Discursive-Material Analysis and its Ontological Foundations

What makes people and groups powerful in times of datafication? Is it the possession or capacity to process vast amounts of data? Or, perhaps, the capacity to define the possession and processing of data as a criterion of superiority in the first place? These seemingly abstract questions can have crucial implications for empirical research since the answers provided will orient the observation towards particular dynamics and inform the type of conclusions provided. In Western thought, and more specifically continental philosophy, this dilemma has been regarded as a discussion over the role of the discursive and the material in the configuration of the social order. Some recent contributions to this debate constitute the point of departure for the analytical framework I am proposing.

Challenging either-or approaches, Nico Carpentier's (2017) DMA constitutes a hybrid analytical framework in which the discursive and the material are considered equally constitutive of social phenomena and therefore necessary for analysing the reproduction and disruption of the social order in a non-reductionist way. Rejecting dichotomous understandings, DMA brings together the discursive and the material by acknowledging their ontological inseparability and proposing a set of pragmatic procedures for grasping them in empirical work. As I describe

below, Carpentier's approach draws on Ernesto Laclau and Chantal Mouffe's DT and different entry points for the material.

The analysis of this thesis employs Carpentier's DMA as an overall framework but with two differences. One of them refers to the specific entry points employed in order to address the material. Whereas Carpentier draws on a number of sources, here I privilege Marxist social theory and STS. The second difference is that in this framework I also draw on ethnographic anthropology and feminist theory in order to address the politics and ethics of fieldwork and research.

3.2.1. The Discursive: Struggles over Meaning

There are different formulations of discourse, but most of them invite the researcher to look at how representations do not only describe but actively construct the phenomena they purport to represent, exerting power by defining what is open to discussion and what has to be considered as part of the natural order of things (Jørgensen & Phillips, 2002). Laclau and Mouffe's DT, which is the approach I employ in this thesis, would echo this definition in general but specify that the notion of 'representation' might underestimate the role of discourse in the constitution of the social world, as I explain below.

For DT, the social order is always constructed in accordance with the rules of signification. A basic rule in this regard is that meaning is derived in a relational way—as I mentioned in the previous chapter, what something is (a dog) depends on what it is not (a cat) (Jørgensen & Phillips, 2002, p. 10). As I also pointed out earlier, this observation explains the conflictual character of society since the construction of any identity necessarily relies on a negative association. Due to their interrelated character, such processes of signification end up positioning signs within a net, which in turn creates structures of meaning that construct the world and therefore the social order in particular ways. Thus, 'discourse' points to particular arrangements of signs within a net of meaning.

A key assumption of DT is that the position of the signs in the net is arbitrary and not determined by any external factor. In linguistic terms, this means that there is no objective link between the signifier (the word 'dog') and the signified (the actual dog). Due to this, discourse does not follow the logic of necessity but that of *contingency,* which means that the social order could always have been different. The politics of discourse revolve around attempts to conceal this contingency and present the links between signs as though there would not be any other alternative, setting as the goal of the analysis the foregrounding of their contingency. One of the

most controversial claims of DT is that *all* practices—certainly linguistic but also extralinguistic ones such as building a wall (Laclau & Mouffe, 1990, p. 100)—are discursive insofar as they are intelligible. Hence, no field of human activity, including scientific research and the economy, escapes from the logic of discourse.

For Laclau and Mouffe, the discursive is a field criss-crossed by conflict since any arrangement of signs necessarily involves discarding alternative options. Certainly, a given discourse can gain temporary fixity by stabilising meaning in a way that transforms certain assumptions into common sense. Moreover, an extremely sedimented discourse can give rise to a 'social imaginary', a concept I employ in chapter six and that constitutes 'an absolute limit which structures a field of intelligibility' (Laclau, 1990, p. 64). However, the contingency of discourse implies that it never achieves total closure, remaining open for contestation. Attending to this tension between stability and unfixity, discourse can be defined as 'a structure in which meaning is constantly negotiated and constructed' (Laclau, 1988, p. 254). A given discourse thus consists of a particular arrangement of signs that gives rise to a social order and that, even though it can acquire different degrees of fixity, is always subject to contestation and change.

Laclau and Mouffe proposed a number of concepts in association with DT, but two of them are particularly helpful for this study. The first one is 'articulatory practices', which are the actions through which agents establish, strengthen or dissolve the relations between the different signs that make up discourse (Laclau & Mouffe, 2014, p. 91). Articulatory practices can be empirically grasped by looking at how actors forge or challenge connections between words, concepts or representations, as is the case when policy makers in Chile make the case that 'astronomy data' is crucial to attain 'economic development'. The second concept is 'nodal points', which are 'privileged signs around which a discourse is organised' (Jørgensen & Phillips, 2002, p. 28). Nodal points are central to discourse because they provide fixity, infuse other signs with meaning and usually constitute a semantic battlefield. One of the analytical stages of this study consisted of identifying the nodal points underlying the discourse on astronomy data in Chile. As I explain in the next section, the chapters of this thesis were structured on the basis of three nodal points—collaboration, extractivism and territory—that are being re-signified and giving rise to semantic struggles as actors draw on them in order to make sense of what is going on.

The macro and holistic approach privileged by DT is particularly suitable for this thesis. In analytical terms, DT privileges a macro orientation towards 'general, overarching patterns' (Jørgensen & Phillips, 2002, p. 20), looking at how discourse relates to the broad social context (Carpentier & Cleen, 2007, p. 277). In practical terms, this choice makes it possible to explore the

relationship between datafication and the type of structures that are central for decolonial thinking such as the capitalist modern/colonial world system. The second advantage of DT points to its holistic character. As I argued earlier, DT sees all spheres and social practices, and not only written and spoken language, as mediated by the rules of signification and therefore subject to discursive analysis. This choice allows for examining the different types of empirical data I collected in my fieldwork, including semi-structured interviews, field notes and documents, that pertain to the spheres of scientific research, economic policy making and territorial conflicts.

DT's macro and holistic orientation explains why it represents a more appropriate framework for this thesis than alternatives such as critical discourse analysis (CDA) as developed by Norman Fairclough and Lilie Chouliaraki (Chouliaraki & Fairclough, 1999). In methodological terms, CDA emphasises everyday practices as well as talk and written language (Jørgensen & Phillips, 2002, p. 60). Among other procedures, it involves a close analysis of the linguistic features of a text as well as its context of production and consumption. Such a detailed textual analysis could provide fruitful insights about the linguistic mechanisms and settings underpinning the development and circulation of the discourse on astronomy data in Chile, but it might also distance the analysis from the interest of this thesis in macro patterns of power. DT also differs from Foucauldian discourse analysis inasmuch as it does not seek to examine a particular knowledge regime dominating in a period of history but rather to emphasise the conflicts taking place between different discursive articulations (Jørgensen & Phillips, 2002, p. 13).

There is a recurrent confusion concerning DT's ontology of the social that is worth clarifying here. Laclau and Mouffe never held an 'idealist' position, or the vision that there is no external reality. Instead, their argument was that 'our access to [external reality] is always mediated by systems of meaning in the form of discourses' (Jørgensen & Phillips, 2002, p. 35). In other words, DT's claim is not that there is nothing beyond discourse but rather that everything is rendered intelligible through the filter of discourse. To give an example, DT does not interrogate whether a stone exists but highlights that this stone can become 'either a projectile or an object of aesthetic contemplation' (Laclau & Mouffe, 1990, p. 101) depending on the discourse from which the stone is made intelligible. This observation is crucial for DMA since it negates the 'classical dichotomy' (Laclau & Mouffe, 2014, p. 94) that conceives of societal phenomena as either discursive or material, instead proposing that even what seems to be the most 'physical' phenomena have a discursive dimension. Such a claim is coherent with DMA's view of these two dimensions as ontologically inseparable even though, as I point out later, DT still presents deficiencies for grasping the material in practice.

A contradiction might arise when considering that the deconstructive ethos of DT might tend to disrupt *any* notion of totality. Certainly, when taken to an extreme, DT might operate as a weapon capable of revealing the arbitrary character of the even more profound assumptions that make social life possible. However, as decolonial thinkers argue, the problem is not the idea of totality itself which DT seems to target but rather modernity's 'totalitarian totality' (Mignolo, 2018, p. 147) that undermines alternative worldviews. Ernesto Laclau himself acknowledged the risk engendered by DT, which is why he did not consider deconstruction as an end in itself but rather as a tool functional for his theory of hegemony (Marchart, 2018, p. 19). By the same token, in this thesis the use of DT is anchored in the political horizon of collective autonomy, which provides discourse analysis with a purpose and sets a limit to its deconstructive drive. More specifically, this thesis primarily interrogates discourses that conceal the power dynamics encompassed by the modern/colonial world system and work against a pluriversal horizon by creating hierarchies between different ways of thinking and doing.

In sum, the discursive is considered herein as a crucial dimension structuring the social order. Discourse analysis has as one of its main goals foregrounding the political character of such an order by revealing its always contingent and contested character. In the next section I turn to the material in order to address an equally constitutive dimension of the social.

3.2.2. The Material: Acknowledging the Economy, Technosciences and Nature

As I explained, DT rejects dichotomous distinctions between the discursive and the material, understanding both dimensions as constitutive of the social order. However, in practice Laclau and Mouffe did not provide tools to grasp dynamics that might not adapt to the rules of signification (Carpentier, 2017, p. 37) and tended to highlight the *structuring* rather than the *structured* character of discourse (Jørgensen & Phillips, 2002, p. 18). For Arturo Escobar, theoretical formulations of this type have made important contributions but also reflect 'bits of modernism' (2020, p. 36) in their anthropocentric neglect of the role of objects, things and a whole range of other-than-human actors, including nature itself, in the configuration of reality. Because of this, further theoretical elaboration is needed in order to understand the logics of the material and how this dimension interacts with discourse.

Inspired by Carpentier's strategy, in this section I foreground and specify the role of the material in the constitution of the social order by looking at particular entry points or, as Paul Dourish would put it, to different 'materialities' (2017, p. 57). In particular, I draw on historical materialism and material semiotics due to their capacity to illuminate the role of the economic-productive processes, data infrastructure and nature in the case of astronomy in Chile. It is

important to note that providing an overarching definition of the material is outside the scope of this thesis, but, following discourse studies scholar Johannes Beetz (2016, p. 67), a starting point would be to associate this dimension with the physical realm, namely matter, mass, waves and so on. While helpful to get a first impression of what the material could mean, the points below clarify why this definition is too limited.

The first entry point to the material concerns phenomena pertaining to the economy, such as the alleged potential of astronomy data to overcome Chile's extractivist model that I analyse in chapter five. Historical materialism, which is the social ontology underlying Karl Marx's work, is particularly relevant in this regard. In this case, the material refers to the arrangements through which societies meet their subsistence needs, namely their 'modes of production' (Beetz, 2016, p. 21). Certainly, societies can transform their economic matrix, but they often find themselves within existing material productive structures that shape their positionality and capacity to act. In practical terms, historical materialism requires a degree of abstraction since the modes of production are the outcome of historical factors and make up complex structural arrangements. Still, it is possible to grasp the role of this understanding of the material by paying attention to 'observable human activity; practices; processes; definite (i.e. objective) relations individuals enter with things and other individuals; forms of property; and so forth' (Beetz, 2016, p. 28). This entry point to the material shares similarities with what Dourish and Mazmanian call 'the material conditions of information technology production', which they understand as 'the economic conditions favored by the speed, ubiquity, and manipulability of information rendered into digital forms' (Dourish & Mazmanian, 2013, p. 6). In the case of this thesis, and along the lines of world-system theory, observations over data-intensive modes of production focus on the way productive arrangements configure a planetary distribution of labour.

A question that arises is whether acknowledging the material in the form of modes of production implies undermining the role of discourse. In the view of Beetz and Schwab, the current formulations of discourse tend to approach the economy as part of the mere background of the phenomena studied rather than as a structuring agent in and of itself (2018, p. 343). To address this problem, they turn to early French discourse theorists and observe that discourse and the economy are intimately connected since discourse (1) always emerges under particular conditions of production and that (2) is key for the reproduction of these conditions of production. For them, these observations set as a task for the analyst 'to describe how they [discourse and conditions of production] practically interact in a given historical conjuncture' (2018, p. 346). In other words, the interaction between economic configurations such as the

distribution of labour in times of datafication and discourse cannot be assumed but rather depends on each case.

Besides historical materialism, the second entry point to the material in this thesis seeks to account for some of the transformations and challenges engendered by the employment of increasingly large volumes of astronomy data in scientific research and the expansion of its associated infrastructure. A useful notion of the material in this regard stems from the social ontology of 'material semiotics', a framework developed by STS authors, most notably Bruno Latour and Donna Haraway (Beetz, 2016, p. 109). Looking at technoscientific practice, Latour called for incorporating the agency of nonhuman actors such as laboratory instrumentation in analyses insofar as these also can 'modify a state of affairs by making a difference' (2005, p. 71). The material in this case comes to represent the capacity of an actor to matter (Haraway, 2016, p. 12), i.e., to inform a course of action, even if such a course of action is not intelligible in discursive terms. Some relevant technical arrangements I discuss in the empirical chapters structuring the phenomena studied are, for example, the dislocations ushered in by the observation mode of data-intensive survey telescopes (chapter four) and the constraints posed by the archiving protocols of an observatory (chapter five).

The inclusion of material semiotics in the analysis also makes it possible to grasp the ontology of nature held by Indigenous groups from different latitudes, including the Lickan Antay people affected by the construction of the ALMA observatory. One of the implications of the suspension of the dichotomy between human and other-than-human actors is a rejection of the divide between nature and culture that conceives of these as the passive background and the active agent of history, respectively (Escobar, 2018, p. 100). Such a binary is a modern/colonial construction since some non-modern cosmologies conceive of nature and culture as mutually constituted in non-hierarchical ways, which in turn gives rise to a politics and ethics of care with the territories. Acknowledging the mutual constitution between nature and culture challenges the anthropocentrism of discursive-oriented approaches, including postcolonial theory, since it reveals that the fate of communities and individuals might rely on dynamics that escape discourse. Paraphrasing Gayatri Chakravorty Spivak, attending to the agency of nature allows other-than-human others, including the territory, to speak (Jackson, 2014, p. 80).

Wrapping up the above observations, historical materialism and material semiotics direct the attention to instantiations of the material relevant for understanding the way economic arrangements, technoscientific infrastructure and nature interact with discourse and come to structure the social order. A point shared by these authors is that they approach the material in a relational way, rejecting the view of authors for whom 'materiality' is an 'essence' possessed by

'enchanted' things (Beetz, 2016, p. 118). Instead, historical materialism and material semiotics consider that the material only gains its identity in relation to human productive relations and heterogeneous assemblages. As Paul Dourish puts it, this approach departs from attempts 'to assert the brute materiality of things' and advocates examining 'the particular materialities that come to matter in different settings' (2017, p. 57). More broadly, the two materialities I have reviewed here respond to different genealogies and are incommensurable between themselves, making it impossible to come up with an overarching definition.

3.2.3. Bringing the Two Dimensions Together

Having explained my understanding of the discursive and the material, I proceed to discuss how I understand the relationship between them. From an ontological point of view, in this thesis I embrace the view of authors who conceive of these two dimensions as ontologically indivisible and co-constitutive of each other. Nico Carpentier's metaphor of the Gordian knot convenes this idea, portraying the discursive and the material as 'intrinsically, intensely, and intimately entangled' (2017, p. 13). As feminist philosopher Karen Barad argues: 'The relationship between the material and the discursive is one of mutual entailment ... Neither discursive practices nor material phenomena are ontologically or epistemologically prior … Neither has privileged status in determining the other' (2003, p. 822). Seen from this angle, societal phenomena are not discursive *or* material but rather both discursive *and* material at the same time. For DMA both dimensions are constitutive of social phenomena, constantly structuring each other, which means that their role should not be analysed in isolation.

Despite the above, a different picture emerges when approaching the problem from a methodological perspective. First, no author so far has provided a unified framework capable of foregrounding the logics of the discursive and the material in a completely symmetrical way. Even though both DT (Laclau & Mouffe, 2014, p. 94) and material frameworks (Dourish, 2017, p. 57) might agree on the ontological inseparability of the discursive or the material, their conceptual toolboxes tend to privilege one of these dimensions. Furthermore, a more basic constatation is that linear text makes it impossible to provide a completely symmetrical account. For example, such a limitation is implicit in Barad's argument that discourse needs to be materialised in order to exist and circulate (2007, p. 148). Conversely, one could also say that the material is discursively constituted, which means that Barad's observation presumes the pre-existence of a material medium. Thus, from a pragmatic point of view, I sustain that any analytical framework seeking to address both the discursive and the material necessarily has to rely on a procedural-methodological, albeit not necessarily ontological, prioritisation. What is

needed is a 'tactical move' (Dourish, 2017, p. 47) apt for the task of acknowledging the particularities of each case study, which in this case is astronomy data in Chile.

My deployment of DMA privileges DT as an initial organising tool—hence the name discursive-material—, acknowledges the role of the material in a second stage and wraps up the analysis with observations on the mutual constitution of these dimensions. In the case of this thesis, the procedural priority of DT does not respond to ontological arguments but to the infeasibility of conducting a symmetrical analysis and the particularities of the case study. As to the latter, in the case of astronomy data in Chile, many actors actively participating in the discussion, such as policy makers and activists, have not worked directly with this data and therefore have tended to formulate their views in predominantly speculative terms. Certainly, speculation does have a material dimension, but arguably the full significance of claims over the possibilities afforded by astronomy data can be better grasped by attending to the discursive. Another reason for granting analytical priority to DT in this thesis is that it is particularly well-suited for analysing interviews, which, given the practical impossibility of undertaking an in-depth participant observation in the multiple settings relevant in the governance of astronomy data in Chile, constituted my primary source of data. For these reasons, in the empirical chapters I do make references to the discursive and the material in different instances, but these should be understood as analytical and not ontological distinctions.

One of the challenges that arise when conducting DMA is that the discussion over the relationship between the discursive and the material tends to point to profound philosophical questions that might be difficult to transform into fruitful analytical tools. To address this, Nico Carpentier (2017, p. 77) proposes approaching the analysis of empirical data from the sociological notion of the 'sensitising concept'. Sensitising concepts transform theoretical concepts into lenses through which the empirical data can be examined, orienting the interpretation in a focused manner and enabling a dialogue between abstract concepts stemming from high theory and the phenomenon studied. The use of sensitising concepts differs from completely inductive approaches since it incorporates a selection of pre-defined theoretical considerations; however, it does so without reifying theory given that it privileges a cyclical approach in which concepts can be re-examined so as to better illuminate the phenomenon at stake (Carpentier, 2017, p. 15). In the next section I delve into the sensitising concepts employed in this thesis—which include the discursive and the material but also additional ones—and their role in the analytical procedures.

From a theoretical perspective, DMA provides crucial advantages for the study of datafication in a capitalist modern/colonial world system. In relation to decolonial thinking, DMA

resonates with Quijano's attempt to incorporate epistemology and political economy into a single analytical framework. As he argued, the world system encompasses both a 'cultural and intellectual intersubjective configuration' (2000, p. 540) as well as 'forms of labor control around capital' (2000, p. 540). Even though Quijano did not use this vocabulary, these two dimensions resemble the definitions I have provided of the discursive and the material. Moreover, DMA is also well-suited for bridging studies that have looked at datafication from different angles. From the side of discourse, David Beer argues that 'the way that these data are framed in particular rationalising discourses … needs to be treated carefully if we are to form a more detailed appreciation of the social implications of those data' (Beer, 2016, p. 113). However, there are fundamental reasons to think that a merely discursive approach to datafication would leave important features outside the analysis. In fact, one of the characteristics of digital data compared to other forms of recording is that its production involves removing its semantic content (Kallinikos, 2009). In addition to this, the properties and configuration of data and its infrastructure can equally shape its interaction with the social world (Dourish, 2017), making clear the need to also attest to the notions of the material I discussed earlier.

As I have argued, DMA is employed as an overarching analytical framework in this thesis in order to acknowledge the interplay between the discursive and the material in the governance of data. DMA understands the discursive and the material as mutually constituted, and in analytical terms my approach takes the discursive as a starting point, accounts for the material at a second stage and ends up by interrogating the entanglements of the two dimensions. As I discuss next, however, DMA has not yet incorporated a reflexive layer when it comes to the politics of conducting fieldwork. This limitation constitutes a significant deficit considering the series of questions that emerged when I undertook this empirical study.

3.2.4. The Politics of Fieldwork in Ethnographic Anthropology

During my fieldwork, I ran into profound methodological, ethical and political questions that neither decolonial thinkers—an exception being Catherine Walsh (2018)—nor discourse and material theoreticians have thoroughly addressed. These concerns ranged from specific situations that emerged from the interaction with participants to broader reflections about my own position within the modern/colonial world system. To address these issues, I took inspiration from discussions proposed in the context of the so-called postcolonial wave of anthropology that undertook a reconsideration of the politics of fieldwork in light of the increased awareness of ethnography's complicity with colonialism (Clifford & Marcus, 1986).

The first aspect of relevance for my thesis concerns the very notion of 'fieldwork'. Whereas in the past ethnographers tended to spend years in non-Western communities to 'describe' their habits and worldviews, political and theoretical transformations in the second half of the twentieth century rendered this approach obsolete. Because of this, many anthropologists now conceive of the identification of the cultural formation at issue not as a given but as a question that is part of the research itself (Marcus, 1997, p. 96). This situation pretty much captures my experience when conducting fieldwork. Initially, I considered that investigating the case of astronomy data in Chile would entail looking at scientific research and technological development, and elaborated my research design accordingly. However, as I started talking to people, I realised that this approach was too narrow to grasp the whole range of implications at stake from the perspective of collective autonomy. Paying attention to discussions on ethnography makes it possible to interpret the expansion of my initial locus of interest not as a secondary order consideration but rather as a finding in itself. In fact, the need I faced to expand the initial delimitation of my fieldwork is telling of the incapacity of existing frameworks of data governance to anticipate the types of issues that emerge when acknowledging that datafication is taking place in the context of a modern/colonial world system. Inspired by ethnographic anthropology, I describe the adjustments I undertook in detail in the next section.

A second matter central to ethnographic anthropology concerns the politics and ethics related to the position of the researcher and potential asymmetries with the participants. The colonial roots of ethnography have prompted anthropologists to develop a profound critical reflexivity of their complicity with asymmetrical social structures. As anthropologist George E. Marcus (1997) argues, the challenge in this regard is to conduct fieldwork in a way that is both aware of such connections but, at the same time, rejects the assumption that the researcher is always in a position of power. More generally, anthropology and ethnography have engaged with questions concerning the position of the native informant, the representation of 'the other' and the politics of speaking for other groups, in which the influence of postcolonial and feminist theory have been of particular help (Gajjala, 2002). One of the ways in which I deal with these issues in this research is by making an active effort to situate myself explicitly in the narrative and to account for the way my positionality informed the study. Such instances can be found in different parts of this thesis, but especially in the reflexivity section of this chapter. This choice is aligned with decolonial (Mignolo, 2009) epistemologies that advocate for revealing rather than concealing the location of the knowing subject.

To be clear, my aim in this section is not to propose an anthropological or an ethnographic study. One of the reasons for this is simply because spending a long period of time

observing people's everyday lives, which is what most ethnographers do (Atkinson & Hammersley, 2007), does not represent the best means to address the concerns underpinning this thesis. However, the way I approached the questions that emerged when conducting this study does build upon reflections conducted in relation to ethnographic anthropology.

3.3. Conducting and Operationalising DMA

3.3.1. Adjustments in the Field: Scaling Up the Research Design

Originally, this research project intended to observe the laboratory practices of scientists and engineers working with astronomy data in Chile. With this goal in mind, in October 2018 I got in touch with the staff of ChiVO, an initiative focused on the archival and standardisation of ALMA data located at the Federico Santa María Technical University (UTFSM) in the industrial area of San Joaquín, Santiago. Thanks to the generosity of ChiVO's team, I was based in their office from December to 2018 to May 2019, which is the period when I undertook my fieldwork.[23] Spending time with the ChiVO team and attending talks and conferences with them was crucial for this research since it allowed me to gain familiarity with the vocabulary, the actors and the history surrounding astronomy data in Chile. In compensation, I worked on their website and gave them a hand in order to expand their outreach. I shall not underestimate the influence of my proximity with ChiVO over the analysis, which is especially clear in chapter four when I refer to its trajectory of collaborations.

However, the situation in the field made me introduce profound changes into the design of this study. At the time I conducted my fieldwork only three people were working regularly for ChiVO, of whom only one would attend the office more than two days a week. This meant that in practice I had to abandon the idea of using participant observation as the primary source of data. In addition to this, I noticed that astronomers and astroinformaticians were only two of the groups involved in the discussion surrounding astronomy data. Policy makers and representatives from local companies had been debating the possibilities afforded by astronomy data for years. Even more, my arrival in Santiago coincided with the launch of the DO private-public partnership between the Ministries of the Economy and Science, AWS and UAI I mentioned in the introductory chapter. Later on, I also decided to incorporate the view of the Lickan Antay Indigenous communities affected by the construction of one of these observatories. These choices

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[23] The empirical chapters are narrated in present tense taking this period of time as their referent.

expanded the scale of my research significantly, making it necessary to replace the workplace ethnography I had envisioned with an approach capable of addressing what was going on in a broad range of domains. Against this backdrop, discursive-material analysis and interviewing became a feasible way to account for the wide-ranging spheres and actors at stake.

Incorporating the view of Lickan Antay people into this study deserves further reflection because it speaks to my areas of ignorance as a researcher and the coloniality of discussions on data governance. Before the fieldwork I had heard about the conflicts ushered in by the concession of the Chajnantor mountain by the Chilean government to ALMA in 2002, when Indigenous communities protested since they considered this mountain as part of their ancestral territories. Due to the lack of reliable information on this dispute, I decided to talk to at least one member of this community. At that point I was thinking of this interview as a means to provide a fairer account of the background of my study. However, meeting with this interviewee constituted a turning point since it allowed me to realise that the Lickan Antay people did have a profound message on the connection between data governance and issues such as extractivism, territory and the design of data infrastructures. In Catherine Walsh's words, this encounter allowed me to 'unlearn in order to relearn' (2018, p. 87), pushing me to reconsider the issues and actors that the literature on data governance had taught me I should take into account. Besides the ignorance of the literature on the subject, this shift reveals my own modern/colonial assumptions as well as the systemic neglect of Indigenous voices in Chile. The vision of the Lickan Antay people ended up having a fundamental role in this thesis inasmuch as it signals an opportunity to rethink datafication from a perspective that challenges the narrow frame of modernity/coloniality.

Scaling-up the research design took me to a much broader range of settings than I had initially envisioned. In Santiago, the capital of Chile, I spent most of my time in ChiVO's offices, but also visited the facilities of the Ministry of the Economy and the Ministry of Foreign Affairs in the civic centre; companies that have provided digital networking services to the observatories; astronomy and engineering departments at public and private universities; the Calán Hill hosting the National Astronomical Observatory;[24] and the offices of international observatories and scientific organisations. I also went to many cafés in the neighbourhoods of Santiago Centro and Providencia, where I would meet with some participants and escape the summer heat that reached record-breaking temperatures of over 38ºC in January 2019. I also undertook field trips to the two main sites of astronomical observation in Chile. In the Coquimbo Region, I attended a conference

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[24] The National Astronomical Observatory is run by the Department of Astronomy at the University of Chile and is currently employed for training and tours.

at the University of La Serena and participated in a private visit to the LSST guided by its director, Steven Kahn. I was fortunate to be able to get relatively close to the LSST team and these facilities since, as I explain in the next chapter, this observatory's large volumes and velocity of data have been crucial in the debate on astronomy data. In the Antofagasta Region, I attended a public event in Antofagasta City, visited the Very Large Telescope (VLT) and talked to Indigenous activists in the city of San Pedro de Atacama.

Figure 1: *Map of Cities and Observatories I Visited during the Fieldwork*
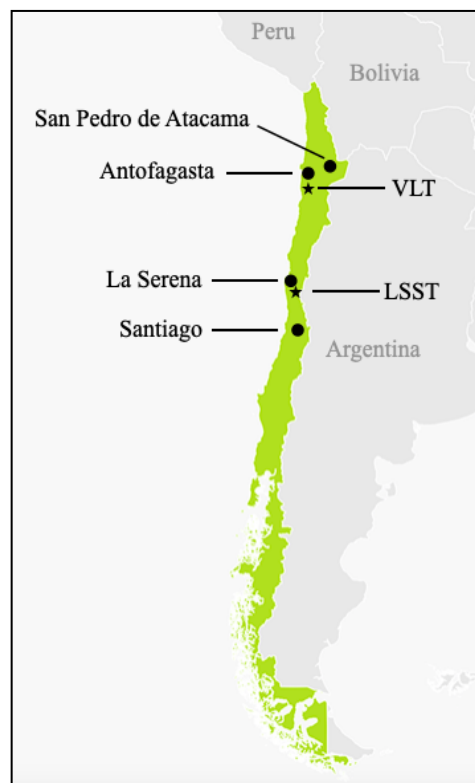
Note. The circles (●) represent cities and the stars (★) observatories.

3.3.2. Data Collection: Interviews, Participant Observation and Documents

The data analysed in this thesis stems from interviews, field notes and documents. For reasons I discussed earlier, interviewing was central for the analysis. One of the strengths of this method is that it grants the researcher a degree of control over the data produced, which sits well with the theoretical-laden research questions of this thesis. Most of the interviews followed a semi-structured strategy (Brinkmann, 2018), which means that the questions were based on a topic guide. My initial topic guide worked pretty well in the case of scientists and engineers, but

as I talked to more people, I decided to adopt an increasingly open attitude to find out about themes and concerns that I had not envisioned originally. The sampling of the interviews mainly followed a purposive strategy (Denzin & Lincoln, 2018, p. 553) that relied on two criteria: that participants would be (1) working with, seeking to work with or affected by astronomy data and/or its technical infrastructure as well as (2) working for organisations based in Chile. Even though I originally considered incorporating actors working for the observatories, I decided to leave them outside the sampling since after two pilot interviews I concluded that they had not elaborated much on the opportunities afforded by astronomy data outside the field of astronomy research itself. The only exception in this regard is Jorge Ibsen, the Head of Computing at the ALMA Observatory, whom I interviewed and incorporated into the analysis given that, as many participants expressed to me, he has been one of the most influential actors in the discussion over the last decade.

I conducted 34 interviews in total, which allowed me to talk to some of the most influential actors and to representatives of all the groups with an active role in the discussion. The interviewees had a background in astronomy (12), engineering (8), informatics (4), Indigenous activism (3), law (2), arts (2), physics (1), business management (1) and journalism (1). At the time I talked to them they were working for academia (16), the public (8) and private (5) sectors, activist groups (4) and an observatory (1). The interviews were conducted in Spanish and only two of them were not held face-to-face since the participants were in Germany and Concepción, in the south of Chile. All the participants were familiar with the local astronomy community and had relatively strong connections with Chile even though this was not a criterion I pursued. None of them requested any type of anonymity, which is why I employ their names in the empirical chapters. Only on a few occasions I provide quotes without any associated name to avoid exacerbating existing tensions, an aspect I discuss in chapter four.

In terms of gender, interviewees identified as men (27) and women (7), which reflects the balance of the astronomers working in the Chilean academia (Chilean Astronomy Society, 2019). As in other contexts, there are profound cultural and material barriers in Chile impinging upon the participation of women in this field (CONICYT, 2017). This issue was an important concern for the astronomy community at the time I conducted my fieldwork. In that period of time, international and national media were starting to foreground female figures such as Katie Bouman, the data scientist behind the first picture of a Black Hole (Ellis-Petersen, 2019), and María Teresa Ruiz, a Chilean astronomer who was the first woman honoured with the National Award on Exact Sciences (University of Chile, n.d.). Some programmes and campaigns in Chile were also seeking to highlight the role of women in the discipline (e.g., ALMA, 2019b).

Beyond the issue of representation, feminist authors have long argued that the dominant paradigm in modern science and technology has been shaped by 'phallogocentrism', viz. the conception of the researcher as a neutral actor who merely describes the natural world (Haraway, 1991). Among other problems, such a vision brackets off broader questions about how seemingly neutral scientific depictions of reality produce and reproduce social and cultural hierarchies. More recently, feminist authors have shown that this way of thinking has also permeated the nascent field of data science, which tends to reproduce 'masculinist, totalizing fantasies of world domination', only that this time they are 'enacted through data capture and analysis' (D'Ignazio & Klein, 2020, p. 151). Computational sciences—which includes data science, Machine Learning (ML) and AI—constitutes an environment especially hostile for Black women and women of colour inasmuch as it has rendered invisible their contributions and has not managed to undo misogynistic and racist assumptions in its practices and research focuses (Birhane & Guest, 2020).

In addition to the interviews, I also conducted participant observation at five events, all of which are listed in Table 1. As with the interviews, a purposive sampling strategy was employed that took into consideration both the topics to be discussed and the people attending them. In practice, these events reflect an almost exhaustive list of the ones that took place in Chile between December 2018 and May 2019 touching on astronomy data. Looking at the table below, the first of these events had an academic character, the second and fourth ones sought to introduce the DO to particular audiences, the third one was a public event and the fifth one gathered people working in digital academic infrastructure from Latin America and the United States. The first one organised by the LSST Chile team was the most productive for the purposes of this thesis since it allowed me to observe the interactions between local astronomers, the staff of the observatories and policy makers. This event's aim was also especially suggestive: 'to prepare the Chilean community for the large volumes of data coming from LSST, which represent an excellent opportunity to develop world class scientific research' (LSST Chile, 2019).

Table 1: *Events Attended During the Fieldwork*

Title	Date / City	Participants
IV Workshop LSST Chile: Towards Science in Chile with LSST	6-9 March, 2019 La Serena	LSST observatory, local researchers and DO
Data Observatory: From Astronomy to the Industry	21 March, 2019 Santiago	DO and UAI
Puerto de Ideas Antofagasta	12-14 April, 2019 Antofagasta	Observatories and local astronomers
Data Observatory Announces Founding Partners[25]	16 April, 2019 Santiago	DO, AWS, astronomers and astroinformaticians
South American Astronomy Coordination Committee (SACC)	17 April, 2019 Santiago	Observatories, DO and infrastructure operators

In the interviews and events, I introduced myself as a PhD researcher at the London School of Economics and Political Science studying the relationships between the observatories and local actors. I also provided details about me and this research project in a consent form that all interviewees signed (Appendices 2 & 3). It is likely[26] that my affiliation to a prestigious university according to international rankings granted me a higher degree of access and might have induced some actors to provide socially desirable answers to audiences in the Global North. Another aspect of my positionality that could have had repercussions in this research is my position in Chilean society. Markers such as my accent and surname could have prompted participants to guess my nationality (Chilean), class (upper), city of origin (Santiago) and race (Euro-Mestizo Latin American).[27] In some cases my social position could have encouraged identification, as might have been the case of part of the staff of the Ministry of the Economy that identify as men, grew up in Santiago and graduated from the Pontifical Catholic University and universities in the Global North (Marchetti Michels, 2018). In other cases it could have produced

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[25] I could not attend this event due to personal reasons, but I employed an audiovisual record on Twitter for the analysis (Ministry of the Economy, 2019c).

[26] I use a conditional assertion since accounting for one's and other people's identities is always a speculative task (Pillow, 2003, p. 181).

[27] As is usually the case with social categories, there are nuances about my identity. However, this is how I think that participants read me overall. The term 'Euro-Mestizo Latin American' is not employed in Chile but I am drawing on it in order to account for my racial positionality despite the silence in the country regarding issues of race (Barandiarán, 2012).

a de-identification, as was the case when a member of ChiVO staff would highlight my background at the Pontifical Catholic University or when an Indigenous activist would call me 'Chilean'. I discuss further the political significance of my positionality in the reflexivity section.

Besides interviews and participant observations, a third body of data stemmed from documents, which were particularly fruitful for analysing the evolution of the conversation and the inclusion and absence of certain actors through time. In some cases, these documents also contained information on the flows of financial resources and data that were incorporated into the analysis. The sampling of documents also relied on a purposive strategy, this time aimed at covering: the origins and trajectory of local initiatives (Barba et al., 2008; DO, n.d.; Ministry of the Economy, 2019b; UTFSM, 2015a), the possibilities afforded by astronomy for the Chilean industry (ADDERE, 2012; Aguilera & Larraín, 2018; CONICYT, 2012, 2013), and the environmental disputes between the ALMA observatory, the Chilean state and Lickan Antay Indigenous groups (Antofagasta Region Assessment Commission, 2017; Council of Atacameño Peoples, n.d.-a; Environmental Assessment Service, 2018).

When it comes to the social context, my fieldwork coincided with something akin to a parenthesis between two moments of intense social unrest in the country. In May 2018, before I arrived in Santiago, a feminist uprising occupied several universities and spurred widespread protests across the country in order to demand a non-sexist education system (Zerán, 2018). In October 2019, four months after I left and when I was in London trying to make sense of what I had seen and heard in the field, the unprecedented social uprising I mentioned in the introductory chapter took place (Contardo, 2020). Since the period of data collection finished before this social uprising, its impact is not reflected in the empirical chapters.

3.3.3. Analysis: Coding, Sensitising Concepts and Nodal Points

Having discussed the methodological foundations of this research and the context of my fieldwork, in this section I refer to the specific procedures I carried out for the analysis of the data. In order to provide an overview, I summarised the four stages entailed in the analysis in Table 2.

