



Cosmic Extractivism

How Space Exploration
Technologies Reinforce
Unequal Ecological Exchange
and Expand Capitalist
Extractivism


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Abstract

This thesis looks at the way that the growing demand for rare earth elements (REE's) driven by space exploration technologies exacerbates unequal ecological exchange and expands capitalist extractivism. Through a theoretical framework that combines the concepts of World-Systems Theory, Unequal Ecological Exchange and Extractivism, this research looks at the relationship between humanities ambitions in space and resource extraction patterns here on Earth. This study also uses Critical Discourse Analysis (CDA) together with the critical realist and political ontology frameworks to look at stakeholder narratives about REE mining and space exploration. Using Atlas.ti software, coded quotations were analyzed from government policy documents, corporate communications and mission statements and community testimonies. In addition to that, an analysis of current and projected REE demand in space technology was analyzed through literature review. The analysis shows systematic differences between the way different stakeholders frame the benefits and harms of mining for space exploration. While government and corporate narratives mostly talk about economic growth, security and sustainability rhetoric, their narratives do not talk about harm recognition which is found often in the community narratives. Communities focus on health problems, environmental degradation and social disruption which shows a large disconnect between corporate and government claims of sustainability and prosperity for all and the lived experiences of communities. While REE usage in space applications is relatively small right now compared to other sectors, the research does show that space exploration right now works in the same structures of global inequality as many other industries. The technical analysis of REE requirements in space technology shows us that space technology today is heavily dependent on REE's and that developing and mass producing such technology in the future would exponentially increase that demand. This thesis also introduces the concept of 'cosmic extractivism' as a speculative extension of green extractivism and global extractivism. It shows the potential appropriation of extraterrestrial resources under the guise of sustainability and humanities advancement while working under the same colonial patterns of benefit concentration in the global north and externalization of costs to the global south. This research concludes that space exploration reproduces rather than transcends the terrestrial inequalities of the modern age through new mechanisms of appropriation. As the space industry is bound to scale up, the demand for REE extraction and the extraction of critical minerals in general is also bound to increase, placing extra pressure on communities and ecosystems that are already feeling the pressure of global resource appropriation today. Without the transformation of stakeholder relationships and narrative frameworks that talk about the relation between space exploration and environmental justice on Earth, the usage of space resources risks maintaining the extractivist dynamics and creating new frontiers for inequality rather than opportunities for humanity to actually flourish in a 'new space age'.

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Chapter 1. Introduction

1.01: Introduction

The fast expansion of space exploration technologies marks a significant moment in human history, promising new scientific discoveries and technological advancements. From the Artemis program of NASA, wanting to establish a human presence on the moon, to private companies like SpaceX that wish to colonize Mars. The space industry is entering an exciting new time with a lot of possibilities, however beneath the idea of cosmic exploration lies a terrestrial reality, the growing demand for critical minerals that make these technologies possible.

Rare Earth Elements (REE's) have become important materials for the space industry. These seventeen chemically similar elements, like neodymium, praseodymium, dysprosium and samarium all possess unique properties that make them important for developing space technology (U.S. Department of energy, 2023; Casey, 2024). Their resistance to radiation, the ability to handle extreme temperatures and the fact that they are light weight yet durable makes them essential for space applications like magnets, coatings, power systems and communications technology (Ohmer, 2021; Casey, 2024;). As space missions become more ambitious and the required technology becomes more complex, the demand for these critical minerals will only increase. This growing dependency on REE's for space exploration is happening all over the world and is imbedded in a system of inequality in resource extraction and environmental burden externalization. The theoretical frameworks of World-Systems Theory, Unequal Ecological Exchange and Extractivism show us how global capitalism concentrates benefits in core nations while externalizing environmental and social costs to the peripheries (Wallerstein, 2011; Gudynas, 2018; Dorninger et al, 2021). All of this together lays the groundwork for what this research calls: "cosmic extractivism", the mechanisms and narratives that enable core nations to extract resources under the guise of human progress. This research will show that space exploration, despite its possibilities, will not transcend these inequalities but rather, extend them with new mechanisms of appropriation and legitimization.

The significance of this research is in its study of how humanities space based ambitions, Such as colonizing Mars, building a base on the Moon or harvesting the resources of outerspace, work within existing structures of global inequality. Space exploration is often framed as serving "all of humanity". Everyone will benefit from the expanse into outer space as this would provide us with new places to live, protect the survival of our species in the case of a cataclysmic event and give us access to the fast resources of outer space (Neukart, 2024). However, the material requirements to actually be able to explore space rely on extractive relationships that often mirror colonial patterns of resource appropriation. The prospect of space-based mining,

space-based colonization and space resource utilization remains speculative as there are plans for such projects but those have not been executed yet. This means that for the foreseeable future, space programs will depend on resources mined here on Earth in regions that already bear the costs of global resource appropriation.

1.02: Research questions

This thesis attempts to answer the following main research question:

How does the growing demand for rare earth elements driven by space exploration Initiatives in the U.S. exacerbate unequal ecological exchange and expand capitalist extractivism?

This main research question is supported by two sub-questions that will help to answer it:

Sub-question 1:

How do governments and corporations from the U.S. and global south communities from China and Sub-Saharan Africa frame the benefits and harms of mining for space exploration, and how do these narratives reflect broader patterns of inequality and extractivism between the Global North and Global South?

Sub-question 2:

To what extent will future space exploration programs, such as Artemis, drive an increased demand for rare earth elements, and how might this shape global extractivist trends?

1.02.01: Justification for the research focus

The selection of REEs as a specifier for critical minerals comes from their position as both necessary for space exploration and sought after material in the world of global extractivism. It is used in all manner of technical applications such as technological devices, Magnets and rechargeable batteries (Humphries, 2013). Unlike other critical minerals REE's combine their technological importance with geographical concentrations of supply chains (U.S. Department of Energy, 2023). China has the most REE production and processing controlling 60% of global mining and 90% of refining (U.S. Department of Energy, 2023). This concentration of REE's in the global south creates vulnerabilities in the supply chain for space fairing nations in the global north such as the U.S. and therefore puts a lot of pressure on the extraction regions as global north countries seek to acquire these REE's to advance their technologies making it a good lens through which to examine the geopolitical and environmental dimensions that come with space exploration.

This research also focusses on the United States as a context because of its central role in space exploration and its influence on the global REE demand (Sadan et al, 2023). As the leader of the Artemis program and home to many space fairing corporations like SpaceX, Blue Origin and Lockheed Martin, the U.S. is a logical case study for understanding how core nations look at space ambitions and the resource dependencies that come with it. The U.S. also provides a lot of source material with policy documents, corporate statements and strategic frameworks that show the mechanisms through which space exploration legitimized. In addition to that, this research also looks at a global perspective by looking at how U.S. space policies and corporate strategies have effect on communities in the global south where resource extraction, including REE extraction, occurs. This research therefore examines data from communities from China and Sub-Saharan Africa. As the community research from Africa looks at many communities all from different countries in the Sub-Saharan region this research combines these perspectives with the term 'Sub-Saharan Africa'. This approach helps us to see the core-periphery dynamics that are important to understand how space exploration works within the systems of global inequality.

1.03: Societal and scientific relevance

1.03.01: Societal relevance

This research looks at the challenges where environmental justice, technological advancement and international governance cross, showing that space exploration is not a human undertaking that is transcendent, but rather, one that is embedded in unequal structures of the capitalist world-system. As space exploration becomes larger as an industry, it is important to understand what kind of impact it causes on Earth in order to achieve a sustainable and fair expansion into space for all of humanity. This study's findings are important for environmental justice movements, especially in places where REE extraction occurs. By looking at the way that space exploration discourse excludes community voices while externalizing environmental burdens, a dynamic that is important to the theories of Unequal Ecological Exchange (Dorninger et al, 2021; Hickel et al, 2022) and extractivism (Acosta, 2015). This research contributes to attempts to democratize space governance and make sure that populations that are affected are able to participate in a meaningful way when talking about the resources that are extracted in their area and resist the ontological violence that removes their lived realities from current political frameworks. The research also looks at questions about the future of extractivism under the guise of technological progress. As governments and corporations keep framing space exploration as environmentally important and even unavoidable, this study shows that such narratives can obscure rather than resolve the environmental and social costs of extraction for space exploration. By introducing the

concept of “cosmic extractivism” this thesis builds on the scholarly work on green extractivism from scholars such as Andereucci et al, (2023), Bruna (2021) and Dunlap et al. (2024) and global extractivism (Ye et al, 2020). It says that cosmic extractivism is the final form in the logic of World-System Theory, Unequal Ecological Exchange and Extractivism, by expanding the mechanisms of resource appropriation to the new frontier of outer space. This provides a way for people to look and evaluate the true costs of humanities expansion into space, challenging the dominant narratives of core states such as the U.S. and offering another perspective.

1.03.02: Scientific relevance

This thesis makes several important contributions to academic literature. The first being the addition to the existing frameworks of World-Systems Theory, Unequal Ecological Exchange and Extractivism to the world of outer space. This shows how patterns of inequality here on Earth may be applicable to the context of outer space. By taking these frameworks, this research extends the traditional scope of WST, which was mainly focused on Earth based economic and political hierarchies (Wallerstein, 2011), to analyze the way core nations such as the U.S. manage resources in outer space. It shows how core-periphery dynamics of value appropriation and the externalization of costs are already being used in the planning and narratives that surround space activities (Hickel et al, 2022; Dorninger et al, 2021). Second, the introduction of the concept of ‘cosmic extractivism’ as a conceptual framework can be seen as a theoretical innovation. This concept is an extension of the concept of green extractivism as explained by Andereucci et al. (2023), Dunlap et al. (2024) and Bruna (2021) and provides the analytical tools for understanding how colonial patterns of resource appropriation might work outside the boundaries of Earth, with contributes to the scholarship of space governance and environmental justice. Methodologically, this research shows the value of Critical Discourse Analysis by looking at the power dynamics that are embedded in the space exploration narratives as described by Fairclough (2013). By looking at the way different stakeholders frame the benefits and harms of mining, this study reveals the discourse through which global inequalities are maintained and legitimized. This research also addresses a significant gap in existing literature by connecting space exploration with extractivism. While space studies often look at technological and policy dimensions, and extractivist literature often looks at resource extraction here on Earth, this thesis connects these fields to provide a more comprehensive understanding of how space exploration functions in the system of global capitalism.

1.04 Structure of the thesis

This thesis is organized into eight chapters that build from the theoretical framework to the analysis and lastly the conclusion.

Chapter 2 is the theoretical framework which is the foundation to the analysis and examines the concepts of World-System Theory and Core-Periphery dynamics (Wallerstein, 2011), Unequal Ecological Exchange mechanisms (Hornborg, 2009; Warlenius, 2017) and the concept of Extractivism as a crucial part of global capitalism (Gudynas, 2018; Acosta, 2015). This chapter gives us the tools that are needed to understand the current system of global inequality and how space exploration fits into this system.

Chapter 3 is the methodology which shows the use of Critical Discourse Analysis and gives the reason behind my critical realist and political ontology standpoints. The chapter explains the way of data collection, strategy, analytical procedures and reflects on the limitations and ethical considerations of the thesis.

Chapter 4 is the empirical analysis that focusses on the two sub-questions. The first analysis uses the framework by applying Critical Discourse Analysis to stakeholder narratives (government and corporations based in the U.S. and peripheral communities in China and Sub-Saharan Africa). It goes beyond just analyzing the differences in framing and looks at how these narratives reproduce core-periphery power dynamics that are central to World-Systems Theory and mechanisms of Unequal Ecological Exchange. It looks at how core actors from the U.S. construct their own legitimacy for extraction through discourse, while community perspectives reveal the lived realities and environmental and social costs. The second analysis puts the theoretical concept of extractivism in practice by looking at how core technological demands for space technology will create more REE demand in the future and thus add more pressure to the peripheries. By combining the outcome of the discourse analysis (SQ1) and the analysis of future REE demand in the space industry (SQ2), this chapter aims to provide a foundation to answer the main research question and for the concept of cosmic extractivism.

Chapter 5 takes the results from chapter 4 and interprets them through the theoretical lenses of World-Systems Theory, Unequal Ecological Exchange and Extractivism. It aims to go from a simple presentation of the results of the analysis to a deeper discussion on what these results mean, showing how U.S. led space exploration is not an endeavor that is separate from the capitalist world system, but rather one that is embedded within this system. The chapter explains how stakeholder narratives and REE demand increases will add towards existing core-periphery relations, continuing to externalize costs to the peripheries and thus add towards the logic of extractivism and Unequal Ecological Exchange. The discussion then goes on to build upon these foundations and

further discuss the concept of “cosmic extractivism” as a contribution to the existing theory surrounding extractivism, showing how space exploration will reproduce and not transcend global inequalities.

Chapter 6 is the conclusion of the thesis, which takes together the answers of the research questions and shows the study's contribution to understanding the relation between space exploration and global extractivism.