As I argued earlier, for pragmatic reasons my analysis started with the interview data. The first step in this regard was to deploy a thematic strategy of coding in order to obtain a general picture of the topics touched on during the conversations. The development of the codebook (Appendix 1) for this process combined both inductive and deductive criteria since it started with

a set of pre-constructed codes informed by the theoretical framework that was expanded after a pilot of five interviews.

After the coding, I deployed a DMA by conducting a selective re-reading of the interviews focusing on the connection between some codes of interest and the sensitising concepts of 'the discursive', 'the material', 'collective autonomy', 'the capitalist modern/colonial world system' and 'the political' due to their relevance in the conceptual framework I laid out in the previous chapter. Relying on these sensitising concepts allowed me to incorporate a more deductive criterion for selecting potential topics to be explored in more detail, discarding some themes such as 'meritocracy' that did not hold direct relevance in light of the conceptual framework.

Third, I identified the nodal points emanating from the interviews and interrogated their relationship with the overall themes present in the interview data with an emphasis on the semantic struggles associated with each of them. In this case the analysis did not follow a quantitative criterion but rather focused on the role of particular signifiers in the overall discourse, by which I refer to their capacity to explain and justify phenomena, to articulate different concerns and to challenge dominant assumptions. As a result of this process, some themes emerged as potential candidates for further analysis, such as the approach to astronomy data as a form of 'nation-building'. However, I ended up privileging three nodal points of particular interest for addressing the research questions and that pointed to different spheres of social activity: 'collaboration' in research, 'extractivism' in economic policy making and 'territory' in territorial conflicts. Collaboration was one of the most frequent signifiers I heard during my fieldwork, and looking at it in more detail made me realise that it was fundamental for understanding who was who and the hierarchical configuration of the relations between the actors involved. The cases of extractivism and territory are different because, even though in some cases they were mentioned explicitly, I used these specific signs as umbrella terms in order to group a broader range of statements over the repetition of a pattern in Chilean history (extractivism) and the unique geographic conditions of Chile for the production and management of data (territory). The three empirical chapters of this thesis are structured on the basis of these nodal points, offering a panoramic view of the modern/colonial power dynamics operating in relation to astronomy data in Chile.

In two of the three analytical stages (sensitising concepts and nodal points) I interrogated the role of the discursive, looking at semantic struggles; paid attention to the role of the material in such semantic struggles, asking how the productive matrix and other-than-human actors could be shaping the phenomena at stake; and, finally, looked at the mutual constitution between the

discursive and the material, approaching them in non-hierarchical terms as equally constitutive aspects. For this reason, it is possible to find observations about each of these dimensions and their mutual constitution in all the empirical chapters.

Finally, after the interviews I undertook a 'triangulation' (Flick, 2018) of the data, analysing how the insights obtained from the interview data could be deepened, complemented or contradicted by the field notes and documents. Even though I was open to discovering tensions and contradictions not addressed in the interviews, these sources of data were coherent with the insights I had arrived at; they therefore allowed me to expand my observations by illustrating them with anecdotes and stories and providing a more richly textured account of the phenomena.

Table 2: *Stages in the Analysis of the Empirical Data*

Stage	1	2	3	4
Type	Coding	Discursive-Material Analysis		
Strategy	Thematic Coding	Sensitising concepts	Nodal Points	Triangulation
Aim	Capturing the main themes discussed	Filtering codes based on theoretical concepts	Identifying privileged signs and their attendant power dynamics	Comparing field notes, documents and interviews
Data	Interviews			Field notes and documents
Scope	Broad	Narrowing down (from broad to in-depth)	In-depth	
Dimension	None in particular	The discursive, the material and the discursive-material		

Taking advantage of the flexibility afforded by DMA, the analysis encompassed different units of analysis in both the interrogation of the data and the presentation of the results. Because of this, the findings discussed in the empirical chapters draw on forms of evidence that range from text-based semiotic observations, in which I conduct interpretations based on the position of particular signs in a quote or an image, to longer chunks of texts referring to stories and anecdotes, which I approach from a hermeneutic-interpretive lens. As I argued earlier, the

flexibility of DMA also allowed me to bring together partial traces of evidence scattered in the interview data, field notes and documents.

3.3.4. Validity: Coherence, Fruitfulness and Triangulation

In positivist frameworks, the criterion of 'validity' seeks to measure the degree of accuracy of a study based on standardised assessments. This approach would be unsustainable in this thesis considering that decolonial thinkers as well as Laclau and Mouffe understand the establishment of universal criteria as an act of power, even more so when it comes to knowledge production. Despite this, I do not want to abandon the intention of providing some degree of accountability since I hope that this research will speak not only to qualitative social scientists but also to natural scientists, engineers and policy makers interested in the subject and with whom I spoke during my fieldwork. Because of this, in this section I draw on Jørgensen and Phillips (2002) and Uwe Flick (2018) and discuss the way this project relates to the principles of 'coherence', 'fruitfulness' and 'triangulation'.

Coherence points to the plausibility of research for a community of scholars (Jørgensen & Phillips, 2002, p. 172). Following this criterion, I would argue that this research will make sense to a broad range of social scientists familiar with constructionist paradigms—such as post-structuralism, decolonial thinking and STS—that conceive of knowledge production as deeply embedded in relations of power. In addition to this, I expect that the explanation of the epistemological and ontological foundations of this thesis would allow readers adhering to different paradigms to understand the suppositions underpinning this research and the location from which I am speaking. It is important to note that different theoretical and methodological frameworks would have illuminated different aspects of the case study. For example, a micro-ethnographic approach such as the one I initially envisioned might have tended to emphasise the ingenuity of local researchers in the laboratory at the expense of a broader understanding of the role of planetary structures in the governance of data.

To propose that this study represents one among multiple potential readings raises another question—why *this* approach and not another? It is with regards to this concern that the criterion of fruitfulness (Jørgensen & Phillips, 2002, p. 172) comes in handy. In the tradition of critical research, fruitfulness points to the extent to which a study can help transform the social world based on principles of social justice. My contribution in this regard has been to turn to decolonial thinking in order to explain how a way of thinking and implementing the governance of data connects with macro patterns of power. Not coincidentally, the themes that emerged from the analysis respond to long-term social justice struggles in Latin America and can provide an

orientation for activists and communities from different latitudes for whom mainstream discussions on data governance do not reflect their concerns. Broadly speaking, the search for worlds otherwise driving this research has become particularly urgent in light of the current political and social conjuncture marked by an ongoing terricide, increasing inequalities and the rise of racist, misogynistic and climate-denier leaders, such as Jair Bolsonaro in Brazil and Donald Trump in the United States, across the planet (Escobar, 2018, p. ix). I discuss further the implications of this research outside academia in the concluding chapter.

Finally, the principle of triangulation, which I also approached earlier as a stage in the analytical procedures, calls for reflection on how each of the methods deployed constructed the phenomena studied. In this study, the methods of data collection yielded consistent insights and therefore allowed me to dive deeper into the themes I discuss in the empirical chapters. However, it is important to note that in some instances the relationship between this data was incommensurable, which made it impossible to make them speak to one another. For example, in this study I did not use some of the field notes from my observation of ChiVO, especially those that I wrote down at the beginning of my project, since their micro focus express concerns closer to the field of human-computer interaction (HCI) that were difficult to put into productive dialogue with the meso- and macro-scale analyses that I privileged afterwards.

Coherence, fruitfulness and triangulation, as well as the idea of validity in itself, constitute contested concepts for constructionist paradigms. However, in the above paragraphs I have approached them from a perspective coherent with the ontological and epistemological assumptions of this study. Referring to these criteria provides an opportunity to open up this thesis to the scrutiny of researchers subscribing to different paradigms of knowledge.

3.4. Reflexivity: Doing Research under a Civilizational Crisis

In this section I interrogate how my positionality as a researcher, as well as the political economy and the critique underlying this study, might have informed the observations I arrived at. More broadly, I also consider the impact of this project outside academia and its entanglement with the modern/colonial hierarchies it seeks to denounce. To do so, I take inspiration from the discussions on anthropology and ethnography I mentioned earlier as well as from feminist authors with a post-structuralist, decolonial and STS sensitivity. This process of reflexivity brings to the fore contradictions that, rather than 'issues' to be 'solved', are 'critical to exposing the difficult and often uncomfortable task of leaving what is unfamiliar, unfamiliar' (Pillow, 2003, p. 177).

3.4.1. Positionality: Tensions and Contradictions

Assuming that knowledge production and power are intimately related, reflexivity constitutes an account of how the social and epistemological location of the researcher could have informed the insights discussed and affected the setting studied. As I mentioned earlier, one of the most noticeable aspects of my positionality as a researcher in the eyes of the participants was my affiliation to the LSE. This is especially relevant in light of a decolonial framework since it implies that studying in a prestigious university in the Global North inserted me into some of the dynamics I describe in the empirical sections. Perhaps the best way to illustrate this point is by drawing on an argument I advance in chapter four and to argue that it is likely that my affiliation to the LSE could have transformed me into an actor that local actors wanted to 'collaborate' rather than to 'compete' with. This is not an aspect I explicitly discussed with the participants, but on more than one occasion I perceived a subtle nod when I would introduce myself as a PhD researcher at the LSE. My academic affiliation might have also been interpreted in a positive way by members of ChiVO, who perhaps read my interest in their project as a recognition of their trajectory by a prestigious European university.

I have already discussed how my belonging to the Chilean elite in terms of race, gender and class could have encouraged identification and disidentification from the side of the participants. Besides this, my relationship with them was also mediated by disciplinary and epistemological divergences and convergences. A particular anecdote illustrates the degree of the gap I experienced with some of the participants with a background in natural sciences and engineering. Before coming back to London, I was invited by the people from ChiVO to present some preliminary insights in a series of talks organised by the Department of Informatics at the UTFSM. The title of my presentation was 'Imagining Astronomy Data'. At that moment I was thinking of the concept of sociotechnical imaginaries by Sheila Jasanoff and Sang-Hyun Kim (2015), but the word 'imaginaries' produced varied reactions from the audience. One person asked me whether I was referring to the technocratic ideology of science. Another thought that by this word I was disregarding the real value of data and went on to mention the example of Switzerland, a country that in his view was investing in concrete and costly initiatives because they had already understood the opportunities afforded by big data. Even though I tried to be as clear as possible in my definition of the sociotechnical imaginaries, I found out that I would have to be very careful from then on when talking about the concepts employed in my research so as to avoid misunderstandings.

This epistemological distance was shorter in the interactions I held with Indigenous and civil society activists since their views tended to reveal more awareness of the power dynamics of

my interest. I felt especially enthusiastic in the conversations with Lickan Antay activists, whose visions of science, technology and development were much closer to mine despite our different social positions. In my view, the risk encompassed by this sense of proximity is not offering a 'subjective' account but instead adopting an uncritical attitude towards the views of those I felt closer to. Puerto Rican sociologist Ramón Grosfoguel captures this issue with the notion of 'epistemological populism' that points to situations where 'whatever is said by an Indigenous or a Black person is by definition decolonial and whatever is said by a European is colonial' (Grosfoguel & Martínez Andrade, 2013, p. 8). What is required, then, is a stance critical of pre-constructed categories capable of interrogating the role of assumptions and practices in relation to the modern/colonial world system.

Finally, I do not underestimate the impact of the historical processes that took place during the writing up of this thesis. Perhaps the one that had the most significant impact was the massive and unprecedented social uprising in October 2019 in Chile, which was accompanied by state violence, opened up a constituent process and coincided with a global wave of protests in places such as Lebanon (Lehuedé, 2019). Another crucial event was the COVID-19 pandemic that extended from 2020 to the submission of this thesis and that, beyond the harms produced by the virus itself, laid bare the incapacity for collective action in both Chile and the United Kingdom (Lehuedé et al., 2020). In parallel with the pandemic, the Black Lives Matter movement experienced a resurgence in the United States and the United Kingdom, which in turn had an impact in British academia and the Department of Media and Communications at the LSE. The climate crisis has also been an important critical factor underlying this study. Prompted by the influential 2018 report by the UN Intergovernmental Panel on Climate Change (IPCC), the Extinction Rebellion environmental justice group gained momentum in the United Kingdom before the pandemic. In parallel, Indigenous and peasant activists in Latin America opposing extractivism continued being harassed and murdered in places such as Colombia and Brazil (Greenfield & Watts, 2020).

These processes shaped my thinking in ways that are difficult to account for. In general, I felt that these historical events were inaugurating what Indian writer Arundhati Roy conceived of as 'a portal, a gateway between one world and the next' (Roy, 2020, p. 48) or, in the vocabulary of communities in Latin America, an opportunity for transitioning to a different 'civilizational model' (Escobar, 2018, p. X). More personally, the COVID-19 pandemic made the process of writing lonelier than I would have wanted, which in turn made me especially sensitive to different injustices and forms of violence that I could not help following on social media. On some occasions I even raged against my decision to investigate astronomy data at a time when there

were more urgent necessities and problems. I felt particularly compelled by Seeta Peña Gangadharan and Jędrzej Niklas's (2019) observations regarding the contrast between the techno-centrism of some approaches to algorithmic discrimination *vis-à-vis* the priorities of social justice groups. An outcome of these reflections is my attempt in this thesis to unearth the relationship between data governance, the Chilean model of development and harms such as the ongoing terricide. Furthermore, the social context of this study also motivated me to attend more carefully to the connections between datafication and long-standing power dynamics and struggles in Latin America, a choice that fit quite well with the decision to scale-up the original micro focus of this research.

3.4.2. The Epistemological Extractivism of Indigenous Knowledges

While writing this methods chapter, I attended a virtual conference about sciences in Chile that invited me to reflect on the way I was employing Indigenous knowledges in this thesis. On this occasion, a Mapuche participant expressed:

> Cultural extractivism is what bothers us the most … My complaint is that people who have achieved the degree of doctor in sciences take advantage of the Indigenous peoples in order to extract knowledge, even to publish abroad … And they never mention, they don't even name, the *lamgenes*[28] from whom they extracted the knowledge.

Different authors have denounced the colonial roots of research and how such practices extend to this day in academia (Smith, 1999). Nevertheless, hearing the above remarks made me see with greater clarity the academic capital I would obtain by drawing on the knowledge of Indigenous people. 'Processing' the interviews held with Indigenous activists and 'applying' the knowledges of the Lickan Antay people and other communities would allow me to obtain a degree in a renowned university based in the Global North, reinforcing pre-existing planetary and national asymmetries. Furthermore, the funding source of my scholarship, the Becas Chile programme, comes from the same nation-state that attempted to destroy the modes of existence of Indigenous communities (Bengoa, 2004), has been criticised for privileging a small elite in the country (Quevedo, 2017) and has predominantly benefited universities from the Global North

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[28] 'Lamgen' stands for 'sister' in the Mapuche language (Ministry of Social Development, 2021, p. 38).

(CONICYT, 2019b). A much more pessimistic take on the potential contributions of this research emerged as I took these observations into consideration more seriously.

The above reflections echo some of the insights expressed by Silviera Rivera Cusicanqui. Denouncing the practices of some members of the modernity/coloniality group, Rivera Cusicanqui argues that academic knowledge production is criss-crossed by extractivist dynamics, with some researchers based in the Global North taking advantage of the knowledges produced in Latin America in order to benefit from the 'economy of salaries, perks, and privileges that certifies value' (2012, pp. 102–103) in academia. Regarding her criticism of authors such as Aníbal Quijano, it is relevant to point out that I do share her points on the lack of recognition of work by Indigenous and Black women authors, which reflects a problematic and paradoxical form of coloniality in Quijano's work (see algo Grosfoguel & Martínez Andrade, 2013, p. 8). Nevertheless, Rivera Cusicanqui's points also reflect back onto my positionality and the effect of this thesis, since when I finish my PhD I will be able to increase my academic capital and that of the LSE without necessarily having contributed to the struggle of the Indigenous people from whom I draw in the theoretical and empirical chapters.

However, this sense of reproduction of coloniality does not capture the whole range of political consequences that this thesis might engender. Even though the Lickan Antay activists are currently facing urgent problems such as the extraction of lithium, before our conversation they were not aware of the relevance that astronomy was acquiring for the economy and of the government's plan to invest in astronomy data as a means for development. This exchange of information and sentiments produced something akin to the type of complicity between researcher and participant advocated by the anthropologist George E. Marcus. For Marcus, this type of complicity 'derives from having a sense of being *here* where major transformations are under way that are tied to things happening simultaneously *elsewhere*, but not having a certainty or authoritative representation of what those connections are' (Marcus, 1997, p. 96, emphases in the original). Something was going on with astronomy data in Chile, something that had to do with the Atacama Desert but that had connections with Santiago and other regions of the world, something strange but not necessarily secret, that both my knowledge as a researcher and the knowledge of Lickan Antay people could help unravel. In that sense, many of the insights I provide in this thesis constitute the product of a fruitful collective process of figuring out with Lickan Antay activists and other actors the shifting landscape of knowledge production, economic policy making and territorial struggles under datafication.

One of the goals of this thesis is to make room in the debate on datafication for groups and communities engaged in the construction of worlds and knowledges otherwise. A significant

barrier in this regard is my role as a mediator, which reinforces centuries-old domestic and planetary hierarchies. At the same time, however, this research also engendered a degree of complicity between different forms of knowing in a context of rapid technological change. Even though this process was interrupted by my return to London, I wish that in the future I will be able to further engage with Lickan Antay activists so as to continue the conversation kicked off by this thesis.

3.4.3. Critique: New Ways of Relating and the Distrust in Sciences

A final point I would like to address in this chapter relates to the type of critique underlying this thesis, and particularly to the need to depart from the model of the researcher as 'a Zeus of critical distance, uninvolved and untouched by the wars it causes—or describes' (Puig de la Bellacasa, 2017, p. 41). A concern in this matter would be whether the observations I make here are too critical, by which I mean excessively focused on deconstruction at a time when what is needed is the re-constitution of the worlds threatened by modernity/coloniality. In response to this, I would argue that this thesis constitutes a way of putting into dialogue the view of scientists, engineers and policy makers with people thinking critically about modernity in Latin America, weaving new relations and ways of relating that can transform astronomy data into a matter of care for a broader range of groups. In addition to this, and as any rigorous qualitative research should endeavour, my critique is coupled with a nuanced attentiveness to the agency of local actors, whose connections between scientific data and development has produced admiration among some of their international colleagues, as well as with a sensitivity to the constraints shaping their choices and thoughts.

Another potential issue that emerges in relation to my critique concerns whether the critical stance of this thesis could make a contribution to the increasing distrust in the sciences in the so-called 'post-truth' era (Mejia et al., 2018). In this regard, this project aligns with proposals to rethink how societies generate and share knowledge based on not only criteria of efficiency and economic growth but also pluriversality and peaceful coexistence. The rhetoric of modernity affirms that the harms produced by modernity—such as the terricide and inequality—are a price to pay if societies want to enjoy amenities such as electricity, clean water and so on (Mignolo, 2011a, p. 47). However, no argument has proven that these technoscientific developments are incompatible with a pluriversal world. In fact, many of the foundations of modern sciences are the product of a dialogue between civilizations holding different views on knowledge and epistemology. Astronomy constitutes an excellent example of this point since the 'discoveries' made by Galileo Galilei, who is considered the father of the discipline, would not have been

possible without Islamic science (Saliba, 2007). The Eurocentrism present in astronomy, as manifest in the construction of observatories in Indigenous territories without consent and the erasure of their knowledges, would benefit to a great extent from thinking critically about its historical forms of exclusions (Neilson, 2019). Against this backdrop, Latour's call for a more open and politically engaged science (Kofman & Latour, 2018, para. 24) will not suffice under the current circumstances. Instead, my view aligns with that of postcolonial feminist author Sandra Harding (2008), for whom the reconnection of sciences with society necessitates a type of epistemology 'from below' that puts at the centre the experience and knowledges of marginalised groups.

3.5. Conclusion

In this chapter I drew on a broad range of sources in order to address the methodological challenges raised by the study of datafication in a modern/colonial world system. The resulting framework comprises ontological and analytical observations about the discursive and the material, reflections on the politics of fieldwork, specific procedures of data collection and analysis, a notion of validity and a series of concerns related to reflexivity. These observations were developed in light of insights stemming from discourse theory, historical materialism, material semiotics, anthropology, decolonial thinking, feminist theory and STS. Rather than an 'anything goes' approach, in this chapter I opted for a careful consideration of the ontological, epistemological, political and ethical resonances and tensions emerging from this combination, providing a multidimensional but nonetheless structured hybrid framework.

To sum up, I proposed DMA as an overarching analytical framework capable of attending to both the discursive and the material as well as to their interrelated character. Inspired by reflections held in relation to anthropological ethnography on the politics of fieldwork, I explained how the particularities of the case study of astronomy data in Chile informed the selection of the methods of data collection and the analysis. I also referred to the role of interviewing, participant observation and documents in the analysis, as well as to my deployment of thematic coding, sensitising concepts, nodal points and triangulation. Some considerations on the validity of this study were discussed in order to speak to a broader range of audiences. Finally, I reflected about the power dynamics that emerge when considering my positionality as a researcher, my affiliation to a university in the Global North, the incorporation of the view of Indigenous communities and the role of critique.

As I already explained, the following empirical chapters are organised based on three nodal points I identified in the analysis. In particular, the next chapter looks at a hierarchised

articulation of collaboration in the field of scientific research and its stakes for epistemic obedience. Illustrating the productivity of DMA, both discursive and material dynamics are brought to the fore in the analysis by bringing together observations regarding semantic articulations and financial and material affordances and constraints.

4. Collaboration as Obedience:
Articulating a New Positionality in Times of Data-Intensive Research

4.1. Introduction

In 2017, *Las Últimas Noticias*, the most popular newspaper in Chile, interviewed Mauricio Solar. Unlike the usual type of people featured by this newspaper, such as celebrities or politicians, Solar was working in the nascent field of astroinformatics. However, Solar was not just another astroinformatician. He was the founder and director of ChiVO, an initiative based at the UTFSM working on the standardisation and archiving of astronomy data. In the interview, he explained that by then ChiVO had only worked with data produced by ALMA, but that they also had more ambitious goals. 'In the future', expressed Solar, 'we want all the data being produced in Chile to get inserted automatically' (Torán, 2017, para. 5). In other words, he wanted ChiVO to be able to work with the 19 mega observatories operating and under construction in the Atacama Desert.

Considering that most of these observatories are under the control of scientific organisations from Europe and the United States, I initially read Solar's statement as an attempt to adopt a more antagonistic stance to data governance, an approach that would align with the notion of sovereignty that I referenced in chapter two. However, the picture that arose when I undertook my fieldwork challenged this interpretation. After talking to Solar and other local researchers, I could confirm their interest in ensuring a more egalitarian relationship with the observatories. Nevertheless, these researchers were not trying to subvert the status quo. Instead, they were interested in ensuring mutually beneficial partnerships with the observatories and transnational technology companies. As participants explained it to me, their strategy was to adopt a predominantly 'collaborative' attitude in order to become peers with the observatories. As I proceeded with my fieldwork, the frequent references to collaboration by local actors made me ask about the implications of such an emphasis in the context of a modern/colonial world system.

Whereas collaboration is usually portrayed as an achievement enabled by data sharing, an analysis inspired by the concept of collective autonomy reframes this term by linking its prominence with modern/colonial power dynamics. Along these lines, in this chapter I show that this collaborative positionality is favouring an obedient stance in research, making it difficult for local actors to negotiate the implementation of data-intensive astronomy in a way that speaks to their own concerns and priorities. Following Walter Mignolo (2009), I argue that this obedience responds to a particular way of understanding the role of the actors involved in knowledge generation and that, in the long run, promotes the uncritical acceptance of the agenda of

international scientific organisations. Thus, undertaking epistemic *dis*obedience becomes crucial as data-intensive research gets implemented in different latitudes and scientific communities are offered the opportunity to work with already existing data.

In order to develop this argument, the chapter is split into three parts. First, I set the scene by describing the dislocations faced by the Chilean astronomy community prompted by the implementation of data-intensive research. Second, I argue that local actors are responding to these shifts by articulating a collaborative subject position that strives to engage in horizontal partnerships with the observatories. The discursive and material underpinnings of this articulation are examined in light of empirical data. Third, I delve into the specific forms of epistemic obedience—a dis-embedding of the data producers, the erosion of local ties, an obscuring of the asymmetries involved and a data conformism—brought about by this collaborative positionality and discuss the way these reconfigure conceptions and practices of knowledge generation. In the conclusion of this chapter, I make clear the stakes of these observations for thinking about data governance from the perspective of collective autonomy in astronomy in Chile and other cases of data-intensive insight generation.

In the context of this thesis, this first empirical chapter puts the focus on the field of scientific research. Correspondingly, the protagonists here are astronomers and astroinformaticians who see themselves as part of the Chilean astronomy community,[29] although I occasionally also cite actors working in other spheres. Most of the stories I refer to in this chapter draw on the trajectory of ChiVO, which reflects the six months of participant observation I undertook in this initiative.

4.2. Dislocated by the Data Tsunami

4.2.1. Data-Intensive Research Dislocates the Astronomy Community

The increasing availability and complexity of data enabled by the development of sophisticated instrumentations are ushering in profound changes in scientific research. These changes have been described by US computer scientist John Gray as the emergence of a 'fourth paradigm of sciences' (Hey et al., 2009) in which the capacity to process large volumes of information becomes paramount. The shift is particularly acute in the case of 'data-intensive

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[29] In this chapter I also refer to the Chilean astronomy community as 'the local community' or 'local actors'.

astronomy' (Djorgovski, 2012), where the production of 'the biggest data of all' (McCray, 2017) by increasingly sophisticated observatories is transforming astronomers into specialists in the management and analysis of data. Even though this phenomenon is transcending national boundaries, the particularities of the Chilean case are providing these shifts with a dislocatory character, rendering obsolete the way local actors have positioned themselves over the last decades *vis-à-vis* the observatories constructed in the country and transnational cloud companies.

As I explained in the introduction, the Chilean astronomy community has faced an explosive growth and a significant increase in prestige, productivity and impact over the last decades. However, this sense of success coexists with a profound concern over their capacity to sustain this position as data-intensive astronomy gains ground in the discipline. Like other communities, local astronomers and astroinformaticians feel that the existing social and technical—hence 'sociotechnical'[30]—research infrastructure is insufficient in this new context. Measures such as adopting interdisciplinary organisational practices, developing programming and statistics skills and upgrading the existing equipment are considered necessary adjustments. Without undertaking profound changes, there would be little chance for the astronomy community to take advantage of the 'data tsunami' (Barba et al., 2008, p. 24) taking place in the Atacama Desert.

The words by astronomer Amelia Ramírez, the Dean at the Faculty of Sciences at the University of La Serena who holds a PhD from the University of São Paulo in Brazil, illustrate the worries of local actors on this matter. As she explained to me:

> In the science that is coming from the future … they [the observatories] will not lend you their telescopes for you as an astronomer to do your *pichirucho* work. Instead, you will have to attach yourself to the network of large data sets, know how to query the data that is stored in there, and be able to handle that.

The word *pichirucho* comes from the Quechua Indigenous language and connotes insignificance, smallness and thinness (Arteaga Campos, 2014), similar to 'wee' in the United Kingdom. As Ramírez explained it to me, her team has been working on upgrading their previous

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[30] I employ the term 'sociotechnical' to point out that the infrastructures that make possible the generation, sharing and maintenance of knowledge encompass both social (skills, ideas, institutions) and technical (data and equipment) dimensions (Edwards, 2010, p. 17).

pichirucho infrastructure at La Serena University in order to prepare for the new context by, for example, launching a PhD programme and improving the existing digital connectivity. I will come back later to Ramírez's view, but it is relevant to point out that the use of *pichirucho* in the above quote reveals a concern for the capacity of the existing sociotechnical infrastructure to deal with data-intensive astronomy.

In addition to the pressure felt by communities worldwide, an aspect that is especially worrying for the Chilean astronomy community is that data-intensive astronomy will decrease the value of their cherished access to the 10% of observation time in the mega observatories, endangering a mainstay of their success over the last decades. There are two reasons for this. First, because in the new context data re-use, namely research conducted with data sets available in the archives of the observatories, will become increasingly relevant. For the Chilean astronomy community, this situation will usher in an increased degree of competition since it will allow astronomers elsewhere to make discoveries without necessarily counting on privileged access to observation time. Second, the arrival of data-intensive astronomy concerns local actors because the 10% rule will be rendered obsolete in the case of survey telescopes, which are expected to become increasingly relevant in the future. Currently, most of the observatories employ a 'queue observation' (McCray, 2004, p. 66) mode in which astronomers apply for observing time, receive the data from the observatory and enjoy between three and eighteen months of a proprietary period before the data is made public (Borgman, 2015, p. 100). Under queue observation, realising the 10% rule is straightforward since it operates by granting a quota for local researchers. By contrast, large digital survey telescopes capture pre-programmed portions of the sky and share the results in a continuous stream of data with all their partners simultaneously (Djorgovski, 2012, p. 613). Because of this, survey telescopes do not grant exclusivity for the data collected as in the queue observation mode. Worryingly for the Chilean community, the 10% rule will not apply in the case of survey telescopes since they do not operate on the basis of proposals put forward by astronomers.[31]

The disruption of the 10% rule and the broader shifts taking place in astronomy have become central concerns for the local community. Amid this shift, the voice of researchers knowledgeable on data-intensive astronomy, such as Francisco Förster, have gained prominence. Förster graduated from a PhD in Astronomy at Oxford University in the United Kingdom in

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[31] As for the LSST, the biggest survey observatory in Chile that is currently under construction, existing agreements replace the 10% rule with a situation involving researchers based in Chilean institutions having the same degree of access to the data as astronomers based in the United States, which is the country funding the project (University of Chile & AURA, 2008).

2009. His office is located in the interdisciplinary Centre of Mathematical Modelling (CMM) at the University of Chile, a Google-esque workplace in Santiago city centre. The ALeRCE[32] team he leads is one of the five community brokers in charge of organising and distributing the alerts produced by the LSST (LSST, n.d.). ALeRCE is composed of astronomers, programmers and designers from different universities that work with cloud computing, machine learning algorithms[33] and Agile organisational principles.[34] This is how Förster sees the situation opened up by survey telescopes:

> The new telescopes such as the LSST are completely going to change the situation because that 10% is going to be over. There is going to be horizontal access with researchers who have access to the LSST, which could be all of the USA, some groups in Europe, potentially the whole world, we don't know. So you will not have that exclusive access anymore. You will have to compete as equals. You won't have any alternative but to learn to work with those large volumes of data.

For Förster, the new context is bringing about increased competition for local researchers since the 10% rule will not bring them the benefits that it did in the past. Because of this, the shifts engendered by data-intensive astronomy are changing the rules of the game and configuring an uncertain and difficult scenario for the Chilean astronomy community.

But there is more to this. Förster also explained to me that the construction of survey telescopes such as the LSST will transform astronomy *as a whole*. The following quote illustrates how he thinks the discipline will look like in the future:

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[32] The acronyms ALeRCE and ChiVO make reference to Chilean flora and fauna. While a *chivo* is a type of goat, an *alerce* is a tree similar to the cypress. It is not rare to find such references to national symbols in the acronyms of scientific teams.

[33] Usually understood as a series of logic procedures, algorithms can be better defined as 'generative agents conditioned by their exposure to the features of data inputs' (Amoore, 2020, p. 12). Machine learning is a technique in which algorithms learn from their own outputs in an iterative and nonlinear—that is, recursive—way (Amoore, 2020, p. 11). Many AI developments rely on machine learning.

[34] Agile is a design and management system that privileges quick response and continuous improvement, two capabilities considered fundamental for contexts marked by rapid technological change (Moore, 2018, p. 44).

I imagine in the future data streams coming from several directions—from space, from the LSST, from the SKA,[35] from LIGO.[36] I mean, you will have data streams coming from everywhere. And astronomers who don't catch up will not be able to do much. So we need to prepare for that, for being able to digest all those streams and cross-reference them in real time, classify them in real time, and react in real time (...) The LSST is like the star project (...) but I'm thinking beyond the LSST.

The astronomy Förster is talking about is characterised by the proliferation of data flows stemming from different sources. In this scenario, only those able to manage and analyse such streams at high speed will be able to thrive. The LSST's stream of more than ten million alerts per night, which I introduced earlier, is a case in point. Against this backdrop, and similarly to Amelia Ramírez, Förster considers that the Chilean astronomy community would need to adopt a broad range of measures for being able to deal with real-time sources of data such as that of the LSST.

4.2.2. Private Interests in Data-Intensive Astronomy

Even though participants agreed that data-intensive astronomy would profoundly transform the discipline, I also identified divergences within the local community regarding the origins and scope of the ongoing shifts. While for some participants data-intensive research represents an organic evolution enabled by the availability of new technologies and methods, other actors consider that the prominence gained by this type of research is the product of factors that go beyond science itself. Gaspar Galaz is an example of the latter view. Galaz graduated from Astrophysics at the Université de Paris VII in 1997 and his research focuses on extragalactic astronomy—more specifically, galaxies located close to the Milky Way. At the time of the interview, he was the head of the Astrophysics Institute at the Pontifical Catholic University of Chile. In his words:

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[35] The Square Kilometre Array (SKA) is a radio telescope under construction co-hosted by Australia and South Africa.

[36] The Laser Interferometer Gravitational-Wave Observatory (LIGO) focuses on the field of gravitational-wave astrophysics and is located in the United States.

Astronomy that uses databases is only one part of astronomy ... There is an infinite part of astronomy that implies work that focuses on little things in which you can have extraordinarily powerful and substantial results that can change the course of astronomy. What happens is that the LSST is going to arrive in Chile … and it is going to enable a new type of science that will be revolutionary … But the whole thing has been a little exaggerated ... There is a general movement of excitement because with the LSST we will be confronting a monstrous amount of data… There are vested interests ... to feed businesses and other entities, let's say. You know. You mount a little production machine and then you are hiring informatic engineers … We're living in a neoliberal society.

Galaz's view underplays the relevance of data-intensive astronomy by reducing it to a strand, not necessarily the most important one, within astronomy research. He thinks that there has been an 'exaggeration' over the implications of data-intensive research for astronomy that responds to the infiltration of financial and occupational interests. Like Galaz, some researchers have drawn on the term neoliberalism in order to denounce the increasing influence of private profit in scientific research over the last forty years in Chile (Gibert, 2016) and elsewhere (Lave et al., 2010). But Galaz's observation also echoes that of Vincent Mosco (2014), who has explained that the transnational cloud industry as well as influential global and domestic players have become influential promoters of big data methods, a positivist type of research that also turns out to be a profitable business for cloud companies. In the Chilean context, data-intensive research is already creating previously non-existent bridges between astronomy and the private sector, as the work of one of the members of ALeRCE with a local forestry company illustrates (University of Concepción, 2019). For Galaz, this type of crossover between academia and the private sector demands approaching data-intensive astronomy with more caution than the one shown by the local community.

Compared to Galaz's, Förster's profile is relatively rare within the local community since not many astronomers work hand in hand with astroinformaticians, programmers and designers nor have experience in both theoretical and data-intensive research. However, the view held by Föster has gained influence over the last decade, becoming the order of the day in talks and conferences and attracting the attention of the private sector, the government and the media.

As I have argued, for those who subscribe to Förster's view, data-intensive astronomy can have an especially high impact in Chile since, in addition to the challenges posed for astronomers worldwide, it is disrupting the basic orientation points that have allowed local researchers to understand their position and role in the discipline. In the vocabulary of discourse theory, data-

intensive research is engendering a 'dislocation', or a discursive disruption engendered by 'the emergence of an *event*, or a *set of events*, that cannot be represented, symbolized, or in other ways domesticated by the discursive structure' (Torfing, 1999, p. 148, emphasis in the original). In the case of data-intensive research, these disruptions have a predominantly material-technical origin, such as the infeasibility of applying the 10% in survey telescopes. Along these lines, the ongoing changes in astronomy are posing profound questions for local researchers, such as the type of relationship they want to sustain with the observatories and the private sector and their role in relation to the planetary astronomy community. In the following sections I analyse the response of local actors to this dislocation and the implications of this response in the context of a modern/colonial world system.

4.3. From Landowners to Collaborators

4.3.1. Articulating a New Subject Position

As I argued above, the arrival of data-intensive astronomy has prompted local actors to rethink their relations with the observatories and the way they position themselves *vis-à-vis* the global astronomy community. A shared agreement among the astronomy community in this regard is that, even though the 10% rule has allowed them to achieve a great deal of success so far, the attitude it has fostered might be detrimental for striving in the new context. In the words of Mauricio Solar, the head of ChiVO: 'We have 10% of the observation time … This is very comfortable. It's very good for astronomers who are from here, but we aren't contributing anything besides "get in there and give me the 10%"'. For Solar, the security provided by the 10% rule has made it possible for local researchers to take advantage of existing agreements without much effort. Unlike colleagues from other countries, the Chilean astronomy community has not needed to go through intricate processes of consensus-building and public advocacy required to ensure funding for the construction of costly instrumentation. Instead, Solar thinks that local researchers have tended to rely on their condition as hosts in order to work with what the observatories can provide for them.

Seeking to move past this attitude, voices within the local community are calling for adopting a new approach, which, in their view, would leave local researchers in a better position as data-intensive astronomy takes hold in the discipline. An example of this comes from Amelia Ramírez, the astronomer concerned about the limitations of the existing *pichirucho* infrastructure I quoted earlier. One of the goals of Ramírez has been to ensure that her team can take advantage

of their physical proximity to the LSST, whose construction works are located less than one hundred kilometres away from La Serena University. Reflecting on the way she and her team have sought to become partners with this observatory, Ramírez expressed:

> If you approach [the observatories] as a local community … they will give you a kind of outreach … [But] if you approach as an educational entity, with first-level scientific collaboration teams, the communication is much better. It's one of peers. So here the observatories only did outreach for a long time. And now that we have a doctoral programme and an astronomy group … Now we're partners. We can offer them an alternative outward route for their networks … and that's not gringo[37] or anything. And they're not giving us anything for it. We're offering it to them. So when you establish a relationship at the level of 'I give to you and you give to me', then their attitude is quite good.

In contrast to the 'comfortable' attitude depicted by Solar, the above remarks advocate for the adoption of a more proactive approach towards the observatories so as to ensure the establishment of projects in which both parties benefit. More specifically, the employment of terms such as 'peers' and 'collaboration' indicates an aspiration to approach the observatories from a more egalitarian position. In Ramírez's view, her team can only strive for this type of relationship after having upgraded their sociotechnical infrastructure, which ensures that they will have something to contribute. Especially relevant for her is that they are now capable of providing a digital networking solution to the observatories, which proves that they are not merely interested in obtaining resources from them but rather in establishing a reciprocal partnership. Furthermore, Ramírez points out that the infrastructure they are offering is not 'gringo or anything', a fact that needs to be highlighted because it goes against the historical reliance of Chilean researchers on the infrastructure provided by the observatories.

For some, local researchers should also adopt the proactive attitude depicted by Amelia Ramírez in their affairs with the private sector, especially when it comes to transnational cloud companies. Diego Mardones, an astronomer from the University of Chile who supports ChiVO, shares this view. Mardones explained to me that he is not interested in the money that companies

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[37] 'Gringo' is used in Latin America to refer to people from the United States and in some cases from the Global North in general. Its use in the quote does not necessarily suggest a negative connotation.

such as Amazon could bring, but that their infrastructure could benefit the Chilean astronomy community and local initiatives such as ChiVO by providing online storage and processing services. This is how he explained to me the right way of approaching cloud companies:

> As you put more and more conditions on them, they might suddenly look at their account books in red and black and say, 'I better leave' or 'I won't come'. So you can't tell them 'You're rich, so pay up'. You have to say, 'Ah! You're rich, so let's see how we can use a tiny piece of that wealth so that we all win'. Right? So, when you ask them for something, you have to give them something. And that something can be recognition, putting their logo on your web pages, saying in classes that they're nice people. Whatever. … So we have to learn as well. Scientists are used to ask for things just because, you know? What's needed is a process of asking for and giving so we all win.

The central point in the above quote is the idea that relations with cloud companies should entail mutually beneficial agreements. To enable this, local actors need to consider the resources they have that might benefit the other party, with most of the suggestions put forward by Mardones referring to ways of increasing the companies' brand reputation. The idea of promoting particular companies in the classroom illustrates one of the forms in which the crossover between academia and the private sector can take place in times of datafication and that Galaz considered necessary to approach cautiously. For Mardones, whether cloud companies get installed or stay in Chile depends on the capacity of local scientists to 'learn' that they also need to offer something to companies interested in supporting academic research.

Beyond astronomy, the emphasis on collaboration has also permeated policy making. The following quote summarises how systems engineer Demián Arancibia and his team from the Ministry of the Economy's DO explained to me what he considers a successful strategy for approaching the observatories:

> First we had to let go of that idea of passing the hat around as a poor country and start telling [the observatories]: 'Hey, we want to have a role as protagonists, pass us the data. We'll be able to take care of your data, we'll respect the principles you've established: that they're public, that we won't make profits out of your data, with astronomy data or with the function of those data'…. So far, Chile has approached the observatories as a

small country asking them for money, and that approach has resulted in a situation where they don't consider you as a potential collaborator or a protagonist in anything.

Like Ramírez and Mardones, Arancibia advocates adopting a more egalitarian and horizontal relationship with the observatories. For him, breaking down hierarchical structures would allow the Chilean astronomy community to move on from the position of a 'poor' and 'small' country, instead becoming a 'collaborator' of the observatories. It is believed that better results can be achieved if mutually beneficial exchanges are pursued rather than merely asking them for money, which is the attitude that has dominated in the past. A crucial point for Arancibia is to be able to provide the observatories with something so that the benefit is mutual. Whereas Ramírez underscored her new infrastructure solution at La Serena University and Mardones talked about promoting cloud companies in the classroom, Arancibia suggested to me that in the case of the DO this collaborative attitude materialised when the government decided to put fresh money on the table.[38]

An important point expressed in the three quotes above is the need to leave behind the position of 'local community' or 'poor country'. This aim has become crucial in times of data-intensive astronomy since at stake is the capacity to approach the observatories horizontally and as scientifically and technically competent partners. Such a need to become something beyond a mere host has also been a long-term effort for the Chilean state. Gabriel Rodríguez, the Director of Energy, Science and Technology at the Ministry of Foreign Affairs, put it in the following terms:

Why does Chile have astronomy? Because it has a natural resource … that's called the sky. Period. Now, like any country, you can exploit that natural resource by charging rent … Which is one option …. But the other is [exploiting this natural resource] through joint work. We've oriented our work in Chile towards becoming partners of the international observatories in astronomy science, and we also want Chile to become partners in the field of big data.

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[38] The Ministry of Economy contributed CLP$3,200,000,000 for the creation of the DO public-private partnership (DO, 2019, p. 19). This equals approximately £3,094,808 (XE Currency Converter, n.d.).

As in the previous cases, Gabriel Rodríguez's preferred way of approaching the observatories is through 'joint' types of work and as 'partners'. In his vision, this has been the approach privileged by the state so far in astronomy and the one that he considers also needs to be adopted in times of big data. This choice differs from that of merely 'charging rent', which would be similar to the 'comfortable' attitude depicted by Solar and the 'passing the hat around' criticised by Arancibia. The term 'rent' has a negative connotation in political economy since it represents the means through which landowners appropriate the surplus value produced by the workers (Encyclopedia of Marxism, 2018). In the Chilean context, 'rentism' has been employed to denounce the alleged backward mentality of the business elite that have not managed to incorporate added value into their products and services (Guzmán, 2015). For Rodríguez, acting as a landowner that merely charges rent might bring some benefits, but it could also be detrimental in the long term for the aim of taking advantage of the presence of the observatories in the country. Certainly, the transposition of 'rent' into the sciences reveals a great deal of discursive innovation since it draws on a criticism circulating in the country in order to advocate for a particular course of action in the field of science and technology policy. However, the depiction of local actors as 'rentiers' has its own limitations, such as overlooking the role of human and other-than-human actors that make possible the maintenance of the territories sustaining the operations of the observatories in the first place, as I discuss in chapter six.

In discursive terms, the distinction between the two attitudes delineated in the above quotes opens up two different subject positions. Unlike the term stakeholder that is common in governance discussions, and as I explained in the theoretical chapter, the notion of subject position brings to the fore the power dynamics that take place in the identification and characterisation of the parties at stake (Jørgensen & Phillips, 2002, p. 40). It is my contention that, when interpreted from this lens, the Chilean astronomy community is articulating the subject positions of the 'landowner' and the 'collaborator'. On the one hand, the subject position of the landowner emerged as a response to the 10% rule and seeks to obtain benefits by resorting to the compensations for hosting the observatories. In the view of participants, this subject position might have worked in the past but needs to be abandoned in the future if the community wants to keep up its momentum. On the other hand, the collaborative subject position constitutes a response to the dislocations engendered by data-intensive research and proactively strives for engaging in horizontal, reciprocal and technical-oriented partnerships with the international observatories and transnational cloud companies. Given that the local astronomy community is

not a member of these mega observatories,[39] the collaborative subject position operates as a strategy for reaching the same level of scientific and technological excellence as colleagues from Europe and the United States since it encourages local actors to improve the sociotechnical infrastructure so as to be worthy of such partnerships.

The sign 'collaboration' figured prominently in my fieldwork, acting as a nodal point capable of encapsulating one of the biggest aspirations of astronomers, astroinformaticians and policy makers working in the field of astronomy data in Chile. If for Bruno Latour the production of scientific data constitutes an 'achievement' (1999, p. 42), the case of astronomy data in Chile suggests that in some cases the achievement is the establishment of reciprocal and technical-oriented relationships with those producing the data or providing technology capacity. More broadly, the use of 'collaboration' by local actors draws on a series of discourses circulating in the sphere of science, technology and innovation. Initially, this word gained popularity in the West after World War II along with the rise of big science, a type of research encompassing robust international and interdisciplinary coordination (Borgman, 2015, p. 5). In the nineties, collaboration also came to connote the type of research afforded by digital infrastructure between geographically dispersed individuals and groups, giving rise to terms such as 'collaboratory' in the USA (Carusi & Jirotka, 2010). More recently, collaboration has become increasingly popular in public discourse, being used to promote the idea that data collaborations can help solve a broad range of problems in the North and the South, such as issues of water distribution and epidemiological crises (e.g., Verhulst, 2017). Bringing together these articulations, the choice of collaboration by local actors represents an appropriation of a predominantly positive signifier floating in society, putting it to work to represent the aspirations of the astronomy community. While previous studies with a post- and decolonial sensitivity have shown data collaborations are criss-crossed by planetary asymmetries (Abebe et al., 2021), my analysis foregrounds the aspirational character of the term 'collaboration' for the Chilean astronomy community inasmuch as it represents something akin to an entry ticket to the world of big science from which they have been excluded so far and to the world of data-intensive research that is threatening their current momentum.

The collaborative subject position acquires additional significance when analysed in the context of the modern/colonial world system. At the initial level, it speaks to the modern

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[39] An exception is the Gemini South Telescope, which is owned by a consortium of scientific organisations from the United States, the United Kingdom, Canada, Australia, Argentina, Brazil and Chile (CONICYT, 2012, p. 59).

imaginary idea that reciprocal exchanges, rather than altruism, offer the best means for a 'harmonious coexistence' (C. Taylor, 2004, p. 15). However, this subject position also reveals the other face of modernity, which is that of coloniality, as it conceives of data collaborations as an opportunity to upgrade the status of the Chilean community within the global network of astronomy by partnering with colleagues in the Global North. The modern/colonial asymmetry between the actors at stake is particularly evident in the way an interviewee depicted what he deemed as a case of successful collaboration with an international observatory: 'It was [a work] between equals, not … of "Ok, children, go play in the sandpit, but we will manage the actual data here"'. Interpreted from the lens of coloniality, the reference to childhood evokes Immanuel Kant's conception of the European Enlightenment as a step forward that would allow mankind to become adult beings, a move that automatically transformed non-Westerns into children (as cited in Mignolo, 2012, p. 63). In this vein, engaging in collaborations constitutes a form of 'coming of age' for the Chilean astronomy community, an upgrade in their status that materialises as they manage to partner with their colleagues from the Global North on an equal footing.

4.3.2. The Pain of Materialising Collaborations

The analysis of the collaborative subject position I made above mainly relied on a textual analysis of interviews. In addition to this, and in accordance with a discursive-material framework, this articulation has also been taking shape through the practices of local actors, which becomes especially evident when attending to some of the stories I heard during my fieldwork. When seen from this angle, what emerges with more clarity are the material challenges faced by local initiatives for putting these partnerships into practice, or, as I put it below, the 'pain' required to materialise collaborations.

The case of ChiVO provides an excellent vantage point from which to analyse this issue since its history has been marked by the establishment of partnerships with international organisations. To give some context, the history of ChiVO can be traced back to 2008, when a report funded by the state agency Commission for Scientific and Technological Research (CONICYT) expressed concerns about the lack of an appropriate national digital infrastructure for dealing with the Atacama Desert's 'avalanches of data' (Barba et al., 2008, p. 2008). In the wake of this report, astroinformaticians from the UTFSM, in partnership with astronomers from other local universities, launched ChiVO in 2015 (UTFSM, 2015b). Since then, the initiative has secured collaborations with ALMA, the standards-setting body International Virtual Observatory Alliance (IVOA) and the Chinese Academy of Sciences South America Center for Astronomy (CASSACA).

Each of the above partnerships has represented an opportunity to articulate and enact the collaborative subject position in practice but has also posed significant technical challenges for the ChiVO team. One of the most crucial of these challenges has been the ability to transport the data from ALMA to ChiVO's data centre. This task might sound simple considering that ChiVO's offices are located less than 10 kilometres away from ALMA offices in Santiago. However, the increasing volumes of data produced each year by this observatory—which reached 246 TB in the 2017 Northern Hemisphere academic year (ALMA, 2019a)—has transformed this process into an uphill effort. Lacking the coordination and digital connectivity utilised by ALMA to transmit its data to the archives in the United States, Europe and Japan, it would have taken days for ChiVO to download this data through the regular internet infrastructure. In this sense, the partnership between ChiVO and ALMA introduces an additional element to the collaborative subject position, which is the challenge of reversing the outward-facing architecture of the infrastructure underpinning astronomy data in Chile, a point that I discuss in the next chapter under the rubric of technoscientific extractivism.

In the first days of my fieldwork, members of ChiVO shared with me the story of how they finally managed to conduct the first transfers of large volumes of data. On more than one occasion in 2017, ChiVO sysadmin,[40] undergraduate student Camilo Núñez, would visit ALMA's administrative building in Santiago to download the data onto several physical hard drives. On his way back, Núñez would leave the offices of the observatory in the high-class Vitacura neighbourhood, located in the foothills of the Andean Mountains, and travel past the busy city centre carrying a 90-litre backpack on the underground in order to get to ChiVO's offices in the former industrial area of San Joaquín. Núñez described this method to me as 'very messy' but also pointed out that it was 'faster' than relying on the fibre optics available at UTSFM. A new window for overcoming this situation opened in 2018 thanks to the installation of a fibre optic cable that would enable a virtual ingestion (ChiVO, 2019), but at the time I concluded my fieldwork ChiVO had not managed to obtain the approval from ALMA.

With respect to the collaborative subject position, ChiVO's story speaks to the precarity of the existing technical infrastructure, the asymmetries between the parties involved and the ingenuity required to adopt the proactive attitude advocated by the local community. In fact, ChiVO faced similar difficulties for partnering with the other two organisations. It struggled to comply with the technical requirements to become a member of IVOA, a process that required a

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[40] 'Sysadmin' stands for system administrator, which is the person in charge of the configuration, maintenance and upkeep of hardware and software systems.

degree of mastery in the software and protocols employed by the organisation (Hanisch et al., 2010). In the end, the technical support and personal networks provided by a researcher from the German Astrophysical Virtual Observatory (GAVO) in a visit to Chile were crucial for ensuring ChiVO's membership in IVOA. Another significant challenge has been to be able to operate and maintain the China-Chile Astronomical Data Center (Chi2AD) developed by Huawei and shared with CASSACA. For example, one day a failure of the fans caused the data centre to flood. Even though there was a system in place for such accidents, the ChiVO team did not get alerts on their phones as they were supposed to since there were still some configurations adapted to China's telecommunications system. When they were notified, they had to use brooms and a bucket to take out the water. At the moment there is a dehumidifier inside the data centre that is supposed to prevent the same problem from happening in the future, but there is no absolute certainty about whether this strategy is going to work. As a whole, these two anecdotes reveal that enacting the collaborative subject position depends on not only discursive but also material dynamics—hence discursive-material ones—given that factors such as financial resources and technical infrastructure can enable, constrain or foreclose potential partnerships. Such an observation should not come as a surprise since, unlike in previous forms of records, the management and processing of large volumes of digital data rely on standards and equipment such as data centres, fibre optic cables and software (Borgman, 2015, p. 4) that can operate as exclusionary barriers.

But rather than an obstacle, going through and overcoming material difficulties can be considered part and parcel of the collaborative subject position. In the view of Núñez, technical precarity can cause *sufrimiento* [pain] but can also lead towards a type of science more attuned with the concrete reality faced by scientific and technological teams. When I asked him what he meant by that, he referred to the way policy makers approach astronomy data:

> They would speak about teras [Terabytes] as if it was something you literally take out of a chocolate wrapping you got from a grocery store. But behind that information there is a huge pipeline of work. To bring them, to store them, give them security, with the confidence that the data that you are storing are being kept under certain standards, that's a very complex process. So, for someone at the Ministry of the Economy who doesn't have much knowledge about this, for that person it's easy, but it's not that easy in practice.

Núñez's remarks illuminate two aspects of the collaborative subject dimension that come to the fore when foregrounding its technical-material dimension. One is that putting into practice

these partnerships intersects with questions concerning the distribution of labour. In the case of ChiVO, this initiative has had to overcome technical difficulties that the other party (ALMA) did not have to confront and has also had to deal with policy makers that might underestimate the effort required to materialise these partnerships. In this way, an attentiveness to the material analytical dimension brings to the foreground dynamics of 'emergence, constraint, and accident' (Dourish, 2017, p. 207) that only a first-hand approach can make visible, an aspect that affects who does what in 'collaborative' contexts. The second point is that the willingness to go through the 'pain' required to materialise partnerships with international actors is a central aspect of the collaborative subject position. In this sense, the ascetic philosophy mobilised by Núñez symbolises the moment in which a local actor abandons the 'comfortable' subject position of the landowner that merely asks for benefits so as to be able to secure collaborations with international partners. Literature on the different types of *frictions* (Edwards et al., 2011) entailed by the production, sharing and processing of data have tended to approach them in negative terms, although more recently Alison Powell (2021, p. 133) has provided a different account by arguing that such frictions can support forms of collective action challenging dominant visions about datafication. In the case of the Chilean astronomy community, the view of Núñez and other local actors has a more pragmatic underpinning since it considers data frictions as a necessary step to enact the collaborative subject position and therefore thrive in the new context.

The articulation of the collaborative subject position reflects the way the Chilean astronomy community has decided to navigate data-intensive research. From a pragmatic standpoint, this choice solves a number of issues—in particular, how to leverage their proximity with some of the biggest data producers in the world without menacing Chile's reputation as a welcoming host for future astronomical projects. Even though the term subject position is usually associated with discourse, the stories I have mentioned demonstrate that to a large extent its articulation and the possibility of enacting it has material contours. Having described the collaborative subject position, the question that emerges is the stakes behind such an approach when acknowledging that it is taking place in a modern/colonial world system. In the next section I draw on Walter Mignolo's notion of epistemic disobedience to portray the underside of this articulation.

4.4. Emerging Forms of Epistemic Obedience

Having discussed the discursive-material articulation of the collaborative subject position, I now analyse its stakes in the context of a modern/colonial world system. Going back to the introduction of this chapter, this section asks what it means to transform collaboration into an

aspiration rather than privileging alternative approaches such as sovereignty and the significance of this for a data framework based on collective autonomy.

Before proceeding, it is necessary to make a theoretical note in order to explain the approach I take in this analysis. In chapter two I discussed Aníbal Quijano's (2007) criticism of the universalism underpinning the modern/colonial rationality. Based on this idea, I mentioned that Walter Mignolo (2009) argues that confronting modernity/coloniality requires undertaking epistemic disobedience, namely unmasking the knowing subject and revealing their worldview and interests. The move he advocates is to decentre debates regarding the *known*—in this case, astronomy research—and instead put the focus on the *knower*—the astronomy community, the observatories and other actors involved. Epistemic disobedience, observes Mignolo, has become especially relevant nowadays since the focus on global scientific collaborations and the increasing circulation of sophisticated scientific instrumentation is distracting actors from asking more profound questions such as *for what* or *with whom*. Along these lines, below I discuss how the assumptions and practices that make up the collaborative subject position are impinging upon the capacity of local actors to interrogate data-intensive research's built-in suppositions, concerns and priorities and therefore compromising their ability to generate knowledge in tune with local needs and visions. More specifically, below I identify four forms of epistemic obedience accompanying the articulation of the collaborative subject position by the astronomy community in Chile.

The way I introduce the types of epistemic obedience is predominantly discursive, focusing on the semantic construction of the actors at stake, although in each case I also refer to the role of the material. Just like the collaborative subject position, each of these forms of epistemic obedience reflects a discursive-material entanglement emerging from the interaction of these two dimensions.

4.4.1. Dis-Embedding the Data Producers

The first form of epistemic obedience is present in the way the collaborative subject position constructs the actors producing the data—as following logical and transparent criteria rather than responding to particular visions and interests. As I argued earlier, a crucial element of the collaborative subject position is the privilege of mutually beneficial partnerships, which means that very often local actors need to wonder what they can offer to potential international partners. When these potential partners are the observatories, a strategy advocated by some local actors is to demonstrate that engaging in a partnership will increase the re-use of the data available in the archives of the observatories. For example, ChiVO's case for engaging with

ALMA is premised on the idea that standardising the data of this observatory would attract researchers employing innovative methods such as multi-wavelength data fusion,[41] which in turn would produce more discoveries employing data that ALMA has already produced.

The promise of increased productivity is evident in the way lawyer Aisén Etcheverry, the director of the DO, explained to me her initiative's strategy for becoming a partner of the observatories.

> The idea is to become their partners and, in that exchange of data that they make for us, to work in a way that can be useful for them too. So, part of what we have discussed, for example … [is that] one of them is how the observatories assess their results, I mean, whether they are doing a good job or a bad job, by looking at the number of times the data from their observations get cited. So we tell them, 'Perfect. If we get people from other sciences working with your data, they will cite you more and therefore your KPI will improve'.

In the above quote Etcheverry is mobilising both an explicit and an implicit argument. The explicit one seeks to demonstrate that partnering with the DO will help increase the KPI of the observatory, improving a key metric in the performance of the observatory. The implicit one, I suggest, communicates something akin to, 'Look, we did the job and this time we will not resort to our role as a host country. This time we are willing to demonstrate, in your own language, that this is also good for you'. This pragmatic choice might allow local actors to achieve some immediate goals, but from a discursive perspective it reflects an asymmetry in which one party (the locals) adapts to the logic of the other party (the observatories). The fact that Etcheverry draws on the term KPI, which in business management stands for key performance indicator, illustrates an attempt to master the terminology that, she thinks, governs the decisions of the observatories.

Jorge Ibsen, the Head of Computing at ALMA, also relied on business jargon in order to explain to me the way the observatories assess potential collaborations with local initiatives. Ibsen's view is relevant because he is an influential voice when it comes to the possibilities

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[41] Usually, astronomy research involves data obtained in a particular wavelength, such as visible or radio. Multi-wavelength data fusion provides a 'panchromatic' (Djorgovski, 2012, p. 614) approach by combining data pertaining to different wavelengths.

afforded by astronomy data for development and has convened several partnerships between ALMA and local universities. In his words:

> In the end, this is a factory. And as such you've got all the components of a factory: there's demand, a chain of production, a final product, a distribution and, finally, a use. Our product as an observatory is a record of a scientific phenomenon … That product is used by a market, and the market is a scientific community that wants to take that product, extract information from it and transform that into knowledge.

For Ibsen, understanding that the observatories follow 'merely operational' logics, as he expressed to me, is a necessary step to envision and ensure collaborations with them. Again, the rationale of the observatories is explained by resorting to business terminology such as 'demand', 'chain of production' and 'market'.

More broadly, Ibsen and Etcheverry's reliance on business management jargon reflects a profound change taking place in astronomy. According to historian Patrick McCray, in the nineties, and due to a combination of technological, economic and political factors, astronomy communities and funding agencies from the United States and Europe put a great emphasis on the optimisation of the observation time. Vocabulary and metrics from business management, such as KPI, became strategic for this purpose, giving rise to a vision of the observatories as 'data factories' (McCray, 2004, p. 274). Some of the causes underlying this discursive shift had a technological-material character, such as the implementation of remote observation facilitated by communication technologies that challenged the more romantic approach proper to a time when astronomers used to travel to the observatories and manipulate the telescopes by themselves. In the view of Etcheverry and Ibsen, approaching the observatories as data factories and focusing discussions on potential alliances in relation to productivity constitutes the best approach for local initiatives interested in securing partnerships with them.

Even if unintentionally, the move advocated by Etcheverry and Ibsen engenders a fresh form of epistemic obedience. No longer regarded as scientific organisations with a particular research agenda, when they are approached as data factories, observatories are transformed into actors whose decisions respond to the transparent and detached criterion of productivity. Under this view, a local team is worthy of collaboration as long as it helps the observatory do more with less. Furthermore, this view assumes that the observatories do not hold particular interests and visions since their decisions are taken on the basis of the rules of supply and demand, with the

latter being defined by the global astronomy community. This construction of the observatories creates a fertile ground for epistemic obedience since it presents them as dis-embedded from any social, historical, political and even scientific context, rendering pointless any interrogation of the motives or rationales behind their decisions. In this way, instead of striving for a horizontal dialogue in which all the actors involved would be open about their needs and visions, local actors are invited to internalise the vocabulary of the observatories and to demonstrate the capacity to improve the performance of their potential international partners. Approaching the observatories from a different stance would be read as a failure, as a step back from the collaborative subject position to the comfortable attitude of the landowner.

4.4.2. The Erosion of Local Ties

The second form of epistemic obedience emerges when contrasting the effort of local actors to speak the language of the observatories with the miscomprehension and criticism that reigns in the relations with their local colleagues. Whereas I almost did not hear complaints about the behaviour of the observatories, local actors felt free to express to me their disagreement with the aims, style and impact of initiatives such as ChiVO, ALeRCE and the DO. For example, this is how one astronomer referred to a local initiative: 'It's like creating a bureaucracy around something that's not necessary … It's useless … They created this artificial idea about something that was not necessary, or at least that's not necessary right now'. Another example: 'If you tell me that [name of the initiative] is going to be a place where we will store a copy of the data that are already there, of the data taken by the observatories constructed in Chile, I think that's a waste'. During my fieldwork I did not hear any comment of this sort in relation to the observatories.

Local actors felt free to diverge and even be antagonistic towards initiatives developed in Chilean institutions. Instead of trying to understand their logic and adapt to them, or even showing some degree of empathy in light of the shared constraints, astronomers and astroinformaticians felt compelled to criticise the projects of their local colleagues. Rather than predictable and transparent like the observatories, local research initiatives employing the data of the observatories are deemed as incomprehensible and as subject to assessment. When making their judgments, interviewees would not hesitate to rely on their own concerns and views about the discipline in order to express their disappointment with the choices of their local colleagues, a move that they did not undertake when speaking about the observatories, in which case they would spend more energy trying to understand the way they operate and finding out the best way to adjust. In the case of the Chilean astronomy community, then, the sign 'collaboration' acts as a

template that works vertically (when approaching the data producers) but not horizontally (when approaching other local initiatives) in times of data-intensive research.

Mónica Rubio, an astronomer based at the University of Chile with experience in policy making, agreed with my observations regarding the horizontal hostility within the field of data-intensive astronomy in the country. She did have some reservations about the aforementioned initiatives but was also mindful of the high degree of criticism between local actors. Rubio considers that the lack of a shared horizon and the insufficient funding has translated into an 'atomisation' of the community and the privilege of a territorialist approach to the observatories in which 'it is one [local] institution with one observatory, another institution with another observatory'. For Rubio, this situation also reflects a broader phenomenon in Chilean academia. In fact, scholars have argued that the neoliberal policies imposed in the eighties made universities subject to a 'predatory competition' (Gibert, 2016, p. 12), a situation that sets the conditions for conducting research and that has remained in place despite reforms introduced later. Taking this factor into consideration, it is possible to affirm that the growing interest in astronomy data is exacerbating an already thorny landscape.

It would be unfair to claim that the concern over the cultivation of local ties is entirely absent in the Chilean astronomy community. In a 2012 report led by Mónica Rubio in her role as head of the governmental Astronomy Programme, she and her team suggested a national survey to define the priorities of the local community as an 'initial significant step' (CONICYT, 2012, p. 10). During a workshop hosted by the LSST in La Serena in 2019, eight years after the report was issued, I witnessed the sense of frustration shared by local astronomers in terms of their inability to carry out this study. Some members of the community agreed on a budget and a methodology, but they did not manage to convince the government or the observatories—which already fund around 20% of the budget of the astronomy community (CONICYT, 2012, p. 68)—to provide financial resources for the initiative. As an astronomer expressed at the conference, so far they have not been able to come up with 'a bigger picture of what we want as a community'. The lack of instances of coordination and dialogue, a constraint posed by the existing material-financial conditions, makes it difficult to envision a way out of the atomisation discussed by Rubio.

Even though this chapter focuses on the stakes of the collaborative subject position in the field of research, it is important to mention that it has also infiltrated policy making, engendering what some local initiatives and communities interpret as neglect and exclusion. Looking at the history of astronomy in the country alongside the design of the DO reveals the state's interest in adopting a 'global vision'. This proactively incorporates the vision of international 'experts' from the Global North at a very early stage in the design of national policies in a way that contrasts

with the state's approach to some local actors, such as the Lickan Antay Indigenous community and ChiVO. I discuss this further in the next chapter, when I examine in more detail the role of the state.

More broadly, the implications of an erosion of local ties for knowledge production has been a long-standing issue for Latin American critical thinkers and has also been discussed in other contexts, such as the African one. For Colombian sociologist Orlando Fals Borda, one of the aims in Latin America should be to develop a *ciencia propia* [one's own science], which would involve 'speaking more among ourselves and for ourselves' (1971, p. 19). More recently, African philosopher Kwasi Wiredu has argued that 'knowing thyself' (1992, p. 332) becomes crucial in times of international team science and when the circulation of sophisticated instrumentation can catch the attention of local actors at the expense of undertaking more profound reflections.

The logic of competition underpinning Chilean academia and the lack of formal instances in which astronomers and astroinformaticians from different initiatives could talk among themselves make it difficult for local actors to assess how to approach the vast volumes of astronomy data produced in the Atacama Desert in a way that speaks to their own priorities. To put it differently, without a common platform of dialogue between local initiatives it becomes difficult to interrogate the extent to which the agenda of the observatories and cloud companies aligns with the concerns of the local context, favouring its uncritical adoption by local actors. Due to this, epistemic obedience in times of data-intensive research gets reinforced as the collaborative subject position strives to collaborating with international partners at the expense of critical collective reflexivity.

4.4.3. Obscuring Asymmetries

The third form of epistemic obedience stems from the observation that the sign 'collaboration' frames technological and scientific partnerships in a way that obscures potential power dynamics taking place between the actors involved. During the fieldwork, this form of epistemic obedience became especially evident to me as I noted the struggle between different ways of naming the partnership between ChiVO and CASSACA. This partnership was formalised in a ceremony held in 2015 at La Moneda governmental palace when an agreement between the UTFSM, CASSACA and the Chinese technology company Huawei gave birth to the Chi2AD data centre (Figure 2). The Chi2AD is currently located at the UTFSM, and its 860 TB storage capacity has made it possible for ChiVO to archive large volumes of data stemming from ALMA.

According to specialised media, Chi2AD is the largest centre of astronomy data in Latin America (Pizarro, 2017).

Figure 2: *Picture of the Chi2AD at the UTFSM*

Note. Photo taken by the author in December 2019.

Of particular interest from the perspective of epistemic obedience is how the web articles published by both CASSACA and the UTFSM referred to what went on during the signing of the agreement at La Moneda. On the one hand, CASSACA privileged the term 'joint work', employing it nine times in the three paragraphs of the article and resorting to repetitions in order to make assertions along the lines of 'The Joint Data Center is a joint endeavor' (CASSACA, 2015, para. 2). On the other hand, the UTFSM relied on a broader range of alternatives— 'collaboration', 'cooperation', 'joint effort' and 'mutual support alliance'—most of which nonetheless evoke the same sense of reciprocity conveyed by 'joint work' or 'joint endeavour'. However, the UTFSM's article also mentions 'donation', a sign that at first glance seems to belong to a different semantic family. This word was mentioned by Mauricio Solar, the director

of ChiVO, when he affirmed: 'With this *donation* we are accessing an infrastructure of the highest level for national scientific development' (UTFSM, 2015a, para. 7, emphasis added).

As I learnt while volunteering for ChiVO, at some point the word 'donation' came to be considered inappropriate for depicting the type of exchange encompassed by Chi2AD. In February 2019, I drafted a document aimed at introducing ChiVO to people from an outside organisation. Probably influenced by the article I discussed above, I referred to Chi2AD as a 'donation' from CASSACA. When I showed this draft to a member of ChiVO, he approved it in general but specifically asked me to replace 'donation' with *trabajo conjunto* (joint work). Even though in the past a member of ChiVO had used this term, I was now being discouraged from using it. Unfortunately, at that point I was not fully aware of the significance of this request, although the fact that I wrote it down in my field notes reveals that it did catch my attention to some extent. However, when interpreted in light of the circulation of 'collaboration' among the local astronomy community, this suggestion can be read as an attempt to portray the relationship between ChiVO and CASSACA in more egalitarian terms, evoking the sense of horizontality advocated by the collaborative subject position. Unlike 'collaboration' or 'joint work', 'donation' connotes a philanthropic action undertaken by a materially privileged actor, which conveys a degree of asymmetry between the parties involved. Whereas most of the words employed could be technically right, the emphasis encompassed by 'joint work' and 'collaboration' is functional to the collaborative subject position inasmuch as it removes from the picture the direction of the flow of resources.

The effect of privileging terms such as 'joint work' or 'collaboration' becomes clearer when comparing this choice with the way Latin American thinkers have referred to these types of partnerships in the past. Particularly illustrative of this point is Argentinian thinker Óscar Varsavsky, who put forward the concept of 'scientific colonialism' as a criticism of the positive connotation of 'scientific integration' circulating in the region in the sixties and seventies. In his words, 'Accepting technology from the North implies that … we will do the same as they do, we will be like them, and therefore the battle for economic or even political independence will lose its meaning' (Varsavsky, 1969, pp. 20–21). Compared to other alternatives, scientific colonialism constitutes a politicised way of framing international partnerships given that it draws a historical parallel and brings to the fore the direction of the exchange. By contrast, terms such as 'joint work' and 'collaboration' are ahistorical and suggest horizontality, privileging a depoliticised reading of the type of relationship going on between the actors involved.

It is not difficult to imagine how privileging terms such as 'joint work' or 'collaboration' can engender epistemic obedience—the sense of horizontality conveyed by these signs renders

unnecessary questions about the interests and visions of the parties involved inasmuch as all the actors seem to be contributing and benefitting on equal terms from their participation in a given partnership. Discursively obscuring the balance of the exchanges also makes less likely the emergence of concerns over potential relations of dependency, which has been a long-standing concern for Latin America critical thinkers. Some might argue that speaking of 'joint work' and 'collaboration' can avoid determinist interpretations by highlighting the agency of local actors in the translation and appropriation of technologies, even when these constitute a 'donation'. Despite this, 'joint work' or 'collaboration' might also work against the implementation of a type of data-intensive research capable of responding to the local context since it keeps actors from questioning the terms of the collaborations.

4.4.4. Data Conformism

Finally, the fourth form of epistemic obedience I identified responds to the conformism that has risen in the astronomy community over the last years as actors have opted for concentrating their efforts on the reuse of the already existing datasets rather than on figuring out ways of generating new ones. One of the few interviewees who explicitly referred to this issue was Mónica Rubio, the astronomer aware of the atomisation of the astronomy community I mentioned earlier. For her, abandoning the ambition of developing local instrumentation, which constitutes a condition for generating data, would imply a compromise for the astronomy community. In her words:

> The country could make very important contributions in certain areas of astronomical knowledge if it is capable of building specialised instruments … Otherwise, one can only do the science afforded by the instruments that are designed by the owners of the observatories or the consortia. And that is a limitation.

In the above quote, Rubio refers to what she considers to be a loss when it comes to working with already existing instruments. In her view, this choice runs the risk of ruling out the possibility of doing a type of science not envisioned by the data producers. In contrast to the vision of the observatories as data factories, in which these supply the demand of the global astronomy community, Rubio considers that it does matter *who* has the capacity to design the instruments producing the data in the first place. Following this logic, only directing the efforts and resources of the community to initiatives employing the data available in the archives of the

observatories impinges upon the possibility of envisioning and producing data that would better reflect the priorities and lines of research of local actors. A form of epistemic obedience emerges in data-intensive research as actors give up the possibility of pursuing research questions and employing methodologies not contemplated in the built-in hierarchies of the existing data.

The dilemma between investing in instrumentation or existing data[42] has been a recurrent concern in some circles in Chile over the last decade. Looking at the evolution of the conversation, the prominence gained by astronomy data at the expense of instrumentation has coincided with a reduction of the awareness over potential power dynamics in the field of astronomy research. For example, the 2012 report by Mónica Rubio and her team that I cited earlier proposed 'to deliver a Chilean led instrument' (CONICYT, 2012, p. 11) in order to transform the astronomy community into a leader in the field. This suggestion, though, was accompanied by an important warning: 'We propose that this initiative not be a mere lateral or *subordinate* collaboration with the international observatories' (CONICYT, 2012, para. 11, emphasis added). In the previous section I argued that the term collaboration evokes a sense of horizontality, but in the case of this quote the incorporation of the adjective 'subordinate' reflects a concern over asymmetries that can take place within such partnerships.[43] In that sense, the emphasis on instrumentation seems to go hand in hand with an awareness of potential asymmetries, a concern that receded to the background as data gained currency in the debate. For many participants, the dilemma between data and instrumentation was won by the former when the government decided to invest in the creation of the DO in 2019. Still, and as I mentioned in the introductory chapter, some participants also highlighted that there are valuable initiatives taking place in the field of instrumentation (ADDERE, 2012).

One of the factors contributing to an increased emphasis on data has been the transformation of astronomy data into a tool for economic development. This move has overshadowed concerns pertaining more directly to astronomy research, such as the capacity to formulate different research questions. In fact, the prominence gained by data over instrumentation has coincided with the incorporation of economic-focused actors such as the Ministry of the Economy, the Chilean Economic Development Agency (CORFO) and the

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[42] Some participants also referred to this dichotomy as a choice between software (such as data and algorithms) or hardware (components of the observatories) and between astroinformatics or astroengineering.