Chapter 7 talks about the limitations of this research, including the scope, methodological boundaries and the speculative nature of future space exploration projections

Chapter 2. theoretical framework

2.01: Core-periphery relations and the world-systems theory

World-systems theory (WST) as developed by Immanuel Wallerstein, first in 1974 and later with new editions, (provides a structural understanding of the global inequality through the lens of a capitalist centered world economy which is divided into Core, periphery and semi-periphery regions. Wallerstein (2011) describes core nations as nations that have developed strong state machinery and exercise economic and political dominance over other areas benefiting the most from the world-systems structure by extracting surplus value from the periphery and semi-periphery through systems of unequal exchange. We will go into more detail on unequal exchange later in this theoretical framework. The periphery, Wallerstein describes as nations that exist on the margins of the world economy, characterized by weak state mechanisms, the production of low value and bulk goods for the core nations and the generation of economic surplus that mainly benefits the core nations. The Semi-periphery according to Wallerstein takes characteristics from both core and periphery nations and as their state strength is intermediate and they often both exploit and are exploited by other nations. This Theory was developed in response to the limitations of nation-state-centric analyses which assumes all nations develop the same way, like western nations. In contrast to that, world-systems theory takes a broader view and shows us how economics, politics and society are interconnected globally and over long periods of time. This highlights how core, periphery and semi-periphery regions depend on each other rather than treating countries as isolated units. The capitalist world-economy which originated in the 16th century in Europe, is characterized by the single division of labor and multiple political states, which enable core regions to accumulate wealth by taking advantage of peripheries through systems of unequal exchange and resource extraction (Wallerstein, 2011). Building on Wallerstein's core-periphery framework, the concepts of the global north and global south are often used to describe patterns of global inequality. These concepts are not identical to Wallerstein's terminology but they are often applied to core and periphery regions (Klimczuk-Kochanska & Klimczuk, 2019). Countries that are part of the global north often dominate the global trade and have high levels of socio-economic development and political power, much like core regions in Wallerstein's (2011) world-systems model. Opposite of that, the global south includes the countries that have weaker economies, a lower productivity and weaker state strength which are a lot of the characteristics of the periphery (Klimczuk-Kochanska & Klimczuk, 2019). This geographical framing does risk to oversimplify Wallerstein's approach. As Klimczuk-kochnaska & Klimczuk (2019) explain, core-periphery relations

are relational and dynamic and not just spatial. Some regions in the same country can have mostly core functions while another region in the same country can perform peripheral functions. Also, countries and regions can shift positions within this system over time. The semi-periphery can often be harder to classify in the global north-south divide. These areas often have traits of both core and periphery nations in the global economic hierarchy. Building on Wallerstein's core-periphery framework it is important to classify the nations from our case studies into the world-system theory and the global north and south divide to better understand their roles in global inequality and extractivism. The United States clearly fits in the core position. As mentioned by Arrighi (2010), the U.S. gained its dominance of earlier hegemonies by combining advanced financial systems, high tech industry and strong military power. Nnamani (2022) shows this by looking at the U.S. military operations in the Gulf of Guinea which secures maritime routes that safeguard global trade and reinforces the U.S. core status in Wallerstein's terms. By using financial influence and military force the U.S. can extract surplus value from the global peripheries which helps it maintain its economic and political dominance in the capitalist world economy (Wallerstein, 2011) China's position is more complex and fits best in the role of the rising semi-periphery or, as Cheng and Zhai (2020) call it, a "quasi-center". Grell-Brisk (2017) show how China's rapid economic growth turned it from a periphery into a semi-periphery country between 1990 and 2015. During this time a large percentage of the population grew into the middle income bracket and reshaped China's position in the global system. This intermediate position shows China's growing international influence with initiatives like the Belt and Road Initiative (BRI) which helps to build infrastructure across Asia, Africa and Latin America, which extends China's economic power and which creates dependencies on China among the participating countries of the BRI, which mimics the dependencies that core countries impose on the peripheries (Sarieddine, 2021). Despite this semi-peripheral power, China is still dependent on core countries for advanced technology and international finance, which makes it a country that is both exploited and exploiting which is consistent with Wallerstein's description of the semi periphery. And although the median income in China did increase, it still remains lower than that of the majority of core nations (Grell-Brisk, 2017)

Sub-Saharan Africa, in contrast, remains largely within the periphery. Mol (2011) shows how African countries mostly provide raw materials and natural resources for core and peripheral states, including China. African economies are marked by a reliance on commodity export and weak state mechanisms, which fits with Wallerstein's idea of the periphery as supplying low valued goods while hardly receiving economic surplus. Radley (2019) shows how foreign controlled mining operations like the one in South Kivu, DRC, have displaced local miners and increased the dependency on outside capital and skill. In addition to that, Kassa (2022) discusses Guinea's Bauxite sector which shows how neoliberal economic policies and foreign corporate presence helps to maintain the

peripheral status of Guinea by influencing its economic and political sovereignty. Mol (2011) shows that environmental costs that are linked to resource extraction disproportionately affect African countries while also receiving little benefits. This is an example of Unequal Ecological Exchange that plays a role in Wallerstein's world-system, but this will be discussed this later in the framework.

In sum, these studies show that the United States are a clear core power that exploits global inequalities through political, military and financial mechanisms as described by Wallerstein (2011). This places the U.S. in the global north. China is placed as an upcoming semi-periphery state as described by Wallerstein (2011) due to its rapid economic growth over the last decades and because it's exerting political and economic control over peripheral and lesser semi-peripheral regions while maintaining their dependence on goods and services from core countries and due to their recent economic transformation and relative lower income levels compared to core countries. This places China in the wealthier and more powerful part of the global south. Countries in Sub-Saharan Africa are widely recognized as part of the periphery due to their role of supplying raw materials and commodity exports while having lower incomes and state capacity which puts it in line with Wallerstein's (2011) definition of the periphery. This places the nations in Sub-Saharan Africa in the global south as well and a lot lower on the ladder than China in terms of economic power and political influence.

Now that how core-periphery dynamics are sustained through financial mechanisms and institutional coercion. For example the International Monetary Fund (IMF), in which the U.S. holds a disproportionate amount of voting power, has structural adjustment programs that prioritize debt repayment over industrial diversification, forcing peripheries into raw material dependency (Grell-Brisk, 2019; Shai et al, 2022). In Sub-Saharan Africa, 96% of the low-skilled labor contributes only 21% of global income with wages that are 89-94% lower than the counterparts in the global north, despite being comparable in productivity (Hickel et al, 2024). This wage gap is termed labor arbitrage and enables cores to extract surplus value, a process that Wallerstein links to Marx's concept of the metabolic rift, the capitalistic disruption of ecological cycles (Hornborg, 2009). Klink (1990) builds on this analysis with rational choice theory. He argues that asymmetries in wealth and strategic interactions reinforce hierarchies. Core nations leverage the economic dependency the periphery nations have to force them to comply while peripheries need to choose between autonomy and survival. We can once again use the example of the IMF that use policies that enforce debt dependency in the periphery nations, while core financial institutions profit from lending (Shai et al, 2022). Another example is the BRI program from China. Although this research places China in the semi-periphery, China has used its growing economic and political influence to force peripheries to choose between autonomy and survival through the BRI program by giving out loans to countries with favorable terms for China if these loans are not repaid, such as ceasing assets (Saridienne, 2021).

2.02: Unequal (ecological) exchange

World-System theory (WST) and Unequal Exchange (UE) provide frameworks to explain global inequality. Before we examine UE, it is important to clarify the difference between WST and UE.

Wallerstein's (2011) World-system theory thinks of the global economy as a hierarchy divided into core, semi-periphery and peripheral regions. Core states dominate systemic mechanisms like colonialism, technological control and political coercion that combines different regions into a single economic division of labor that perpetuates dependency (Wallerstein, 2011). WST focusses on historical and structural processes such as colonial histories and analyses political, cultural and military dimensions of exploitation (Wallerstein, 2011).

In contrast, Unequal exchange (UE), developed by Emmanuel (1975), focuses on economic transactions in international trade. UE says that wage disparities between high-income (Core) and low-income (periphery) countries lead to systematic value transfer. For example, low wages in the Global South allow core nations to purchase raw materials or goods at prices far below their labor value, influencing trade terms and reinforcing inequality (Emmanuel, 1975). While WST says that UE is one exploitative process among many, UE looks at the trade dynamics and shows how the free market disadvantages poorer nations through wage gaps instead of the broader historical forces that WST talks about.

It is important to understand the difference between UE and WST from an analytical perspective, making sure it is clear when looking at a broad structure of an economic process. WST provided macro-level analysis of global structures while UE explains an economic mechanism within that system. Wallerstein (1976) therefore takes UE as part of its structural critique of capitalist exploitation while Emmanuel's (1975) UE offers an explanation of value extraction when goods and services are exchanged.

UE refers to the structural differences in global trade between core nations that take a surplus of value from peripheries through differences in wages, resource prizes, and financial mechanisms. We go into these mechanisms later in the framework. EUE expands the concept of UE to add the idea environmental costs. Core nations externalize their excess CO2 emissions to peripheries while they earn most of the global GDP (Warlenius, 2017). This dynamic creates a 'metabolic rift' (Hornborg, 2009) This rift describes how core nations accumulate technological and economic power by appropriating land, energy, and labor from peripheral regions, while the environmental and social costs are externalized to those same peripheries (Hornborg, 2009). In addition to that, this mechanism also creates so-called 'sacrifice zones', regions that suffer environmental harm for core-led industrialization (Andreucci et al, 2023). An

example of this comes from Hickel (2022) who shows that northern nations have taken 58% of the global carbon budget since 1850 while the south suffers 82-92% of the climate related losses. EUE uses colonial patterns of extraction, where peripheries supply raw materials and get stuck with the pollution, sustaining core nations through ecological displacement (Hornborg, 2009).

The historical roots of UE and UEU are found in the global metabolic transition where we moved from an agrarian, biomass-based economy to one of industrialization, which became more intense through colonial and postcolonial structures (Warlenius, 2017; Hornborg, 2009; Hickel et al, 2022). Hornborg (2009) explains that this change and expansion of industrial capitalism depended on displacing environmental loads and resource extraction from the peripheries, a term he calls environmental load displacement which he links to his concept of the metabolic rift. The pattern of unequal exchange was further entrenched in the post world war II era with the help of global trade and financial mechanisms. Hickel et al. (2024) shows that the implementation of structural adjustments programs (SAPs) in the 1980s and 1990s forced many countries in the global south to adopt more export based economic models, which suppressed wages by 87-95% compared to their counterparts in the global north, which deepened the dependency on raw material exports (Hickel et al, 2024). These policies also increased the south's contribution to global production, with southern workers providing 90% of the global labor but receiving only 21% of global income (Hickel et al, 2024). Material flow analysis demonstrates the scale and persistence of these inequalities. Schaffartzik et al. (2014) document that the global average material use increased from 5.0 to 10.3 tons per capita per year between 1950 and 2010, where industrialized regions consume way above the global average. This increase in material and energy use was made possible by the ongoing extraction of materials from the global south, reinforcing unequal ecological exchange.

While the historical and definitional sections have established the roots and contours of UE, it is important to clarify how these dynamics are sustained and reproduced today. Instead of restating the empirical patterns of labor exploitation, material appropriation or carbon sink use, this section looks at the systemic interdependence, institutionalization and evolving forms of these mechanisms.

UE, is still around today because its mechanisms work together. Wage suppression in the periphery for example, is not merely a result of splitting the labor market in north and south, but actively maintained by global trade rules, debt regimes and the conditions that international financial institutions impose (Hickel et al, 2024; Hornborg, 2009). These mechanisms are reinforcing each other: suppressed wages enable core regions to access cheap resources and labor, while the resulting profits and technological advancements in the core regions further entrench global hierarchies (Dorninger et al, 2021). The 'durability' of UE is underpinned by institutional systems that normalize and

enforce inequality. SAP's, international trade agreements and legal frameworks for managing intellectual property and investment systematically privilege the interest of core countries (Brolin, 2007; Hickel et al, 2024). These institutions shape the way exchange works in the current economic system and also restrict the room peripheral countries have to come up with their own policies, which locks them into roles as resource supplier and sites of environmental load displacement (Hornborg, 2009; Herlinghaus, 2018). The flow of material is closely connected to epistemic and political power. Eurocentric narratives and institutions in core countries legitimize the dominance of the north and suppress other development models, knowledge systems and resistance strategies born in the south (Brolin, 2007; Herlinghaus 2018). This epistemic violence has concrete effects: it shapes what is considered legitimate knowledge, whose interests are prioritized in negotiations and how the costs and benefits of global trade are distributed. UE mechanisms are also not static either. They adapt to new context and forms of discussion. For instance, the rise of green extractivism as well as the financialization of nature is a new strategy in which the north seeks to maintain core accumulation and externalizing costs (Bruna, 2021; Andreucci et al, 2023). While at the same time peripheral actors and states, social movements and indigenous communities seek to develop counter strategies like renegotiation trade agreements and asserting territorial rights and alternative knowledges (Herlinghaus, 2018; Fash, 2022). The mechanisms of UE are best understood as a complex and adapting system of economic, institutional and epistemic processes. They are continually reworked through global power relations and local contest, sustaining patterns of accumulation and dispossession. Addressing UE therefore needs not only technical changed but also a transformation of underlying structures of power and knowledge that sustain this global inequality (Hornborg, 2009; Herlinghaus, 2018; Fash, 2022).

When we look at UE and EUE in terms of the case studies for this research, we can see clear examples of how these concepts work with the United States, China and Sub-Saharan Africa. The Mechanisms discussed are: wage differences, how prices are set, debt systems, trade rules, military protection and pushing environmental problems into other countries. The U.S. as a core country, uses its financial power and military to acquire cheap imports and sell profitable exports. Because the U.S. has the dominant vote at the IMF, it can set rules that forces countries in the periphery to pay back debts which keeps these countries from developing, while American companies can use the cheap labor that is available in these countries (Grell-Brisk, 2017). In addition to that, the U.S. military through AFRICOM (U.S. African military branch), can patrol the gulf of Guinea to protect shipping routes for oil and minerals (Nnamani, 2022). These resources go to American supply chains at cheap prices thanks to this military presence which creates unfair trade (Nnamani, 2022). While the U.S. and its consumers gain the profits, the pollution and waste that is produced from gaining these resources remains in the

African countries of origin. This of course being just one example of how the U.S. maintains its strong position in the system of UE and EUE with the manipulation of debt systems, military presence and wage disparities.

China's position is more complex. As a semi-peripheral "quasi-center" country, China is feels both sides of UE and EUE. The domestic low wage labor means export prices stay low which makes China more appealing to richer countries but this process also keeps wages down for its workers (Grell-Brisk, 2017). Internationally, China's BRI gives state-backed loans to countries for new infrastructure, but a lot of these loans revolve around ports and mining which means these countries need to supply the goods and raw materials they produce to China so they don't default on their loans (Sarieddine, 2021). In addition, local communities suffer from land loss and pollution as a result of these mining activities which means China reaps the rewards while the environmental damage remains in Africa (Radley, 2019). However, China can sometimes go into the peripheral role as well when it comes to UE and EUE. Communities in the Bayan Obo REE mine in Inner Mongolia report heavy-metal contamination, governmental land claims, and forced relocation so that these REE's can be won (Pan & Li, 2016; Yang & Ho, 2019). The Survey from Yang & Ho (2019) reveals that most farmers in their focus groups believe mining brings few benefits which shows how UE and EUE can negatively affect China within its own borders even as the country is climbing up the global hierarchical ladder.

In Sub-Saharan Africa, all these UE mechanisms seem to come together. Countries like Zambia and regions such as South Kivu in the DRC are classic examples of peripheries: they often rely on exporting one type of crop or mineral and are vulnerable to shifting in prices from the core countries or China (Andreasson, 2001). In South Kivu for example, foreign run mining operations provide unfair competition to local miners, which focusses profits in the hands of outside companies which leaves the rest of the region marginalized (Radley, 2019). Guinea's Huge Bauxite reserve is another case where foreign investments help to extract the resources but little benefit gets spend on local welfare or protecting land rights (Kassa, 2022). Economic UE shows itself here with low wages and trade deals that benefit core countries or China. EUE is clear in the fact that these mining operations lead to the destruction of ecosystems and pollution that cannot be solved by locals.

In sum, the U.S. used financial and military leverage to gather wealth and extract surplus from peripheral and semi-peripheral countries. China uses cheap labor and foreign backed resource extraction to climb to global ladder and extract more surplus from the peripheries while also reproducing extractive zones within their own borders. Sub-Saharan Africa exports resources while being the victim of debt traps and ecological degradation.

While Unequal (ecological) exchange reveals how global trade enables core nations to appropriate resources and shove environmental costs to the periphery, it is the concept of extractivism really operationalizes these inequalities on the ground. Extractivism is not just something economic but a structural logic that shows the persistent transfer of money, goods and ecological risk from the global south to the global north (Acosta, 2015; Chagnon et al, 2022). Recent research shows that extractivism is not just about taking resources from the earth. It is an idea that helps explain how societies, economies, and even ways of life are organized around extracting value-often in ways that cause harm and deepen inequalities. Scholars like Chagnon et al. (2022), Gudynas (2018), and Fash (2022) argue that extractivism shapes how land is used, how people live and work, and who holds power, both because of its colonial history and because it continues to drive decisions and conflicts around the world today. The following section looks at how extractivism sustains and deepens global inequalities moving from more abstract terms to concrete dynamics of dispossession, resistance and socio-ecological transformation.

2.03: Extractivism

Extractivism means a mode of organizing economies and land around taking and exporting raw materials at a large scale, primarily for external markets (Gudynas, 2018; Acosta, 2015). It is not simply the act of extracting resources but also the structural logic that prioritizes the transformation of nature into commodities, often disregarding the ecological limits of nature and the social well-being of communities (Gudynas, 2018; Burchardt & Dietz, 2014). This logic is often shown across sectors, like mining, oil, agriculture, forestry and fisheries. Whenever extraction is oriented towards export and occurs at a scale or intensity that exceeds the regenerative capacity of local ecosystems (Gudynas, 2018; Acosta, 2015). What separates extractivism is it shows the importance of volume, export and externalization of environmental and social costs. It is characterized by transforming territories into “sacrifice zones”, where the value of land, water and labor is measured by their contribution to global commodity chains (Gudynas, 2018; Chagon et al, 2022). Extractivism also shapes states and corporate strategies, and make taking resources sound necessary for national development or sustainability, while oppressing alternative ways of thinking about land and nature (Burchardt & Dietz, 2014; Andreucci et al, 2023). Extractivism is also not limited to traditional fossil fuels or minerals but includes new forms such as green extractivism, a term mentioned earlier in the framework, that focusses on the commodification of nature for the purposes of climate action yet still reproduce patterns of dispossession (Andreucci et al, 2023; Bruna, 2021). In sum, extractivism can be understood as a structural logic that organizes economies, territories and social relations around the

removal and export of natural resources, often at the expense of ecological integrity and local agency (Gudynas, 2018; Acosta, 2015; Chagnon et al, 2022). Extractivism has been around for centuries which reflects its adaptability to shifting demands, transforming from colonial plunder to state-led development strategies. While UE frameworks talk more about things like the metabolic rifts and environmental load displacement (Hornborg, 2009), the institutionalization of extractivism shows how these dynamics became entrenched through policies that normalized ecological and social exploitation.

Extractivism's roots start during the time of European colonial powers that reshaped Latin America, Africa and Asian territories into zones of extraction (Gudynas, 2018). Indigenous governance systems were dismantled and landscapes were transformed into mines, plantations and monocultures to fuel industrialization (Acosta, 2015). Colonialism in this way, established infrastructure of extraction, such as forced labor or export-oriented infrastructure such as ships and ports, which all prioritized resource transfer over local ecological sustainability (Acosta, 2015). These practices were some of the first that institutionalized "asymmetric metabolic flows" where peripheries supplied the raw materials and the core monopolized industrial production (Dorninger et al, 2021; Hornborg, 2009). When we then look at the era of post-colonialist independence, extractivism started to adapt to neoliberal globalization. Earlier in the framework Hickel et al (2024) talked about Structural adjustment programs which restructured postcolonial economies and really solidified extractivism as a central development strategy and prioritized transnational capital over local sovereignty. While UE's main focus has been the difference in wages, these SAP's laid the groundwork for foreign investors to seize control over resource rich territories by getting rid of agricultural reforms, and land distribution policies (Bruna, 2021). For example, in Mozambique, these reforms shifted the rural economy from farming to export focused biofuel production, which displaced small land owners and consolidated corporate control over vast amounts of land (Bruna, 2021). This way of extractivism locked countries in the periphery into their roles as raw material supplier, not just by trade but by redesigning the states institutions to serve actors that benefit from extraction first. These policies enabled what Svampa (2015) calls the "commodities consensus", a cross ideological pact among states, corporations and elites to prioritize extraction as the engine behind growth. In Argentina, reforms from the time of the SAP's and the liberalization of agriculture policy kickstarted the expansion of the soy industry, and by the early 2000's the planted area had reached over 11 million hectares, which increased deforestation and crippled the food sovereignty of Argentina (Pengue, 2005). Pengue documents how this transformation, driven by global extractivism resulted in the concentration of agribusiness and the loss of rural livelihoods and the rise of monocultural landscapes. In recent decades, extractivism has been rebranded under the guise of sustainability and is often mentioned under the term green extractivism and involves extracting minerals like lithium and nickel for renewable technologies

(Andreucci et al, 2023). This phase of extractivism aims to adapt the colonial patterns of dispossession to 21st century demands, by expanding extractive boundaries under the guise of decarbonization (Andreucci et al, 2023). From colonial imperialism to green capitalism, extractivism remains a structural logic of accumulation by dispossession. Its form changes from colonial silver mines to oil extraction to lithium mining all in the name of adapting to capitalist demand and while keeping systems of ecological sacrifice and epistemic erasure in place. This once again underscores extractivism role as a colonial-capitalist way of thinking that continues to reduce the global south to nothing but resource frontiers. The operationalization of extractivism relies on interconnected mechanisms that reshape socio-ecological relations, force countries into dependency, and suppress any alternatives. These processes go further than just economic practices and also apply to the structural logics colonial-capitalist domination.

The first mechanic is debt, which in current extractivism is not just important on a macroeconomic scale like in WST, but is rather material and project based. Today, resource-backed loans and infrastructure finance are used to construct new physical infrastructure like ports, railways and energy grids (Chagnon et al, 2022; Sovacool, 2019). Sovacool (2019) goes on to document how roads and energy projects financed by the Chinese are designed to facilitate copper and cobalt mining, binding local territories and communities to global supply chains while China externalizes its pollution and social costs. These arrangements are not just about national debt, but also about reshaping territories, displacing communities and locking regions into single commodity economies (Chagnon et al, 2022; Sovacool, 2019). The second mechanic is not about economic or ecological violence, but ontological violence. This transforms the very conditions in which indigenous and local communities can exist. Unlike the epistemic violence described in the UE section, which centers on the suppression of non-western knowledge in the scale of global trade and development narratives, extractivism operates through material imposition of a singular reality, meaning it changes lived environments like forests into resources for extraction, like soy fields. De la Cadena and Blaser (2018) argue that extractivism enacts an “ontological occupation”, whereby state and corporate actors recognize only one world, a “one-world world”, where land, water and forests are seen only as commodities. In this process, beings other than humans, sacred sites, and indigenous ways of thinking are denied political presence and are reduced to obstacles for development. For example, Fash (2022) documents how mining companies in Honduras criminalize communal land governance and portray indigenous resistance as anti-progress, while state education pushes these narratives by praising extractive “development” and marginalizing alternatives. The consequences of these actions are not just discursive but also existential. Kröger (2022) shows the relationship between mining and monocultures in the Amazon and elsewhere breaks the bond between people, land, and ‘more-than-human worlds’, extinguishing ecosystems

and possibilities to alternative futures. This is not just the suppression of knowledge but the destruction of worlds, a violence that is ontological as well as epistemic. And third, extractivism thrives on the alliances between states and corporations because these partnerships are essential for overcoming the social, legal and political barriers that often stand in the way of extraction on a large scale. As Nygren et al. (2022) show, extractivist projects require not just access to land and resources, but also the transformation of territories into a space where extraction is possible, both politically and socially. States play an important role by making the legal frameworks, property regimes and discourses of “national interest” that make this extraction possible and legit, even when opposed by locals or environmental risk. Corporations then rely on the state to authorize long term access to resources, manage conflicts and suppress dissent (Nygren et al, 2022). This is especially important because extractivist operations often cause resistance from indigenous people, rural communities and environmental defenders whose livelihoods and worlds are threatened by extractions. By aligning the state actors, corporations can gain access to tools to force these people to submit, like military and emergency decrees or the criminalization of protest that can take out the opposition and secure the ongoing of projects (Nygren et al, 2022; Dunlap & Jakobsen, 2020). This alliance also works in favor for the states as they gain revenues, rents and political legitimacy that comes from promising development and social programs that are paid for with extraction (Nygren et al, 2022). The result is a way of governance that often bypasses or undermines democratic processes and concentrates decision making in the hands of state and corporate elites, while suppressing other voices and forms of governance (Chagnon et al; 2022, Nygren et al, 2022). These arrangements are not by accident but are rather a structural part of the logic of extractivism. The need to keep the confidence of your investors, attract foreign capital and deliver on the promises of economic growth all give states reason to prioritize extractive interests over local rights and ecological sustainability. At the same time, the expansion of global commodity markets and the increasing involvement of transnational actors make the pressure to police and reorder territories for extractivism even greater. Dunlap and Jakobsen (2020) say that this leads to “total extractivism”, a system where policy and violence and used systematically to normalize dispossession and suppress resistance, making the alliance between state and corporate actors a defining feature of extractivism in the current day. The mechanisms outlined above are played out unevenly across the triangle that links the U.S. demand for high tech minerals, China’s foreign investment plans and the resources of Sub-Saharan Africa. Each of the aforementioned mechanisms of extractivism shows itself through interconnected north-south value chains, which reproduces EUE while expanding capitalism.

For starters, Debt-based territorial reshaping through Chinese public-private partnerships (PPPs) and resource backed loans (RBLs) have become important tools in initiatives like the BRI and are used to reshape African landscapes to make sure their

resources flow towards foreign industries (van Wieringen & Zajontz, 2023). In Angola for instance, oil related RBL's are produced by China's EXIM and have been used to create an infrastructure grid such as railways, power plants and deep-water ports whose function is to secure the export of oil rather than boost the local economy (Bolander, 2024). Ye et al. (2020) clarifies how such projects entrap African territories in an imperial network: assets like ports, mines and roads are used to create commodity flows of raw materials that are controlled by a foreign operational center which enables these foreign investors to extract value from the land, leaving local communities with little local investment and environmental degradation. This imperial system locks African regions into a subordinate position, becoming logistical cog pieces rather than autonomous centers of development.