[43] The word subordination has also been employed by Pablo Kreimer, for whom the current stage of Latin American research is one of 'integrated subordination' in relation to the interests of the Global North (Kreimer, 2006, p. 443).

Federation of Chilean Industry (SOFOFA) in the debate over the 'spillovers' (Guridi et al., 2020) of astronomy. As interviewees expressed to me, these actors consider that focusing on data would constitute a shorter, cheaper and more straightforward strategy for ensuring a certain degree of technology transfer to the private sector. Whereas it could take decades to figure out how the development of components such as astronomical mirrors could fuel the economy, some companies in Chile are already familiar with the opportunities afforded by big data and therefore are in a good position to integrate skills and technologies derived from data-intensive astronomy. Consequently, the increased interest and investment in astronomy data by the public and the private sector has implied neglecting the limitations for research of privileging the work with existing archives.

The conformism I am describing here connects tightly with the widespread idea that data constitutes a neutral and objective resource (Gitelman & Jackson, 2013), suggesting that it would be inappropriate to call into question the needs and visions underlying existing datasets. What this view does not acknowledge, though, is that '[t]he availability of data may drive [the] research questions that can be asked and the methods that might be applied' (Borgman, 2015, p. 9). Moreover, the involvement in the production of the data provides a specific advantage since, even if the producers make available datasets with appropriate metadata[44] and set up support systems, 'the individuals and teams who create datasets retain an inherent advantage in interpretation over any other prospective data reuse who may come along later' (Pasquetto et al., 2019, p. 23) due to their holistic understanding of the theories, methods and instruments utilised in the production stage.

Against this backdrop, a form of epistemic obedience emerges in situations in which actors without access to large volumes of data adopt a conformist stance that focuses on ensuring collaborations with the data producers at the expense of engaging in efforts to imagine and generate data that respond to the needs and visions of the local context. Whereas data sharing has been presented as a partial solution to addressing global scientific (e.g., International Science Council, 2015) and astronomy (Peek et al., 2019, p. 5) divides, little is asked regarding the extent to which such measures can distract communities from the goal of developing their own sources of data. The problem is not merely one of the 'capabilities' required to properly employ the already existing data (e.g., Bezuidenhout et al., 2018) but rather that the conformism engendered

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[44] The National Information Standards Organization (NISO) from the USA defines metadata as 'structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource' (as cited by Borgman, 2015, p. 66).

by the availability of data can incite an epistemologically obedient attitude that overlooks the relevance of envisioning and producing data that could better speak to the priorities of 'data poor' scientific communities.

4.5. Conclusion

Going back to the opening story of this chapter, here I examined the limitations of the collaborative stance privileged by ChiVO's Mauricio Solar, which is shared by the astronomy community in Chile, in the quest for archiving the data being produced by the international observatories constructed in the country. My main point is that this move, which is also advocated as a means to approach cloud companies, is engendering new forms of epistemic obedience that can impinge upon the capacity to conduct a type of research that responds to the needs and visions of the local context. Whereas usually the notion of collaboration evokes horizontality, the one mobilised by local actors underpins a hierarchised vision that does not apply equally to all the actors involved.

To develop these arguments, I first described the hopes and fears of the Chilean astronomy community, for whom the arrival of data-intensive research is dislocating their positioning *vis-à-vis* the observatories constructed in the country and the global astronomy community. In particular, I argued that the community is responding to these shifts by calling for the adoption of a collaborative subject position that strives to ensure reciprocal and technical-oriented partnerships with the observatories and cloud companies. I analysed the discursive-material hierarchies underpinning such a call by attending to the discursive articulation of this subject position and to the 'pain' required to put it into practice. Nevertheless, I showed that in the case of astronomy data in Chile there is a fine line between collaboration and epistemological obedience. In particular, I argued that the collaborative subject position tends to dis-embed the producers of the data from the social context, erode local ties, blackbox asymmetries and foster data conformism. These forms of obedience are prompting the implementation of data-intensive research without prior interrogation of the historicity of these methods and tools, whose purposes they serve and the extent to which their built-in hierarchies and priorities speak to the local context. Like the articulation of the subject position itself, these forms of epistemic obedience encompass an entanglement of discursive and material dynamics inasmuch as they involve a particular way of understanding data-intensive research *vis-à-vis* technological and financial configurations and constraints.

For the above reasons, the collaborative subject position can undermine the ability of local actors to devise alternative ways of conducting scientific research in times of datafication.

In the vocabulary of decolonial thinking, epistemic obedience reveals the coloniality of data collaborations, or the darker dimension that comes to the fore when acknowledging that data sharing does not occur in a vacuum but rather in a hierarchised modern/colonial world system. From this angle, data-intensive research runs the risk of becoming what Sabelo J. Ndlovu-Gatsheni calls a 'technology of subjectivation' that, as in the case of African academia, can 'prevent the emergence of another-thinking, another-logic, and another-world view' (2015, p. 489). Because of this, it would be impossible to envision and put into practice a data governance based on collective autonomy without addressing the forms of epistemic obedience I discussed in this chapter. It is only through epistemic disobedience that data and algorithmic systems developed elsewhere can be interrogated and negotiated so as to respond to the diversity of views and needs of the vast majority of the world population rather than to the worldview of a reduced group of people.

Herein I mainly referred to academic research, but these observations can be extended to a range of spheres implementing and employing data-intensive insight generation. Areas such as policy making, urban development (as in the so-called smart cities) and the judiciary have seen a shift towards data-intensive forms of knowledge production in different regions of the world. Some of the consequences of overlooking the forms of epistemic obedience accompanying the implementation of these systems have already started to become clear. Just to cite one example, this has been the case in the introduction of the big data policing system Domain Awareness System (DAS) in the state of São Paulo, Brazil (Altenhain, 2017). Here, the lack of critical questions over the relevance of a tool developed in and for New York for operation in a Latin American city translated into a series of unexpected issues and posterior adjustments. This type of case can be analysed from multiple angles, but the notion of epistemic obedience makes it possible to foreground the limitations engendered by the universalist assumptions and practices that come attached to data-intensive insight generation.

In this chapter I focused on scientific and technology research, but the dynamics I described have overflown this sphere. One group of actors that I referred to in this chapter were economic policy makers and members of the private sector, whose interest in taking advantage of the existing astronomy data for building industrial capacity has overshadowed concerns pertaining to research. The influence of these actors is not a coincidence since the vast amounts of astronomy data produced in the Atacama Desert have not only been heralded as a tool for catching up in times of data-intensive research but also for upgrading the national productive matrix. In the next chapter I look at the sphere of the economy in more detail, identifying the way

the case of astronomy data in Chile is intersecting with long-standing debates held in Latin America over development, extractivism and the role of the state.

5. The Future of Extractivism:
Building a Data Economy in a Modern/Colonial World System

5.1. Introduction

April 2019. It is a sunny day in Santa Lucía Hill, which is located in the heart of Santiago, next to the busy Libertador Bernardo O'Higgins Avenue. Representatives of the government, the observatories, academia and the private sector are gathered for the launch of the Data Observatory (DO), a public-private partnership aimed at leveraging the large volumes of astronomy data produced in Chile for economic development. After years of working on the design of this policy, the Ministers of the Economy and Science are finally laying bare the other two co-founders of the initiative: the local Adolfo Ibáñez University (UAI) and the cloud company Amazon Web Services (AWS) (Ministry of the Economy, 2019a). Highlighting the high degree of resolve underpinning the DO, the Minister of the Economy, José Ramón Valente, expresses his hope that this day will be remembered as 'the day in which Chile wore the trousers … and in which it definitively integrated the economy of the fourth industrial revolution'. Whereas in the sphere of research the aim is to catch up with the fourth paradigm of sciences, in the case of the economy the horizon is 'the fourth industrial revolution', a stage of industrial production marked by the embeddedness of digital technologies in a broad range of spheres in society (Schwab, 2016).

But Valente's quote does not only point to the future. Those familiar with Chilean political history would know that the expression 'wearing the trousers' was also employed more than fifty years ago during Salvador Allende's government. In particular, it was used as political propaganda to promote the nationalisation of copper through which the state gained ownership of mines previously owned by majority US companies (Larrea & Larrea, 1971). Certainly, there are obvious differences between these two initiatives. The nationalisation of copper was part of a democratic socialist agenda seeking to assert economic sovereignty, and as such involved *expelling* foreign capital. As I mentioned earlier, Allende's government also worked on a futuristic computing system called CYBERSYN to ensure the management of state-owned factories with the participation of workers. The DO, in contrast, is committed to global free trade, which means that it aims at *attracting* foreign capital, and does not aim at creating state technical capacity but at supporting the private sector. But despite these differences, I argue that both the nationalisation of key industries in the seventies and the DO follow a similar recipe—attaining economic development, overcoming extractivism and transforming the state into a protagonist of these processes. In a heteropatriarchal world system, 'wearing the trousers' also asserts that

transforming the economy is men's affair. The specific methods at play might change, but the formula repeats itself.

In this chapter I trace the efforts to construct a data economy in Chile and their intersection with the capitalist modern/colonial world system. To do so, I first argue that development is operating as an overarching frame to imagine the role that astronomy data could play in the economy despite long-standing criticism of this notion. After that, I sustain that the hopes and fears of local actors with regards to astronomy data draw to a large extent on the discourse on extractivism, giving rise to different articulations of the term in order to address the particularities of astronomy data and the discursive and economic shifts in the region. Whereas two of these articulations—the technoscientific and competitive ones—depoliticise extractivism by dis-embedding the phenomenon from the capitalist modern/colonial world system, the proposal put forward by Indigenous communities affected by the construction of an observatory—ontological extractivism—can help revitalise the mobilising strength of the term. For reasons I explain later, the latter articulation can provide an inspiration for delineating a framework of data governance based on collective autonomy. Finally, in this chapter I refer to the role of the state in times of the fourth industrial revolution and argue that the adoption of the collaborative subject position in this sphere follows a hierarchised pattern that neglects and excludes some local experiences.

With respect to the previous chapter, this one changes the sphere at stake—from science and technology research to the economy and policy making—and brings to the fore three new actors: the Chilean state, a transnational technology company and an Indigenous group living close to an observatory. As to the analytical categories employed in my analysis, here I expand the type of dynamics related to the material. Whereas in the previous chapter I predominantly discussed the role of technical infrastructures, this chapter incorporates the means of production as a structuring force in world capitalism. All in all, it is important to note that the ultimate aim of this chapter is not to find out whether the account of the actors fits with an allegedly objective structure but rather to analyse its implications for rethinking the governance of data from the perspective of collective autonomy.

5.2. Astronomy Data as the Missing Piece for Development

5.2.1. Figuring Out the Value of Astronomy Data

Some scientific data has a clear commercial value. For example, the information stemming from rich biodiverse settings in Colombia has acquired utmost importance for pharmaceutical companies interested in the genetic data contained in plants and other living beings (Escobar, 2008, p. 138). However, this does not seem to be the case of astronomy data. Common sense in this discipline indicates that the information produced by the observatories does not have much, or even any, economic value. Jim Gray, the influential computer scientist from the USA who coined the term fourth paradigm of sciences, considered that astronomy data was simply 'worthless' (McCray, 2014, p. 9130). From this perspective, one of the pillars underpinning datafication, namely the imperative to untap the hidden value of data through innovation (Mayer-Schönberger & Cukier, 2013, p. 100), does not seem to hold in the case of this discipline.

Going beyond assertions such as Gray's, scientists, engineers and members of the public and private sectors in Chile have carried out a fruitful debate in the last decade over the opportunities afforded by astronomy data for the national economy. As I touched on previously, this debate had its origins in the question over the 'spillovers' (Guridi et al., 2020) of astronomy, namely how the construction of the observatories could benefit not only astronomy research but also other activities in the country. Initially, astronomers and engineers argued that increasing their involvement in the design and construction of the observatories and the provision of hardware components could help create a productive industrial base (CONICYT, 2012). More recently, though, the incorporation of actors from the Ministry of the Economy (DO, n.d.) and the private sector (e.g., Acevedo, 2014) into the discussion inclined the balance towards the investment in data, software and informatics. In the view of these actors, the large volumes of astronomy data produced in the country provide a shorter, cheaper and more straightforward way of ensuring technology and capability transfer to the private sector. During my fieldwork I heard about different examples demonstrating that this transfer was already taking place, as is the case of astronomers working with a forestry (University of Concepción, 2019) and a technology company focused on the optimisation of public transport (Chilean Innovation, 2017).

A shared assumption regarding the opportunities afforded by astronomy data is that its large volumes and relatively open accessibility represent crucial advantages for ensuring technology and capability transfer. In the view of local actors, the 16.5PB expected to be produced in 2021 (Ministry of the Economy, 2019b, p. 3) can attract data scientists from different

backgrounds interested in learning from the challenges posed by the management and analysis of such sheer amounts. But since numbers do not speak for themselves, members of the astronomy community and policy makers elaborated a compelling visual figure comparing the data produced by the observatories with the one produced by social media platforms such as Twitter (Figure 3). As this figure suggests, both domains generate similar sizes, but next generation telescopes are expected to surpass digital companies. In addition to its volume, another important characteristic of astronomy data is its relatively open accessibility. Astronomy data is considered one of the most 'open' disciplines since most of the observatories upload their data to public archives within a range of three to eighteen months after the observation (Borgman, 2015, p. 100). As interviewees explained to me, the openness of astronomy data is also granted by the fact that it is not subject to the political and ethical issues surrounding personal data to which the public has become increasingly sensitive over the last decade.

Figure 3: *Volumes of Data from Observatories and Social Media Platforms*
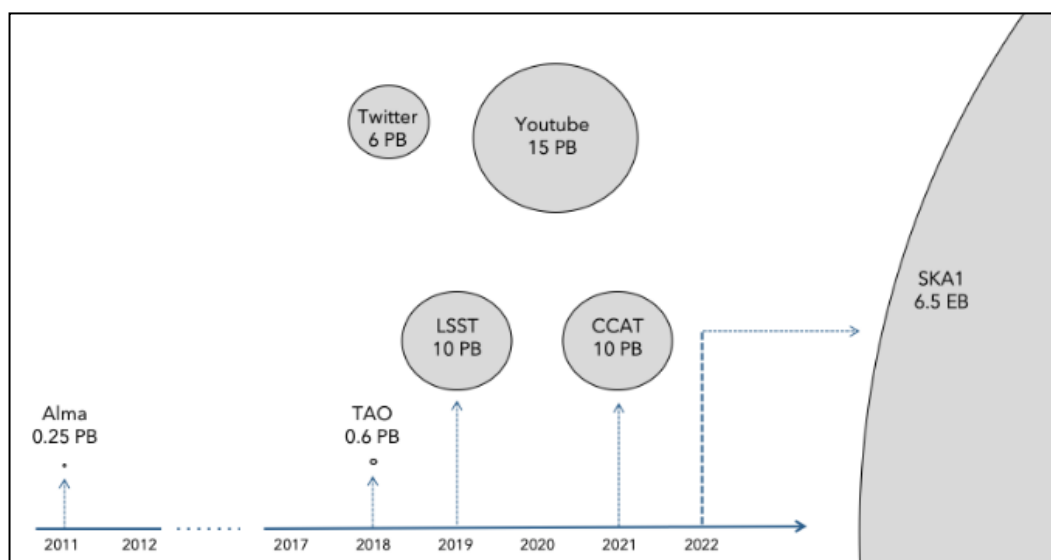
Note. All the observatories mentioned are already constructed or under construction in Chile, excepting the Square Kilometre Array Phase 1 (SKA1) whose telescopes will be built in Australia and South Africa. Used with permission with the following accorded excerpt: 'Figure by Juande Santander-Vela developed in the context of the AstroDATA Programme (FIE Grant FIE-2016-V022, CORFO Grant 16IFI6626) and employed by the Ministry of the Economy in the DO's Call for Partners'. It is possible to find the latter document in (Ministry of the Economy, 2019b, p. 3). The AstroDATA programme preceded the DO.

Challenging what had been common sense in astronomy, local actors arrived at the conclusion that the value of astronomy data does not reside in its content. Unlike the case of personal data stemming from social media platforms, whose information can enable behavioural prediction and manipulation (Zuboff, 2019), astronomy data does not have a direct commercial application. However, this does not mean that it cannot have any role in the economy. Astronomy data's large volumes and open accessibility can transform it into a valuable learning tool of the skills and capabilities known as data science that are paramount in the context of the fourth industrial revolution. In addition to this, the infrastructural requirements for the management and processing of this data could help attract research and development (R&D) investment from cloud companies such as AWS. As I discuss next, these insights have made it possible for local actors to conceive of astronomy data as the 'missing piece' for development.

5.2.2. Bringing In Development

In parallel with the discussion over the value of data, local actors have also sought to make sense of the role that this resource could play in relation to the broader trajectory of the Chilean economy. In this debate, economic development is emerging as an overarching sign capable of describing the possibilities afforded by astronomy data in a way that takes into consideration the economic and political orientation of the country. The words of Carlos Jerez, an engineer from UAI, perfectly encapsulate this vision. For him, astronomy data is the 'new gold' that will become the basis for transforming Chile into a 'leader' and a 'developed country' (*Segunda*, 2020, p. 16).

A slide developed by systems engineer and DO member Demián Arancibia is worth analysing at length since it reveals the investment put by some local actors into discursively fixing the link between astronomy data and economic development (Figure 4). One of the most notable aims of this graphic is its attempt to establish parallels between astronomy (depicted above the timeline) and the economy (below the timeline), an articulation that bridges two previously autonomous domains. In the slide, astronomy appears as a key resource for helping Chile transition towards a knowledge-based productive matrix, a stage that is yet to be reached and therefore is put within question marks ('¿KNOWLEDGE?'). Leveraging this opportunity would allow Chile to leave behind its historical dependency on copper—which made up around 40% of the country's gross exports in 2018 (Observatory of Economic Policies, 2020, p. 29)— and to adopt less physical forms of economic production. The incorporation of images depicting the hands of a saltpetre miner (*salitre* in the slide), a smelter machine in the case of copper, and the complete absence of humans in the case of the knowledge-based economy conveys a

progressive transition towards increasingly technological-intensive modes of production. The combination of English and Spanish words and characters is probably a mistake but reflects the DO's aim of targeting both domestic and international audiences.

Figure 4: *Timeline of Stages of Astronomy and Economic Production in Chile*
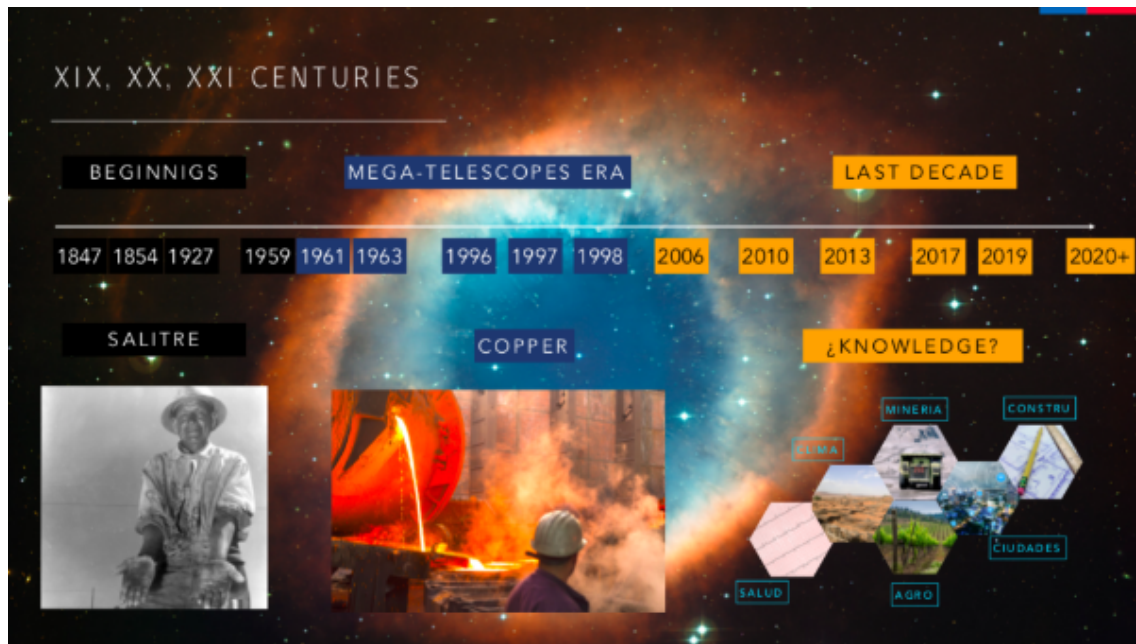
Note. Used with permission with the following accorded excerpt: 'Slide by Demián Arancibia in his role as Executive Director of the AstroDATA Programme (FIE Grant FIE-2016-V022, CORFO Grant 16IFI6626). Presented at Alameda Bdo. O'Higgins 1449, September 2017, in a meeting with University of Chile, UTFSM, Pontifical Catholic University of Chile'.

From a discursive perspective, the above image draws on the core elements of development, the 'magic formula' (Escobar, 1995, p. vii) elaborated in the fifties by the United States that I discussed in the conceptual framework. Based on the European experience, development has operated as a seductive horizon for the Global South and as a way of categorising societies according to their degree of advancement. In the slide, development appears in the form of a narrative of progress, assuming a notion of temporality in which societies move forward so as to catch up with the historical present. From a decolonial perspective, one of the problems of this unilinear take on temporality is that it obscures the fact that past, present and future do not simply replace each other but rather coexist in complex ways, especially in the multicultural and multicoloured Latin American societies (Rivera Cusicanqui, 2012, p. 95). For example, the slide presents the Chilean trajectory as if at a certain point it would manage to break

free of physical forms of production. However, there are reasons to suspect that what this slide presents as 'the past'—low-skilled extraction of natural resources—will remain in place in the future since modern technologies and the fourth industrial revolution rely on the extraction of mineral resources such as copper itself (Crawford, 2021, p. 25). Also absent from this slide is the observation that in relative terms Chile exports ever less refined, i.e., processed, and more raw copper.[45]

The articulation between technosciences and economic development is not surprising. In the secular stage of modernity/coloniality, science and technology have acted as gauges of the inferiority and superiority of societies (Adas, 1989). Not coincidentally, thus, science and technology have constituted key pillars of the developmentalist project since the early days of the concept. As US President Harry Truman expressed in one of the first formulations of development in 1949: 'Greater production is the key to prosperity and peace. And the key to greater production is a wider and more vigorous application of modern scientific and technical knowledge' (as cited in Escobar, 1995, p. 3). Moreover, the discussion surrounding astronomy data in Chile follows a long trajectory of policies in Latin America that have conceived of information and communication technologies (ICTs) as fuel for economic progress, albeit quite often these initiatives have come accompanied by a series of universalist presuppositions that have rendered them ineffective (e.g., Chan, 2013). In the case of astronomy data, local actors consider that taking advantage of this resource would help infuse the private sector with an innovative mindset, prompting it to abandon its current inertia and to catch up with 'knowledge society', viz. the moment in which the primary source of wealth creation is not capital, natural resources or labour but knowledge itself (Drucker, 1993, p. 7).

The way local actors are thinking about astronomy data implies a renewed belief in the validity of development after decades of criticism by intellectuals and social movements (Escobar & Esteva, 2020). In the Chilean context, development still constitutes a valid horizon for the political and economic elite, with some authorities playing the game of predicting the year in which the country will become a 'developed' one (Mujica, 2018). For those who still believe in development, astronomy data is providing an opportunity to renovate the promise of progress by highlighting the unique opportunities enabled by the proximity of Chile to an increasingly valuable resource in the current scientific, technological and productive era.

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[45] The rate of raw copper increased from 5.4% in 1990 to 20.5% in 2018 in relation to the net Chilean exports (Observatory of Economic Policies, 2020, p. 29).

5.3. Data Extractivism in a Capitalist Modern/Colonial World System

The story I just told in the previous section about the incorporation of astronomy data into the economic sphere would not be complete without acknowledging the intriguing but suggestive references that interviewees made to extractivism. I use the word intriguing because the term is not present in any policy report, research proposal or public speech concerning astronomy data. However, as I talked to scientists, engineers, policy makers, representatives of the private sector and Indigenous activists affected by the construction of an observatories, I noted that their hopes and fears were drawing to a large extent on many of the elements that make up the discourse on extractivism, especially when it comes to observations over the repetition of a historical pattern that has prevented Chile from leaving behind an economic model based on the export of raw resources. The implicit reference to the nationalisation of copper by the Minister of the Economy I mentioned in the introduction is an illustration of this. When asking more details about this idea, however, I would get a varied range of responses, with local actors adopting different positions regarding what exactly the problem is and, more importantly for the argument of this chapter, the relationship between this phenomenon and broader structural patterns. As they relied on extractivism to make sense of the situation, I noted, different meanings of this signifier emerged, expanding the reference-points associated with this signifier.

In this section I identify three articulations of extractivism circulating in relation to astronomy data—the technoscientific, competitive and ontological ones—and interrogate their implications in the context of a capitalist modern/colonial world system. As I mentioned earlier, the exact term 'extractivism' was not always explicitly mentioned as such by interviewees. However, I consider the assumptions underlying some of their remarks—such as claims about the export of raw materials in connection with economic development—to be part of the 'regularity in dispersion' (Laclau & Mouffe, 2014, p. 91) that characterises the discourse on extractivism.

5.3.1. Extractivism in Latin America

In order to make sense of the significance of the emerging articulations of extractivism in relation to astronomy data it is necessary to take a step back and look at the circulation of the term in Latin America. Initially, extractivism designated a type of industry based on the extraction of natural resources (Gudynas, 2015, p. 10). In the fifties, the term acquired a more negative connotation, coming to represent not an industry—which evokes the imaginary of a factory and technological progress—but 'a type of extraction of natural resources in large volumes or with high intensity that is essentially oriented towards exporting raw materials, without processing, or with a minimal degree of processing' (Gudynas, 2015, p. 13). Along these

lines, extractivism in Latin America is associated with an unfair global system of appropriation, deep pathologies such as poverty, corruption and the destruction of communities and the environment (Acosta, 2012). Considering that in most cases the companies undertaking extractivism are based in the Global North—although there is also extractivism in the North— some actors tend to establish a historical equivalence with the pillage and looting during the Spanish and Portuguese colonialism. As Uruguayan writer Eduardo Galeano wrote in the seventies: 'Latin America is the region of open veins. Everything, from the discovery until our times, has always been transmuted into European—or later United States—capital, and as such has accumulated in distant centers of power' (1997, p. 2). In Latin American critical thinking, extractivism is a constitutive feature of capitalism that speaks to the hierarchical categorisation of the groups populating the earth, where some are able to enjoy the benefits of the appropriation of surplus value and others have to see their territories transformed into so-called 'sacrifice zones' (Svampa & Viale, 2014, p. 86). Recent discussions have advocated an expansion of the term so as to encompass the extraction of knowledge (Grosfoguel, 2016), heteropatriarchal forms of appropriation of women's and children's bodies (Segato & Fink, 2018), and broader processes through which capitalism expands its fields of operations, such as personal data (Gago & Mezzadra, 2017).

Despite its economistic tinge, the term extractivism can play an essential role for decoloniality. Mignolo's take on dependency theory captures this idea since for him, notwithstanding its focus on the economy, this theory laid bare that 'the myth of development and modernization was a myth to hide the fact that Third World countries cannot develop and modernize under imperial conditions' (Mignolo, 2011b, p. 276). By the same token, I would argue that the understanding of extractivism that circulates in Latin America brings to the fore that the fate of societies does not only depend on their will but on a broader system of exchanges that benefit so-called developed regions and groups at the expense of the harms of extractivism in so-called developing regions. In other words, this critical understanding of extractivism inscribes planetary relations within a capitalist world economy. In post-Marxist vocabulary, this form of politicisation can be crucial for collective autonomy since it implies approaching planetary hierarchies not as the natural order of things but rather as part of a power structure that is contingent and therefore subject to change.

5.3.2. Technoscientific Extractivism: Reversing an Outward-Facing Infrastructure

The first articulation of extractivism I identified in my fieldwork circumscribes the phenomenon to the field of astronomy and conceives of astronomy data itself as being subject to

an extractivist dynamic. In the view of some interviewees, the current situation could be depicted as one of extractivism inasmuch as the information produced by the observatories is being exported in *raw* rather than *processed* form. Even though astronomers working for Chilean institutions are already successfully employing this data in their research (Cortes et al., 2018), the technoscientific articulation focuses on the usually invisible layer of production, transmission, standardisation and archiving of the data cycle that goes on before scientific research itself (Plantin, 2019). The words by the representative of a technology company who worked as a contractor for the observatories summarises the general picture encompassed by technoscientific extractivism:

> As a country we were, and still are, exporters of copper, of raw materials. What we've got to do is to start exporting knowledge. And to export knowledge the only relevant raw material are data. And if we don't have data to start building knowledge, we will never get out from [exporting] raw materials. So what is going on in the world of astronomy? Once again we're only delivering raw material, because the real analyses are being done in Europe, Japan and the United States.

The remarks above convey a sense of tragedy since, when looking at the case of astronomy data, Chile is reproducing its historical role of mere exporter of raw materials. As in other instances during my fieldwork, the interviewee illustrated this point by referring to the incapacity of the country to deliver processed copper. Drawing on the widespread conception of data as the building block of knowledge (Kitchin, 2014, p. 9), the interviewee regrets that the country has not abandoned what world systems theorists would call a peripheral status in so far as Chile is not exporting knowledge, which represents the processed form of data. As the remarks point out, and in contrast to the predominantly economic import of the term extractivism, these observations refer to 'the world of astronomy', which is why I call this articulation 'technoscientific'. This does not mean that this articulation does not draw connections with the economy, but, as I said earlier, it nonetheless puts the focus on the processing of astronomy data itself rather than on the role that this data could have for upgrading the productive matrix.

The technoscientific articulation of extractivism holds a specific concern for how sociotechnical infrastructures can impinge upon the capacity of local actors to process astronomy data. Under this understanding, the observatories' assemblage of telescopes, data centres, transmission cables, protocols and processing computers make up an outward-facing architecture that poses a challenge for making the data stay and get processed within Chilean borders. A

recurrent example I heard during my fieldwork pointed to ALMA, which has two data centres in Chile, one of them in the desert—the Operations Support Facility (OSF)—and another one in Santiago—the Santiago Central Offices (SCO). However, I learnt from an engineer working for this observatory that only automated operations such as consistency checks are carried out in Chile. Instead, what this participant understands as the processing of the data, namely its classification and archiving, takes place in the ALMA Regional Centres (ARCs) located in Germany, the USA and Japan. ALMA's handbook is worth citing in this regard since it describes the data cycle:

> The ALMA Archive at the OSF is designed to provide up to a year of temporary storage for the instrumental data … and the monitoring data. The instrumental data are then transferred to the main archive at the SCO, where the pipeline is run and from where the data and pipeline products are distributed to the three ARCs. At this stage, a sizeable fraction of the data are processed at the ARCs and then mirrored back to SCO (Remijan et al., 2020, p. 180).

As can be inferred, ALMA's data goes back and forth between the Atacama Desert, Santiago and its archives in the United States, Germany and Japan. However, the infrastructure and the rules are designed in a way that most of the data gets processed outside Chile. As I explained in the previous chapter, this arrangement has constituted a challenge for ChiVO, who has had to overcome 'painful' material challenges in order to reverse this architecture and to be able to transmit the data from ALMA's SCO to their Chi2AD data centre. From an analytical perspective, the introduction of technical infrastructure as an other-than-human actor that can enable or disable extractivist dynamics transforms the technoscientific articulation into a discursive-material phenomenon.

As astronomy data gains prominence, local actors are seeking to modify the outward-facing architecture I just described in order to ensure that more important processes can take place within the borders of the country. One of the ways to do so has been to engage in the development of technical infrastructure. For example, in two instances local projects have sought to modify ALMA's technical architecture so as to provide Chile with a more relevant role in the processing of the data. ChiVO and the DO have proposed in different moments to create a Chilean ARC with the same or similar access, processing and support capacities as the ones in Germany, the USA and Japan. Whereas ChiVO ended up abandoning the idea after a failed funding application, developing a Chilean ARC constitutes the first concrete project of the DO.

Astronomers, astroinformaticians and policy makers supporting this idea explained to me that this project would make it possible for the DO to cultivate links with ALMA and to provide a faster downloading service to astronomers from Latin America. Conversely, I also heard criticism pointing out that it would be convenient to invest in more innovative observatories such as the LSST and that a Chilean ARC would benefit only a limited number of astronomers in Chile working in radio astronomy.

Another way of redressing the outward-facing architecture of the infrastructure underlying astronomy data in Chile is being conducted at the level of the negotiations of the compensation agreements with new observatories. For example, in the case of the LSST, the data-intensive observatory par excellence under construction in Chile, the agreement incorporates the development of a Chilean LSST Data Access Centre (University of Chile & AURA, 2008, p. 3), which is currently under construction in La Serena. Some interviewees saw the construction of this data centre as an achievement since they considered that it would make it possible to do more things with LSST's data within Chilean territory, especially for universities located in the Coquimbo Region. Nevertheless, I also heard concerns that this data centre could eventually end up operating as a mere buffer before the data gets transmitted to the LSST's centres of analysis located in the United States and France. All in all, the engagement in infrastructural development and the incorporation of this concern in more recent agreements speak to the ambition of increasing the participation of local actors in the processing stage within the data cycle and, in that way, challenging the unfavourable architecture of the infrastructure in place. The series of doubts concerning the Chilean ARC and the Chilean LSST Data Access Centre show that local actors do not have a clear idea on how to put this intention into practice.

Another aspect that stands out as to the technoscientific articulation of extractivism, and that holds a more discursive character, concerns its reliance on a clear-cut distinction between 'raw' and 'processed' data. As critical data scholars have shown, the boundary between these two statuses is not a given but rather depends on disciplinary and social considerations (Gitelman & Jackson, 2013). Moreover, historical evidence shows that the allocation of the border between raw and processed data constitutes an act of power entangled with modern/colonial hierarchies. A paradigmatic example of the latter is the pharmaceutical books in the Americas that were authored and commercialised by Jesuit priests during Spanish and Portuguese colonialism without acknowledging the role of Indigenous people in their production (S. J. Harris, 2005). In the case of astronomy data in Chile, acknowledging the role of local actors in the generation of the conditions for producing this data would help to challenge binary distinctions and go beyond the idea that the data leaving the country is 'raw'. For example, such an approach would

foreground ongoing efforts by cities located close to the observatories to decrease their light emissions to help guarantee the quality of the data (Ministry of the Environment, n.d.). This type of engagement, however, is not considered relevant for the technoscientific articulation of extractivism, which is premised on a stark contrast between the raw and processed status of the data leaving Chile.

Compared to the critical understanding circulating in Latin America, which conceives of extractivism as a dynamic favouring the appropriation of resources by a core, the technoscientific articulation does not hold a clear position regarding the agent undertaking extractivism. In other words, it does not refer to who is extracting astronomy data let alone for what purpose. As a product of this, rather than responding to planetary structures, the responsibility of overcoming extractivism ends up lying on the shoulders of local actors. This view is present in the remarks by Gustavo Dubó, a CORFO officer in La Serena city who referred to the observatories in the following terms:

> They are super collaborative, [but] they know there are restrictions. So we have to devise a way to absorb that and take more advantage of it [astronomy data]. The decision to install a Chilean astro data centre[46] did not come from the observatories, it came from the Chileans. They [the observatories] are super collaborative, but the thing is … that we have an elephant in the room. How do you take advantage of that?

The collaborative attitude that Dubó perceives in the observatories implies that they are already making an effort to enable Chilean development, so it is the responsibility of local actors to make sure that the parties get closer. Dubó considers that part of the solution consists in *ingeniarnos*, a verb I translated above as 'to devise' but that also suggests that local actors need 'to fix it'. This expression is used in Chile to refer to a type of non-grandiloquent inventiveness that can help solve specific problems. In the case of Dubó's quote, *ingeniarnos* is employed to express that overcoming what I call technoscientific extractivism, a challenge that for him has become an elephant in the room, looks more like solving a logic puzzle than mobilising for structural change.

The politics associated with the technoscientific articulation diverge from the ones underlying the critical articulation of the term circulating in Latin America in at least two ways.

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[46] This 'astro data centre' probably refers to the Chilean LSST Data Access Centre I mentioned earlier.

First, because the technoscientific articulation tends to obscure the agent undertaking extractivism, an aspect that becomes especially worrying when considering that, as Walter Mignolo (2009, p. 162) affirms, any attempt to dismantle coloniality involves unmasking *who* is setting the terms of the conversation. Second, technoscientific extractivism conceives of the issue in terms of a technical challenge rather than as a relation with discursive and material foundations, a view that transforms extractivism into the product of the lack of ingenuity from the side of local actors. As I argue later, these characteristics render this articulation an unlikely alternative for a data governance framework based on collective autonomy.

5.3.3. Competitive Extractivism: Favouring Free Trade

The second articulation, which I call competitive extractivism, focuses on the economy and speaks to Chile's historical reliance on the extraction of natural resources and its export in raw form. Compared to the technoscientific articulation, the concern in this case is not that astronomy data itself is getting out of the country without much processing but rather that local actors have not been able to leverage astronomy data to boost the local productive matrix and move up in the global value chain. Thus, the focus is put on the affordances of astronomy data for providing the 'material conditions' (Dourish & Mazmanian, 2013, p. 6) required to thrive in the context of the fourth industrial revolution.