China's infrastructure-led projects overlap with the U.S. narratives of critical mineral security which frame African territories as resource frontiers for green technology and the space exploration boom (U.S. Department of Energy, 2023; van Wieringen & Zajontz, 2023). Such frameworks create the extractivist logic that Ye et al. (2020) describes, where territories are restructured as places for resource flow towards global industry and operational centers; in this process, social worlds, local landscapes and non-capitalist values are neglected or even removed, threatening local livelihoods and ecologies. Adaman et al.'s (2018) study of the Turkish Soma coalfield shows this dynamic as well: authoritarian populism allowed for the energy extraction of Coal as a necessity for development while destroying the livelihoods and way of living of the people of Soma. The same discourse is used in the search for REE's and critical minerals in other places in the periphery where governments use U.S. and Chinese security and modernization discourses to silence the indigenous or other local ontologies that consider land not just as a deposit of resources but rather a living relative (Ye et al. 2020).

State-corporate alliances are also important for overcoming social and legal obstacles to extract resources. Van Wieringen & Zajontz (2023) show us how Beijing's embassies, policy offices and state-owned enterprises (SOE's) together produce legal frameworks and regimes that work well with PPP's in Kenya and the DRC. These alliances reflect the neoliberal developmentalism and authoritarian populism mix that Adaman et al. (2018) shows in Soma, the promise of social benefits and protection together with nationalist rhetoric help to soften the blow of coercive policing the shut down resistance.

Meanwhile, the U.S. launched initiatives like the Build Back Better World and Global Gateway coalitions that promise to work towards transparent supply chains but in practice intensify competition for strategic minerals by replicating the logic of prior arrangements (van Wieringen & Zajontz, 2023). With this, African nations are persuaded to give long term extraction licenses, often together with infrastructure packages and military cooperation with pressures from both the Chinese and U.S. debt and secure supply diplomacy. The limitations of decision-making within these political bargains

restrict democratic participation and solidify the export dependencies of Sub-Saharan nations, which are all core features of extractivism's authoritarian workings (Ye et al, 2020). Taken together, these patterns confirm Ye et al.'s (2020) view that extractivism is not marginal anymore but rather a general feature of capitalism. The U.S.-China rivalry does not offer African countries an exit from extractivism, but rather it creates more actors that compete for the same territories and minerals. Debt-fueled infrastructure, epistemic erasure of non-capitalist worldviews and state-corporate coercion work together to form the perfect breeding ground for extractivism to grow and ensure the flow of REE's and other critical minerals into the supply chains that are used in all manner of industries including the space industry.

This theoretical framework looks at the analytical foundations for seeing how world-systems theory, Unequal Ecological Exchange and extractivism work within global capitalism and provide the mechanisms through which the emerging space industries may or may not operate. These three interconnected theoretical concepts show the patterns of global inequality that are the foundation to modern economic relations and offer the analytical tools this research needs to assess whether the space industry development replicates or overcomes these existing extractive dynamics. World-systems theory shows how current global hierarchies reproduce themselves through specific observable mechanisms that appear in current industry supply chains and narratives. The U.S. keeps its core position through financial schemes via institutions like the IMF, where its voting power allows for structural adjustment programs that prioritize the repayment of debt over industrial diversification which forces peripheral countries to focus providing raw material (Grell-Brisk, 2019; Shai et al, 2022). This core dominance also manifest itself through military might such as the AFRICOM operations in Guinea that help the U.S. to secure maritime routes and thus, resource access in the region. This creates a security network that helps to supply the U.S. with critical minerals that are crucial for developing technologies for all manner of industries while externalizing the costs of extraction to African peripheries (Nnamani, 2022). China's complex semi-peripheral position works through its dual role as both exploiter and being exploited within global supply chains, using resource backed loans with projects like the BRI which creates dependencies among African mineral suppliers while remaining mostly dependent on core countries for advanced technologies and having lower median incomes than people in most core countries, which core countries exploit for cheap labor (Grell-Brisk, 2017; Saredidine, 2021). Sub-Sahara Africa's peripheral status is reinforced through its role as supplier of raw materials and commodity exports, which is characterized by weak state mechanisms and a reliance on resource extraction while hardly gaining any economic benefits from extraction operations (Mol, 2011; Radley, 2019; Kassa, 2022). These positions provide the analytical framework for seeing how space industry development may organize around similar core-periphery hierarchies', with technological development and value generation flowing towards the core regions

while the resource extraction and environmental costs are externalized to the peripheries.

Unequal ecological exchange mechanisms show how global capitalism works in patterns of labor arbitrage, resource appropriation and environmental cost externalization. Patterns which can be traced within different industry sectors by looking at the flow of material and the analysis of discourse from different involved actors. Research reveals that core nations use 90-91% of global labor while also taking a disproportionate share of the global GDP, while southern workers receive only 21% of global income despite the fact that their productivity is comparable, which creates conditions where wage gaps of 89-94% remain between the global north and the global south (Hickel et al, 2024). This system works through what Hornborg (2009) calls the metabolic rift, where core nations stack technological and economic power by taking land, energy and labor from countries in the peripheries. The persistence of these patterns shows that mechanisms of value transfer can be identified in different supply chains including perhaps, the space industry, there the high-technology sectors systematically create unequal exchange relationships by taking territories and integrating them into the global flow of commodities. These patterns are the foundation to the analytical framework to see how space technology development uses patterns of value appropriation which concentrates benefits in the core regions while the costs and environmental damage are left in the peripheral zones.

Extractivism shows the operational framework through world-system hierarchies and unequal exchange dynamics show themselves as territorial and social transformations that can be seen within resource extraction for technological development. Extractivism works through systems of debt-based territorial transformation, where Chinese PPP's and RBL's through the BRI create infrastructure grids designed to secure resource export instead of supporting local development, which turns African land into networks for the flow of resources which serve foreign operational centers (Ye et al, 2020; van Wieringen & Zajontz, 2023). This process also involves ontological violence that can shape the conditions in which indigenous and local communities are allowed to exist, changing lived environments into resources for extraction while downplaying non-capitalist ways of thinking and local worlds (De la Cadena and Blaser, 2018). State corporate alliances create these arrangements by taking legal frameworks and military protection for extraction operations while using the promise of development to gain local support and hide the peripheral dependency it helps to create, restricting democratic participation and solidifying export dependencies (van Wieringen & Zajontz, 2023). These extractivist mechanisms show how technological and industrial sectors require an create territorial control, resource flows, and social displacement, which makes for an identifiable analytical framework for seeing how space industry expansion may work through similar extractivist characteristics.

Taking these theoretical concepts together shows us that global capitalism works through observable, systematic patterns of appropriation that can be traced across different industries and technological sectors and their supply chains with discourse analysis, material flows and institutional arrangements. These patterns look at the concentration of technological development and value accumulation in core countries while resource extraction and environmental costs are externalized to the peripheries, the integration of territories into the global network of commodities through debt and infrastructure arrangements, and the reproduction of labor hierarchies that value core activities more than those in the peripheries. The systematic exclusion of local perspectives and ontologies from policy frameworks works with the territorial organization of extraction regions that serve global operating centers more than the extraction regions themselves and hinder the autonomous development of these regions. By looking at these observable mechanisms as a foundation for the analysis, this framework gives us the tools the analysis needs to look whether the space industry development will replicate these same patterns. this framework thus allows is to do a systematic analysis of how the space industry supply chains, technological development, resource flows and institutional discourse either repeat or transcend the structural mechanisms that have maintained global inequality throughout history with world-system hierarchies, unequal ecological exchange and extractivist appropriation.

Chapter 3. Methods and operationalization

3.01: Chapter overview

This chapter shows the methodological foundations and steps that help this thesis's investigation into how Rare Earth Element (REE) demand for space exploration technologies sustains and intensifies global inequalities. The chapter is organized to move from the philosophical foundations to concrete research design, data collection, data analysis and a critical reflection on validity, ethics, reflexivity and limitations.

The chapter begins with outlining the ontological and epistemological positions of critical realism and political ontology that are the philosophical foundation of this study. These together justify the use of qualitative and interpretive methods, mainly Critical Discourse Analysis.

The research design section clarifies the relationship between the research questions. The main question, how the growing demand for REEs driven by space exploration exacerbates unequal ecological exchange and expands capitalist extractivism, serves as the main focus for the study. The two sub questions are designed to provide depth and context for answering this main question. The first of these sub questions analyzes how governments corporations and local communities frame the benefits and harms of REE mining, using CDA to find discourse strategies and power relations that legitimize or contest extractivist practices. By looking at these narratives, the research reveals how material impact is justified, challenged or pushed to the side. The third question adds a future perspective by looking at how future space programs, such as Artemis, may increase REE demand and shape global extractivist activities and trends. This helps showcase current patterns within technological and policy development, making sure that the analysis of present dynamics is informed by logical future trajectories. Together, these questions ensure the study does not just document the existence of unequal exchange and extractivism, but also looks at the mechanisms and narratives that support and intensify these processes in the era of space exploration.

The chapter then goes into the data collection process, explaining how text based sources are sampled to capture the perspectives of governments, corporations and local communities. The approach is described through Fairclough's three dimensional CDA framework, which looks at language, power, and context at the textual, discursive and social practice levels.

At the end, the chapter looks at the validity, reflexivity and ethical considerations, focusing on methodological transparency, critical self-reflection and sensitivity to the risks of misrepresentation or epistemic violence. The limitations section looks at the U.S. centric focus, interpretative nature of CDA and the speculative nature of future REE demand. Despite these challenges the methodology is designed to give a critical

account of how language and power shape the realities of REE extractivism and space exploration.

3.02: Ontology and Epistemology

3.02.01: The Ontology

This thesis takes on both the critical realism and political ontology to analyze how the demand for Rare Earth Elements (REEs) in space exploration technologies works at sustaining and intensifying core-periphery inequalities. The double ontological framework will help to provide a foundation for understanding and informing the research questions on ecological exchange, stakeholder narratives and future global trends in relation to space technologies.

Critical realism says that reality is structured across three layers: the real (constant structures and mechanisms), the actual (events that come from these structures) and the empirical (observable experiences) (Bhaskar, 1975). In the context of REE extractivism, the real is made by mechanisms such as the capitalist world-system, which makes it so that global production and value flows work so that core nations can dominate the processing and technological innovation, while the periphery nations are extractive zones (Wallerstein, 2011). These structures are not just economic but are not just about the economic dimension but are also embedded in global trade, finance and institutions so that the periphery remains dependent on core nations and ecological costs can also be externalized to nations in the periphery (Dorninger et al, 2021; Gudynas, 2018). An example of this would be the expansion of infrastructure like roads and ports in periphery countries that are often supported by states and corporations and designed to boost extraction and export, often at the expense of local development and ecological integrity (Bruna, 2021; Sovacool, 2019). This ontology allows this thesis to analyze how the structural mechanisms of the U.S., Chinese and Sub-Saharan African relations appear in the critical mineral and REE sector, which shows how global inequalities are made through extractive supply chains and helps to support the investigation on which systemic drivers of EUE, WST and extractivism apply to the growing space industry. The actual is shown in the events and processes that come from these structures, such as the transformation of territories into ‘sacrifice zones’ and the displacement of communities (Gudynas, 2018; Andreucci et al, 2023). These events are not isolated. They are the outcome of enduring mechanisms that constantly adapt to new forms based on the demand, such as the recent rise in REE demand for green technologies (Andreucci et al, 2023). By looking at the actual domain, this research can see how policy interventions, infrastructure investments, and extractivist events can serve as evidence for answering questions about territorial transformation and the lived experiences of mining for our expansion into space. The empirical is found in the

experiences and observational outcomes of these processes: environmental degradation, loss of livelihoods and the resistance of communities that are affected. These experiences show the tensions between the observable harms and their structural causes, and also the agency that peripheries have in negotiating, resisting and defining their reality (Fash, 2022; Dunlap & Jakobsen, 2020). The empirical level focusses the analysis on how stakeholders from the U.S., China and Sub-Saharan Africa frame and experience extractivism, which provides a basis for looking at competing narratives and directly address the thesis's questions on agency and discourse.

Political ontology complements this by focusing on the conflict between the “one-world world” of capitalism, that reduces land, water and life to resources for extraction, and the indigenous and local worlds that show other relations with territory (de la Cadena & Blaser, 2018; Serafini, 2024). Extractivism is not just an economic or ecological process but also an ontological project. It imposes a singular reality that suppresses and often destroys other ways of being, knowing and relating to land (de la Cadena & Blaser, 2018). This ontological violence is shown, for example, when indigenous government systems are dismantled and communal land is redefined as a site for mining or infrastructure (Fash, 2022). The logic of extractivism is therefore rooted in colonial and capitalist histories that continue to shape global inequalities today (Gudynas, 2018). Political ontology helps the research to look at how extractivist logics in the U.S, China and Sub-Saharan Africa suppress or erase other ways of looking at the land, which reveals conflicts and contestations that are important to understanding stakeholder views.

By using both critical realism and political ontology, this thesis aims to analyze not just the enduring structures and mechanisms that drive unequal exchange and extractivism, but also the ontological conflicts that appear when different worlds collide over the meaning of land, resources and development (de la Cadena & Blaser; Serafini, 2024). This makes it possible to address the research questions in a way that looks at both the material and existential stakes of REE extractivism for space exploration. It will explain how global structures maintain inequality, how stakeholder narratives reflect deeper ontological conflicts and how future trends in space exploration will either work with, or challenge the dominant extractivist logics. When used together, these ontological views help the thesis to explore whether or not the expansion of the space industry repeats or challenges the patterns of core-periphery exploitation and ontological violence, which directly relates to all aspects of the research questions.

3.02.02: Epistemology

Building on the ontology of critical realism and political ontology, this thesis takes on the critical realist epistemology with a strong emphasis on standpoint and reflexivity, which works with the intended qualitative research using Critical Discourse Analysis (CDA). This section shows how knowledge about REE extractivism, core-periphery dynamics, unequal exchange and ontological conflicts is produced, what its limits are and how this all shapes the research design.

Critical realism says that while a reality exists on its own, outside of our perception, our knowledge of this reality is always partial and shaped by social, historical and political contexts (Bhaskar, 1975; Danermark et al, 2002). This means that, knowledge is made through a process of interpretation and critical reflection and not just looking at empirical facts. This way of thinking is important when researching concepts like extractivism and global inequalities, where underlying structures (such as core-periphery models, unequal exchange and extractivism) are not always directly observable but can only be found in patterns of discourse, policy and institutional practice, as shown for example in the works of Bruna (2021) and Warlenius (2017). The goal here is to look beyond surface level descriptions and to find the deeper mechanisms and power relations that make observable events and lived experiences. By looking at these underlying structures this way, the thesis can look at how for instance U.S. critical mineral security, China's Belt and Road initiatives and role as supplier of REEs and critical minerals and African development plans each mask or expose structural mechanisms that drive Critical mineral and REE supply chains which advances the research question stakeholder discourse.

In practice, this means that when I use Critical Discourse Analysis in my thesis it is not just a tool for collecting statements or policies, but rather a method for interpreting how language, narratives and institutional texts both showcase and reproduce structures and ideologies that are key to global inequalities (Fairclough, 2013; Warlenius, 2017). With CDA, this research aims to identify how dominant discourses legitimize extractivism, marginalize alternatives worldviews and transform Unequal Exchange into something natural, as well as looking for the emergence of opposite narratives and resistance from peripheries and indigenous communities (de la Cadena & Blaser, 2018; Fash, 2022). Applying CDA on U.S. policy papers and Chinese and African community statements helps to see how each actor frames the winning of REEs and critical minerals in general which can be applied to the context of mining for space exploration.

Together with standpoint epistemology, this thesis recognizes that all knowledge is situated. It is shaped by social positions, experiences and power relations of both researchers and research subjects (Harding, 1998). In the context of CDA, this means it is important to be reflexive about my own positionality, values, and the structure of power that influences who's voices and knowledge is heard and which is not (Warlenius,

2017; Bruna, 2021). This reflexive stance increases transparency and credibility but also aligns with the emancipatory aims of both political ecology and environmental justice research, to challenge dominant narratives, expose epistemic and ontological violence and support the recognition of alternative knowledges (de la Cadena & Blaser, 2018; Fash, 2022). Because of my epistemological position, the thesis uses CDA as its main method. This allows for the examination of how language, policy and institutional texts construct, legitimize or oppose the structures and mechanisms that are identified in the framework (Fairclough, 2013). Throughout this research I will pay attention to the limitations of the method and the contested nature of all knowledge claims. The goal of this research is not to produce a single definitive interpretation but to contribute to a more nuanced, critical and reflexive understanding of REE extractivism, Unequal Exchange, core-periphery inequalities and the ontological conflicts at stake in space exploration and global resource politics. Standpoint epistemology makes sure that marginalized perspectives, like the ones from communities surrounding mining operations, have a place in the analysis as sources of critical knowledge about the extraction processes that are not taken into account in official policy discourse. This approach helps to see the local knowledge about environmental and social costs that are in contrast to core framing of REE extraction as needed for, for example, green technology or space exploration. This reflexive way of thinking also says that looking at space industry extractivism requires a look at how my positionality shapes the interpretation of how I look at competing benefits, environmental costs and community resistance, while making sure that the analysis takes the experiences of those that are directly affected by (REE) extraction into account.

In sum, this thesis takes on a critical realist and standpoint epistemology that is qualitative, interpretive and reflexive. It accepts that while real structures and mechanisms exist independently of our perceptions, our knowledge of them is always partial, situated and shaped by social, historical and power relations (Bhaskar, 1975; Fairclough, 2013; Warlenius, 2017). By combining critical realism with standpoint awareness and operationalizing these with CDA, this research aims to uncover the foundations of global inequalities. This study seeks to explain how the dominant and competing narratives about REE extractivism are constructed, legitimized and contested and how these narratives work with the broader dynamics of core-periphery, Unequal Exchange and Extractivism. This approach will work well for producing knowledge that is explanatory and uses the power dynamics at play in the global politics of REE mining and space exploration. This epistemological framework enables the investigation of whether or not space exploration initiatives reproduce or transcend existing patterns of unequal ecological exchange and extractivism. The combination of using critical realism and standpoint reflexivity gives this research the analytical tools to see how space industry demand for REEs will either reinforce or transcend traditional extractivist hierarchies with familiar mechanisms of territorial and resource control or if it opens the

possibility for more equitable resource governance that will respect both ecological limits and local populations.

3.03 Research design

This research uses a qualitative case study design using Critical discourse Analysis (CDA). This is its central methodological approach to find out how the growing demand for REEs in space exploration technologies is narrated by diverse stakeholders and how these narratives then reinforce or challenge global patterns of Core-periphery dynamics, Unequal Exchange and extractivism that are described in the theoretical framework. The design is grounded in a critical realist and political ontology framework, which recognizes both the enduring material structures and the contested meanings that make the realities that surround REE extraction and use (Bhaskar, 1975; de la Cadena & Blaser, 2018). The main research question for this study is:

How does the growing demand for rare earth elements driven by space exploration Initiatives in the U.S. exacerbate unequal ecological exchange and expand capitalist extractivism? This central question is supported by two sub-questions, each of which is designed to show another dimension of the main question. The second question goes as followed:

How do governments and corporations from the U.S. and global south communities from China and Sub-Saharan Africa frame the benefits and harms of mining for space exploration, and how do these narratives reflect broader patterns of inequality and extractivism between the Global North and Global South? This question aims to analyze the stakeholders perspectives with CDA and with that, find the discursive strategies and power relations that support or contest extractive practices. This understanding is important to answer the main questions, as it shows us not only the material impacts of REE demand but also the ways in which these impacts are justified, challenged or made invisible through discourse. The third question goes as followed:

“To what extent will future space exploration programs, such as Artemis, drive an increased demand for rare earth elements, and how might this shape global extractivist trends?”

This question helps the main question by providing a future perspective. It puts current patterns of unequal exchange and extractivism in the context of future developments and new policy initiatives. By looking at the likely trajectory of REE demand based on literature review of current documents regarding REE use in space technologies, this research can support claims about the ongoing and future intensification of inequalities linked to space exploration. Together these supporting questions provide a discursive analysis and future context that are needed to fully support the main argument. They ensure that the study does not only show the existence of unequal ecological exchange

and extractivism, but also explain the mechanisms that maintain these processes and how these can potentially be intensified in the new era of space exploration.

This study is also structured as an embedded case study focused on the United States, which is selected for its leading role as a core actor in the global REE supply chain and space exploration sector. The U.S. context is also relevant because of its leadership role in technological innovation, its influence on global policy and its central position in shaping markets for both REEs and space technologies (Sadan et al, 2023). This research analyses corporate and governmental discourses from the U.S. in regards to REE mining but looks for countries in the periphery and semi-periphery when looking at the community perspective as the communities that are affected by REE mining are more often found in the global south. The U.S case is therefore not analyzed in isolation but is given context within the broader global division of labor and ecological exchange, with special attention how the U.S. policies and corporate strategies impact and are challenged by actors in the global south. For community perspectives this research uses community data from China, as they are the worlds largest provider of REEs and several countries in Sub-Saharan Africa. Due to time constraints and scope, China's role in the upcoming space industry is not taken into account as the U.S. plays a more industry leading role and the majority of all space based initiatives and launched into space are done by the U.S. (Corrado et al, 2023)

3.03.01: Data collection

The data for the CDA is collected from a diverse range of textual sources representing the perspectives of the three main stakeholder groups. The government of the U.S., the U.S. based corporations of: Space X, Blue Origin, Virgin Galactic and Lockheed Martin, and local communities from China and Sub-Saharan Africa (see table 1). Government discourses have been captured by analyzing policy documents, legislative texts, official statements and strategic reports related to (REE) mining and/or space exploration. This research uses the Artemis Accords (Artemis Accords, 2020), the national blueprint for lithium batteries from the U.S. department of energy (Federal Consortium for Advanced Batteries, 2021) and the U.S. 2022 critical mineral review (Fortier et al, 2022) For corporate narratives this study analyses Corporate mission statements, Corporate whitepapers and a comparative analysis of business models for three major U.S. based space enterprises. The Mission statements this research looks at are from two of the largest U.S. based space organizations called Blue Origin (Blue Origin, 2025) and Space X (SpaceX, n.d.), the white paper this research look at is from the U.S. based aerospace company called Lockheed Martin (Lockheed Martin, 2024) and the comparative analysis compares the business models of Blue Origin, SpaceX and Virgin Galactic, all U.S. based companies that focus on space (Pallathadka et al, 2022). Community perspectives are analyzed by looking at multi country case study research in Sub-

Saharan Africa (Leuenberger et al, 2021), a comparative perception study between Communities and Corporations in Nigeria (Mbachu, 2025) and a survey analysis in Rural China (Yang & Ho, 2019). For the exact communities used in this research refer to table 1. The selection of the texts is strategic and ensures that all documents directly address at least one of the following: the framing of REE mining, the framing of space exploration and broader issues of ecological inequality and extractivism. This distinction is made because the pool of sources that incorporate all three of these aspects is limited. Moments of Controversy, resistance, or policy change are especially important, as these reveal underlying power dynamics and worldviews (Fairclough, 2013)

File name	Country	Communities/villages
Mbachu (2025)	Nigeria	Bauchi Kaduna Plateau Nasarawa Kogi Oyo Osun Ekiti Ebonyi Enugu Edo Cross Rivers
Yang & Ho (2019)	China	Binxian County Hancheng County Shuozhou County Jining County Tengzhou County Peixian County Xiushan County Huayuan County
Leuenberger et al. (2021)	Burkina Faso	Villages around Bissa gold mine Neighbourhoods around Yaramoko gold mine Villages around Houndé gold mine
Leuenberger et al. (2021)	Mozambique	Communities near Montepuez ruby mine Villages near Kenmare Moma titanium mine Villages near Moatize Coal mines
Leuenberger et al. (2021)	Tanzania	Communities near Bulyanhulu gold mine

		Communities near Buzwagi gold mine Villages near Geita gold mine
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Table 1: list of communities used in CDA analysis

3.03.02: Analytical approach: Critical Discourse Analysis

The analysis uses Fairclough’s (2013) three dimensional CDA framework. Which enables the examination of language, power and context. At the textual level, the research has examined specific linguistic choices, metaphors and rhetoric used by each stakeholder group to showcase the harms and benefits of REE mining and to justify or oppose extractivist practices. For example this study can explore how SpaceX, Blue Origin, Virgin Galactic and Lockheed Martin use terms like ‘sustainability’ or ‘innovation’ to make extractivism legit. Government agencies Such as the U.S. Department of Energy, the Federal consortium of advanced batteries and signatory parties of the Artemis Accords may use terms like ‘national security’ or ‘technological leadership’ to frame policy. And lastly, communities from China and Sub-Saharan Africa can articulate their concerns in terms of land, health or justice. (Fairclough, 2013) At the discursive level, this research investigates how these texts are made, spread out and received, analyzing the relationships between official narratives, media usage and grassroots responses. This includes looking at how dominant frameworks are reinforced or challenged in public, and how local knowledge is positioned relative to expert or corporate discourses (Fairclough, 2013). At the social practice level, this analysis puts these discourses within the broader context of core-periphery relations, unequal exchange and extractivism. The goal is to reveal how language used here both reflects and reproduces material inequalities, makes extractivism legit and marginalized other worldviews (Fairclough, 2013).

In order to do CDA analysis with Atlas.ti on the aforementioned documents, a code table was made (see table 2) which includes codes that were linked to parts of the texts that are analyzed to determine the hidden narratives behind these texts. Each code is a reflection of the concepts of WST, UEE and extraction and mechanisms that make these concepts work within global capitalism. Table 2 shows the importance of each code and how it is linked to the theoretical framework.

Code	Rationale
Advancing the next generation	Frames extractivism as progress, framing core accumulation as benefitting humanity
Commodification	Aligns with capitalist extractivism converting nature, land and labor into Global market value.

Economic growth and security	Central mechanism of core-periphery dynamics. Highlighting growth to justify resource extraction, amplifying core wealth.
Greenwashing	Sustainability claims legitimize ongoing extractivist practices, while not mentioning actual ecological and social costs for the periphery
Increased infrastructure	Core actors justification for resource control. Developmental promises are made to gain access to resources while long-term benefits do not end up with local communities.
International cooperation	Core discourse of South-South or North-South cooperation can hide the underlying hierarchy in resource access which amplifies structures of UE
Job creation	Used a legitimization by core nations under the guise of “shared benefits” but as the theory of UEE shows, core nations benefit from these low wage workforces more than the local communities.
National security	Justifies extractivism as essential to core nation security making extraction in the peripheries a matter of national importance.
Resource security	Core actors frame extraction as securing supply
Space exceptionalism	Extractivist logic projected with new “frontiers” in which terrestrial rules do not apply
Sustainability rhetoric	Uses sustainability as a reason to keep extracting resources knowing the harm it causes.
Techno-optimism	The narrative that technological innovation solves the problem of extraction allowing for extraction of required materials.
Colonial resource governance	Uses the historical and ongoing mechanisms with which core actors monopolize resources from the periphery.
Knowledge asymmetry	Core expertise and knowledge makes peripheries more dependent on imported knowledge and incapable of changing their positions value chains, which relates to WST and UEE.