The competitive articulation still conceives of extractivism in negative terms, but tends to be accompanied by optimistic notes regarding the possibilities afforded by astronomy data for moving on. Even though the DO is still in its infancy, it is assumed that the creation of this public-private partnership signals that Chile has finally managed to adopt the forward-looking attitude required to overcome extractivism. The remarks by Aisén Etcheverry, the head of the DO, echo this optimism and are worth citing in toto since they touch on most of the tropes accompanying this vision of extractivism:

> Chile is a tiny country. We have a very small population, we're far from the rest of the world. We welcomed an open commercial policy with open arms; we are the country with the highest number of free trade agreements; we export to the whole world; we created a network that connects us through flat-rate fibre optics and pay-as-you-use internet rates to the whole world. And that network has been used to sell grapes, to sell wine, to sell copper. And a few years ago the idea arose that through this network we could sell super-specialised services, and ultimately take the leap from a society that extracts natural

resources to a society that exports knowledge. And that means having very skilled people, having the best data scientists, having the best data librarians. And under that logic the Data Observatory fulfils a very important role because in the end it creates one of the biggest data repositories in the world in Chile. It is very focused on enabling transfer to industry ... Someone said to me the other day: 'With this we can manage it so that the food processing factory or the mining company or the guy manufacturing cars in China who needs highly specialised data scientists will come here to get them'. You see? When this person needs something ultra-boutique, ultra-specialised, this person will come to Chile to find it. And they won't even need to come because we'll have a fibre optic cable to Asia that will allow us to do that in real time.

Etcheverry sees the conjunction between the production of astronomy data and Chile's open economy and evolving digital infrastructures as an opportunity to leave extractivism behind and participate in the knowledge economy. In her view, the characteristics of the type of productive matrix brought about by astronomy data—open and global—are attuned to the economic model, geographical isolation and low demographic density of the country. The free trade policies in place and recent digital infrastructural developments provide the appropriate conditions for materialising development in times of the fourth industrial revolution and, in the end, allow Chile to leave behind its peripheral status in the world economy. The choice of China in the above quote is not a coincidence considering that this country is the number one purchaser of Chile's overall exports (Observatory of Economic Policies, 2020, p. 33) and that the Chilean government plans to build the first undersea fibre optic cable connecting Latin America and Asia (Undersecretary of Telecommunications, 2019a). As a whole, therefore, Etcheverry's words mobilise a belief in globalisation, *laissez faire* and technology as the best means for overcoming extractivism. Such a belief in free trade stands in opposition to the one held by critical political economists from Latin America, for whom such policies have been beneficial rather than detrimental to extractivism (Svampa, 2015). Etcheverry's words also present the free trade model adopted by Chile as the product of a consensus which, according to her, has been 'welcomed with open arms'. With this assertion Etcheverry might be pointing to the embrace of neoliberal globalisation by part of the Chilean Left (Chodor, 2015, p. 5); but when taken more broadly, her remarks overlook decades of criticism of the liberalisation of the Chilean economy by academics (Ffrench-davis, 2016) and social movements (Joignant et al., 2020).

But besides supporting free trade, the competitive articulation of extractivism displaces the actors deemed responsible for the sustainment of extractivism, putting the focus on the local

elite controlling public and private companies. Such actors, affirm those sustaining this articulation, have not managed to catch up with the times inasmuch as they have been incapable of incorporating more innovative and technology-intensive processes in their operations. This incapacity connects to existing planetary economic incentives, but it primarily responds to a reluctance to adopt a more innovative mindset. The words of Jorge Ibsen, the Chief of Computing at ALMA who was introduced in the previous chapter, illustrate this view:

> They [mining companies] can put the rock outside and sell it. That's it. There is no interest in adding value. The client's been served! This is where we are different in astronomy. We always have to add value. An observatory is not something static. We have a development programme that is funded by countries from overseas; at any moment if I already know how to do X, next year I have to do X times 10, and the following year X times one hundred … So we live in a state of permanent change, in a state of permanent imbalance. As soon as I know how to do something, it becomes boring. I want to do something else. The problem I see in mining is that they already have a niche that they know how to exploit.

The words above acknowledge the role of external demand in the continuation of extractivism as they point out that local companies 'put the rock outside and sell it'. However, they also portray the problem in the form of a lack of 'interest' in overcoming this situation, an argument that constructs extractivism as the product of a lack of will on the side of the economic elite. Relying on a romanticised notion of the sciences that has become difficult to sustain in times of neoliberalism (Lave et al., 2010), a clear contrast is made between the drivers behind extractivist companies—profit and comfort—and those behind the sciences—entrepreneurship and sheer curiosity. Pointing to one of the core assumptions underpinning the DO public-private partnership, Ibsen also explained to me that bringing together the sciences and the private sector would make it possible to infuse the latter with a more dynamic mentality.

The articulation of extractivism delineated by Etcheverry and Ibsen converses with ideas about economic development circulating since the nineties. On the one hand, its focus on innovation shares similarities with Michael Porter's notion of 'competitive advantage'—hence the name 'competitive extractivism'—which postulates that the wealth of a country 'depends on the capacity of its industry to innovate and upgrade' (1990, para. 2). Porter's explanation for the 'success' of economies mainly considers internal factors such as 'strong domestic rivals, aggressive home-based suppliers, and demanding local customers' (1990, para. 2), conveniently

obscuring the planetary dynamics that have been long underscored by Latin American critical thinking. On the other hand, competitive extractivism also resembles some of the arguments put forward by César Hidalgo, a name that came up in different instances in my fieldwork as an example of someone aware of the importance of data for economic development. Hidalgo is a data scientist who grew up in Chile, has a background in physics, worked for the Massachusetts Institute of Technology (MIT) Media Lab and currently chairs the Artificial and Natural Intelligence Institute (ANITI) at the University of Toulouse. One of this author's central claims is that the wealth of a given country is tightly linked to the level of complexity of its economy, which he understands as the capacity to manipulate physical atoms so as to produce 'crystallised imagination' based on ideas developed by innovative individuals. Following this logic, Hidalgo criticises the 'exploitation of foreign creativity' (2015, para. 60) carried out by Chile and other developing countries. After explaining that copper is one of the minerals that make electricity possible, he argues that:

> The idea of crystallized imagination should make it clear that Chile is the one exploiting the imagination of Faraday, Tesla, and others, since it was the inventors' imagination that endowed copper atoms with economic value (2015, p. 60).

Hidalgo puts extractivism upside down, proposing a reversed model in which peripheral countries appropriate the creative labour of inventors at the core. Such a statement is politically problematic for a number of reasons. Besides dismissing the collective character of innovation and devaluing the care and maintenance required to put it into practice, Hidalgo's view ignores work with a postcolonial sensitivity conducted in different latitudes of the world that shows that what gets considered as 'innovative' is the product of an act of power in which those at the bottom of the capitalist modern/colonial world system have few chances of succeeding (Irani, 2019; Mavhunga, 2017). Even though I did not hear arguments in line with Hidalgo's in my fieldwork, his views have become increasingly influential in Chile, as revealed by his appointment to the Experts' Committee for the development of the Artificial Intelligence National Policy (Ministry of Science, n.d., p. 15).

The competitive articulation of extractivism shares some similarities with the critical understanding inasmuch as it keeps the conversation on the realm of economic production and acknowledges, even though to a limited extent, existing planetary incentives. However, this articulation differs in that the competitive one considers that extractivism can be overcome by sustaining free trade policies, developing digital infrastructure and changing the mentality and

incentives of the local business elite. Whereas the technoscientific articulation is incommensurable with economic-oriented understandings, the competitive one seems to be in a direct discursive struggle with the one that emerged in the twentieth century in Latin America, acknowledging part of the problem identified by dependency and world-economy theorists—the existence of a periphery and a core—but removing the explanation behind this diagnosis—historical structures impinging upon the capacity of peripheral countries to upgrade their economy.

5.3.4. Ontological Extractivism: Foregrounding Communication

Finally, a third articulation represents a significant departure from the two previous ones inasmuch as it does not put the focus on technosciences or the global status of the national economy but rather on horizontal communication and the acknowledgement of the material conditions that make possible the production of astronomy data in the first place. This vision stems from activists from the Lickan Antay[47] Indigenous group, which encompasses eighteen communities living in towns, villages and *ayllus*[48] close to the ALMA observatory in the Antofagasta Region and that are organised in the ethnic-activist Council of Atacameño Peoples (Council of Atacameño Peoples, n.d.-b).

The vision on extractivism held by Lickan Antay activists with regards to astronomical data is based on two conflicts they experienced with ALMA and the Chilean state. The first one took place in 2003, when CONICYT granted concession of the Chajnantor mountain to ALMA for fifty years (*Mercurio de Antofagasta*, 2003). This agreement prompted protests and a road blockage by Lickan Antay activists, who argued that Chajnantor was part of their ancestral territories and that some members of the community were still using it for shepherding activities. The process ended up with an agreement in which the head of the Council approved the construction of the project in exchange for compensations for the community. A second tension took place more recently, in 2018, when ALMA announced the expansion of its gas infrastructure. The conflict arose when the observatory decided to not remove the old pipes despite the environmental concerns expressed by some Lickan Antay communities. The legal

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[47] The Lickan Antay are also known as 'Atacameños' due to a misnaming by the Spanish invaders (Bengoa, 2004, p. 157)

[48] The Lickan Antay and other Andean Indigenous groups understand an *ayllu* as 'a group of humans and other-than-human persons related to each other by kinship ties, and collectively inhabiting a territory that they also possess' (de la Cadena, 2015, p. 43).

verdict benefitted ALMA but mandated it to take some measures to avoid any risk in the future (Environmental Assessment Service, 2018).

Against this backdrop, Lickan Antay activists have come to understand extractivism as a mentality and a modus operandi in which the human and other-than-human actors inhabiting the territory are taken for granted. Extractivism takes place when external actors such as mining companies and astronomical observatories carry out their processes without engaging with the reality of the local communities and the environment. As the President of the Council, Sergio Cubillos, explained it to me:

When you talk about extractivism you imagine a well, the extraction of water, the extraction of minerals, a machine, digging wells, a machine making holes. But ALMA's would be a more superficial form of extractivism. An extractivism of the knowledge of the territory. If you want to go in that direction, clearly it is an extractivist company, but not in a literal way because it does not extract anything. But it is extractivism from the perspective of knowledge, of occupying the territory to be able to do these studies, to produce knowledge … Because the thing about extractivism is that it does not give back. It only takes. So from that perspective, yes [it is extractivism] because they take away the knowledge without leaving anything. None of it remains here for us.

At the moment, the Lickan Antay people are fighting against the water-intensive extraction of lithium in the Atacama Salt Flat—paradoxically, lithium is a key material for developing so-called 'green' technologies (Gundermann & Göbel, 2018). This struggle, as well as their relationships with ALMA, has taught them that the core problematic underpinning extractivism encompasses a broad phenomenon that cannot be reduced to the appropriation of natural resources, as implied in Gudynas's and other economic-oriented definitions cited earlier. Instead, the above remarks portray extractivism as indifference towards the territory, as a lack of interest in understanding the consequences of activities carried out in distant places. Along these lines, Cubillos' remarks draw a criticism of the attitude of those who do not engage with local communities and seek to obtain benefits without taking into consideration the reality of the other parties involved.

The notion of extractivism delineated by Cubillos challenges the previous critical understanding of the term by incorporating immaterial—'superficial', in his words—resources as part of what can be extracted. Moreover, it does not see the appropriation of a surplus as the main

problem of extractivism. When criticising ALMA for not 'leaving' anything in the territory, Cubillos did not refer to *material* benefits. As he explained to me, ALMA has already put into place financial support for community projects, such as the Alma Region II Fund that in 2021 contributed USD 349,500 (ALMA, n.d.-a). Instead, Cubillos was referring to something that seems to be simpler: the lack of communication and dialogue, of sharing with the local community what the observatory does, what kind of discoveries it makes, and who is funding it. As another interviewee from the Council expressed: 'Considering how close they are to us, I feel they still haven't brought the knowledge they are generating to the people'.

In the view of Lickan Antay activists, horizontal communication would require ALMA to incorporate Lickan Antay ancestral astronomy into its research, something they were unsure whether was being done or not, despite their awareness of a publication funded by the observatory on the cosmovision of the elders (ESO, 2013). Due to this lack of horizontal communication, interviewees also referred to ALMA as an 'island'. For them, material aspects such as the strict security measures and the metallic and futuristic architecture of its buildings and antennas also contribute to this mysterious vibe.

The vision of the Lickan Antay activists regarding ALMA contrasts with the one held by the political elite based in Santiago. This divergence became clear to me with the revelation of the first ever picture taken of a Black Hole in April 2019 (Devlin, 2019), an achievement that took place during my fieldwork. Given that ALMA was one of the eight observatories involved, the Chilean Senate awarded it with a silver medal (ALMA, 2019c). In the corresponding ceremony, the Senate president, Jaime Quintana, commented that senators were 'filled with pride' for being able to recognise the role of ALMA in such a ground-breaking discovery. In contrast, Lickan Antay people did not even know that such a discovery had happened. As Cubillos said: 'Ask people from San Pedro [the biggest town in the area] if they know that that happened. They have no idea. A closer relationship would allow people to be aware of what's happening'. As this anecdote reveals, political authorities in Santiago, which is around 1,200 kilometres away from ALMA, hold a sense of pride for hosting the observatory, one that is not necessarily shared by the people living close to its site of operations.

The view of Lickan Antay people aligns closely with arguments put forward by Indigenous activists from other latitudes struggling against different forms of extractivism. The following quote by Mississauga activist and writer Leanne Betasamosake Simpson from the Idle No More movement in Canada resembles the views held by members of the Council of Atacameño Peoples:

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The act of extraction removes all of the relationships that give whatever is being extracted meaning. Extracting is taking. Actually, extracting is stealing—it is taking without consent, without thought, care or even knowledge of the impacts that extraction has on the other living things in that environment. That's always been a part of colonialism and conquest (Simpson & Klein, 2013, para. 11).

Drawing on Betasamosake, Simpson and Silvia Rivera Cusicanqui (2012), Ramón Grosfoguel decentres economistic approaches and argues that extractivism has its origins in colonial, capitalist and patriarchal mindsets and practices. For Grosfoguel, these mindsets and practices represent an *ontology*, i.e., 'a way of thinking, and of being in the world' (2016, p. 38), which is why he uses the term 'ontological extractivism'. This view expands articulations of extractivism that emphasise the extraction of natural resources such as copper, and makes it possible to understand the divergences between the Lickan Antay communities and the observatories. For example, before the construction of ALMA, a representative of the observatory claimed that '[t]his is not a commercial but a cultural project. This is not an invasion. We won't extract anything but rather capture what comes from space' (*Estrella del Loa*, 2002). From an ontological understanding, the main problem is not whether ALMA is extracting or appropriating a resource but rather the asymmetrical relationship it is establishing with the territory in which it carries out its operations.

Compared to the previous articulations, this understanding of extractivism introduces a new actor, namely the territory. As I argued in the conceptual chapter, in Latin America territory not only points to a piece of land but also to the human and other-than-human actors living on the basis of a balanced coexistence (Escobar, 2018, p. 173). The emphasis on territory decentres the question over the raw or processed status of astronomy data since it is understood that this data is made possible thanks to the agency of the territory and the human and other-than-human actors taking care of it. At the same time, the acknowledgement of the material interdependencies that make up the territory inspires an ethics of care that invites Lickan Antay activists to combat extractivism in all its forms. I delve at length into the implication of acknowledging the territory in the governance of data infrastructures in the next chapter.

A final note on the ontological articulation has to do with the type of actors that are deemed as potential agents of extractivism. For this articulation, not only mining companies and astronomical observatories but also the state itself can undertake extractivist practices or behave in a way that is complicit with such practices. In the view of Lickan Antay activists, the state permits extractivism when it draws on notions of progress that are detrimental to a horizontal

dialogue between different ways of thinking and doing, i.e., for bringing about the pluriverse. As I discuss in the last section of this chapter, Lickan Antay activists consider that the state and its multiple bureaucratic bodies—municipalities, regions and the central government—have tended to privilege the interests of international scientific organisations and mining companies. In accordance with one of the postulates of collective autonomy, the state seems to be reinforcing rather than challenging modern/colonial hierarchies.

5.3.5. Dis-Embedding and Re-Embedding Extractivism

The three articulations of extractivism emerging in relation to astronomy data shed light on different intersections between datafication and centuries-old power dynamics. A question that arises, though, is the extent to which these articulations can help move towards the horizon of collective autonomy in data governance advanced by this thesis. Certainly, the technoscientific, competitive and ontological articulations provide fruitful sites from which to interrogate datafication, calling for understanding technoscientific practices and infrastructures, productive processes, the associated distribution of labour and the relation with communities living close to the production centres as potential sites of extraction. In that sense, these articulations represent emerging loci of data extraction, an observation that echoes calls for expanding notions of extractivism that restrict the phenomenon to the extraction of natural resources (Gago & Mezzadra, 2017; Grosfoguel, 2016).

Nevertheless, not all these articulations are equally well positioned to unravel the connections between datafication and modernity/coloniality. As I explained earlier, the way the Left and social movements understand extractivism in Latin America assumes that the phenomenon responds to a planetary system of exchange, or what political economists would call a capitalist world system. It is not only that this system places 'wrong' incentives, but rather that the existing dynamics are supported by a small but nonetheless powerful and wealthy group of countries who benefit from the existing distribution of labour. By contrast, the way astronomers, astroinformaticians and representatives of the public and the private sector are making sense of astronomy data's relation with extractivism points in a different direction. Whether through a silence over the actors conducting extractivist practices (technoscientific extractivism) or a focus on the mentality of the business elite (competitive extractivism), they tend to dis-embed extractivism from the capitalist world system, presenting it as a phenomenon solvable by unilaterally increasing investment and efforts in science and technology and by promoting a more innovative mindset. Rather than striving to change the rules of the game, i.e. structural change, the prescription in these cases is restricted to domestic-level shifts and policies. Against this

backdrop, the production of large volumes of astronomy data in Chile becomes something akin to a test—now that Chile has a powerful tool for economic development within its reach, will it be able to fulfil the expectations and abandon its peripheral status in the sciences and the economy? Approaching data governance from such premises would lose touch with extractivism's analytical and political strength.

By contrast, the ontological articulation inscribes data extractivism within a capitalist modern/colonial world system, foregrounding the type of power patterns denounced by decolonial thinkers. One of the reasons for this is because the vision of the Lickan Antay activists I talked to not only derives from an interpretation of their relationship with ALMA but also with other actors with presence in the region, such as lithium extractive companies and tourist operators. Looking at the problem from this perspective makes it possible to understand that the situation of the Lickan Antay responds to what seems to be a hierarchy in which the respect for ways of thinking and doing that do not conform to the precepts of modernity are considered secondary to more urgent developmental goals—hence the not only capitalist but also *modern/colonial* character of this dynamic. The other way in which the ontological articulation inscribes extractivism within the capitalist modern/colonial world system is by reframing the problem and the associated solution from a relational perspective, advocating for dialogue and communication rather than adopting unilateral measures. Such a view echoes the systemic view held by dependency and world-systems theorists, for whom extractivism is not the product of the 'backwardness' of one of the actors but rather the effect of an asymmetrical system. Despite—or perhaps *because* of—this strength, so far the ontological articulation has not permeated the discussion on astronomy data, with the technoscientific and competitive ones having an almost undisputed dominance in academia and the public and private sectors.

Underscoring the modern/colonial character of extractivism makes it possible to overcome the Eurocentrism of the understanding circulating among orthodox political economists. In some cases the employment of the notions of 'extraction' and 'extractivism' in the literature on datafication has tended to rely on Marxist political economy (e.g., Thatcher et al., 2016), a framework that does not necessarily speak to the worldview of Indigenous communities. By contrast, ontological extractivism strives for horizontal dialogue, pushing towards a pluriverse in which the goal is balanced coexistence rather than finding out who is appropriating value. This approach can help undo narrow economic-focused understanding of extractivism by identifying the presence of patterns of coloniality in a varied range of relations mediated by data, such as between scientific organisations and local communities in the case of astronomy data in Chile but also between social media platforms and their users, to mention but one example. In sum, the lens

of ontological extractivism can strengthen a data governance framework based on collective autonomy by making it sensitive to the way both capitalist and modern/colonial hierarchies reproduce in the field of datafication. When combined with the capacity of the technoscientific and competitive articulations to specify sites of extraction, ontological extractivism can provide a fruitful analytical and normative vantage point that draws on the experience of social movements and Indigenous, Afrodescendant and peasant communities in struggle in Latin America.

5.4. The State's Hierarchised Collaborations

As it is possible to infer from the previous sections of this chapter, the discussion over astronomy data, development and extractivism has been marked by claims about the role that the state should adopt in this context. This concern held great prominence during my fieldwork given that my stay in Chile coincided with the launch of the DO. In addition to this empirical observation, the question of the state has been central in struggles over autonomy in Latin America, as I discussed in the conceptual chapter. For these reasons, below I explore the role of the state in the implementation of a data economy by looking at the history of astronomy in Chile and the design of the DO. Based on these cases, I contend that the adoption of a collaborative subject position by the state has encompassed a hierarchised take of relations in which the degree of investment put into the establishment of collaborations with international scientific organisations and transnational companies contrasts with the neglect and exclusion faced by ChiVO and Lickan Antay communities. I commence this section by describing the DO's 'global vision' since, as I argue later, it sheds light on the discourse underpinning the asymmetries I describe.

5.4.1. Imbuing a Global Vision

As I explained in the introductory chapter, since the sixties the Chilean state has proactively promoted the construction of international astronomical observatories in the country. Benefitting from this experience, the DO has built alliances with first-class international scientific organisations and an influential transnational technology company in order to, among other aims, generate 'the markets of the future' (Ministry of the Economy, 2019b, p. 7). The DO is a non-profit public-private partnership formed by the Chilean Ministries of the Economy and Science, AWS and UAI. AWS, the corporate co-founder of the DO, is a subsidiary of Amazon and the world's biggest provider of data storage and processing infrastructure, possessing 33% of the cloud industry (Synergy Research Group, 2021). As Couldry and Mejias (2019, p. 38) observe,

AWS is a key player since it provides the logistic infrastructure that makes possible data colonialism. UAI, on the other hand, is a private university with a focus on business and economics whose main campus is located in Valparaíso city (Mönckeberg, 2013). UAI concentrates the largest rate of students from private schools in Chile and is headed by Harald Bayer, a previous Minister of Education in the current president Sebastián Piñera's first term.

Imbuing a 'global vision' (Arancibia et al., 2017, p. 6) has been a crucial principle in the design of the DO. This goal has translated into an active effort to incorporate the view of international actors in the design of the project. The first roadmap of the initiative was developed based on a survey conducted in 2017 of 400 'international experts' (DO, n.d., para. 9) in the field of astroinformatics. The same year the Chilean government invited 12 people that were selected due to their 'capacity to provide a global perspective' (Arancibia et al., 2017, p. 6) to brainstorm ideas; all of them were men working for organisations based in Europe, the United States and Australia (Arancibia et al., 2017, p. 7). This group met in Puerto Varas, an affluent city in the South of Chile, and for three days they discussed the opportunities afforded by astronomy data for Chilean development. The government also created an advisory board formed by eight senior experts, half of whom were men working for astronomy organisations based in Europe and the United States. The DO is also based on the results of a study it commissioned and that was carried out by the transnational consultancy firm EY, which in 2018 arrived at the conclusion that astronomy is between five and ten years ahead of the private sector when it comes to big data technologies (DO, n.d., para. 17). Finally, the same year the government, AWS and UAI carried out a proof of concept in order to put to the test the assumptions underlying the DO regarding the transfer of cloud capabilities and infrastructure. It is important to note that the DO has also included the voices of astronomers, astroinformaticians and other experts working in Chilean institutions (Valente, 2019), but the summary I have provided here shines a light on what it has meant to incorporate a 'global vision' in practice.

Putting this global vision into practice has also translated into attempts by DO staff to create an institutional arrangement suitable for the incorporation of partners such as transnational technology companies in the initiative. So far this has been one of the main tasks of Aisén Etcheverry, the head of the DO with previous professional experience in the government and the AWS Public Policy for Latin America team (CONICYT, 2019a). As she explained to me, one of her areas of expertise consists of removing existing bureaucratic barriers in the state so as to generate innovation-friendly governance structures. This expertise has been fundamental in the case of the DO since, in her words: 'The DO is a freak of nature, something that does not exist in public law … You have to break public structures, make room for it, pave the way, and only then

the project will pass and you will be able to carry it out'. Etcheverry's call for disruption resembles Facebook CEO Mark Zuckerberg's dictum 'move fast and break things' (Vance, 2012), a key ingredient in the recipe for creating innovative companies. The significance of Etcheverry's words became clear to me after the National Comptroller Agency expressed a series of objections to the presidential decree that gave birth to the DO (National Comptroller Agency, 2020). Not coincidentally, these observations pointed to the lack of justification regarding the employment of unorthodox administrative mechanisms that would grant flexibility to the state to establish partnerships with different actors but that could work against the principles of transparency and fairness: the lack of a public tender process, the constitution of a legal entity subject to private (not public) law and the indefinite character of such partnerships. What this case reveals is that removing bureaucratic barriers for allowing the state to establish and sustain collaborations is worth the administrative risks since it is considered a condition for the state to participate in data-intensive forms of innovation.

Looking back at the previous chapter, the assumptions and practices underpinning the DO are intimately connected with the collaborative subject position being articulated by the astronomy community, especially when it comes to the adoption of a proactive attitude and to the aim of establishing and cultivating horizontal partnerships with international actors. In both cases, the capacity to engage in horizontal collaborations with first-class scientific organisations and transnational cloud companies is seen as a condition for leveraging the opportunities afforded by astronomy data. As to the DO, enacting the collaborative subject position has implied incorporating the voice of experts working for European, USA and Australian organisations at a very early stage of the project and developing a flexible institutional scaffolding.

The DO's approach echoes some of the observations made by literature on the changing vision and role of the state in times of technology-driven economic growth. The adoption of the collaborative subject position by the state connects with the form of 'neoliberal statism' discussed by political theorist Wendy Brown, a vision in which the state proactively buttresses the creation and operation of markets (2005, p. 41). Under this scenario, one of the state's main aims becomes coordinating a broad range of actors, privileging collaborations between the public and the private sector and proposing common goals between different stakeholders. To some extent the Chilean state has also adopted what economist Mariana Mazzucato (2015) would call an 'entrepreneurial' approach in which it not only 'fixes' but also creates and shapes markets. Looking at the history of astronomy in Chile and the DO, it is possible to affirm that the state has adopted a predominantly collaborative and entrepreneurial stance or, to be more precise, that it

has acted as such in its quest to imbue a 'global vision' in its policies as it builds and cultivates alliances with international and transnational actors.

5.4.2. Neglect and Exclusion of Local Experiences

During my fieldwork I also talked to groups for whom the Chilean state has not acted with the collaborative and entrepreneurial attitude I described earlier. This is particularly so in the case of ChiVO and Lickan Antay communities, for whom the assumptions and practices of the state in the field of astronomy data and astronomy more broadly have encompassed neglect and exclusion, respectively.

As I explained in the previous chapter, ChiVO has been a pioneering initiative in Chile in the field of astroinformatics. Because of this, after the launch of the DO in April 2019, some members of ChiVO could not help feeling disappointed for not having been able to become one of the co-founders of the initiative. They complained that the DO did not even have a clear response for the role that his project could play in the short, medium or long term. After talking to policy makers and attending presentations by the DO staff, I could confirm that there was not a detailed plan in place for incorporating ChiVO in future projects. Such a neglect was especially significant when considering that, as I mentioned earlier, the DO's first goal is to develop a Chilean ARC, a project in which the experience of ChiVO with ALMA data would have come in handy. During my fieldwork I also heard researchers from other initiatives sharing similar feelings, critiquing different barriers that were making it difficult to get involved in the DO, such as extremely short deadlines, a restrictive threshold of initial monetary contribution and a lack of clarity regarding the aims and concrete measures of the project. Some of these complaints were reflected in a letter published by the Council of Rectors of Chilean Universities (Council of Rectors of Chilean Universities, 2019) that denounced a deficit by the DO in terms of participation of local universities and research initiatives. These accusations were rebutted by the Minister of Economy, who argued that the design of the DO encompassed the participation of more than 400 local and international experts (Valente, 2019, para. 2). As a response to ChiVO's criticism, members of the DO affirmed that they would expand their alliances in the future.

A similar picture arises when analysing the development of astronomy in Chile from the perspective of Lickan Antay communities. As can be deduced from the previous section, for the Lickan Antay activists affected by the construction of ALMA the state has privileged the interests of the observatories at the expense of the communities living in the area. As Leticia González Silvestre said to me, in the negotiations with the Chilean state during the concession of the Chajnantor Mountain to ALMA in 2002 the voice of the Indigenous people was acknowledged at

a very late stage. In her view, this exclusion has been the rule in their relations with the Chilean state:

> They shouldn't come to you at the very end, ask you at the very end whether you agree or not with the project. The project should start by speaking with you … The whole thing is very disguised and fake, that sort of sudden concern of the state.

Different forms of compensation are offered in some cases, but for González this constitutes a form of paternalism that does not make up for the exclusion from the design stage. Furthermore, this exclusion does not necessarily come from the state but also from actors who privilege the state as the only valid interlocutor, ignoring the forms of organisation proper to the Lickan Antay communities, as was the initial approach adopted by ALMA. In that sense, there is a stark contrast between the hope on the part of scientists, engineers, policy makers and members of the private sector that the state will help overcome extractivism, on the one hand, and the Lickan Antay activists' conception of the state as *complicit with* extractivism, on the other. As Paola Ricaurte (2019, p. 357) observes, the exclusion of Indigenous voices from digital policies constitutes another form of internal colonisation inasmuch as it reproduces the coloniality of relations within the borders of the nation-state.

The experience of ChiVO and the Lickan Antay communities contrasts with that of the international scientific organisations and transnational technology companies, who have had the chance to inform the development of astronomy and astronomy data policies from a very early stage. Particularly relevant to understand this neglect and exclusion from the perspective of decolonial thinking is the DO's concern of imbuing the 'global vision' I referred to earlier. As Walter Mignolo (2012) argues, one of the characteristics of modernity/coloniality has been the dominance of 'global designs' that, despite their inspiration on the basis of the European trajectory, are considered as unproblematically applicable elsewhere. The Christian salvation, the civilising mission and development are examples of such global designs. By contrast, visions and experiences that do not conform to the European experience tend to be undermined by portraying them as local, partial and particular, which is especially acute in the case of the knowledges of Indigenous people. The case of the DO and astronomy in Chile reveals a similar pattern in which some voices are considered bearers of a 'global vision' and able to anticipate the future, and therefore taken seriously into consideration in the design of policies, and other ones are deemed as particular and therefore only incorporated at a secondary stage. Racial (white), gender (men) and geographical (North) hierarchies intermesh when it comes to defining whose voices count as

'global' and have the capacity to envision the future and the role that Chile could play in it. For example, generating networks with other public and academic initiatives in Latin America working on the archiving of scientific data, among which Colombia's Biodiversity Information System (SiB Colombia, n.d.) is but an example, has not been considered as relevant so far.

Rather than appealing to nationalist arguments, the neglect of ChiVO and the exclusion of Lickan Antay communities reveal that the 'collaborative' stance privileged by the Chilean state in the history of astronomy and astronomy data has tended to adopt visions and interests deemed as universally valid but that do not necessarily speak to the needs and views of local actors. Such a hierarchised take on relations ignores the particularities of the context, such as the challenges faced by ChiVO and the forms of organisation privileged by Indigenous communities, and considers a narrow group of people as capable of representing a 'global' vision. This approach is prone to conceiving aspects of the local context, such as under-resourced research teams and the existence of Indigenous communities, as obstacles for the achievement of the goals set up by the state. For these reasons, the notions of 'collaboration' and 'entrepreneurship' under the terms I have described here would constitute problematic starting points for thinking about data governance from the perspective of collective autonomy.

5.5. Conclusion

In this chapter I traced the creation of a data economy in Chile and described its intersection with notions of development, extractivism and the state that have been long-standing concerns for intellectuals and mobilised groups in Latin America. In the view of scientists, engineers, policy makers and members of the private sector, astronomy data offers a unique opportunity to advance economic development, but at the same time there is a risk of not being able to overcome the extractivist pattern that has haunted Chile for centuries. When attending to the view of local actors with more detail, the attempt to make sense of the current situation is giving rise to three articulations of extractivism—the technoscientific, competitive and ontological ones. Among them, I argued that the latter provides an opportunity to revitalise the term's analytical and political strength by embedding the phenomenon into a modern/colonial world system. Finally, here I also pointed out that the connection between astronomy, astronomy data and development goes hand in hand with a state that, aimed at incorporating a 'global vision' in the design of its policies, adopts a take on collaboration that for some local actors has implied neglect and exclusion. A relevant conclusion that can be derived from these observations is that a formulation of data governance based on collective autonomy would require rethinking the connection between extractivism and data in a way that does not remove the underlying capitalist

modern/colonial patterns from the picture and that considers all the voices as equally relevant in the formulation of potential futures.

As in the sphere of scientific and technological research, the articulatory practices of local actors show a great deal of agency when it comes to thinking about the role of astronomy data in the economy. This agency manifests in some of the aspects I touched on in this chapter, such as the decision to challenge the assertion that astronomy data is simply worthless, the articulation of different understandings of extractivism, and the entrepreneurial attitude adopted by the state for ensuring the generation of the markets of the future. Despite this agency, the way local actors are thinking about astronomy data might not be as innovative as it appears at first glance. In particular, the assumptions and practices surrounding astronomy data have tended to shy away rather than confront long-standing issues in the region. So far academic researchers, policy makers and members of the private sector have tended to bracket off difficult aspects such as the endurance of the horizon of development despite its incapacity to account for the complexities of the local context, the connection between extractivism and the capitalist modern/colonial world system, and the reproduction of modern/colonial hierarchies by the state.

Bringing together this and the previous chapter, epistemic disobedience and acknowledging that data economies participate in a capitalist modernity/coloniality emerge as two conditions for aligning data governance with collective autonomy. In addition to this, the case of astronomy data in Chile also offers an opportunity to reflect on another aspect relevant for decolonial thinking. Going back to the conflicts between ALMA and the Chilean state with the Lickan Antay communities, an attentive reading of the divergence underlying these two positions indicate that at stake are different and to some extent incompatible imaginaries of territory. Expanding on this, in the next chapter I look at another concern ignored by dominant frameworks of data governance and explore the intersection between Indigenous territorial conflicts in Latin America and the expansion of the exoskeleton enabling the production, management and processing of large volumes of astronomy data in Chile.

6. Re-Imagining the Territory:
The Stakes of Data Infrastructure for the Sustainment of the Lickan Antay World

6.1. Introduction

The *ctenomys fulvus*, known as *chululo* in Chile, is a rodent of no more than 30 centimetres that lives in tunnels and rarely leaves its burrow (Charron, n.d.). The *chululos* prefer sandy and high environments, two conditions perfectly met in the eastern border of the Atacama Desert, where it meets the Andes Mountains. There is scarce scientific information about the *chululos*, but something that has caught the attention is that they share many similarities with moles, without being blind (personal communication with Daniela Ortega, 13 April 2021). Additionally, it is believed that the *chululos* are crucial for the environment since their holes might favour the circulation of oxygen in the soil and keep at bay certain plagues. In 2016, these little animals were dragged into a controversy when ALMA presented its plans to employ natural gas, which required installing new underground pipelines in an area covering 25 kilometres (Antofagasta Region Assessment Commission, 2017). After three observation campaigns, the experts hired by ALMA did not identify any significant potential issue associated with this project. However, the scenario changed drastically when members of the Lickan Antay community of Toconao, the closest village to the observatory, identified several *chululo* borrows in the area. The debate ended when a committee of ministers in Santiago approved the plan and, based on technical and legal arguments, estimated that ALMA could proceed without removing the old pipelines but protecting the integrity of the *chululos* (Environmental Assessment Service, 2018).

Figure 5: *Picture of a* Chululo

Note. Used with permission (Iriarte Walton, 2008, p. 162).

The story of the *chululos*, to which I return later, prompted me to wonder about the concerns that I discuss in this chapter—whether the conflicts aroused by the expansion of data infrastructures[49] could be understood as the beginning of a new chapter in the history of Indigenous territorial struggles in Latin America. Furthermore, this story also made me wonder how ALMA, one of the most cutting-edge observatories in the world, capable of looking at faraway galaxies, could not spot the *chululos* living around its facilities. It was only when I put together some initiatives that I heard about in my fieldwork and the conversations I had with Lickan Antay activists that I realised that the initial omission of the *chululos* by ALMA was not a mere coincidence. Instead, it reflected the workings of a particular imaginary that, aimed at enabling 'spaces of flow' (Castells, 2010, p. 407) and conceiving the expansion of built infrastructures as an imperative for progress (Mattelart, 2000), has ended up rendering secondary the objects and living beings with no direct relevance for this aim, with the *chululos* being a perfect case in point.

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[49] In this chapter I understand 'data infrastructures' as consisting of technical equipment such as data production devices (the observatories, in this case), data centres and fibre optic cables as well as the broad range of components that make them function, including gas pipelines. This expanded understanding is premised on the observation that infrastructures are inseparable from the material conditions that enable their construction and operations (Parks & Starosielski, 2015, p. 5).