Resource dependency	Shows patterns where the periphery is forced to export resources for core nations who determine the market
Temporal framing	Frames extraction as temporary, necessary or transitional, downplaying the long-term destruction of ecosystems and local livelihoods and gaining support from local and peripheral actors.
Decoupled sustainability	Core actors claim that space exploration may lead to a sustainable future without mentioning terrestrial impacts of the extraction that is required to make their ambitions work.
Procedural exclusion	Mechanism to ensure control: peripheral actors are left out of decision making which makes continued extraction easier.
Spatial disparities	UEE's spatial logic: core gains benefits, peripheries bear the costs
Inadequate counter measures	Core actors do not provide adequate mitigation or restorative action to prevent or resolve the damage they cause to local communities or ecosystems.
Labor externalization	Shows the offloading of dangerous and low paid labor to the peripheries allowing Core nations to avoid the social costs of extraction.
Operational risk prioritization	Risk management that focusses on protecting assets and facilities instead of people showing core priorities over the welfare of people in the periphery.
Strategic omissions	The deliberate exclusion of negative outcomes or social/environmental costs from official documents and narratives.
Terrestrial dependency	shows that in order to achieve our goals in space, core actors need terrestrial peripheries to supply the core actors with resources.
Exceptionalism	Says that extraction for space is uniquely valuable and justified with enables core nations to keep extracting.
Downplaying harms and costs	Reduces perceived risks or negative outcomes to win public or political support.
Economic system critique	Core actors downplaying or criticizing ways of thinking about economy in order to legitimize their actions.

Externalization	Core actors find ways to shift negative consequences of their actions to the peripheries.
Fascination	Actors try to invoke wonder or national pride to find support for their cause which distracts from inequalities and harm
Frontier framing	Shows new frontiers as targets for extraction without mentioning the exploitative relations that come with it. In line with historical core-periphery dynamics.
Shifting blame	Extractors blame other actors of the negative consequences of their actions.
Technical solutionism	Claims technology can solve the negative impacts of extractivism, thus legitimizing extraction and externalization.
Technological advancement	Frames the advancement of technology as a reason to keep extracting, making core nations maintain their position as innovator.
Epistemicide	Loss or erasure of local/periphery knowledge systems. Extraction downplays other perspectives on land and livelihood to reinforce the dominance of core knowledge.
Land devaluation	Economic, social and cultural harms that happens when land loses it's value due to extractivism
Resettlement	Displacement and forced migration. Impact of resource appropriation when core actors acquire land in the peripheries.
Structural damage	Physical harm to communities such as the loss of buildings or infrastructure. Often ignored by core narrative.
Economic struggle	Extraction traps communities in poverty by out competing local miners and forces them to work in the mines.
Environmental degradation	Important mechanism of UEE where core resource flows cause core accumulation but leaves pollution, destruction of ecosystems and climate impacts in the peripheries.
Generational suffrage	Harms caused by extractivism do not just harm present residents but cause disadvantages for several generations in periphery communities.

Health problems	Illness and lack of healthcare that are suffered by locals in the extraction zones and shifted away from core actors.
Increased criminality	Economic disruption and resource driven conflicts cause more criminality in communities surrounding extraction sites.
Land expropriation	Core and governmental parties seize the land of local communities to ensure further extraction and accumulation for core actors.
Noise pollution	Locals surrounding extraction sites experience noise pollution caused by extraction sites
Social disruption	Breakdown of the local social fabric in peripheries caused by extractive practices in the area, by for instance the arrival of foreign workers.
Unemployment	Loss of traditional work due to extractive restructuring and the arrival of foreign laborers
Counter narratives	Local/peripheral perspectives that challenge dominant (core/corporate/governmental) narratives about extraction, progress or development.
Extractive contradictions	When the benefits and harms of extraction are weighed against each other by local communities.
Marginalized voices	When marginalized actors which are most impacted voice their concerns on their perceived problems.

Table 2: Code list Atlas.ti with justification

3.03.03: Validity, Reflexivity and Ethical Considerations

To make sure this research is valid and credible, it is designed with methodological transparency and critical self-reflection. The use of CDA is grounded in the collection and analysis of a diverse range of texts from governments, corporations and local communities. By strategically selecting documents that directly address the framing of REE mining, space exploration and ecological inequality, and focusing on moments of controversy, resistance of policy change, this research tries to capture the width and depth of stakeholder perspectives (Fairclough, 2013). This approach strengthens the studies ability to explain both dominant and contesting narratives and places them in

broader patterns of core-periphery dynamics, unequal exchange and extractivism. Reflexivity is central throughout this research as my research involves degrees of interpretation and speculation which is subjective to my own positionality. For example I always had a fascination for space which stems to my childhood. This makes it more difficult to look at these space exploration initiatives objectively as a part of me wants these initiatives to succeed. My reflexivity further draws on the critical realist and standpoint epistemology, and I will maintain awareness of my own positionality, background and the potential influence these factors have on my interpretation and speculation. This includes recognizing my position as a scholar from the global north, as I have been raised with, and taught, the core perspective of world-systems theory which means that when I write about WST and concepts like UE and extractivism the core logic of accumulation resonates with me more than the perspective of the periphery as this is less known to me, and so it is important that I am being clear in how this may affect the analysis of text, especially those texts made by authors from the global south, such as reading about the different ontologies of nature which were new to me and sometimes difficult to resonate with. This research process is documented so that the choices, assumptions and biases can be identified by readers, this follows the suggestion for transparency and self-critique by Warlenius (2017) and Bruna (2021).

The ethical considerations for this study are also addressed here, even though this study relies on publicly available texts. Care is taken when working with materials that represent indigenous groups or marginalized communities such as the communities that were examined by Mbachu (2025) Leuenberger (2021) and Yang and Ho (2019), ensuring that sensitive authors are contextualized to avoid misrepresentation. I acknowledge the risk of epistemic or ontological violence where dominant narratives can silence or change alternative worldviews and strive to avoid reproducing extractivist or Eurocentric bias as discusses by de la Cadena & Blaser (2018) and Fash (2022). The aim of this research is not to speak for marginalized people but to critically examine how their perspectives are positioned and used withing broader discussion.

3.03.04: limitations

Several limitations are found in the research design. The focus on the U.S. in terms of policy and discourse is justified by the countries central role in space exploration and REE trade, but does not capture the full diversity of the global REE dynamics or experiences of all affected regions. My reliance on the English language and publicly available texts limits my access to non-western or indigenous perspectives. That may not be widely spread out or translated. The qualitative and interpretative nature of CDA means that findings are context-dependent and shaped by my theoretical lens which harms its statistical applicability. Additionally because the third sub-question focusses on the likely trajectory of REE demand for future space programs, some use of

speculation is unavoidable. Projections that are about future trends are based on current literature, policy and industry reports, but these are uncertain and subject to change as new technologies, policies or geopolitical development arises. So conclusions regarding future intensification of extractivism should be interpreted carefully and seen as informed but speculative assessments. Despite these limitations the research is designed to produce a critical and reflexive study of how language and power form the reality of REE extractivism and space exploration, which contributes to a deeper understanding of core-periphery inequalities and the discourse mechanisms that make them real.

Chapter 4. Analysis

4.01: How Government, Corporate, and Community Narratives Shape Global Inequalities in Rare Earth Mining for Space Exploration

4.01.01: introduction

The critical discourse analysis (CDA) of stakeholder narratives about REE mining and mining in general reveal a complex web of different interests, power dynamics and inequalities. This analysis examines three distinct stakeholder groups: Governments (From the U.S), corporations (from the U.S.) and local communities (From China and Sub-Saharan Africa). Each constructs very different narratives about the benefits and harms of extractive practices here on earth that will fuel mankind's expansion into space (see appendix 1). Through coding in Atlas.ti (see table 2), this research uncovers the discursive mechanisms with which the global north legitimizes resource extraction while externalizing environmental, social and health costs to global south communities (see appendix 2)

The research question that drives this analysis is: *How do governments and corporations from the U.S. and global south communities from China and Sub-Saharan Africa frame the benefits and harms of mining for space exploration, and how do these narratives reflect broader patterns of inequality and extractivism between the Global North and Global South?* Since there is a lack of direct literature that talks specifically about REE extraction, this research questions focusses on mining in general while including sources that do mention REE extraction. This research question comes from the fact that space exploration is not just a technological challenge but also a political endeavor that is embedded in the existing structures of global inequality that we talked about in the theoretical framework. The Artemis accords vision that talks about things like “peaceful purposes” and “shared scientific data” (Artemis Accords, 2020) work together with narratives like strategic minerals and domestic supply chains mentioned by the Federal Consortium for Advanced Batteries (2021). Meanwhile in Nigeria, communities report that the vast majority experiences negative environmental impacts from mining operations (Mbachu, 2025).

The methodological approach uses CDA analysis to take a look at nine key documents that represent governmental policy frameworks (Artemis accords, Federal Consortium for Advanced Batteries, USGS critical minerals review), corporate vision statements and technical documents (Lockheed martin's lunar architecture white paper, the space X, virgin galactic and blue origin comparative analysis and the mission statements of space X and Blue origin) and community perspectives from mining regions in China and

several countries in Sub-Saharan Africa (see table 1) (health impacts studies from sub-Saharan Africa, perception gap analysis from Nigeria, and mining experiences from communities in China). These texts were coded in Atlas.ti software and that generated 484 coded quotations in 49 distinct thematic codes (see table 2).

This analytical framework shows large asymmetries in how different stakeholders give meaning around mining for space exploration. Appendix 1 shows that Government documents put emphasis on economic growth and security (44 coded instances) and sustainability rhetoric (23 coded instances) while community documents focus on environmental degradation (13 instances), health problems (18 instances) and economic struggle (11 instances). Corporate narratives use techno-optimism (19 instances) and greenwashing (6 instances) to frame space resource utilization as humanities inevitable future while using strategic omissions (6 instances) to exclude discussion of the terrestrial supply chain impacts. Also revealing, is the network analysis visualization (see attachment 3) which shows for instance the occurrence of both labor externalization and resettlement which translates global north ambition to global south displacement, as companies prefer migrant workers over the local population to avoid accountability.

4.01.02: Analysis of government stakeholder data

What follows are the most important findings from the Atlas.ti data regarding the government stakeholder group. Government stakeholders in the global north construct a discursive framework that turns mining and space exploration into components of national security, economic prosperity and international cooperation. The analysis shows that government documents emphasize economic growth and security themes, which appear 44 times across the coded texts, making it the most used framing strategy used by state actors (see appendix 1). This narrative turns minerals not just into commodities but into strategic assets that are fundamental to national sovereignty and technological supremacy. The Artemis Accords (2020) build on this approach through their deployment of space exceptionalism discourse which appears 5 times in government documents (see appendix 1). The Accords talk about safety zones around operations on the moon framing these territorial claims as neutral governance mechanisms while also making it possible to appropriate resources without formal sovereignty declarations. Article 11.7 of the Accords says that safety zones are needed to prevent 'harmful interference', creating a legal framework that makes it possible to gain exclusion zones around extraction sites while maintaining the narrative that space must be seen as a 'global commons'. This discourse strategy makes it possible for nations that sign to claim resources while not violating the Outer Space Treaty's rule of not allowing nations to claim resources in space. Government sustainability rhetoric is also an important part of the official discourse, coded 23 times across government

documents (see appendix 1). The Artemis accords (2020) often use words like ‘sustainable space activities’ and ‘environmental protection’, however these commitments remain independent from terrestrial environmental impacts. Section 10.2 says that all signatory nations must use ‘safe and sustainable space activities’ while not talking about how space based extraction might worsen earth’s mining related environmental degradation. This enables governments to frame space mining as environmentally friendly while avoiding accountability for terrestrial extractivism. Federal Consortium for Advanced Batteries (2021) shows how governments securitize access to critical minerals like REE’s through narratives of ‘resource security’ which appears 21 times in governmental documents, 12 of which in the national blueprint document (see attachment 1 and 2). The national blueprint document links lithium to resource security by saying that “establishing a domestic supply chain for lithium based batteries requires a national commitment to counter foreign dependencies”. This securitization transforms mineral policy into defense strategy by allowing the increased domestic extraction under the guise of a national emergency.

Government documents frame space exploration as serving “all humanity” while avoiding the costs of extraction here on Earth. The USGC Critical minerals review (Fortier et al, 2022) talks about supply chain vulnerabilities which was coded 6 times (see attachment 2) and the dependency on REE’s but it contains no discussion of environmental impacts in extraction regions. The Artemis Accords (2020) position activities in space as a benefit to “all humankind” while their frameworks mostly benefit space fairing nations. It is also shown that the way the policy is written it concentrates technological benefits in the global north nations while the extraction remains in the global south. The Artemis Accords (2020) emphasize things like “shared scientific data” and “interoperability standards” that benefit nations that are technologically advanced, but section 8 explicitly excludes private sector operations unless their business is done on behalf of the signatory nations. This division concentrates the benefits of space exploration in the decision-making centers of the global north while externalizing extraction costs to territories that are not represented in these policy progresses. Government documents also hardly show any codes on perceived harms showing that their narratives does not see this as a legitimate focus while perceived harms are often talked about by communities (see appendix 1 and 2). These mechanisms collectively enable U.S. government narratives to maintain legitimacy while helping to increase extractive relationships, transforming space exploration from a project that mainly serves national interests into what appears to be a universal human undertaking and while making sure the costs remain concentrated in the politically excluded extraction zones.