In the following sections, I compare two imaginaries of territory emerging in connection with astronomy data in Chile and discuss their stakes in the context of a modern/colonial world system. On the one hand, I identify an 'assetised' imaginary that, conveying scientific and commercial rationales, transforms features of the geography into resources to attract investment from international scientific communities and transnational technology companies. I flesh out this imaginary by looking at the Natural Laboratories governmental policy and the Datagonia project put forward by a technology company. On the other hand, I discuss a 'relational' imaginary mobilised by Lickan Antay communities in their controversies with ALMA and the Chilean state. In this case, the territory is conceived of as an entanglement of human and other-than-human actors living in balanced coexistence. As I argue here, the assetised imaginary reveals the infrastructural dimension of data coloniality since it endangers modes of territorial existence that do not conform to the precepts of modernity/coloniality. The relational imaginary, instead, signals a way out of this conception and represents a condition for a data governance framework based on the perspective of collective autonomy. In particular, it opens up the possibility of de-linking from the modern imperative to infrastructure, and aligning the governance of data infrastructure with the struggles of communities in Latin America seeking to 'reconstruct and defend the territories of hope' (Toledo Llancaqueo, 2005, p. 96).

One of the difficulties that emerge in the analysis of the case of the *chululos* is finding a vocabulary capable of grasping what is at stake in these two different imaginaries. In this respect, and going back to a point I made in chapter two, this chapter follows the view of anthropologists Mario Blaser and Marisol de la Cadena (2018), for whom such divergences do not only point to conflicts over resources (political economy) or between perspectives about nature (political ecology) but, more profoundly, to the types of entities that are taken to exist as well as to the relationship between them and the territory—a kind of inquiry they call 'political ontology'. As Escobar argues, 'environmental conflicts are often at the same time ontological conflicts—that is, conflicts over contrasting ways of existing and making worlds' (2020, p. 25). At stake, thus, is not only the preservation of the Earth and the survival of ancestral cultures but the very possibility of constituting worlds otherwise, that do not adapt to the precepts of modernity/coloniality. Such 'reworlding possibilities' (Blaser & de la Cadena, 2018, p. 4) have become especially relevant in times of the terricide.

A final point to make before proceeding regards a theoretical-methodological observation. In this chapter I speak of 'imaginaries' of territory to acknowledge the ontological dimension of the assumptions and practices at stake. For Ernesto Laclau, an imaginary represents 'an absolute limit which structures a field of intelligibility and is thus the condition of possibility

for the emergence of any object' (1990, para. 64). Along these lines, an imaginary scales up the analysis, directing it to the examination of the type of ontological questions put forward by political ontology.[50] Consequently, this chapter asks: how does the imaginary of territory underpinning the governance of data infrastructures appear when observed from the perspective of political ontology? What possibilities offer imaginaries otherwise for collective autonomy?

6.2. The Assetised Imaginary of Territory

6.2.1. The Natural Laboratories Policy

The first of the imaginaries I discuss in this chapter becomes particularly salient when we examine the vision of territory underpinning the Natural Laboratories governmental policy. This initiative was born when policy makers posed a straightforward question: How could Chile replicate the case of astronomy? Seeking to answer this, in 2011 CONICYT identified a series of 'natural laboratories' afforded by the Chilean geography that, just as the skies of the Atacama Desert, could become 'open instances of collaboration' (Aguilera & Larraín, 2018, chapter 1, section 3, para. 6) and operate as 'attractors' of world-leading research centres. A book co-authored by two governmental officials, one scientific and one economic, defines a natural laboratory as 'a singularity or anomaly of the environment that attracts the attention of world science and, when this occurs in emerging countries, provides competitive advantages that are not replicable in other places or contexts' (Aguilera & Larraín, 2018, chapter 1, section 3, para. 2)[51]. Along these lines, not only the skies of the Atacama Desert but also Chile's frequent and intense earthquakes, cold sea currents, privileged access to the South Pole and a series of other geographic features are being promoted internationally in order to replicate the success of astronomy.

As the above definition makes clear, the Natural Laboratories policy conveys both scientific and industrial rationales. On the scientific side, this policy asserts that establishing partnerships with international scientific organisations will help upgrade 'infrastructure,

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[50] The way I am approaching an imaginary here echoes Charles Taylor, who, in brief, understands it as 'the ways people imagine their social existence' (C. Taylor, 2004, p. 23). Nevertheless, I privilege Laclau's account since his emphasis on conflict is closer to the aims of this chapter of foregrounding divergences between two imaginaries.

[51] A similar albeit summarised version of this definition appeared in the more recent Science, Technology, Knowledge and Innovation National Policy (Ministry of Science, 2020, p. 64).

researchers and scientific production' (CONICYT, 2013, para. 5) in Chile, an assumption that echoes the collaborative subject position I identified in chapter four. On the economic side, local actors expect this initiative to help increase Chile's low R&D expenditure, whose approximately 0.4% of the GDP leaves the country below the average for the region (Guridi et al., 2020, p. 6). Considering observations made in the previous chapters, the Natural Laboratories policy's current formulation has not envisioned measures to address potential issues of epistemic obedience and technoscientific, economic or ontological extractivism. Moreover, existing governmental documentation on the Natural Laboratories does not discuss the lessons drawn from astronomy concerning the difficulties of generating 'spillovers' (Guridi et al., 2020) outside the sciences that could help justify the series of land, tax and diplomatic benefits enjoyed by the observatories.

In addition to the scientific and economic dimension, the Natural Laboratories also has a geographical import since its formulation is usually accompanied by a call for approaching the territory from a different perspective. The words by Gabriel González, a governmental official from the Ministry of Foreign Affairs, illustrate this point. I met with him in the offices of the Energy, Science and Technology & Innovation Division (DECYTI) that he heads and that are located in Santiago's civic centre, next to La Moneda Palace, the seat of the central government. For González, the explanation for the apparent success of Chile in astronomy resides in a change of perspective when it comes to looking at the geography:

> You have to look at the landscape from the point of view of its geography, that is to say, from the point of view of what our participation could be on the planet with what we have got. Chile is a natural laboratory. It has the Humbdolt current,[52] it has the most spectacular skies in the world for studying astronomy, it has the Antarctic zone, with the most direct access to the Antarctic.

In the above words, Gabriel González was inviting me to rethink the Chilean geography by putting the focus on features that could help the country acquire a more relevant role on the global scientific scene. By doing so, the quote advocates a particular way of approaching the territory—as a series of geographical singularities at disposal for the sake of national scientific and economic progress. The choice of the term 'landscape' (*paisaje*) rather than alternatives such

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[52] The Humboldt Current makes the sea water of part of the Chilean coast colder than in the rest of the Pacific.

as 'land' or 'terrain' is particularly telling in this regard. For a landscape to become such a thing requires a human observer, which means that 'landscaping' a territory usually constitutes a form of social appropriation. In addition to this, a 'landscape' evokes a sense of stillness and passivity, which works as a means to render intervention in a given geographical area relatively easy. Also crucial to the interpretation of the quotation above is the 'we' implied in the words 'what we have got' since this 'we' does not point to the human and other-than-human actors inhabiting the natural laboratories but to the imagined community of Chilean people who are considered to be entitled to count on such territories. Against this backdrop, a paradox emerges since the Natural Laboratories calls for foregrounding the territory, for celebrating its unique features, but in a way that does not refer to how potential interventions would fit with the interests, needs and visions of the human and other-than-human actors living there. This view echoes the modern origins of the term 'territory' that emerged in Europe and that portrays it as a bounded space in which the state deploys calculative strategies so as to exercise sovereignty (Elden, 2010).

There is an important correlation between Gabriel González's quote and the definition of the Natural Laboratories as a 'competitive advantage' which I cited earlier. In both cases the territory is approached from a strategic rationality and transformed into a resource for the attainment of a long-term plan. Following Ken Birch and Fabian Muniesa, this move would constitute an 'assetisation' of the territory. In the view of these authors, the conjunction of science, technology and capitalism has prompted the transformation of an increasing number of things—from a piece of land to a life-form—into assets, or something that 'can be owned or controlled, traded, and capitalized as a revenue stream, often involving the valuation of discounted future earnings in the present' (Birch & Muniesa, 2020, para. 4). Thanks to this move, territories previously un- or sub-exploited due to their extreme geographical characteristics can be integrated into the economy and generate a series of social and economic benefits.

Birch and Muniesa's privilege of the term 'asset' over alternatives such as 'commodity' coincides with two characteristics of the way the Natural Laboratories approaches the territory. First, it suggests that these resources are expected to generate an economic gain in the future and not necessarily in the present. In fact, the Natural Laboratories policy does not seek to trade these geographical features in a marketplace but rather to use them as an indirect means to ignite economic development. The construction of sophisticated research centres in Chile might not bring in revenue for the state or the local population, but it nonetheless will promote technology transfer to the local industry, helping upgrade the productive matrix and bringing about social and economic development. A second characteristic is that assets are usually valorised from the viewpoint of potential investors. As I described earlier, the criterion employed to identify natural

laboratories relies on a figuration of geographical features of interest for international scientific research centres. Because of this, the value of these natural laboratories does not stem from their capacity to meet the interests and needs of national scientific communities or of the human and other-than-human actors inhabiting those areas. Instead, the value of these natural laboratories depends on their capacity to attract international investors that could help increase the national R&D expenditure. For a country without the resources to exploit such areas, what counts as a natural laboratory and what does not rely on anticipating the interest of international and transnational players.

The promotion of the Natural Laboratories policy has been accompanied by the employment of techniques of representation aimed at making the territory appear as an asset. In particular, functional cartography and quantitative data have been employed in this case to identify and promote features with unique opportunities afforded by the Chilean geography. Figure 6 represents a map included in the book mentioned above on the Natural Laboratories and employs coloured geometrical figures to highlight potential areas of interest within the Chilean territory. This map conveys the idea that the Chilean geography affords a number of such laboratories—ten, to be precise—scattered all over the national territory, waiting to be exploited by international scientific organisations. The types of sites are varied, ranging from the skies of the Atacama Desert in the North to possibilities for polar sciences in the South. Along with cartography, another technique employed by this imaginary to identify and promote natural laboratories is quantitative information. For example, the aforementioned book specifies that the Atacama Desert holds the highest insolation values—which represent the incidence of solar energy on the surface—of the planet, which range between 7 to 8 kWh/m² per day and constitute a unique opportunity for energy projects (Aguilera & Larraín, 2018, chapter 1, section 5, para. 6). Data of this kind is utilised by this imaginary to illustrate the uniqueness or extreme character of specific geographical features in a way that is easily comparable with other alternatives and that makes it possible to calculate the return on investment of deploying scientific infrastructure in such a remote place.

Figure 6: *Map of Natural Laboratories in Chile*
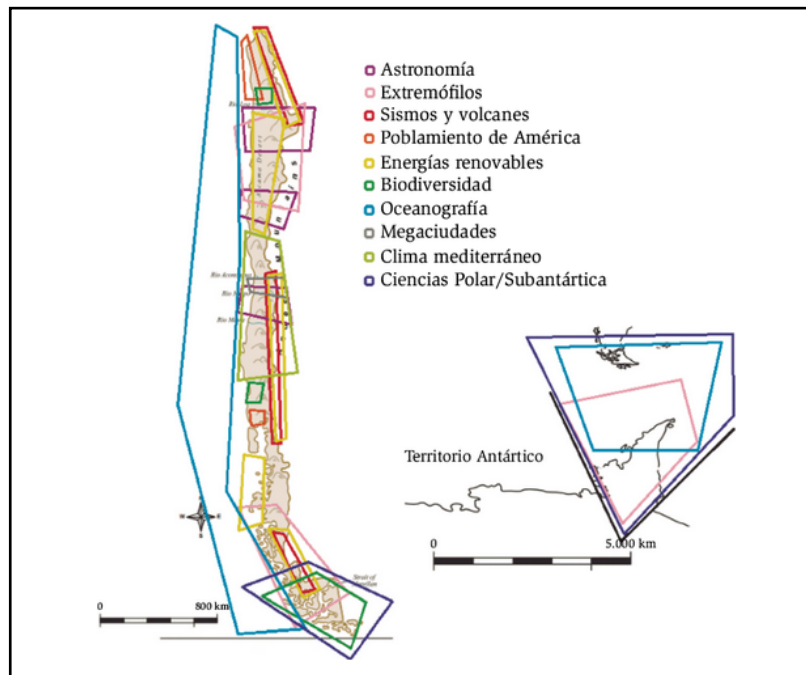
Note. The list reads: astronomy; extremophiles [organisms that thrive in extreme environments]; earthquakes and volcanoes; the settlement of the Americas; renewable energies; biodiversity; oceanography; megacities; Mediterranean climate; polar/subantarctic sciences. As this list suggests, not only geophysical features but also human-social phenomena can act as natural laboratories. Used with permission (Aguilera & Larraín, 2018).

The use of cartography and quantitative data is not a coincidence—both belong to the series of rationalistic techniques of representation that emerged in Europe along with the modern/colonial notion of territory and that enabled the management and control of distant lands during historical colonialism (Castro-Gómez, 2005). In the case of the Natural Laboratories, these techniques are fundamental for not only transforming these territories into assets but also presenting them as worthy of investment, namely 'investibles' (Li, 2014), to a broad range of audiences. Functional cartography and quantitative data are usually seen as universal and self-evident sources of information with the capacity to make phenomena intelligible for different people and groups regardless of their social or cultural context. Particularly interesting for the analysis of the underlying imaginary is that these two techniques undertake a simplification of the territory, rendering it an abstract object whose attributes could be compartmentalised, manipulated and compared. However, such a pragmatic choice does not come without a cost since, in the process, the territory loses its dense and richly textured character. The diversity of animals, plants, atmospheric conditions and geological qualities, as well as the human settlements

present in the territory, are removed so as to make the relevant information easier to process. Due to the relevance of these techniques of representation, it could be said that imaginaries of territory have both an ontological and epistemological, i.e., an onto-epistemic, character.

Existing governmental documentation on the Natural Laboratories policy does not address potential difficulties that could arise in the design and development of scientific infrastructure in the territory. This silence is curious since different frictions have criss-crossed the history of international collaborations in the field of astronomy in the country, such as the lack of adequate infrastructure (not only digital but also transport and electricity), the changing environmental conditions of the country (as in the increasing 'light pollution' in the Atacama Desert), and divergences with local communities (such as the Lickan Antay people). Little is mentioned about these frictions in the book on the Natural Laboratories, which only addresses the disputes between the Lickan Antay people, ALMA and the Chilean state in an indirect way: 'the governance of such laboratories transcends administrative regions, potentially involving diverse actors that range from Indigenous people to international organisations' (Aguilera & Larraín, 2018, chapter 1, section 7, para. 4). By contrast, academic literature has done a better job of foregrounding the lessons and difficulties underlying the construction of the international astronomical observatories and the agreements with local actors (e.g., Barandiarán, 2015; Guridi et al., 2020).

Certainly, the assetised imaginary's silence over potential frictions to be found in the territory is functional for the aim of attracting international scientific organisations and transnational technology companies. As a result of this, however, the needs, interests and visions of the human and other-than-human actors and their complex interactions recede from the scene, transforming the territory into a seamless space, or a space of flows, even if in practice the situation might look significantly different in the field. In the process, rich and complex relations are reduced to geometric figures or quantitative data that provide little information about the interdependencies that underlie both habited and inhabited areas.

6.2.2. The Datagonia Project

A similar imaginary of the territory underpins Datagonia, an initiative worth discussing at length because it speaks directly to the role of the private sector and incorporates an environmental awareness that at first glance might represent a solution to some of the deficiencies of the Natural Laboratories. Datagonia is a project envisioned by Grupo Datco, a company based in Argentina with offices in Chile. The aim of Datagonia is to transform the Chilean Patagonia, the geographical area located in the southern extreme of South America, into a node in the

planetary network of data infrastructures by constructing a farm of data centres. Data centres are usually constructed in regions presenting 'economies of land, tax rates, energy, water for cooling, and proximity to the main trunks of the network' (Amoore, 2020, p. 35), which has taken different regions in the world to compete in order to become the best candidates for the investment of transnational technology corporations. The geographical location of Patagonia comes in handy in this regard since its relatively low temperatures can help save part of the large amount of power required to cool the data centres that make these storage and processing devices contributors to the terracide.[53] Astronomy data has a vital role for Datagonia since the international observatories are expected to become key customers of the service.

I learnt about Datagonia from Yessika Salazar, Grupo Datco's Country Manager with whom I met in Santiago. Salazar has been the leading promoter of the project, having collected evidence, developed a prototype and generated reports and presentations in order to advocate state support. In addition to the geographic conditions of Patagonia, she considered that ambitious digital infrastructure improvements underway in the south of Chile could also create conveniences. Crucial in this regard is the government's Southern Optic Fibre project, in which Silica Networks, one of Grupo Datco's subsidiaries, is participating (Undersecretary of Telecommunications, 2021). In Salazar's view, for international and transnational customers Datagonia could constitute a source of 'redundancy', a term employed in engineering to refer to the development of alternative paths for the transmission of data. In her words:

> Network redundancy, repository redundancy, with an energetic awareness. That's the idea of this. Northern Hemisphere, Southern Hemisphere. The earth has become nothing these days. Distances don't exist. Nowadays, for example, I can do SAP[54] processing here, and I am processing in Germany. That's the cloud. My network with someone else's data centre… There is a huge need for this. Because this is it. We have the technology that makes it possible to store, store, store, store data.

The idea of a planet that is shrinking as mobilised by Salazar resembles the notion of 'space-time compression' that, according to geographer David Harvey (1989, p. 240), has taken

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[53] A 2018 study estimated that global energy use by data centres in 205 terawatts-hours (TWh), which equates to 1% of the global energy consumption (Masanet et al., 2020, p. 985).

[54] SAP stands for Systems Applications and Products in Data Processing and points to the analysis of information carried out for business management purposes.

place due to the combination of capitalist logics and technological advancements. It also evokes Manuel Castells's idea that the information society is giving rise to 'spaces of flows' (2010, p. 407) enabling almost real-time interactions between geographically distant places. For Salazar, being geographically far away is advantageous for Chile since it can transform the country into a source of redundancy for the planetary data infrastructure, operating as a safe backup for information produced elsewhere. In our conversation, Salazar drew on the example of the Vatican Archives, which for her constitute information with value for the whole of humanity, to explain this point. Adding redundancy means that there would still be a reliable version of these files in Chile if there is a natural disaster or catastrophe in the Vatican. As she explained, the possibility of becoming a source of redundancy is afforded by cloud computing, which makes it possible to interconnect data infrastructure located in different regions of the world. The repetition of the verb 'to store' at the end of her remarks is a way of highlighting that the large volumes of data being produced worldwide would provide a constant source of information and therefore a continuous source of profits. In fact, under datafication circulation is paramount for the generation of value (Sadowski, 2019).

Datagonia seeks not only to become a commercially suitable initiative but also an environmentally sustainable one. An essential feature of the project, and one that distances it from the Natural Laboratories, is that it encompasses an explicit concern for the environment. As its website reads, Datagonia aims to become the 'first ecological data centre of the Patagonia region' (Grupo Datco, n.d.). With this goal in mind, Grupo Datco has constructed a prototype in Nubicua, near the city of Osorno, located 1,900 kilometres away from the core of the Atacama Desert. This data centre employs local water sources to cool the storing and processing devices and its walls are built with volcanic rocks obtained from the area to facilitate the circulation of air. Grupo Datco has also developed an architectural proposal in which the data centres intertwine with the natural landscape, and even includes the construction of a recreational park in the area.

In order to promote their idea, Grupo Datco developed a 3D audiovisual piece in which aerial shots convey a strong visual harmony between the farm of data centres and the green and hilly environment surrounding it (Figure 7). Here, data centres are installed in the underground even though it is still possible to note their presence from the ground level due to some terrain elevations. The decision to remove the data centres from plain sight echoes the idea that infrastructures tend to recede and become part of the background (Star & Ruhleder, 1996), but it also challenges this principle by envisioning a conspicuous oeuvre—a park—to celebrate what is deemed as a techno-environmental achievement. Perhaps the tension between visibility and invisibility underpinning Datagonia is better conveyed by the assertion that '[d]ata centers are

information infrastructures hiding in plain sight' (Holt & Vonderau, 2015, p. 74), a design strategy employed to conjugate the contradictory principles of transparency and security that usually underlie projects of this kind.

Figure 7: *Screenshot of a 3D Render Video of the Datagonia project*
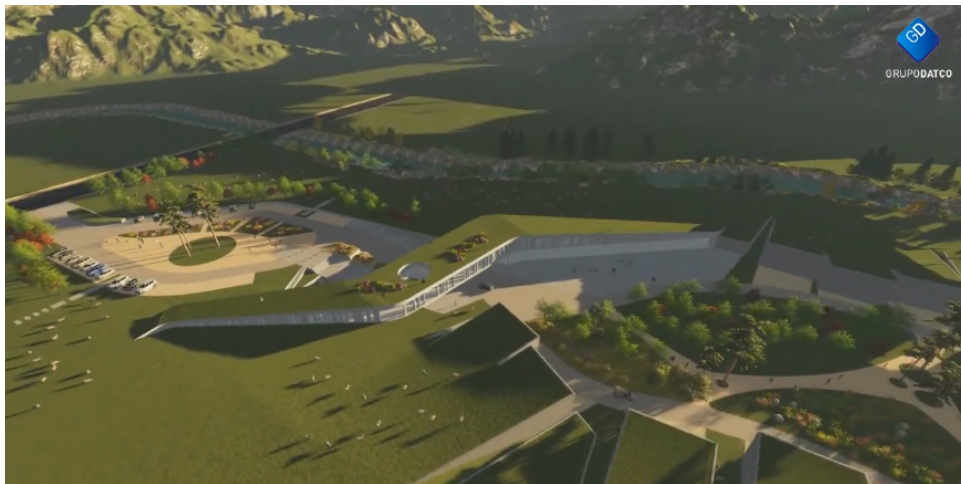
Note. Video by Grupo Datco. Used with permission.

A question that arises is whether the environmental commitment of Datagonia makes it depart from the imaginary of territory underlying the Natural Laboratories policy. Looking at its discursive construction, the answer would be not so much. The way Salazar justified the green commitment of Datagonia shares similarities with the assetisation of the territory encompassed by the Natural Laboratories. This quote on the decision to locate the project in Patagonia is an illustration of this point:

> Here comes the country differentiator … Other people say, 'You know what? We could build a data centre in the abandoned mines' … If you've got an abandoned mine, the cooling off will be done by the darkness, because there is no heat. There is natural cooling. So these are the same concepts, but we have to take advantage of them. So let's do it!

The above remarks present the environmentally friendly character of Datagonia as a 'country differentiator', which echoes the Natural Laboratories' focus on identifying 'competitive

advantages' in the Chilean territory. The genealogy of the term 'differentiator' also stems from business strategy. A differentiator is one of the generic strategies envisioned by Michael Porter (1985) for gaining a competitive advantage—the aim of the Natural Laboratories—in a given market. Along these lines, Datagonia conceives some features afforded by Patagonia, such as the weather and the proximity to water sources, as 'differentiators' that can help attract national and international clients. Adopting an entrepreneurial attitude ('let's do it!') common in innovation circles, Salazar invites other interested parties to 'take advantage' of these geographical features and transform them into an economic opportunity.

The idea of the features of the territory as differentiators in a global market is also present in the way Salazar told me the story of Datagonia. As she explained it to me, she confirmed the feasibility of the project's business model when a consultant from the European Union on matters related to astronomy gave his blessing to the idea: 'He saw the prototype of the green data centre that I had put together and said, "This is what we need! This is what the scientific community wants!"'. The interest expressed by this consultant might explain why data from the observatories, along with volcanology, figure as potential users of Extra Large (XL) storage units (Figure 8).

Figure 8: *Screenshot of a 3D Render Video Depicting Potential Clients of Datagonia*
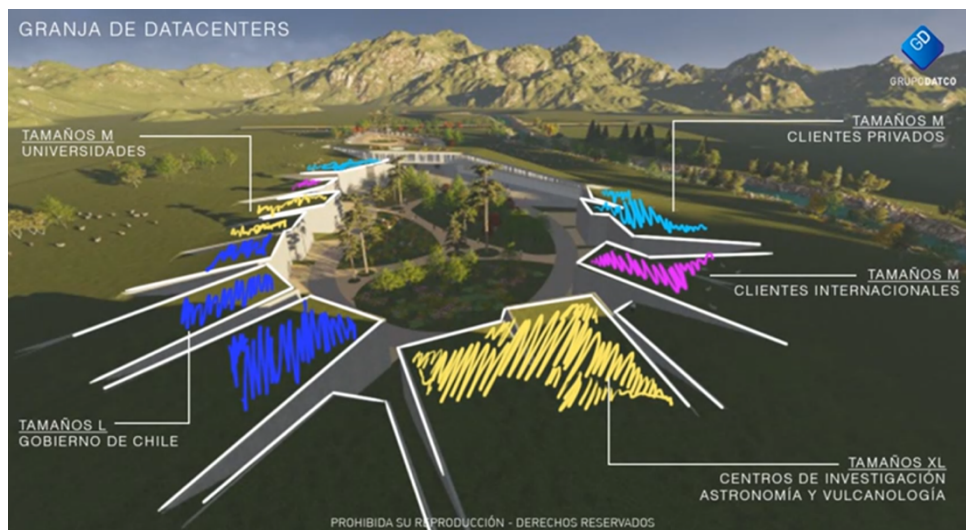
Note. Clockwise, the text reads: M sizes, private clients; M sizes, international clients; XL sizes, astronomy and volcanology research centres; L sizes, Chilean government; M sizes, universities. Video by Grupo Datco. Used with permission.

Despite its attempt to ensure a more harmonious relationship with the environment, the imaginary of territory underlying Datagonia is not that different from that of the Natural Laboratories. Certainly, Datagonia's vision of the territory encompasses a more careful and considerate approach. Besides its green character, Salazar also explained to me how Datagonia could generate a series of synergies with universities and economic activities in the area. However, as in the Natural Laboratories, it is still possible to identify an assetisation of the territory inasmuch as the identification and exploitation of geographical features depend on the interest that these could have for potential environmentally aware national and international customers. In this sense, Datagonia replicates the move encompassed by the emergence of the notion of 'sustainable development' that advocates environmental awareness but does not depart from capitalist logics, conceptualising other-than-human actors and the territory as 'natural capital' (United Nations Environment Programme, 2011, p. 5). More broadly, Datagonia's green character raises additional profound questions, such as whether this project implies a form of outsourcing of climate damage to the South; whether this environmental commitment would still be relevant without a profitable business model; and, more radically, whether simply not constructing these data centres would be a more sustainable option in the first place.

6.3. The Relational Imaginary of Territory

6.3.1. The Lickan Antay People

Whereas in the previous section I analysed a governmental policy and an initiative pushed by a technology company in Chile, now I turn to the imaginary of territory mobilised by the Lickan Antay Indigenous people in their disputes with ALMA and the Chilean state. In a move that echoes decolonial thinking's programmatic aim, here I describe this imaginary in order to not only identify its differences with the assetised one but also to think of a framework for governing data infrastructures in a way that, anchored in the principle of collective autonomy, could open up rather than constraint the cultivation of worlds otherwise.

The Lickan Antay world developed in the Atacama Desert, close to oases, valleys and ravines located between the Salar de Atacama and the Loa River. The almost 30,000 people that identify as Lickan Antay in Chile live in both urban and rural settlements (Ministry of Social Development, 2017), but the insights I discuss here draw on interviews I held with members of the communities scattered in villages and ayllus. In historical terms, the Lickan Antay people and their territories were annexed by the Inca Empire in the fifteenth century, by the Spanish Empire

almost a century later, by Bolivia in 1824 and, finally, by Chile in 1883 after these two countries confronted each other in the War of the Pacific. Initially, the territorial life of the Lickan Antay was based on an adaptable regime according to the seasonal access to water and other resources, but the imposition of modern/colonial ways of living implied adopting a predominantly urban regime (Bengoa, 2004, p. 162). From the Spanish invasion to the twentieth century, the Lickan Antay people have been subject to material dispossession and repression of their cultural patterns (Bengoa, 2004, p. 153). The latter has implied the extinction of the Kunza language and, in ontological terms, threatening a world in which the fate of humans require the collaboration of entities such as mountains and rivers (Núñez Atencio, 2007).

Over the last decades, research efforts have portrayed the Lickan Antay as a culture that flourished between the second and the tenth century, developing its own worldview and mode of subsistence and exchange (Núñez Atencio, 2007). These insights, along with affirmative policies introduced after the return to democracy in 1990 in Chile, enabled a stronger identification of the population with the Lickan Antay ethnicity. Part of this group has acquired an increasingly critical take on development and modernity. The interviewees I spoke to were part of the Council of Atacameño Peoples that I introduced in the previous chapter. In the context of the social uprising that took place in October 2019 across Chile, the Council demanded the establishment of a plurinational state, the restitution of territories, the respect for their worldview, advancing the principle of *buen vivir* [living well] and safeguarding of the *Puri* [water] (Council of Atacameño Peoples, n.d.-a).

The imaginary I discuss in this section draws on the two disputes held by the Lickan Antay with ALMA and the Chilean state that I referred to in the previous chapter. These disputes emerged in relation to the concession of the Chajnantor mountain granted by CONICYT to ALMA (2002) and the installation of a branch of natural gas pipeline by ALMA (2016). As I argued in the previous chapter, Lickan Antay activists consider that ALMA is undertaking extractivist activities in the area since it has not engaged in a horizontal form of communication with the local communities. Currently, ALMA grants financial support for local projects, has invested in archaeological sites and funded ethnographic research on the astrological view of the older people of the community (ALMA, n.d.-a). However, the activists I talked to consider that these benefits do not make up for the lack of dialogue with the nearby communities. In their view, the observatory is an 'island' whose activities and staff are still obscure to them.

6.3.2. Relational Coexistence

The remarks by Leticia González Silvestre offer an illustrative entry point for understanding the difference between the assetised imaginary of territory and the one held by the Lickan Antay people. González holds a degree in agricultural engineering and headed the Council of Atacameño Peoples. When we met in San Pedro de Atacama, she explained to me that her 'double belonging' had allowed her to look at the operations of the mega observatories from two different perspectives. Her first belonging corresponds to her background in sciences, which dominated in a visit she did to an observatory when she was studying in La Serena, a city located between San Pedro de Atacama and Santiago. In her words:

> I had the opportunity to visit El Tololo [observatory located near La Serena] … As a tourist, so to speak … It was nice, let's say, to have that experience. Since I'm not from La Serena, I never felt part of La Serena. I went and studied there, and that was the reason I lived there. I had started working in the sciences about two or three years before that. So from that perspective I said, 'Wow! Everything is cool' and all that.

The other dimension of González's double belonging points to her Lickan Antay identity and her attachment to the Toconao village and the area of the Atacama Desert where she grew up. As she explained to me, returning to San Pedro and being appointed leader of the Council of Atacameño Peoples allowed her to reflect on the things she did not see during her visit to Tololo.

> Do you know what I did not stop to think about at that moment? How does this affect the community living nearby? That's the moment when you realise that when you come as a tourist or a researcher, you come from outside. And it's not your territory. You say 'Oh! Yes. Everything looks perfect'. And you don't get involved in the reality of how it looks from the inside.

The above quote conjures up an imaginary in which the subject's attachments are considered a determining factor when approaching the territory. Rather than a view 'from outside', privileged by functional cartography or aerial shoots, González advocates an epistemology 'from the inside', mindful of the location of the observer, a point that underscores the always situated character of knowledge (Haraway, 1991). Along these lines, it is possible to

interpret the 'inside' and 'outside' mentioned by González not in relation to a geographical location but rather to a subject's epistemological and affective position—situated or detached, from above or below—in relation to the territory. Looking at the observatories 'from inside' makes it possible to connect with the perspective of the communities living there.

The words by Wilfredo Cruz reveal additional insights about the Lickan Antay's imaginary of territory. Recalling his role as the leader of the Council in charge of the negotiations with ALMA in 2002, during our conversation Cruz criticised the type of arguments employed by representatives of the state to support the concession of the Chajnantor mountain granted to ALMA:

> The argument used by the people from the state was: 'Look, you are [just] a community. This is going to benefit all of humanity'. And all that. 'The state has to take care of all the people that are going to work in this sector. How many of you are there? A handful. 400 or 500 people? But with this project we will benefit more than 5 thousand people. You're 10% of that'. So what does Daddy do? The daddy-state says, 'I have to benefit the most people' … 'We live ancestrally', I told him. 'We have taken care of this ecosystem, we have been living here for more than twelve thousand years of history'.

This story can also be read under the lens of the insider-outsider difference articulated by González. The position of the outsider held by the state official makes it possible to engage in consequentialist and quantitative forms of reasoning that mirror the 'calculative mechanisms' (Elden, 2010, p. 809) proper to the sovereign nation-state. Moreover, the state's rush to grant concession of the mountain to ALMA reveals how the state's hierarchised take on collaboration that I discussed in the previous chapter operates in practice, acting with proficiency when it comes to securing partnerships with international and transnational actors but with indifference when it comes to the cultivation of ties with some local initiatives and communities. In order to counter this approach, the interviewee, an insider, argues that the Lickan Antay people have been 'living ancestrally' in the territory and have been 'taking care' of the ecosystem for thousands of years. As Escobar (2020, p. 126) explains, the argument of ancestrality builds upon collective memory but also encompasses a claim about the future; it takes inspiration from the past, from long-standing assumptions and practices threatened by modernity/coloniality, but it does so in order to open up the future for *worlds otherwise*, or imaginaries holding a different conception of what is out there. One of the characteristics of the mode of existence advocated by Cruz is a rejection of consequentialist forms of reasoning, an embrace of an ethics of care in relation to the

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territory and, more profoundly, an alternative way of conceiving of territory and the relations that make it up.

What particular way of living is Wilfredo Cruz referring to in the above quote, and how does this connect with the territory? A statement by the Council of Atacameño Peoples about their worldview shared in the context of the 2019 social uprising in Chile helps us to grasp what is at stake in the disputes with ALMA:

> In our worldview, the territory is indivisible, it is a whole composed of the sky, the earth, water, nature and material and non-material heritage. Because of this, from the territory which we inhabit, we recognise and proclaim ourselves as a *Pueblo-Nación* [People-Nation], exercising the self-determination of the peoples over our ancestral territories (Council of Atacameño Peoples, n.d.-a, para. 6).

The above sentences help situate more clearly the divergences between the Lickan Antay people and ALMA and the state in the terrain of political ontology that I described in the introduction. This statement conjures an imaginary encompassing the entities that make up the territory, the relationship between them and the ethical and political commitments that emerge as a consequence. In the Lickan Antay world, what modernity/coloniality calls 'the environment' is a unitary whole made up by human and other-than-human actors. This vision contrasts radically with the assetised imaginary's focus on geographical features that can be dis-embedded from their environment. The claim to self-determination in the above paragraph derives from this ontology since it is understood that the mode of existence of the Lickan Antay depends on a series of relations with the actors with whom they coexist in the territory. In these cases, the existence of humans and other-than-humans is seen as the product of a radical interdependency in which communities do not precede their relations with the territory but rather are co-produced by them. For this reason, this imaginary is a *relational* one, since the existence of each actor relies on the system of relations it establishes with their environment.

Such an imaginary aligns with the notion of 'Pachamama', a term they share with other Andean Indigenous groups and that equates to 'Earth' or 'nature'. For Silvia Rivera Cusicanqui, the Pachamama reveals the limitations of the conception of the world as a globe of seamless exchanges and, instead, approaches the planet as 'a very complex and infinitely varied conjunction of living and palpitating beings' (2018, p. 54). Rather than a known object that is subject to human control, the planet—and the territory, I would add—becomes 'a complex and

multiple organism that we are just starting to understand' (2018, para. 57). In the context of the terricide, similar ontologies are being advocated by renowned Western philosophers such as Bruno Latour, even if in some cases this has been done in a self-serving way without engaging with Indigenous voices (Todd, 2016) or attending to their current struggles (Chandler & Reid, 2020). In fact, sustaining relational imaginaries of territory has become increasingly dangerous in Latin America *vis-à-vis* the growth of large-scale extractivist operations over the last two decades and the criminalisation, repression and murder of activists (Greenfield & Watts, 2020).

The difference between this relational imaginary and the assetised one is stark—whereas the latter calls for identifying geographical features so as to promote them to potential external investors, the former focuses on the modes of existence afforded by the territory and in attaining a balanced coexistence between human and more-than-human actors. Therefore, for the Lickan Antay communities territory is not conceived of as 'an object nor a use-based exploitable good controlled and dominated by humans' (Walsh, 2018, p. 65), as an assetised imaginary would do, but rather as 'an integral part of life and society that cannot be divorced from women and men, from humanity and society' (Walsh, 2018, p. 65). In the terminology of Escobar, Blaser and de la Cadena, the imaginary held by the Lickan Antay people emphasises the importance of the territory for the sustainment of worlds otherwise threatened by the expansion of modernity/coloniality.

6.3.3. Situated Techniques of Representation

As I argued earlier, the assetised imaginary relies on rationalistic techniques of representation that make the territory appear as resources to be promoted internationally. Under the same token, the relational imaginary can be associated with a specific set of methodologies, although these embrace different, and to some extent opposite, epistemological principles.

I became aware of the epistemological dimension of the relational imaginary when I heard about the story of the *chululos* I mentioned in the introduction of this chapter. Particularly relevant for the Lickan Antay communities in their conflict with ALMA over the gas pipes was undertaking a field visit in 2016 to the area potentially affected by the process. Before this, the environmental experts, who carried out three field visits themselves, did not identify any relevant significant 'adverse effect' (Antofagasta Region Assessment Commission, 2017, p. 28). However, a different picture emerged thanks to the memory of the Lickan Antay elders. This is how Leticia González, the activist I introduced earlier, referred to this episode:

They [ALMA] usually hire consultancy firms from Santiago who do not know the territory and collect their information in two annual campaigns. I'm already familiar with these studies of environmental impact … So I said, 'Let's see' … They were really in a rush to get approval for their pipeline, they needed it urgently. And we said, 'No, the community has to go and check the information that you collected in the field.' … And we saw it in the field … The elders, who know the *chululos*, said, 'It's full of *chululo* burrows here!'. They [the experts from Santiago] had not considered them [the *chululos*]. The gas pipelines were going to pass through there and were going to break the whole ecosystem … They did not know how to spot them [the *chululos*].