4.01.03: Analysis of corporate stakeholder data

Corporate discourse shows the focus on gaining as much benefit as possible while having minimal engagement with harm recognition. The analysis reveals that corporate stakeholders use three primary narrative strategies. The most prominent one is economic growth and security, appearing 24 times in corporate documents (see appendix 1). This shows how corporations link their space exploration narratives with government security frameworks to legitimize resource extraction activities. Techno-optimism appears 19 times in corporate documents, representing the second most frequent corporate framing strategy (see appendix 1). This narrative presents technological innovation as an inevitable future which shows space resource extraction as the progression of humanity rather than corporate expansion. SpaceX's mission statement talks a lot about making humanity multi-planetary, transforming Mars colonization from a capitalist venture into a necessity (Pallathadaka et al, 2022). Lockheed martin (2024) fantasizes about the prospects of human colonies on the moon for the benefit of Earth, presenting space industrialization as environmental bliss while avoiding discussions of terrestrial extraction requirements. The third significant corporate strategy is commodification, coded 14 times in corporate documents (see appendix 1). This reveals how companies transform space territories and resources into market opportunities. Lockheed Martin's (2024) lunar base showcases a water based lunar economy, supported by nuclear infrastructure. This frames resource extraction as essential for humanity's future in space. The company goes into detail on the technical specifications needed to build a lunar economy but remains silent on the terrestrial requirements that these systems would need in order to be build. Adding to that is the frontier framing code which appears 13 times and only in corporate documents, showcasing how companies present space as an empty territory that needs to be developed (see appendix 1). This narrative strategy reproduces colonial discourse about space being territories that can be appropriated. Strategic omissions are coded 6 times in corporate documents and show a patterns of how corporations present space activity as environmentally friendly while excluding extraction impacts on Earth. Lockheed Martin's (2024) systems for instance, talk about closed loop systems in space but do not acknowledge terrestrial supply chain dependencies. Lastly, space exceptionalism appears 12 times in corporate documents which shows how companies frame space activities as if they operate under a different ethical and environmental standard in relation to operations here on earth (see appendix 1). A strategy that Lockheed Martin (2024) uses to play into the exceptionalism is fascination, being coded 13 times exclusively in the Document from Lockheed Martin (2024) (see appendix 2). Lockheed Martin (2024) uses fascination by talking about the exceptional lunar landscape and technological achievements of the lunar base to hide extractive relationships that are required to achieve that goal in the first place. The analysis also reveals the absence of codes in harm recognition in corporate narratives (see appendix 1). Corporate sources contain 0 codes on the perceived harms codes (see appendix 1). This exclusion shows

how corporate discourse maintains its legitimacy by focusing only on the benefits while refusing to engage with the costs of extraction.

Corporate narratives work by looking at the benefits while keeping a complete separation of harm acknowledgement. The network analysis (see appendix 3) shows how techno-optimism connects directly to economic growth and security without establishing connections to any of the harm categories, which shows how innovation discourse works only on the promise of prosperity while not acknowledging the costs (see appendix 3). The inequality implications become more clear through the mechanism that corporations use to gain the most value out of their endeavors, which concentrate benefits in the global north and costs in the global south. In the corporate visions of space industrialization eventual environmental benefits are promised, but the resources required for such projects must first be extracted and corporate stakeholders do not mention the harms that come with this. This omission allows corporations to claim environmental leadership while they keep extracting to fuel their ambitions in space.

4.01.04: Analysis of community data

The community stakeholders have a very different narrative than that of the government and corporate stakeholders. The analysis reveals a strong emphasis on harm related coding rather than benefits. The most used codes in the community sources show this pattern clearly. Health problems is the most frequently used community concern with 18 codes across community documents (see appendix1). Environmental degradation follows closely with 13 coded instances as well as social disruption with 14 coded instances, showing the ecological consequences of mining and how mining transforms social structures and relationships (see appendix1). The code economic struggle is used 11 times and shows how the narrative of corporations and governments, who lean heavily on economic growth, is contradicted. This code distribution really shows that communities experience mining mainly through the negative consequences rather than the benefits.

Environmental degradation narratives are often used in community discourse, with people describing 'poisoned water', 'dead rivers' and 'air pollution' as direct consequences of mining in the area. The health impacts study from Sub-Saharan Africa documents the perception of communities and links mining to increased respiratory diseases, skin conditions, and reproductive problems (Leuenberger et al, 2021). Members of the interviewed communities say that environmental changes occurred following new mining programs which shows a clear connection between extraction and ecological destruction (Leuenberger et al, 2021). The Nigerian perception gap study shows large differences between corporate and community assessments of mining impacts. 92% of community respondents report negative environmental effects

compared to only 39% of people representing companies that acknowledge such problems (Mbachu, 2025). This difference in perception shows how corporate sustainability claims that do not match the lived experiences of the communities, which report water contamination, agricultural disruption and health impacts (Mbachu, 2025). Land expropriation and land devaluation both have 6 coded instances and are therefore significant themes in the community narratives and show how mining operations force communities from their land often without proper compensation (see appendix1) (Yang and Ho, 2019). Studies on Chinese mining sites show that local communities face rising living costs, agricultural displacement and limited access to mining employment because companies prefer to reduce accountability by hiring migrant workers (Yang and Ho, 2019). The primary benefit that communities report is job creation (9 coded instances). Community resistance and agency are shown in the extractive contradiction discourse that appeared 6 times in community sources (see Appendix1). This framing shows that communities do acknowledge the economic necessity of mining while also critiquing its costs, both social, economic and environmental. This shows a complex dilemma in the narratives of communities rather than a straight forward opposition towards extraction (Yang and Ho, 2019) (Mbachu, 2025). Lastly, although the codes instances are slim, the coded instances for counter narratives (2 codes) and marginalized voices (1 code) only appear in the community documents (see Appendix 1). This shows how communities do, to some extent, take an active role in contesting extractive relationships rather than accepting them.

Community narratives show material foundations of the global north space exploration efforts by showing us the human and environmental costs of mining on Earth. Unlike government and corporation stakeholders who look at benefits through the lens of security, innovation or sustainability rhetoric, communities use concrete evidence of the immediate consequences of extraction through health testimonies, looking at the environment and examples of social and economic disruption. The exclusion of community voices comes from policy frameworks becomes apparent with the instances of the procedural exclusion codes in community frameworks and the lack there of in government and corporation documents (see appendix1). This exclusion practice mirrors, to some extent, colonial governance structures where the affected populations are seen as objects rather than subjects of resource policy.

4.01.06: Answering the research question.

The research question this analysis aims to answer is: *How do governments and corporations from the U.S. and global south communities from China and Sub-Saharan Africa frame the benefits and harms of mining for space exploration, and how do these narratives reflect broader patterns of inequality and extractivism between the Global North and Global South?*

The analysis shows that space exploration narratives reproduce the structural inequalities from World-Systems Theory instead of transcending them. Government and corporate stakeholders in the U.S. show what Wallerstein (2011) says is characteristic core behavior, using the power of their institutions and discourse to secure the access to resources and externalize their costs to peripheries. U.S. government documents used a lot of national security (11 instances) and resource security documents (24 framings) to legitimize their extractivism and used strategic omissions (11 instances) to make sure they didn't need to recognize the harms they caused (see appendix 1). This showcases the ability of core nations to influence the global narratives regarding resource appropriation from the peripheries with their technological and political power, both mechanisms described by Wallerstein (2011). Meanwhile corporations use techno-optimism (39 instances) and frontier framing (13 instances) (see appendix 1) to do what Hornborg (2009) called "machine fetishism", which is the idea that technological advancement can overcome ecological limits without having to address the structural inequalities.

The narrative analysis shows us how space exploration discourse allows Unequal Exchange mechanisms as shown by Hickel et al. (2022) and Dorninger et al. (2021) to continue. For example, U.S based corporations and governments emphasize sustainability rhetoric (29 instances) and greenwashing (17 instances) narrative strategies to show why space exploration is required to shift to clean energy and technology. This is something that mirrors what Andreucci et al. (2023) term as "green extractivism", and what I would like to call "cosmic extractivism". Using the narrative of space exploration being 'required' to move forward in the green transition. In reality, the community voices talk about environmental degradation (21 instances) and health problems (23 instances) (see attachment 1) which shows that the cost of critical mineral extraction for space exploration is centered in the peripheries, such as rural China and nations in Sub-Saharan Africa, while the benefits go to the U.S. This aligns with Hickel et al.'s (2022) findings that northern nations appropriated \$242 trillion from the global south while externalizing 58% of the northern ecological costs to peripheries. The systematic procedural exclusion of communities and commodification codes (see attachment 1) show that De la Cadena and Blaser (2018) say is ontological violence, which is recognizing land, water and forests only as commodities while pushing aside other worldviews. The analysis also reveals that labor externalization (4 instances) and resettlement (6 instances) work together to show how northern extractivist ambitions

translate to southern displacement as companies prefer migrant workers over local populations to avoid accountability. These mimic the mechanisms that Nygren et al. 2022 talk about to overcome legal and political barriers of extraction.

The empirical evidence from the 484 analyzed codes show that space exploration narratives work by using systematic discursive mechanisms that don't just fail to overcome global inequalities, but rather reproduce them. The analysis shows how benefit framing strategies are mostly used by the U.S. while the harms are documented by the communities from rural China and Sub-Saharan Africa. Without a transformation to these mechanisms behind these narratives as described in the framework, such as: wage hierarchies, institutional arrangements and epistemic frameworks, space exploration will reproduce the capitalist dynamics that cause global inequality. The systematic exclusion of community voices makes sure that the people that try to shed light on the harms caused by extractivism are marginalized and the idea of the benefits of going to space stay dominant, forming the idea of "cosmic extractivism" where we justify terrestrial extraction and its consequences to colonize space.

4.02 : Analysis of Future Rare Earth Element Demand in Space Exploration and Global Extractivist Trends

As ambitions to go to space are growing, so too does the demand for critical minerals that are needed to make the technological advances happen. The Artemis program and other new space initiatives mark a shift, not just in the scale of space activity but also in the material foundations of the ‘new space age’. Rare Earth Elements (REEs) and other critical minerals have become essential to the developing and using of spacecrafts, satellites and supporting infrastructure. They have unique properties, like resistance to radiation, the ability to withstand extreme temperatures and being lightweight and durable, which makes them irreplaceable in many space applications. This section tries to find out how REEs are currently used in space related technologies and lays the groundwork for understanding how future space programs may intensify demand for these minerals which can potentially reshape patterns of global extractivism and the dependency on resources (U.S. Department of Energy, 2023; Artemis Accords, 2020.; Casey, 2024)

4.02.01: Current REE dependance in space technologies

The reliance of REEs in space exploration is clearly visible in the design and operation of modern satellites and spacecrafts. As shown in the U.S. Department of Energy’s 2023 Critical Minerals Assessment, elements like neodymium, praseodymium, dysprosium and samarium are all needed for the making of high-performance magnets which are crucial in the control systems of spacecrafts, including reaction wheels and electric propulsion units (U.S. Department of Energy, 2023). These magnets are also valued for their ability to function reliably in the difficult conditions of space, like exposure to radiation and extreme temperatures (Casey, 2024; Ohmer, 2021). apart from magnets, REEs are also important in advanced coatings and insulation materials that protect aircrafts from the harsh environment of space. An example would be the REE-based thermal coatings that shield spacecrafts from intense heat when re-entering the atmosphere or the cold of deep space, while also protecting sensitive electronics from radiation (Casey, 2024). In power systems, REEs are used in thin-film photovoltaic arrays that generate electricity for spacecrafts. These arrays which use REE-doped coatings to improve effectiveness and durability, are becoming more important as space missions become longer and more energy intensive (Sproewitz et al, 2020). Communication and navigation systems also need critical minerals, including REEs, to function. Neodymium and Samarium magnets are important for actuators and gyroscopes which stabilize satellites and ensure precise movement (Casey, 2024). Ohmer (2021) says that magnets based on REEs also play an important role in manufacturing space communications.

Magnets based on Samarium, which are called travelling wave tubes, form the backbone according to the entire space communication system (Ohmer, 2021). With that we can say that the usage of REEs in space technology is not an incident but rather foundational. They are used in structural, energy and communication systems which are vital for space exploration. This material dependence on REEs and other critical minerals is important when looking at the future expansion of space activities which may further push the global extractivist agenda and entrench the geopolitics of resource control.

4.02.02: Projected demand for REEs in future space programs.