Without the field visit with the elders of the communities, it would have been impossible to identify what ended up being twenty-two *chululo* colonies (Antofagasta Region Assessment Commission, 2017, p. 28). From a relational perspective, this situation would have threatened not only the livelihood of the *chululos* but also the Lickan Antay world, putting into danger a way of life based on a balanced coexistence with other-than-human actors. But in addition to this, the above remarks mobilise a number of elements that are worth unpacking because they challenge many modern/colonial epistemological assumptions and practices with clear implications for the governance of data infrastructure.

Perhaps the most salient aspect in the above quote is that the field visit required physically displacing the bodies of the knowing subjects to the territory, i.e., their embodied presence. Whereas in the epistemology dominant in modernity/coloniality the body constitutes an obstacle for generating objective and universal knowledge (Mignolo, 2009, p. 174), in this case embodied presence made it possible to identify elements of the material-physical world that otherwise would have remained obscured. This methodology is particularly sensitive to the textured details of the territory such as the *chululo* burrows and stands in opposition to the simplification undertaken by cartography and quantitative data. González's quote also speaks to the relevance of *who* is generating the knowledge, an aspect that challenges the modern/colonial tendency to conceal the knowing subject (Mignolo, 2009). In her account, it was the elders of the Toconao community, and not 'experts' from Santiago, who managed to spot the *chululo* burrows. However, this does not mean that González thinks that Indigenous people have a special ability. In fact, González explained to me that people from younger generations, like herself, were also incapable of spotting the *chululo* burrows. Her explanation provides valuable additional details about the epistemology underlying the relational imaginary:

They [the elders from Toconao] just walked … That's why we say: if someone has to go with you on this visit, it's the elders. They are the people who, before the existence of cars, anything, they would travel all over this terrain by foot. Because that was the way they did it. There were no marks, there was no pavement.

One of the reasons why the elders from the Toconao community managed to spot these *chululos* is because of the type of ontology that emerges when people privilege walking. Whereas automobiles follow pre-designed roads that allow them to move without much friction, walking enables a more intimate and detailed relation with the territory that makes it possible to grasp its sometimes arbitrary character. In this context, little clues such as the *chululo* burrows can become crucial road signs. Manuel Tironi's reflection on geology from his walking experience with a Lickan Antay healer in the desert also applies to the territory: '[t]hrough walking, geology becomes concurrent' (2020). Paraphrasing this quote, it could be said that through walking the territory and its dense interdependencies become concurrent. In other words, the territory might more easily become a seamless globe when riding a car and a Pachamama when walking. Against the backdrop of the terricide, walking acquires a political dimension since it makes possible the reconstitution of worlds and therefore becomes a reworlding practice. As Mapuche poet Adriana Paredes Pinda writes: 'we have to relearn to walk the world as a living being' (as cited in Escobar, 2018, p. 273).

Going back to González's words, it is not a coincidence that the experts who did not spot the *chululo* burrows came from Santiago, the capital of the country. Centralised assumptions and practices have profound roots in Chile, and became especially prominent in the nineteenth century, when the Eurocentric elite living in the capital considered that one of its missions was to extend their 'civilised' way of living to the rest of the country, especially to those inhabited by Indigenous communities (Núñez, 2012). As liberal philosopher and politician Benjamín Vicuña Mackenna affirmed, 'As a template and as a role model, the progress of Santiago equals the universal progress of the community' (as cited in Núñez, 2012, p. 8). Even if under different forms, the case of the *chululos* speaks to the coloniality of this centralist pattern.

As the case I reviewed above reveals, grasping the territory in relational terms requires undertaking what in chapter four I referred to as epistemic disobedience (Mignolo, 2009) so as to challenge the modern/colonial hierarchies that grant superiority to a specific form of knowing— rational, detached, from above—not especially able to grasp the territory in its full complexity and density. Field visits, the memory of the elder and walking constitute critical sources of knowledge for approaching and representing the territory from a relational perspective. These

methods share an epistemology of situatedness in which attentiveness to detail and who is the knower matter. Instead, the techniques of representation privileged by the assetised imaginary encompass an epistemology of withdrawnness (Tironi, 2020, para. 2) that, like the strategies deployed by the sovereign state in the management of its territories, categorises and simplifies. In the case I analysed here the selection of methods had crucial implications for the wellbeing of the *chululos*, but from the perspective of political ontology the stake is greater: the very possibility of cultivating worlds otherwise. Thus, in their conflicts with ALMA and the Chilean state, Lickan Antay activists are building upon a centuries-old legacy of worldly struggles for the protection of modes of existence in balance with the territory.

6.3.4. De-linking from Infrastructure

In addition to the ontological dimension I described above, the conflicts aroused by the construction and expansion of ALMA's infrastructure respond to the disbelief by Lickan Antay activists of the association of built modern infrastructure with progress and development. A widespread assumption among astroinformaticians and members of the public and the private sector in Chile is that the construction and expansion of astronomical infrastructure in Chile constitutes a unique opportunity for scientific, technological and economic progress. In the words of Paola Arellano, the head of the National University Network (REUNA), the observatories are ushering in 'digital infrastructure for development and innovation' (Arellano, 2018). A similar message is conveyed in the governmental propaganda of the Digital Matrix policy launched in 2019. This programme seeks to 'put Chile as the region's technological vanguard' (Government of Chile, n.d.), upgrading the national digital connectivity. As a graphic shared on social media reveals, the improvement of the local digital infrastructure is directly linked to the observatories constructed in the Atacama Desert (Figure 9).

Figure 9: *Graphic of the Digital Matrix Policy*

Note. Graphic shared on social media by the Chilean government (Undersecretary of Telecommunications, 2019b). On the bottom right it reads: 'Connectivity must continue contributing to the astronomical development in Chile'. The hashtag on the bottom left translates as #ForAConnectedChile. Used with permission.

Compared to the discourse linking astronomy, infrastructure and progress, the view held by the Lickan Antay activists I talked to is certainly not as idealistic and definitively more pessimistic. Inspired by their struggle to develop and cultivate worlds otherwise, they question the alleged benefits for humanity and aesthetic qualities of the astronomical observatories and, more broadly, do not subscribe to the way of living that is commonly associated with built infrastructures.

On multiple occasions during my fieldwork participants shared with me the idea that the construction of astronomical infrastructure could benefit humanity as a whole. As an engineer who grew up in Chile and currently works for ALMA put it: 'I got asked once: "How do you feel about working here?" I said that I feel that we are working for humanity, because that is how I feel'. The view of Lickan Antay activists, however, points in a different direction. Sergio Cubillos thinks that the humanitarian benefits enabled by astronomy infrastructure was

impossible to prove since the lack of horizontal communication has kept the local communities from understanding the type of knowledge produced by ALMA. Cubillo's view departs from what seems to be common sense in Chile, namely that the benefits of the observatories for humanity have to be assumed even in some cases without much detail about the activities and type of research carried out by them. Leticia González Silvestre had a more divergent stance. Adopting an ironic attitude, she replied to my question on the benefits of the observatories with more questions: 'What use is it to know about the black holes, all of space? … So what? What are we going to gain with this? If the world collapses tomorrow, we won't be the ones who will end up on a spaceship going to that place'. Without denying the observatories' potential to make contributions to humanity, González questioned the way such advantages would be distributed worldwide. From a decolonial perspective, her scepticism constitutes an acknowledgement of the hierarchised character of the modern/colonial world system in which those at the top of the hierarchy have more chances of enjoying the benefits brought about by science and technology and, in this particular case, by the construction of astronomy infrastructure.

This critical attitude towards modern infrastructure also extends to its visual-aesthetic character. Most participants praised the mega observatories' futuristic and sophisticated buildings and instruments, which they considered inspiring and even mystical. In fact, local research and governmental initiatives widely rely on imagery stemming from astronomy that they use in their visual identity. An example of this is *Imagen de Chile* (Image of Chile), a nation branding organisation that encourages the use of images of the astronomical observatories for promoting the country to international audiences (Figure 10). The experience of Jessika Salazar, Grupo Datco's Country Manager cited earlier, is also illustrative of the sense of admiration produced by the observatories. This is how she explained to me how she felt when she attended the launch of ALMA: 'I will never be able to communicate it to anyone. I got goosebumps when the antennas moved from one place to another one.[55] It was spectacular … In terms of human transcendence, human greatness, human knowledge'. In contrast to this view, the Lickan Antay activists described the observatories as 'distant' and 'mysterious', and one of them even criticised that their metallic and grey structure was out of tune with the environment. As Sergio Cubillos told me: 'You see it [ALMA] up there, on the hill. So it's like, what happens there? And on top of it you're not allowed in'. These divergent views show that the aesthetic attributes of the observatories are not universal but rather reliant on the location of the subject. Paraphrasing

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[55] ALMA's 66 radio antennas move between different pads depending on the observation needs. Given that each antenna weighs around 100 tons, specialised transport trucks with more than 28 wheels are employed in some cases for this purpose (ALMA, 2014).

González Silvestre, when viewed from outside, the observatories look like architecturally sophisticated and cutting-edge modern machines; when looked at from inside, they emerge as buildings which are inscrutable and disconnected from the territory.

Figure 10: *Image of Cerro Tololo in* Imagen de Chile's *Marketing Kit*

Note. This is one of the astronomy-related images available for download in the *Imagen de Chile's* toolkit (Donoso, n.d.). The logo in the top right corner is the one employed in nation branding marketing campaigns. Credits: Max Donoso – *Imagen de Chile* (terms and conditions available in *Imagen de Chile*, n.d.).

In addition to interrogations over the alleged contribution to humanity and aesthetic qualities, Leticia González Silvestre also questioned the promises of progress and development associated with modern infrastructures. This is how she replied when I asked her about the argument according to which the astronomical observatories should be welcomed since they can usher in infrastructure development:

As to the infrastructure, the paving, what it means to have an observatory, our concern is that it doesn't affect us, that it doesn't alter our landscape even more. I mean, this landscape is rich because of what it is, because of its dirt roads, for all that. There will be people who will say, 'It's full of holes'. Because people who come from outside see that,

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they see dirt, they say that 'there is no progress because it's not paved' … People in the *ayllus* are happy that their roads are kept as they are … So, what's theirs [the observatories'], that infrastructure, leave it there.

For González, modern infrastructures, including the astronomical one, are not neutral entities. Instead, they are part of a modern way of living that in some cases might enter into contradiction with alternative ones, or, in the vocabulary of political ontology, with the sustainment of worlds otherwise. Very telling is the sentence in which she affirms that 'what's [t]heirs, that infrastructure, leave it there', which reveals an intention to de-identify from the individuals and groups behind the development and expansion of such infrastructure. For González, her environment is 'rich' for what it is, an assertion that challenges the capitalist modern/colonial association of 'richness' with quantity and technologically-sophisticated developments. This rejection is reminiscent of the remarks of a Zapatista woman: 'We have the riches of our traditions and customs … We are poor rich' (Marcos, 2017, p. 14). As in the case of González, wealth does not translate into 'abundant, valuable, exuberant or excellent' (Marcos, 2017, p. 14) but rather represents the capacity to appreciate the territory and its associated modes of existence for what they already are. This view represents a profound departure from the modern/colonial endeavour to master nature that has dominated in Western sciences (Escobar, 2018, p. 85).

The imperative to infrastructure has been a constitutive feature of modernity/coloniality. As Paul Edwards argues, 'infrastructure is the invisible background, the substrate or support, the technocultural/natural environment, of modernity' (2003, p. 191). For Brian Larkin, in postcolonial contexts infrastructures convey the arrival of progress and societal advancement, operating as a 'fantastic object that generates desire and awe' (2013, p. 191). However, a different picture emerges when taking into consideration the view of Lickan Antay activists. In this case, there is an attempt to go beyond, or even reject, the rhetoric surrounding infrastructure and modernity, revealing that the development and expansion of infrastructure come accompanied by built-in assumptions and practices that can endanger the cultivation of modes of existence otherwise. In the vocabulary of decolonial thinking, this move can be interpreted as a form of de-linking (Quijano, 2007), of rejecting the uncritical adoption of modes of existence developed on the basis of the experience of a limited group of people and, instead, favouring the search for alternative modes of life. De-linking makes it possible to see infrastructure from the location of both the 'outsider' and the 'insider', granting the capacity to see its 'modern' dimension but also its 'coloniality', namely the 'darker side' of modernity that is presented as a mere externality

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rather than a constitutive element of it (Mignolo, 2018, p. 139). Where some see sophisticated machinery capable of answering the most pressing questions for humanity and of ushering in progress, Lickan Antay activists see the lack of horizontal communication, a danger for the colonies of *chululos* living in the area and, as a consequence of this, a threat to the sustainment and cultivation of worlds otherwise.

6.4. Data Infrastructure Otherwise

Before moving on to the conclusion, I would like to wrap up the empirical observations I made in this chapter by spelling out the implications of re-imagining the governance of data infrastructure based on the terms set by a relational imaginary of territory. The move I am advocating implies approaching Indigenous knowledges not as perspectives mired in the past but as a source of inspiration for formulating an alternative approach not constrained by the assumptions underlying modernity/coloniality and introducing previously absent or not sufficiently underscored aspects that become especially relevant in the terricide.

First of all, bringing the territory to the fore in the terms set by the relational imaginary would challenge the assumption of the quasi-free availability of land for the expansion of the technological exoskeleton required to manage and process large volumes of data. Just as European colonisers drew on the *terra nullis* doctrine to appropriate lands by declaring them as belonging to no one (Couldry & Mejias, 2019, p. 9), the assetised imaginary removes the existing relations from the picture so as to declare the territory as apt for the development of data infrastructure. In contrast, a relational understanding would advocate for acknowledging and caring for the existing relational dynamics and associated modes of existence that give shape to the territories. Also inspired by Indigenous relational philosophies, Alison Powell (2021, p. 155) draws on the principles of nonreduction and interconnectedness of life to counter the so-called smart city's drive to data-based optimisation. I sustain that at stake in such a move is the very possibility of sustaining and cultivating worlds otherwise, whether in the Atacama Desert or in mega-cities in the Global North, and therefore of enabling the pluriverse. Designing data infrastructures *from the territory* requires interrogating their equation to progress and development and, instead, concentrating efforts on identifying the way different components— from the most obvious ones such as the data centres but also less striking ones such as their associated gas pipelines—would interact with existing systems of relations. As a result, such a process would call for the introduction of adjustments and—why not?—the suspension of projects.

The relational imaginary also demands an increased awareness of the epistemologies underpinning the techniques of representation and methodologies employed to generate knowledge about the territory. In this chapter I showed some of the limitations of rationalistic techniques such as cartography and quantitative data and the strengths of situated and embodied methodologies such as field visits. Situated methods and resources such as the memory of the elder can be particularly fruitful for grasping the territory in its full complexity and accounting for the multiplicity of agencies at stake. Instead, methods that privilege simplification run the risk of reproducing what Donna Haraway calls the conception of History with only one actor, in which '[a]ll others in the prick tale are props, ground, plot space, or prey. They don't matter; their job is to be in the way, to be overcome, to be the road, the conduit, but not the traveler, not the begetter' (Haraway, 2016, p. 39). In the tale of data infrastructures, the *chululos* should not be 'props' or stumbling blocks for the attainment of human progress but rather characters with a voice. Finally, a relational imaginary would advocate acknowledging the profound limitations of modern scientific theories and models for fully understanding the 'infinite set of practices carried out by all kinds of beings and life-forms' (Escobar, 2020, p. 71) that make up the territories and the worlds they enable.

In the vocabulary I set out in chapter three, the relational imaginary of territory requires paying attention to both the discursive and the material dimensions of reality as well as to the interrelated character of these. The relational understanding emphasises the entanglement of the dimensions that are usually referred to as 'nature' and 'culture' and that can be equated to the analytical categories of the material and the discursive. When it comes to the territory, there is no primacy of either of them. On the one hand, the territory requires the circulation of relational discourses advocating a balanced coexistence; on the other hand, the contours of such discourses are enabled and shaped by the material forms of existence present in the territory. Given that 'the material' and 'nature'—neither of which exist on their own but rather in a mutual constitution with discourse and culture, respectively—are not always intelligible and predictable, the design of data infrastructures requires attentiveness to the way such plans unfold, to the unexpected reactions and interactions that emerge as those designs are realised. This move would make it possible for the *chululos* and other unexpected actors to become relevant actors, or at least to figure as something other than victims, in the script.

Infrastructure studies scholars would argue that the transition from an assetised to a relational imaginary of territory encompasses a move akin to an infrastructural inversion (Star & Bowker, 2002). Under modernity, infrastructures represent the invisible layer of social practices that remain hidden in the background but that nonetheless enable other more visible and

seemingly crucial activities. However, this definition of infrastructure does not fit with the perception of data infrastructure in Chile, which enjoys a great degree of visibility and stands as a symbol of progress. For the assetised imaginary it is not infrastructure that remains in the background but rather the territory and the series of relationships that make it up. It is on top of this 'bioinfrastructure', as Maria Puig de la Bellacasa (2014) calls it, that built technological components are materially and discursively deployed. By contrast, the relational imaginary proposes an inversion to this hierarchy of visibility. Through a gestalt shift, relationality brings to the foreground the territory, which has made datafication possible in the first place, even though it has tended to remain invisible or reduced to the form of an asset in policies and initiatives related to astronomy data. This inversion proposes a horizontal infrastructural hierarchy in which the territory and the modes of existence afforded by it are not in the background but are rather at the centre in the governance of data infrastructures. Such a move, I argue, would make it possible to transform the territory into far more than a space of flows or a seamless surface topped by data centres, fibre optic cables and other components of datafication. Instead, a relational imaginary would allow datafication to acknowledge the dense interrelations that make up the territory, putting into motion a process of de-linking from the imperative to infrastructure and enabling worlds otherwise threatened by modernity/coloniality.

6.5. Conclusion

In this chapter I have shown the need to shift the imaginary of the territory underlying initiatives to expand the data infrastructure in Chile. At stake in this move is the possibility of reconstituting worlds otherwise, i.e., that do not follow the precepts of capitalist modernity. Reflecting on the connection between the history of territorial conflicts in Latin America and the implementation of datafication, I criticised the assetised imaginary of territory dominating policies and initiatives related to astronomy data in Chile for its tendency to transform geographical features into resources to attract investment from international scientific organisations and transnational technology companies. This imaginary, I argued, relies on techniques of representation that tend to simplify the richly textured character of the territory. Such an imaginary contrasts with the one mobilised by Lickan Antay activists during their conflicts with the ALMA observatory and the Chilean state. Echoing the notion of the Pachamama, the relational imaginary conceives of the territory as made up of a dense system of interrelations enabling balanced forms of coexistence between human and other-than-human actors. Situated methods for representing the territory capable of revealing the thick and entangled set of relations in the territory are privileged in this case. According to this imaginary,

thus, it is impossible to separate geographical features from the territory since they make up, they *are*, the territory. Finally, I argued that the relational imaginary can produce a shift in the assumptions and practices underpinning the governance of data infrastructures in a way that aligns with struggles for the reconstitution of worlds threatened by the modern/colonial world system.

The relational imaginary of the territory constitutes a condition for advancing a data governance framework based on collective autonomy. As I have shown in this chapter, the growth of data infrastructure can also usher in a form of 'ontological occupation' (Escobar, 2018, p. 69) in which the expansion of its exoskeleton can impose a world made up by a dichotomous distinction between nature and culture. A data infrastructure governance framework based on collective autonomy would rebel against such occupation by reorienting the focus towards the reconstitution of worlds and the pluriverse. Moreover, I contend that it is in this aspect that an autonomous governance of data differs more clearly from frameworks inspired by the notion of sovereignty. Addressing the territory in relational terms implies striving for balanced coexistence, namely for the pluriverse, and not for asserting a 'superior' source of authority as sovereignty does. The relational imaginary also implies acknowledging that the interdependencies making up the territory might give rise to forms of organisation that do not adapt to those of the state. Finally, an autonomous governance framework inspired by a relational imaginary of territory has become especially relevant in the context of the terricide, when the knowledges and practices of Indigenous people crystallised in notions such as the Pachamama are gaining currency as balanced forms of inhabiting the Earth.

The insights I have provided in this chapter can also pave the way to understanding what the 'decolonisation' of data would look like. Over the last few years, different approaches to datafication, AI and other developments have sought to decolonise these methods and technologies without providing much information about how such frameworks would connect with the more urgent concerns pressing Indigenous communities. As Tuck and Yang argue, the rise of 'decolonisation' as a metaphor in areas such as education has transformed this concept into an 'empty signifier' (2012, p. 7), decentring what they consider should be at stake: the repatriation of Indigenous lands and life. The connection between the implementation of datafication and territorial occupation I explored in this chapter might constitute a way of approaching decolonisation as an ongoing struggle that connects with the reality of Indigenous people. Moreover, the absence of concerns regarding the territory in mainstream frameworks of data governance speaks to the lack of familiarity with the history and situation of Indigenous communities, revealing the location from which such studies have been formulated—with

'location' understood in some cases in geographical terms as the Global North but more generally from a hierarchically superior position within the capitalist modern/colonial world system that only sees modernity and ignores coloniality.

Whereas the two previous empirical chapters focused on knowledge generation (chapter four) and the economy (chapter five), in this one I turned to ongoing territorial struggles spurred by the expansion of data infrastructure. Taken together, these three chapters suggest that some of the shifts and challenges brought about by the implementation of datafication are intersecting directly with power dynamics that decolonial thinkers understand as the product of the modern/colonial world system and that have haunted economic, political and social relations in Latin America for centuries. In the next chapter I lay out overall conclusions drawn from the insights I have provided so far and delineate critical elements for a data governance framework based on collective autonomy.

7. Conclusion: Changing the Content and the Terms of the Conversation

7.1. Introduction

In the previous three empirical chapters I adopted the lens of collective autonomy and identified power dynamics with a modern/colonial character operating in the case of astronomy data in Chile. Under this light, epistemic obedience, development, extractivism, the role of the state and territorial conflicts emerged as relevant points in the discussion about the governance of such data. In this final chapter I take a step back and address the research questions I posed in the conceptual chapter, spell out the contributions of this thesis to scholarly research, discuss its implications outside academia and identify some of its limitations. Before that, however, a brief recap is needed in order to recall what I have said and done so far.

In this thesis I have undertaken an empirical study of the case of astronomy data in Chile, where some actors conceive of the vast volumes of data produced by international observatories in the Atacama Desert as synonymous with progress. To do so, I developed an analytical framework for thinking about data governance in a way that addresses the criticism formulated by work on data coloniality. More specifically, I proposed that the notion of collective autonomy, which combines decolonial thinking and post-Marxism, could work as an alternative to the dominant frameworks based on openness and sovereignty. Among other characteristics, collective autonomy requires situating the analysis of datafication in the context of a capitalist modern/colonial world system and attending to divergent and excluded voices. In terms of methods, DMA allowed me to pay attention to the role of both meaning and matter and their entanglement in the analysis of the interviews, field notes and documents. Filling some of the gaps in DMA, I turned to anthropological ethnography and feminist theory in order to reflect on the politics of fieldwork and my own positionality.

After developing this conceptual and methodological apparatus, I organised the analytical observations into three chapters, each of which focused on the shifts and struggles taking place in a particular sphere. First, I looked at scientific research and showed that the adoption of a collaborative positionality is favouring an obedient stance in data-intensive research. Second, I traced the efforts by local actors to build a data economy in Chile, revealing that this move is encompassing a renewal of the promise of development, the emergence of different articulations of extractivism and the advancement of a state that approaches local and Global North actors asymmetrically. Finally, I examined the stakes of the expansion of data infrastructure for the sustainment of the Lickan Antay world by identifying two divergent imaginaries that conceive of territory as a source of economic assets or as an entanglement of human and other-than-human

interdependencies. I will go back to the arguments discussed in the empirical chapters in the next section, but this summary demonstrates that the concepts and methods deployed in this thesis yielded analytically and politically fruitful results, illuminating relevant concerns that have not been at the centre of the discussion over data governance.

The rest of this chapter proceeds as follows. First, I discuss the main findings of this thesis in light of the research questions formulated in the conceptual chapter. In brief, my argument here is that collective autonomy not only changes the content but also the terms of the conversation about data governance. Second, I refer to the contribution of this thesis for ongoing research and theoretical and methodological discussions. After that I reflect on the implications of this thesis outside academia, addressing matters regarding resistance, geopolitics and policy making. Third, I delve into the limitations of this research, with a particular emphasis on heteropatriarchy and the rise of a potential Chinese hegemony. I finish with a word on the historical context in which I situate collective autonomy and that marked the design, fieldwork and writing up of this thesis.

7.2. Findings: Data Governance from the Perspective of Collective Autonomy

In chapter two I formulated the two research questions of this thesis. In line with decolonial thinking (Mignolo, 2007a, p. 451), the first one had a predominantly analytical and the second one a programmatic character.

RQ1. What concerns overlooked by established paradigms emerge when examining the governance of astronomy data in Chile from the perspective of collective autonomy?

RQ2. Inspired by the case of astronomy data in Chile, what would be central elements of a framework of data governance based on collective autonomy?

The two following sections address each of these questions and in the third I draw broader conclusions obtained from this thesis that exceed the scope of the RQs.

7.2.1. Concerns: Epistemic Obedience, Extractivism and the Destruction of Worlds

The answer to RQ1 is relatively straightforward since each of the empirical chapters revolve around a concern that has remained insufficiently explored so far in established

frameworks. As I explained in the methods chapter, these concerns were identified through a combination of inductive and deductive criteria and constitute nodal points in the discourse on astronomy data in Chile. Even though only 'collaboration' held a quantitative relevance, this sign along with 'extractivism' and 'territory' constitute crucial loci of discursive-material struggle that speak to modern/colonial power dynamics.

First, a framework based on collective autonomy would hold particular concern for the forms of *epistemic obedience* ushered in by the employment of vast volumes of data in scientific research and, potentially, other instances of data-intensive insight generation. As I discussed in chapter four, the arrival of data-intensive research is having a dislocatory effect on the Chilean astronomy community. As a response, local actors are articulating a collaborative subject position that strives to establish horizontal and mutually beneficial partnerships with international scientific organisations and transnational cloud companies. This articulation encompasses both a discursive shift in the positionality of local researchers and a series of technical-material challenges that are conceived of as necessary steps for upgrading the sociotechnical infrastructure. Despite its practical advantages, this subject position is tightly linked to fresh forms of epistemic obedience impinging upon the capacity of the astronomy community to make data-intensive research speak to the local context. In particular, a dis-embedding of the data producers from the social context, an erosion of local ties, an obscuring of the asymmetries involved and a data conformism are keeping the astronomy community from undertaking collective reflection on their own priorities and concerns.

The second concern that emerged in the empirical analysis points to new and to some extent conflicting understandings of data extractivism. Even though in Latin America extractivism has usually been associated with natural resources, new articulations of this term are emerging as scientists, informaticians, policy makers, members of the private sector and Indigenous activists make sense of what is going on with astronomy data in Chile. First, a *technoscientific* articulation puts the emphasis on the capacity of local actors to process the data before it gets sent outside the country and holds a particular concern for the outward-facing character of the sociotechnical infrastructure. Second, a *competitive* articulation focuses on how astronomy data can help overcome the predominantly extractivist character of the Chilean productive matrix, supporting free trade and rendering the local business elite responsible for overcoming this situation. Finally, Lickan Antay communities are articulating an *ontological* understanding that sees extractivism as a way of being in the world that does not engage in horizontal dialogue with the communities living close to the centres of data production. Against this backdrop, a pivotal question for thinking about extractivism from the perspective of

collective autonomy is the capacity of emerging articulations to account for the structural, i.e., capitalist modern/colonial, contours of the dynamics at stake. In the case of astronomy data in Chile, only ontological extractivism has established this link, representing a powerful alternative for envisaging non-extractivist formulations and applications of datafication.

Finally, the third concern emerging from an analysis of data governance based on collective autonomy is that of the threat to worlds otherwise, i.e., those that do not adapt to capitalist modernity. As I argued in chapter six, the expansion of the exoskeleton that makes possible the production, transmission and management of vast volumes of data is intersecting with long-standing territorial conflicts in Latin America, which quite often have involved Indigenous communities. Just like the deployment of large-scale mining or monocultures, the expansion of data infrastructures in Chile relies on an imaginary of territory that transforms geophysical features into economic assets. Fortunately, Lickan Antay activists are confronting this imaginary by sustaining a relational one that focuses on balanced coexistence. Such a form of resistance has become especially relevant in the context of the terricide, when the erosion of the Earth is calling for the re-constitution of worlds.

Each of the three above concerns represents a crucial condition for collective autonomy. Epistemic obedience favours the uncritical adoption of scientific and technological designs without undertaking a profound reflection on their compatibility with the goals and challenges of the local context. In such cases, epistemic *dis*obedience is required in order to ensure an autonomous definition and pursuit of horizons that speak to local needs and visions. Similarly, each of the three articulations of extractivism can prevent local actors from exercising their autonomy, whether due to the perdurance of material-infrastructural constraints (technoscientific extractivism), asymmetrical conditions of planetary economic exchange (competitive extractivism) or the threat to territorial-based forms of existence (ontological extractivism). Extractivism can also work to the detriment of autonomy when it dis-embeds the phenomenon from the capitalist modern/colonial world system, pushing actors to strive for adjustments that do not interrogate the structural forces shaping their conditions of existence. Finally, the connection between the loss of autonomy and the threat to territorial modes of existence is a direct one since to a large extent autonomy *is* the very possibility of constituting worlds otherwise, where the human and non-human actors that make up the territory live in a balanced coexistence. Because of this, *the struggle for collective autonomy in times of data coloniality necessarily involves advancing disobedient, post-extractivist and relational ways of thinking and doing*.

Another critical point that connects the three concerns is their discursive-material character. In the case studied, epistemic obedience responds to both a particular positionality

(discursive) and infrastructural arrangements and financial conditions (material). Second, the struggle over meaning (discursive) taking place as actors draw on the signifier extractivism to make sense of what is going on with astronomy data in Chile is being shaped by an outward-facing infrastructure, a planetary distribution of labour and the agency of the territory (material). Finally, the divergent imaginaries of territory I explored derive from conceptions about the entities that make up reality (discursive), but these cannot be detached from the particular forms of existence afforded by the territory (material). Ignoring one of these dimensions or analysing them as separate realms would be detrimental to providing a comprehensive account of the issues at stake and, therefore, to advancing alternative visions and practices. As this thesis shows, under data coloniality the discursive and the material represent equally relevant battlefields for collective autonomy.

Neither epistemic obedience, extractivism nor the destruction of worlds have constituted central concerns for frameworks based on openness and sovereignty. The reason why they emerged in this thesis is precisely due to the employment of collective autonomy as the main lens orienting my inquiry and to the attentiveness to the discursive-material dynamics at play. Importantly, these concerns are not exhaustive. New or different ones might emerge when analysing other empirical cases and different types of data; however, the ones I have discussed here constitute a solid starting point for illuminating previously obscured concerns brought about by datafication in the spheres of knowledge generation, the economy and territorial conflicts.

7.2.2. An Alternative Framework: Other Actors, Scales and Aims

Having addressed RQ1, I now turn to RQ2 by discussing some of the elements that, in light of this study, would need to be part of a framework of data governance based on collective autonomy. The first point to mention in this regard is that, as I discussed above, such a framework would need to advance epistemologically disobedient, post-extractivist and relational ways of thinking and doing. However, bringing together the insights I expressed in the empirical chapters makes it possible to draw additional conclusions pointing to a higher level of analysis. As I demonstrate below, a holistic reading of the observations reveals that collective autonomy changes not only the *concerns* but also the *actors*, the *scales* and the *aims* underlying frameworks of data governance. This is why, as I explain later, collective autonomy does not only change the *content* but also the *terms* of the conversation.

The first shift undertaken by collective autonomy relates to the *actors* that are brought into the discussion. Debates about data governance have tended to privilege the view of the private sector, scientists, technical actors and, more recently, social scientists (Katz, 2020, p. 78).

In contrast, the voice and experience of Indigenous people have remained absent from the debate, even when related policies have an impact on their ways of living (Ricaurte, 2019, p. 357). One of the challenges to this exclusion has come from proponents of the notion of Indigenous data sovereignty, which has gained prominence over recent years (e.g. Kukutai & Taylor, 2016). However, so far this approach has been predicated on the basis of data pertaining to Indigenous individuals and groups and their territories, without offering a thorough reflection on the way this perspective can challenge existing frameworks of data governance. As this thesis reveals, Indigenous voices can be especially relevant for envisioning frameworks that address data coloniality due to their centuries-old experience of mobilisation and resistance against coloniality in all its forms. From this angle, previously unexplored connections between datafication and coloniality and ways out of these can come to the fore when incorporating these groups into the debate (see also Couldry & Mejias, 2019, p. 196). It is of uttermost importance that such an inclusion would need to ensure Indigenous people's participation in conditions of autonomy and that their demands remain central to such frameworks in order to avoid the co-optation of Indigenous knowledges and the depoliticisation of their message.

A second shift with regards to the actors concerns the privileged role of the state in discussions regarding data governance. The insights I have provided in this thesis indicate that a form of what the Zapatistas call 'state illusion' can take place in the governance of data when policy making and regulation are seen as the only or main means to deal with the opportunities and challenges brought about by datafication. In contrast, the case of astronomy data in Chile shows that the discourses sustaining data coloniality and attempts to challenge it are dispersed among different groups, such as scientific communities and the private sector. Furthermore, changing the technical- and economic-material conditions supporting data coloniality might not be at the reach of a single state, as it would be reversing the outward-facing architecture of data infrastructure and the planetary distribution of labour. More importantly, on some occasions the state can also become an obstacle rather than an aid in the pursuit of collective autonomy. Nation-states are deeply embedded in capitalist modernity/coloniality, especially when in the Global South they adopt development as a unique shared societal horizon. For example, postcolonial states might undertake a series of measures in order to attract international scientific organisations and transnational technology companies in a way that might go against the interests of other local communities and initiatives. For these reasons, collective autonomy would see calls for nationalising data, such as that by Ulises Mejias (2019), with suspicion. For Mejias, civil society should have an important role in the governance of such data, but a historical and grounded analysis reveals that postcolonial states are in an unlikely position to ensure horizontal participation. Furthermore, for historical and political reasons some Indigenous communities

might legitimately be unwilling to engage with the state. A framework based on collective autonomy, thus, does not necessarily go against the state but does have to look beyond it when it comes to identifying the power dynamics sustaining data coloniality and envisioning ways of addressing them.

Third, a framework based on collective autonomy shifts the *geographical and temporal scales* of the discussion. Geographically speaking, collective autonomy demands acknowledging that the power dynamics surrounding the governance of vast volumes of data are not restricted to the nation-state; nor can they be grasped by taking nation-states as the primary units of analysis. Scientific organisations, transnational technology companies and Indigenous communities are relevant actors even if their views and interests do not necessarily fit with those of the nation-states in which they are located. A transnational approach attentive to planetary and domestic power relations is required in order to challenge methodological nationalism (Go, 2009, p. 783). In addition to the geographical scale, collective autonomy also undertakes a shift in terms of temporality. Big data, datafication and other data-intensive technologies such as AI are usually portrayed as innovative and ground-breaking developments, but the observations I have made throughout this thesis show that their success also depends on the continuity of long-standing patterns of power in Latin America, such as extractivism and territorial occupation. A historical approach is required in order to understand 'how the logics, processes and practices put in place during colonialism continue to shape the present and future world' (Meghji, 2020, p. 4).

More profoundly, collective autonomy also shifts the very *aims* underlying the governance of data. Rather than seeking to leverage the value produced by the accumulation of vast volumes of data or to ensure that the nation-state can exercise its jurisdiction over the transmission and management of this data, collective autonomy has decoloniality as its ultimate goal. In practice, this implies dismantling the discursive and material structures sustaining coloniality in the spheres of knowledge production, the economy and the territory as well as putting forward alternative visions based on local knowledges and struggles. Phenomena I observed in my fieldwork, such as the challenges faced by the Chilean astronomy community in identifying its concerns and priorities, the outward-facing character of data infrastructure and the struggle of the Lickan Antay people to protect their balanced coexistence with the environment, represent dynamics that can only be challenged by relying on ways of thinking and doing that do not follow the precepts of capitalist modernity/coloniality. Furthermore, collective autonomy rejects the idea that a single principle of data governance such as openness, sovereignty or even autonomy itself can apply to all contexts, and instead strives for what the Zapatistas in Mexico and decolonial thinkers call the pluriverse, or the world in which many worlds fit. This aim

connects with the history of liberatory theory and praxis in Latin America (Mignolo, 2007a, p. 454), representing a centuries-old aspiration for communities and social movements in struggle that can also inspire the governance of allegedly innovative technologies such as datafication.

In sum, and addressing RQ2, a framework of data governance based on collective autonomy changes not only the concerns but also the actors, scales and aims at play. A way to sum up these observations is by paraphrasing Walter Mignolo (2018, p. 154) and affirming that collective autonomy not only changes the *content* but also the *terms* of the conversation. Certainly, changing the content of the conversation is a necessary step for advancing decoloniality under datafication. For example, granting access to vast volumes of data needs to acknowledge that such a move might engender new forms of epistemic obedience. However, what I have proposed here is a more significant departure from existing frameworks that also encompasses questioning aspects such as who are entitled to participate in such discussions in the first place. This broader shift and proactive critical stance are what I understand as a change in the terms of the conversation. It is only when changing the content and the terms of the conversation that it is possible to reveal the inadequacy of dominant frameworks of data governance and to put forward alternatives otherwise, i.e., aligned with a de-linking of capitalist modernity/coloniality.

7.2.3. The Logic of Technological Hypes vis-á-vis Histories of Local Struggle

As a final finding, I would like to reflect upon the significance of this thesis with regards to the rise and fall of different 'technological hypes' over the last decade. This point is not part of my research questions, but it became especially relevant to me when I was finishing this thesis and looked more carefully at the situation of the academic field. In 2012, there was a considerable amount of academic research targeted at terms such as 'big data' and 'datafication'; programmes, journals, conferences and even a field of study (critical data studies) were put into place in order to interrogate the impact of the increased prominence of data in social life. As such terms started to recede, others took over. AI has become the chief one more recently, attracting the attention of both industry and academia just as big data had done a few years ago. Many researchers updated their focus of interest, and some conferences replaced 'big data' with 'AI' on their names to catch up (Katz, 2020, p. 70).

A crucial question arises against this backdrop: how can the insights provided in this thesis contribute to challenging the logic of technology hypes advanced by the industry and sometimes reproduced by academia? I cannot claim that this thesis is completely innocent of this catch-up logic; however, I do consider that it provides some insights for challenging it. In this

regard, I would say that the key relies not on collective autonomy itself but rather on what collective autonomy represents: the legacy of *historical local struggles* against capitalist modernity/coloniality in Latin America. Drawing on this observation, I consider that challenging the logic underpinning technology hypes requires emphasising three aspects: 'history', the 'local' and 'struggle'.

History is crucial in the analysis I have provided. History is present in this thesis as a source of knowledge on the workings of centuries-old modern/colonial power dynamics and a genealogy of resistance against this power structure, which is encapsulated in the notion of autonomy as well as in the view of Lickan Antay regarding extractivism and territory. Foregrounding history makes it possible to challenge the narrative of innovation that accompanies emergent technologies since it reveals that these technologies' chances of succeeding do not only depend on whether they 'work' but also on their capacity to benefit from existing hierarchies and asymmetries. Furthermore, looking at history can also shed light on certain discontinuities that might be worth paying attention to. This is the case of, for example, the emerging articulations of extractivism I analysed in chapter five since they point to reflections on a patterned phenomenon but nonetheless identify an expansion and shift in the specific loci of extraction. Based on these ideas, it could be said that without history emergent technologies appear as disruptive configurations requiring the development of novel frameworks for addressing their impact; instead, bringing history in makes it possible to challenge their innovative aura and to rely on frameworks developed by groups in struggle to assess their impact and resist them.

However, not simply any history would work in the way I described above. As Mignolo (2012) would say, what are needed are *local* histories. By 'local' I do not mean insular or tradition-bounded, but rather histories anchored in the shared experience of peoples living in the territory rather than in relation to other contexts whose universal validity is taken for granted. As history shows, modernity/coloniality established an epistemological order in which some trajectories, i.e., the European one, hold universal value. The epistemological authority of the horizon of development relies greatly on its reflection of the European trajectory, including the process of industrialisation and the Enlightenment. The conclusion that derives from this, and that this thesis shows with clarity, is that the assessment of how technologies speak to the local needs and visions cannot depend on ready-made templates inspired by the history of Europe. Instead, what is needed is a critical assessment of the validity of such frameworks in light of local histories. Even if such histories might not refer to the specific technology into question, they might still have a lot to say on the impact of such technologies. Furthermore, 'local' also means

that, instead of focusing on the usual suspects, such as Global North countries and transnational technology companies, the governance of emergent technologies needs to take into consideration the agency of a series of actors in the South, such as postcolonial states and Indigenous groups, and the South in the North, such as marginalised communities living in so-called developed countries. These actors can have a crucial role in the creation or resistance of the discursive-material conditions for the success of emerging technologies and can give rise to novel forms of resistance.

Struggle is a third element for challenging technological hypes. An emphasis on struggle in the governance of emergent technologies implies looking at existing divergences and exclusions as well as to the memory of social movements and mobilised communities. This move not only encompasses an act of justice in and of itself, where previously marginalised voices are brought to the fore, but can yield analytically and politically fruitful results as it favours analyses attuned to some of the most pressing concerns held by local actors. In my case, drawing on frameworks based on openness or sovereignty rather than on the vision of mobilised groups in Latin America would have prevented me from seeing the entanglement of datafication with epistemic obedience, extractivism and the territory. Ignoring struggle would also have kept me from approaching Lickan Antay activists as relevant and legitimate voices in discussions over data governance. Last but not least, conducting research sensitive to the struggles of the local context makes it possible to question the worth of studying emergent technologies *vis-à-vis* more potentially urgent preoccupations held by mobilised groups. In my fieldwork, for example, Lickan Antay activists explained to me that they have had to leave aside the international observatories in order to focus on the ongoing extraction of lithium due to its higher environmental impact. This observation allowed me to question whose priorities and interests were represented in my investigation and to reflect on the type of research I would like to conduct in the future.

In sum, and moving beyond the RQs, this thesis has also provided a starting point to tackle academia's apparent involvement in a catch-up game with the technology industry. In particular, I have foregrounded the relevance of history, the local and struggle*, namely of *the history of local struggles*, as a potential way of departing from such dynamic. When adopting this standpoint, both utopian and dystopian narratives are replaced by a grounded approach in which the relevance of emergent technologies is weighed against the concerns held by groups for whom history is not only an abstract set of stages to be completed but rather an agent shaping their everyday achievements and constraints.

7.3. Contributions

Having delineated the main findings, I now set out the main contributions of this thesis in relation to literature, theories and methods I referenced in the previous chapters. In this section I kick off by referring to the body of work on data coloniality and then expand towards more general discussions held in the social sciences.

7.3.1. Data Coloniality: Beyond the Traditional Suspects

As I argued in chapter two, one of the aims animating this thesis was to propose a framework of data governance capable of addressing the criticism stemming from work on data coloniality (Couldry & Mejias, 2019; Ricaurte, 2019). In this regard, the in-depth account I have provided of epistemic obedience, extractivism and the destruction of worlds makes a significant contribution to the latter body of research by signalling new interlinkages between datafication and the patterns of power that emerged in parallel with European colonialism. In addition to this, this thesis has also contributed to expanding the discussion on data coloniality in two ways.

The first contribution has been the incorporation onto the radar of actors that have not been identified as relevant players so far. In this regard, focusing on people working in Chilean institutions was a fruitful decision since it revealed that data coloniality is not only being produced and reproduced by the US and Chinese governments and companies but also by actors located in contexts that are not usually pointed to as the main source of technological innovation. For example, the forms of epistemic obedience I identified in chapter four are being advanced to a large extent by the Chilean astronomy community itself. This does not mean that Global North scientific organisations or transnational companies do not have any role, but it does suggest that holistic accounts of data coloniality need to attend to agencies that have not necessarily been central in their analysis so far. At the same time, I also foregrounded sources of ongoing resistance against data coloniality that are not necessarily mobilised workers from technology companies in Silicon Valley or digital activists but rather Indigenous communities opposing the extractivist ethos of data producers. Thanks to this choice, I was able to identify concerns and actors absent from the discussion, allowing me to reframe what data governance should be about in the first place.

A second contribution of this thesis to work on data coloniality has been strengthening the connections with other literature looking at datafication, particularly with the discussion over the principles that should orient the governance of vast volumes of data. In this sense, collective autonomy has proven a solid conceptual bridge between discussions about data coloniality and

data governance due to its sensitivity to the patterns of power brought about by European colonialism and capacity to operate as an alternative to established frameworks. This move has strategic implications since it provides a means to make relevant the arguments advanced by data coloniality research in a field that has gained relevance over the last decades in international circles and in which the voice of transnational technology companies has dominated so far (Micheli et al., 2020). In addition to governance, in the empirical chapters it is possible to find original contributions to literature on datafication, demonstrating that under data coloniality data-driven development programmes (L. Taylor & Broeders, 2015) are also being articulated and promoted by so-called developing countries; that the growth of planetary data infrastructures (Edwards, 2010) can encompass an outward-facing architecture that favours extractivism; that who gets to valorise non-personal types of data (Sadowski, 2019) is crisscrossed by North-South hierarchies; and that the environmental costs of data-intensive technologies (Crawford, 2021) can also threaten the cultivation and sustainment of Indigenous worlds.

In sum, this thesis draws on and expands the scope of work on data coloniality by emphasising the agency of previously ignored actors and furthering the dialogue with discussions over governance and other relevant themes explored in recent research.

7.3.2. Decolonial Theory and Post-Marxism: An Alternative Approach to Datafication

The notion of collective autonomy that I developed in the conceptual chapter and put to work in the empirical ones is based on two sets of theories: the Latin American modern/colonial programme and Ernesto Laclau and Chantal Mouffe's account of post-Marxism. Even though neither of these two theoretical bodies has science and technology as a central object study, they proved capable of identifying and providing a thorough account of previously unexplored power dynamics taking place in the field of data governance. Whereas decolonial thinking contributed by delineating the context (the modern/colonial world system) of this study as well as illuminating alternatives otherwise (autonomy), post-Marxism provided an analytical lens that oriented this study to the identification of struggles involving dissenting groups (the political) and to the positionality of the parties at stake (subject positions). One of the advantages of this approach is that it not only develops a diagnosis of the situation but also makes it possible to provide normative suggestions based on the views of groups who are not willing to accept the terms and conditions of modernity/coloniality.

However, as I drew on these theories I also contributed to each of them. One of the contributions of this thesis has been to take up the insights provided by decolonial thinkers and apply them to the study of science and technology. In this effort, the historical and transnational

approach of decolonial thinking was particularly fruitful for exploring datafication, a phenomenon of a clear global character that dominant discourses present without a careful acknowledgement of the planetary context in which it is taking place. A challenge I faced in the process was that the modernity/coloniality group has not yet provided a thorough account of the role of science and technology in the sustainment of the modern/colonial world system. To some extent Walter Mignolo and Arturo Escobar have addressed this point, but their focuses have been put in disciplinary boundaries (Mignolo, 2018, p. 200) and the belief in science (Escobar, 2018, p. 88). Against this backdrop, one of the contributions of this thesis has been to formulate an approach to decolonial thinking suited for research that has developments in science and technology as its object of study, expanding the scope of this theory in the process.

I have also made a similar contribution to post-Marxism. Whereas decolonial thinking has gained purchase in places like Britain over the last few years (e.g. Bhambra, 2014), post-Marxism had its apogee in the eighties and the nineties. Since then, this theoretical body has been attacked from different strands, including orthodox Marxists for distorting Karl Marx's work (Howson, 2017, p. 5) and decolonial thinkers for subscribing to the horizon of emancipation rather than that of liberation (Mignolo, 2007a, p. 454). Despite this, in this thesis I have demonstrated the capacity of post-Marxism to provide solid theoretical assistance for projects aimed at decoloniality, especially when it comes to identifying the political character of conflicts taking place in unlikely places, such as the governance of data, and questioning the positionality of the parties involved. Before the analysis of the empirical data I also considered the framework of the sociotechnical imaginaries (Jasanoff & Kim, 2015), but after careful consideration I realised that post-Marxism's capacity to identify the structural stakes of ongoing struggles spoke more directly to decolonial thinking.

Neither decolonial thinking nor post-Marxism have had a prominent role in the study of datafication so far. In this thesis I have shown that these bodies of theory do have important things to say with regards to political frictions emerging with its implementation in the context of a modern/colonial world system that have not been thoroughly explored so far.

7.3.3. Analytical Framework: The Discursive-Material Contours of Datafication

Another significant contribution of this thesis concerns the analytical-methodological framework employed. As I explained in chapter three, most studies on datafication have tended to focus on the material dimension of the phenomenon (e.g., Dourish & Mazmanian, 2013), although some authors have also taken a discursive approach (e.g., Beer, 2016) or sought to incorporate both (e.g. Kitchin, 2014). In contrast, in this thesis I have shown that understanding

the politics of datafication does not require attending to either the discursive *or* the material but instead to both of them, and to do so in a way that approaches them not as separate realms but rather as two deeply entangled aspects (Carpentier, 2017). In this thesis, the forms of epistemic obedience emerging in relation to data-intensive research (chapter four), the three understandings of extractivism (chapter five) and the imaginaries of territory underpinning the growth of data infrastructures (chapter six) encompass an interplay of discursive and material dynamics. Research looking at only one of these dimensions or not approaching them as ontologically inseparable run the risk of obscuring one of these aspects, providing an explanatory authority to one of them rather than accounting for the full complexity of the phenomenon. Furthermore, it is important to note that these two dimensions might interact in different ways in each case, which means that, far from providing a totalising answer, DMA understands that empirical work is required in order to find out about their particular working in different contexts.

The discursive-material approach employed in this thesis also enables the study of broader planetary and domestic structures of power that are in the interest of decolonial thinkers. In particular, it provides an approach that avoids reproducing the dichotomy between accounts emphasising either the 'economic' or the 'cultural' dimension, as world-systems theory and postcolonial theory have tended to do, respectively (Grosfoguel, 2007). Instead, a discursive-material perspective sits better with the way decolonial thinkers themselves have conceptualised the modern/colonial world system, i.e., as a structure and a system whose foundations rely on a capitalist form of production as well as epistemological and ontological assumptions. Furthermore, the flexibility of the discursive-material framework allowed me to put into dialogue the contributions from a broad range of sources, including decolonial thinkers holding different theoretical and methodological inclinations, post-Marxist theory and research on datafication informed by STS. One of the limitations of this hybrid approach is that it makes it harder to provide all-encompassing and totalising explanations; however, for the same reason a discursive-material sensitivity permits reaching more nuanced and richly textured insights that address rather than evade the complexity of the capitalist modern/colonial world system. Certainly, other studies might opt for a different set of entry points to the material, such as *bodies*, as well as other additional dimensions, such as *affect*, that might shed light on aspects not developed in this thesis.

7.3.4. Shifting the Study of Science and Technology in Latin America

This thesis also encompasses a shift in the study of science and technology in Latin America. Broadly speaking, critical thinking and research on this theme can be split into two main stages (Kreimer & Vessuri, 2018; Medina et al., 2014). The first took hold between the

fifties and eighties and was predominantly informed by dependency and world-systems theory. This historical period was marked by the active intervention of the United States, which prompted political economists to wonder how to overcome the peripheral condition of the region so as to achieve national autonomy (e.g. Varsavsky, 1969). The aim of this thesis resonates with the predominantly political concerns and the planetary-scale type of analysis undertook in this period. However, it also departs from it inasmuch as I do not take the nation-state as the primary unit of analysis and, instead of a reified account of centre and periphery, I analysed them as the product of discursive-material articulations. The second current of studies on science and technology in Latin America held sway from the eighties to the first decade of the twenty-first century and was influenced by STS frameworks such as ANT, on one side, and postcolonial theory, on the other. In this period, researchers undertook empirical studies, which in some cases went outside traditional laboratories and workshops, in order to question pre-constructed notions of core and periphery in innovation (e.g., da Costa Marques, 2005). Like this body of work, this thesis privileges an empirical approach to social reality and expands the range of groups considered relevant to the analysis. However, it also departs from it in that I opted for a macro approach capable of addressing the systemic-structural import of science and technology in the region and that acknowledges political economy.

More crucially, in this thesis I pursue an aim that differs from the two aforementioned currents of studies. In my case I sought to identify the connections between the governance of technology and the patterns of power that emerged in parallel with European colonialism and that still shape to a great extent Latin America's fate to this day. This aim differs from those of overcoming structural barriers to development (first stage) and demonstrating that Latin America can also make science and technology, even if in its own way (second stage). Furthermore, here I turned to two theoretical bodies, decolonial thinking and post-Marxism, that have been relevant in political analyses in the region (Escobar, 2020, p. 31) but that have had a secondary role in previous studies on science and technology. I do not necessarily hope that future studies will take the same theoretical and methodological decisions I did but that they will reflect on the capacity of the dominant frameworks to account for the concerns, visions and struggles present in the Latin American context.

7.4. Implications: Struggles, Geopolitics and Policy Making

The observations I have made in this thesis also have repercussions in discussions and processes taking place outside scholarly debates. In the following three points I look at the

implications of the observations I have made so far for the struggle against data coloniality and coloniality, the geopolitics of technology and astronomy policy making in Chile.

7.4.1. A Shared Grammar: Struggles Against Data Coloniality and Coloniality

Just as in this thesis I drew on the knowledges of communities and social movements, the insights I have provided here can be of interest for two relevant groups: intellectuals and activists opposing data colonialism in the South and the North, on the one hand, and communities and social movements sustaining autonomy in Latin America, on the other hand.

At the moment, the increasing acknowledgement of the connections between datafication and patriarchal capitalist modernity/coloniality is giving rise to initiatives aimed at combatting this entanglement. Two examples of such groups are the *Tierra Común* [Common Land] network of activists and researchers from the South and the North (Couldry & Ricaurte, n.d.) and the Mijente group of Latinx and Chicanx activists opposing technology used for immigration enforcement and criminal justice in the United States (Mijente, 2018). One of the implications of this thesis is an expansion of the scope of the struggle of such groups, incorporating scientific data, development programmes and territorial conflicts engendered by the expansion of data infrastructure on their radar. In addition to this, this thesis can be particularly helpful in feeding the interventions of these groups in debates held at the domestic and international level under the label of governance, since autonomy constitutes a straightforward way of signalling an alternative vision aligned with the thoughts and feelings of many groups and individuals resisting data coloniality.

This thesis can also contribute to digital activist organisations combatting the harms produced by digital technologies in Latin America. In particular, the framework I have provided can operate as a starting point for assessing the impact of data technologies in light of long-standing power dynamics in the region, offering an alternative to the concerns stemming from the Global North that do not necessarily reflect the full scope of the shifts at stake. For example, digital activist organisations in Latin America might articulate their work in relation to notions such as 'human rights', 'freedom of expression' and 'privacy' (e.g., Derechos Digitales, n.d.). Such frameworks foreground relevant aspects of the stakes underlying digital technologies, but they do not necessarily address what mobilised groups and critical thinkers have proposed as central concerns for achieving social justice in the region: the capacity to generate knowledge attuned to the local context, the persistence of different forms of extractivism and the threat to territorial modes of existence. It is important to note that incorporating such concerns into the agenda of digital activism in Latin America would constitute a discursive-material move since in

some cases the financial sources making possible the survival of these organisations, which very often stem from the Global North, might condition their adoption of particular frameworks.

More broadly, the account of the intersections between datafication and the modern/colonial world system I have discussed can serve as an orientation for social movements and Indigenous communities discussing the position that data coloniality should play in their struggles. Certainly, many of these groups are fighting more urgent battles with direct consequences for their livelihood, as is the case of the Lickan Antay communities opposing lithium extraction. Against this backdrop, the insights I have advanced in this thesis can work as a valuable input from which such groups can reflect about the priority that datafication should have in their collective efforts. It is especially relevant to consider that in some cases the power dynamics I described here might be taking place without much awareness of such communities and social movements. I experienced this in my conversations with Lickan Antay activists since, for example, they had not heard about the ambitious plans of the government with regards to astronomy data. In the event that such groups decide to engage in resistance against datafication, the notion of collective autonomy I have provided can act as a normative ground that, unlike the dominant paradigms, is aligned with the needs and visions of groups resisting the different facets of coloniality.

Drawing on the above, an important implication of this thesis is that it can bring together struggles against coloniality by mobilised groups and data coloniality by digital activists in Latin America by proposing a shared grammar capable of furthering solidarity among them. For example, epistemic obedience, extractivism and territory can render intelligible the stakes of datafication in the region for both Indigenous communities affected by digital governmental policies and digital activists whose vocabulary does not necessarily rely on the genealogy of critical thinking in the region. This contribution would add to ongoing initiatives bringing together digital activists and Indigenous communities in Latin America working on autonomous technologies (e.g., Association for Progressive Communications, 2021; Bravo, 2017).

7.4.2. Supporting Non-Aligned Politics: Neither the USA nor China

As I suggested in chapter two, the debate over data governance has geopolitical implications with political, economic and security ramifications. Over the last few decades, pundits and the media have transformed the United States and China into the only two established sources of imaginaries of data and technology governance. On the one hand, the United States has advocated open frameworks that can permit the data to flow freely across the planet. Such a framework is presented as a means to expand freedom of information worldwide, but in practice

also supports the interests of this country's technology giants. On the other hand, China has backed sovereignty to reassert the control of the nation-state over data flows for security and industrial purposes. As of today, these two models of governance represent two influential approaches in the international scene, even though the scenario has become more complex as some liberal democracies such as Germany have started to adopt the vocabulary of sovereignty (Pohle & Thiel, 2020). Against this backdrop, collective autonomy can provide an alternative for countries and groups interested in advancing models of governance that speak to their local context rather than to advancing the interests of any global power. Collective autonomy also reveals that there are alternative views in the debate, challenging the Cold War narrative that has ended up rendering 'other parts of the world … somehow void of values or waiting for them to be superimposed on entire states and cultures' (Whittaker et al., 2021, para. 1).

At a planetary level, collective autonomy can also work as an overall framework for planetary-scale initiatives seeking to bring together actors such as the state, schools, political parties and social movements opposing data colonialism. One such proposal circulating in academic circles is Juan Ortiz Freuler (2020) and Ulises Ali Mejias's (2020) Non-Aligned Technologies Movement (NATM). Inspired by the Non-Aligned Movement that emerged in the fifties (Oppermann, 2018, p. 20), this organisation would provide an alternative to the dominant blocs, promoting common approaches to regulation and taxation and, more broadly, showing 'that another world is possible' (Mejias, 2020, para. 27). This initiative is still under development, but collective autonomy could provide a powerful horizon capable of addressing political and technical aspects in a way that, in resonance with the view of marginalised groups in the South and the North, rejects any type of imposition. Thus, collective autonomy could operate as an alternative option in the global field of technology governance, albeit one that would help a non-aligned tech movement change the terms of the conversation by opposing the interests of the states and transnational corporations.

7.4.3. Astronomy Policy in Chile: Decentring the State, Questioning Development

Finally, this thesis also has implications for the discussion on the policies shaping the field of astronomy and astronomy data in Chile. In the empirical chapters I reviewed two such policies: the DO public-private partnership and the Natural Laboratories. In relation to the former, I criticised the hierarchy underpinning the DO's 'global vision', which in practice has translated into a situation in which Global North actors are deemed as bearers of the future and local actors such as ChiVO and the Lickan Antay communities experience neglect and exclusion. When it comes to the Natural Laboratories, I pointed out that the imaginary underlying this policy

transforms the territory into a series of assets for attracting international investment in R&D infrastructure. These two examples reveal that the state's interest in employing the astronomy data produced in the Atacama Desert for advancing progress and development has not necessarily been accompanied by a careful examination of the impact of such measures for actors such as ChiVO or the territory itself. Such an observation should not come as a surprise since, unlike the ideas that dominated in critical Latin American thinking in the sixties and the seventies, autonomous communities and critical intellectuals have tended to regard the nation-state as an actor embedded in modernity/coloniality rather than a source of liberation from it.

In contrast to the view advanced in this thesis, research looking at astronomy and astronomy data policies in Chile has tended to centre on the role of the state (Barandiarán, 2015; Espinosa-Rada et al., 2019; Guridi et al., 2020). For example, Javiera Barandiarán (2015) argues that the state's pursuit of a growth-led type of development and its privileging of diplomatic aims explain the incapacity of the country to take advantage of the construction of the observatories for industrial purposes. Compared to such an approach, this thesis shows that the constraints faced by local actors do not only derive from or depend on the state. Even though I do consider the state as a prominent actor in the field, I also demonstrate that the discursive-material conditions foreclosing or opening up alternatives for local actors are distributed among a broader range of actors, including policy makers, astronomers, astroinformaticians and members of the private sector. For example, the collaborative subject position I described in chapter four is not emerging from any particular state policy but instead is circulating as a discourse among local researchers and permeating policy making and the private sector. From the angle of this thesis, focusing on state policies is certainly relevant, but this should not undermine the role of other actors such as the scientific communities or the private sector in the reproduction of modernity/coloniality in relation to astronomy data.

A second point of divergence between this thesis and work on astronomy policy in Chile concerns their different takes on development. Drawing on Latin American critical thinking, I have analysed the articulation of development and astronomy data and discussed its stakes for the pursuit of collective autonomy. In contrast, existing work has tended to approach development as a given, approaching it from a predominantly economic (Guridi et al., 2020) or scientific (Espinosa-Rada et al., 2019) vantage point without questioning its limitations or acknowledging alternative visions existing in the country. To some degree, Javiera Barandiarán has offered a more complex account in this regard, criticising the fact that astronomy policies have pursued a growth-focused type of development rather than one based on entrepreneurship (2015, p. 142). However, this approach does not question the validity of development itself nor whether

alternative visions could also provide a valid answer to the question of how to take advantage of the constructions of the observatories.

The two above points demonstrate that this thesis departs significantly from previous studies on astronomy policy in Chile. Whereas existing research has tended to discuss the mechanisms and adjustments that need to be introduced by the state so as to achieve development, in this thesis I have considered a broader range of actors in the configuration of the field and suggested that it would be almost impossible to overcome data coloniality as long as policies keep assuming development as the only valid horizon.

7.5. Limitations: The Role of Heteropatriarchy and the Chinese Hegemony

Having discussed the contributions and implications of this thesis, I now turn to some of its limitations. Certainly, the points I propose here are not exhaustive. However, they represent two aspects that I consider would have helped provide an even more thorough account of the politics of astronomy data in Chile.

7.5.1. Acknowledging Heteropatriarchy: Incorporating a Feminist Standpoint

As I argued in chapter two, decolonial thinkers consider heteropatriarchy a fundamental dimension of the modern/colonial world system. Rather than a pattern restricted to gender dynamics, heteropatriarchy represents a condition of possibility for the exercise of colonial, sovereign, extractivist and territorialist forms of power. Despite its relevance, this thesis did not examine this dimension specifically since it was not an aspect particularly salient in the data. Still, an analysis along the axis of heteropatriarchy inspired by feminist theory would have provided an additional conceptual lens to get a deeper picture of the connections between datafication and the heteropatriarchal capitalist modern/colonial world system.

A fruitful way to address heteropatriarchy in data coloniality might certainly be by addressing gender hierarchies. However, another possibility would have been to explore how dynamics that have been central in feminist theory are operating in times of datafication. Just to cite an example, future studies from a feminist-decolonial perspective might want to address the role of 'care' in the governance of vast volumes of data. Factoring in care—understood as 'everything that we do to maintain, continue, and repair "our world" so that we can live in it as well as possible' (Tronto, 1993, p. 103)—to the analysis would have yielded relevant additional layers of analysis. In relation to this thesis, an emphasis on care would have granted a more prominent role to some of the empirical data I discussed in the empirical chapters such as the

story I tell in chapter four on the travels that sysadmin Camilo Núñez had to do in order to transport ALMA data from this observatory's offices to the ChiVO's datacentre. This dynamic speaks directly to an aspect that has been of interest for STS feminist thinkers: the usually invisible and undervalued layers of work necessary to make sociotechnical systems work (Puig de la Bellacasa, 2017). Furthermore, focusing on care would have oriented my questions towards the affective dimension, grasping an aspect of the problem that would sit next to discourse and the material and that might be playing a relevant role in the case of astronomy data in Chile. As the example of care shows, a feminist standpoint can help bring to the fore some of the dimensions of the heteropatriarchal modern/colonial world system that I did not address at length in this thesis.

7.5.2. Geopolitical Shifts: Is There a Chinese Hegemony?

As I explained in the introduction, most of the mega observatories installed in the Atacama Desert are under the control of either United States or European scientific organisations. However, this scenario has started to change. In 2000, a consortium formed by the USA, Canada, Chile, Brazil, Argentina and South Korea constructed the Gemini South Observatory. In 2004, the National Astronomical Observatory of Japan (NAOJ) stepped in with the Atacama Submillimeter Telescope Experiment. As of today, other countries and regions such as Taiwan are also involved in the construction and control of mega observatories. More recently, China has become a crucial player. In 2012, CASSACA inaugurated its offices in Cerro Calán, next to the Astronomy Department of the University of Chile (Cárdenas, 2019). Three years later, and as I mentioned in chapter four, CASSACA and ChiVO signed the partnership that gave birth to the Chi2AD. In 2019, Zhong Wang, the director of CASSACA, informed the Chilean authorities about two important projects: the construction of a mega observatory in the Antofagasta Region and an Astroscience Park with futuristic architecture in the outskirts of Santiago.

As the above suggests, the predominance of the United States and Europe in the field of astronomy data in Chile is giving way to a more diverse number of players among whom China stands out for its ambitious projects. Looking at current geopolitical shifts, this situation echoes the transition from a 'monocentric' to a 'polycentric' world in the 2000s, where the rise of new global powers such as China challenged the hegemony of Western countries (Mignolo, 2011a). In my view, grasping this new scenario requires reconsidering the extent to which the insights provided by the modernity/coloniality group can explain these recent shifts. Some authors have rushed to argue that the rise of China as a new hegemon is not following the same pattern of power as the USA and Europe, departing from an imperial search for hegemony since it does not seek to occupy territories or exercise political intervention (Mignolo, 2011a, p. 46). However, a

more complex scenario emerges when considering that, for example, China and Chinese technology companies such as Huawei are powerful players in data colonialism (Couldry & Mejias, 2019, p. xx) and the controllers of a 'global supply-chain empire' (Khanna, 2016, chapter 9, section 5) holding a great degree of influence in Africa and Latin America. The case of astronomy data in Chile could provide a fruitful vantage point from which to examine the technological and scientific dimension of these broader geopolitical shifts, especially when it comes to identifying whether there is and what would be the shape of an emergent form of hegemony that differs from the one studied by decolonial thinkers. Data, automation, infrastructure and logistics might be crucial elements of coloniality in the context of the fourth industrial revolution, creating a complex entanglement of interests and agencies calling for a profound revision of existing frameworks.

7.6. Final Word: Data Governance in a Civilizational Crisis

In this chapter I have spelled out the capacity of collective autonomy to act as an alternative horizon for thinking about data governance. As I said, collective autonomy not only changes the content and the terms of the conversation but also provides a starting point for challenging the logic of technological hypes surrounding the development and implementation of emerging technologies. Scholarly debates on data coloniality, decolonial thinking, post-Marxism, the discursive, the material and technology in Latin America can draw relevant conclusions from the insights I have provided. Likewise, my observations can also provide a shared grammar for struggles against data coloniality and coloniality in Latin America, serve as an overarching framework for planetary-scales initiatives combatting data coloniality and inform research on policies on astronomy in Chile. Future studies looking at this or similar cases might want to analyse at length the role of heteropatriarchy and the emergence of a potential Chinese hegemony.

Finally, I would like to make an observation on the historical context to which a framework of data governance based on collective autonomy speaks. As I argued in chapter two, debates on data governance tend to aim at either leveraging the value from the accumulation of vast volumes of data or ensuring that the nation-state or other actors can exercise sovereignty over such data. In contrast to these frameworks, collective autonomy grows out from the mobilisation of communities and social movements in Latin America in the context of a 'civilizational crisis' (Escobar, 2018, p. ix). This crisis has been in the making for centuries, but more recently manifests in aspects such as growing planetary and domestic inequalities, increasing gender violence and the erosion of the Earth. In the period I undertook this study, the

persistence of these patterns translated into an upsurge of social uprisings against neoliberalism, heteropatriarchy and internal colonialism in countries such as Chile and Colombia, of the anti-racist Black Lives Matter movement in the United States and the United Kingdom, in the fight against planetary health inequalities in times of the COVID-19 pandemic and the mobilisation of groups in the North and the South against the climate crisis and the terricide. Even though collective autonomy cannot 'solve' these issues, it does strive for the cultivation and sustainment of worlds otherwise, based on precepts that do not adjust to capitalist modernity. In this thesis I have drawn on this spirit to identify modern/colonial patterns intersecting with the implementation of datafication in the case of astronomy data in Chile and to propose an alternative way of thinking about the governance of this data. Certainly, datafication constitutes a rather specific field, but the relevance of AI and the fourth industrial revolution in public and private initiatives shows that data-intensive technologies might remain in place for a few decades and become an increasingly prominent area of struggle.

Unlike the dominant visions, thinking of data governance from the perspective of collective autonomy does not inscribe itself into the quest for endless productivity nor into the search for reasserting the sovereignty of the nation-state or other actors. Instead, collective autonomy implies examining datafication against the backdrop of profound concerns held by mobilised groups, such as their capacity to generate knowledge attuned to local needs and visions, the emergence of new forms of extractivism or the current shape of territorial conflicts. Even though collective autonomy is currently circulating with force in Latin America, researchers looking at other contexts might prefer to draw on horizons capable of foregrounding other histories of struggle. As long as they get their inspiration from groups striving for worlds otherwise, such frameworks will share what is perhaps the most relevant aspect of collective autonomy: the search for a pluriverse in which different ways of thinking and doing can coexist peacefully.

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9. Appendices

9.1. Appendix 1: Codebook

This codebook was employed for the thematic coding. The order of the codes is random. Given the iterative nature of the process, some codes were added after a pilot. The codes highlighted in yellow are the ones that ended up structuring the empirical chapters, although it is possible to find many others that feed into the analysis across the thesis.

RELATIONS	NATION BUILDING	DATA & TECH	ATTITUDES & IDEAS
==Collaboration== Exclusion/Inclusion Competition Dependency Convenience Equality ==Extractivism== Trust/Distrust Misunderstanding Proximity/Distance Strategies Reciprocity Compensation Interfacing Face to face Events Coordination Overlaps Outreach/PR Capture Elitism Public-private Leadership	Development Advancement Capabilities Opportunities Catching Up Branding/Identity Global Order Mentality Lacks/Problems Prescriptions Gaps Size Economy Transfer Productivity	Big data Data science Anonymity Uses/Users Ownership Access Affordances Collection Analysis Hype Archiving Search Value Technical arguments Infrastructure Speed (latency) Redundancy Support Innovation	Optimism Pessimism Caution Challenge Involvement Expectations Preoccupation Affect Patience Care Struggle Waiting Dreams/Imaginaries Speculation Needs Assessments Scepticism Saturation
SCIENCES	**RESOURCES**	**SPACE & TIME**	
Working Styles Shifts Disciplines Quality Impact Astroengineering Astroinformatics Astronomy	Human Capital Outsourcing Money Equipment Added Value Raw Materials Return of Investment	Prediction Acceleration Anticipation ==Geography/Territory== Distance	

9.2. Appendix 2: Information & Consent Form in English

> **Information About this Research**
>
> · This research project is being conducted by Sebastián Lehuedé, a doctoral researcher from the Department of Media and Communications of the London School of Economics (LSE).
>
> · This research explores the social, technical and economic relationships associated with the astronomical data being collected in Chile. In terms of methods, it encompasses interviews with key actors and participant observation of the ChiVO project.
>
> · These data will be stored on the servers of the LSE, complying with the General Data Protection Regulation (GDPR) set by the European Union.
>
> · Feel free to write to s.a.lehuede-bravo@lse.ac.uk in case of further questions or requests.

Consent

In this consent form I would like to express my agreement with taking part in the research project specified above. More specifically, I can confirm that:

· I have been provided with information about the project and the researcher. I have also had the opportunity to ask further questions. ☐

· My participation is voluntary, and I am aware of my right to withdraw from the study at any time without providing any explanation. ☐

· I agree on my interviews to be audio recorded. ☐

· I am aware that the information provided might be employed in presentations and articles. ☐

· In relation to my personal identity, I would rather (select one alternative):

    · Allow the use of my name along with quotes or information I have provided. In this way, I expect my contributions to be recognised as such. ☐

    · Be identified in publications and presentations with an alternative name (specify): ☐

    _____

    · I don't want to be identified in the study at all (you will not be quoted). ☐

Name (voluntary): _____

Date: _____

Signature: _____

9.3. Appendix 3: Information & Consent Form in Spanish

Información sobre esta investigación

· Este proyecto de investigación es conducido por Sebastián Lehuedé, estudiante de doctorado del Departamento de Medios y Comunicaciones de la London School of Economics (LSE).

· El objetivo de este proyecto es explorar las relaciones sociales, técnicas, de conocimiento y económicas asociadas con los datos astronómicos en Chile.

· Los datos serán almacenados en los servidores proveídos por LSE, cumpliendo de esta forma con la Regulación General de Protección de Datos de la Unión Europea (GDPR).

· En caso de preguntas o solicitudes adicionales escribir a s.a.lehuede-bravo@lse.ac.uk.

Consentimiento

A través de este formulario expreso mi consentimiento a formar parte del proyecto de investigación especificado. Más específicamente, confirmo que:

· Se me ha proveído información sobre el proyecto y el investigador responsable. También he tenido la oportunidad de realizar preguntas adicionales. ☐

· Mi participación es voluntaria y conozco mi derecho a retirarme del estudio en cualquier momento sin proveer explicaciones. ☐

· Acepto que las entrevistas sean grabadas en audio. ☐

· La información proveída podrá ser utilizada en presentaciones y artículos. ☐

· En relación a mi identidad, prefiero (elegir una alternativa):

    · Permitir el uso de mi nombre junto a citas o información que yo haya proveído. De esta forma mi aporte podrá ser reconocido. ☐

    · Ser identificado con un nombre alternativo (pseudónimo). Especificar: ☐

    _____

    · No utilizar mi nombre ni ningún seudónimo (anónimo). No serás citado/a. ☐

Name (voluntary): _____

Date: _____

Signature: _____