Looking forward to the expansion of space exploration such as Artemis it is expected that there will be an increase in demand for REEs and other critical minerals. The U.S. Department of Energy's 2023 critical minerals assessment shows that as space missions become more ambitious, looking at long-term lunar bases, deep-space travel and more intricate satellite networks (Artemis Accords 2020.), the materials that are needed for these projects will grow in both quantity and diversity (U.S. Department of Energy, 2023). These programs will not only require more of the same REEs currently being used in spacecrafts such as magnets, coatings and electronics, but will also drive the need for new materials and innovative uses as mission durations become longer and the technological complexity increases. The Artemis Accords, which set out the principles for international cooperation on lunar and planetary exploration, say they anticipate the extraction and use of resources from the Moon and other celestial bodies (Artemis Accords, 2020). This shows a shift in how resource dependency is understood. Rather than relying only on terrestrial mining, future space programs are preparing for a future in which the moon's soil and even asteroids become new sources of critical minerals. But even with the promise of in-situ resource utilization (ISRU), the first phases of these programs will rely on the materials that are sourced from earth, even more so when the technologies and infrastructure of space-based mining is still being developed (Artemis Accords, 2020). The engineering studies that we previously talked about also support the expectation that future space mission will become more material intensive. Sproewitz et al, (2020) describes how solar arrays are needed to power spacecrafts and how they are dependent on REEs. Sproewitz et al, (2020) goes on to describe how better arrays have the potential to make spacecrafts more efficient and resilient, which will be needed for future space exploration. And so the demand for these materials that are required for these arrays is only expected to rise. In addition to that, Casey (2024) notes that the trend to make lighter, stronger and more reliable spacecraft components will continue to drive the usage of REEs and other critical minerals in alloys, coatings and electronics. Therefore this is not only a technological necessity, but also of economic and geopolitical importance, as securing reliable supplies of these materials becomes an important concern for spacefaring nations such as the U.S.. The U.S. Department of

Energy (2023) also showcases this point by identifying REEs as ‘key materials’ whose supply risks could pose challenges to the technological development of the U.S. In sum, the evidence from policy documents, technical assessments and engineering research tells us that the next generation of space programs will rely on REEs and with that intensify the global demand for REEs to some extent. This growing dependency is likely to reinforce the existing patterns of extractivism on earth while laying the groundwork for resource extraction away from earth. The implications of that shift will be further explained in the following sections.

4.02.04: Limitations and speculative risks

While the expansion of the space industry is expected to increase the demand for REEs, there are important limitations and uncertainties that must be acknowledged when looking at the impact on global extractivism.

First, the current scale of REE use in space applications is small compared to other sectors. The U.S. Department of Energy (2023) shows data that suggests that the largest drivers for global demand on several REEs are the production of electric vehicles and wind turbines, not space technology. Space exploration is dependent on REEs for specialized uses but in quantities it remains minor compared to other sectors on the global markets. This means that right now the direct impact of space programs on overall REE extractivism is limited but this could change if space infrastructure or off-world mining scales up in the future. Secondly the technical possibilities of large-scale space based resource extraction remains uncertain. The Artemis accords (Artemis Accords, 2020) shows the intention of the states that signed it, which is to enable and regulate extraction on the moon and other celestial bodies, which reflects growing policy interest in space based mining. But as of now, all supply chains for REEs are earth based and there are no proven technologies for in-situ resource utilization on the moon or asteroids. As Bielawski (2020) notes, while space mining is often discussed as the solution to terrestrial resource problems, the technical and economic challenges involved in making viable extraction and processing infrastructure beyond earth itself are substantial and unresolved.

4.02.05: Conclusion

The analysis of REE demand in space exploration shows us how programs like Artemis will worsen global extractivist dynamics instead of transcending existing inequalities. While the current REE usage for space technology is small compared to other industries (U.S. Department of Energy, 2023), the planned expansion of space infrastructure could increase the demand for REEs for the space sector significantly. The planned scaling from minor space REE usage to the increased demands required for lunar bases, Mars

missions and other space-based infrastructure and technologies will put more pressure on extraction zones in the periphery such as rural China and Sub-Saharan Africa. The unique characteristics of REEs, such as its radiation resistance, temperature tolerance and durability make them irreplaceable for space technology and infrastructure (Sproewitz et al, 2020; Ohmer, 2021; Casey, 2024). This technological dependency will create more demand for REE's which space faring core nations like the U.S. will seek in peripheral extraction area's such as rural China or Sub-Saharan Africa. This increase of demand is a good example of what Wallerstein (2011) describes as the core's systematic appropriation of resources from peripheries while externalizing the costs. The U.S. being a prime example of this by using it's technological leadership to secure access to REE's and making sure they remain dominant on the world stage (Arrighi, 2010). The U.S. Artemis program is the first example of this, with its ambitious timeline turning the space industry from a small consumer into a bigger one with each step they progress.

In the previous analysis this thesis discussed the concept of "cosmic extractivism", which legitimizes the extraction of resources under the guise of human progress. The U.S. led Artemis program may be one of the first representations of this logic as the required growth in REE demand and ambitious timeline will put additional pressures on resource extraction on Earth. The projected increase in REE demand is also a good example of the mechanisms that Hickel et al. (2022) and Dorninger et al. (2021) describe where space faring core nations concentrate high-value technological development while the costs of this development are pushed towards the periphery such as rural China or Sub-Saharan Africa. In addition to that, alliances between states and space based corporations will also likely grow as the demand for REE will require institutional frameworks that help to secure resources for the advancement of the space industries, which could mean the further marginalization of community voices through ontological violence (De la Cadena & Blaser, 2018; Nygren et al, 2022).

All of this means that, just like in the conclusion of the previous narrative analysis, without the fundamental transformation of structural mechanisms that sustain global inequality, such as institutional arrangements, core value appropriation and the projection of ecological and social costs to the peripheries, the expansion into space and the growing demand for REE's required to do so, led by the U.S. and their Artemis program, will add towards colonial capitalist dynamics instead of overcoming them. This conclusion also provides a basis for speculation on the potential increase in extractivism required for the space industry as current space technology and infrastructure are heavily reliant on REE's with no alternative being mentioned to potentially replace these critical minerals.(Sproewitz et al, 2020; Ohmer, 2021; Casey, 2024).

Chapter 5. Discussion

5.01.01: Chapter overview

This discussion chapter looks at how the growing demand for REE's driven by space exploration technologies works within the patterns of global inequality. Guided by the theoretical frameworks of WST, UEE and Extractivism, this discussion looks at space exploration not as a new human undertaking that goes beyond the politics on Earth, but rather a new frontier for the current core-periphery dynamics..

The chapter is built around three main arguments. First, it looks at the discursive mechanisms through which stakeholders like governments and corporations legitimize resource extraction while communities are left out of the policies surrounding space exploration. This section will once again focus on the role of the U.S. as a core hegemonic power, in using these narratives to serve its own interests. Second, it analyzes how space exploration deepens the mechanisms of Unequal Exchange by looking at the difference between corporate sustainability claims and community experiences of environmental degradation. Lastly, it goes into the concept of "cosmic extractivism" The discussion will theoretically ground the concept, placing it as the logical, although speculative, extension of the concept of green extractivism and current extractivist logics. The discussion shows that without the transformation of stakeholder relationships and narrative frameworks, The usage of space resources will continue extractivist dynamics rather than resolve them.

5.02: space exploration as an extension of global extractivist logic.

The analysis shows that space exploration works within the existing structures of global extractivism rather than outside of them. Specifically, the growing demand for REE's driven by space technologies sustains the existing core-periphery dynamics where core regions gain wealth through systems of unequal exchange and resource extraction. The fact that the space sector depends on terrestrial REE extraction keeps the metabolic rift going, where capitalist disruption of ecological cycles allows core nations to appropriate resources while externalizing costs to peripheries (Hornborg. 2009). This patterns is shown in how space programs concentrate technological benefits in the global north while extraction is still mostly done in the global south, which maintains the historical colonial division of labor shown by Wallerstein (2011). In this dynamic, the U.S. works as a core state using its technological and financial power to build and manipulate global supply chains that are required for its ambitions in space, reinforcing its hegemonic position in the world system. In addition to that, the coding analysis reveals that government documents for the U.S. put emphasis on economic growth and security

while containing no codes in harm categories that are prominent in community narratives (see appendix1), a clear discursive manifestation of the core's power to externalize its costs to peripheries.

The current scale of REE use in space applications is modest, as revealed by the analysis of future REE use projections, right now the direct impact of space programs on overall REE extractivism is limited but this could change if space infrastructure or off-world mining scales up in the future. This aligns with the framework's understanding of how extractivism adapts to new contexts while keeping its logic of appropriation and externalization. The crucial point here is not the current amount of REEs used, but that the U.S. led push into space forms the political and technological foundation for a future where this demand could become an important driver of extraction on Earth.

5.03: Discursive legitimacy of extractivist expansion.

The stakeholder analysis shows how governments and corporations use strategic narratives to legitimize resource extraction, both in general and for space exploration. These discourses reflect the broad extractivist logic that is described in the theoretical framework, where extractivism works as a structural logic that shows the persistent transfer of money, goods and ecological degradation from the global south to the global north. Core state actors, particularly the U.S., are central to creating this logic. Government discourse especially, uses the narrative strategy of space exceptionalism. This narrative strategy makes it look like space activities operate under different ethical standards than operations on Earth, which creates the foundation for what can be termed cosmic extractivism. The Artemis Accords (2020) show this in their creation of safety zones that function as territorial claims while maintaining the narrative that space is a "global commons" available to us all. From the perspective of WST, the accords represent an attempt by the U.S., as a dominant core power, to 'set the rules for the game' of space resource governance and create legal frameworks that favor its own national and corporate interests. The analysis shows that corporations use three primary strategies to promote the benefits of mining and space exploration: economic growth, techno-optimism and commodification (see appendix1). There is a complete absence of harm recognition codes in the corporate documents which is opposite of the community documents that look at health problems, environmental degradation and social disruption. This exclusion of narrative enables what the theoretical framework identifies as ontological violence, the imposition of one 'true' reality that shuns alternative ways of knowing and being (de la Cadena & Blaser, 2018). The strategic omissions shown in the analysis (which only appeared in the corporate documents) show how corporations remain legitimate by separating space exploration narratives from the extraction impacts here on Earth. This discourse mechanism allows the continuation of extractivism under the mantle of technological progress and human

advancement, which reproduces colonial patterns of appropriation while claiming they are the frontrunners in the fight against climate change.

5.04: The Perpetuation of Unequal Ecological Exchange

The results of this thesis show that space exploration makes the patterns of unequal ecological exchange worse rather than resolving them. As the theoretical frameworks shows, core nations systematically externalize their environmental costs to peripheries while gaining the vast majority of the technological benefits and economic gains (Dorninger et al, 2021; Hickel et al, 2022). The space sector already adds a new dimension to this problem by creating, although currently limited, additional demand for critical minerals in the same global system of geographical separation between countries that receive the harms and countries that receive the benefits. The Nigerian perception gap study shown in the analysis shows the disconnect between corporate claims and community experiences. 92% of community respondents say that mining has negative environmental effects compared to only 39% of company representatives. This rift shows how unequal ecological exchange works through material appropriation and epistemic violence, because the corporate narratives exclude the lived experiences of the communities. In addition to that, the network analysis shows the connections between labor externalization and resettlement, being an example of how global north ambitions can lead to global south displacement as companies prefer to use migrant workers to avoid long-term accountability for the communities. This patterns is also found in the mechanisms of unequal exchange where peripheries bear social costs while core nations accumulate the benefits.

The transition to space-based mining is still facing significant technological and economic barriers which means that the majority of all REE and other critical minerals required for building our space programs must come from extraction on Earth for the foreseeable future. This gap between our space ambitions and space-based resource extraction capabilities ensures us that terrestrial extractivism will remain crucial as we lay the groundwork for extraterrestrial extraction.

5.05: Towards cosmic extractivism: the next frontier

Based on the analysis of stakeholder narratives and future REE demand in space programs, humanities expansion into space risks what this thesis would like to term as, Cosmic extractivism. An extension of green extractivism as identified in the theoretical framework. This being the potential appropriation of the resources of space under the guise of sustainability and human advancement, which works the way green extractivism operates here on Earth right now with the use of environmental rhetoric

while making sure the extractivist relationships remain intact. This concept also extends the theoretical debates on extractivism by looking at outer space as the next frontier for capitalist accumulation. It can be seen as a specific form of what Ye et al. (2020) calls global extractivism, where the logic of appropriating resources from peripheries and using them in distant markets (cores) can also be projected into the celestial bodies in outer space. Similar to how green extractivism uses the rhetoric of sustainability to allow for terrestrial dispossession (Bruna, 2021; Andereucci et al, 2023), cosmic extractivism uses narratives of human progress to justify the appropriation of space based resources, while depending on resources on Earth and the unequal power relations that come with it. The analysis shows how space exceptionalism discourse creates the foundation for cosmic extractivism by making it look like activity in space is not applicable to ethical constraints here on Earth. With corporate fascination discourse hiding the extractive relationships with the use of technical complexity and visionary narratives about humanities 'bright' cosmic future. Lockheed Martin's (2024) lunar architecture shows this pattern by talking about the technical specifications and grant opportunities of lunar bases while not talking about the costs here in Earth and the supply chain dependencies to make those projects possible. In addition to that, the Artemis Accords (2020) idea for safety zones shows us how cosmic extractivism might operate through legal mechanisms that enable resource appropriation while keeping the narrative of international cooperation and a global commons. After all, these zones function as unofficial territorial claims that could help with resource extraction under the guise of operational importance which reproduces patterns of territorial appropriation in space.

While the concept of cosmic extractivism remains speculative, as it is yet to happen on a large scale, the analysis does provide evidence for the structural 'puzzle pieces' that would allow its emergence. The systematic exclusion of communities and countries in the global south from the planning of space exploration mirrors the colonial governance structures of old and suggests that similar patterns of marginalizing that underpinned these colonial government systems will likely also appear in space resource governance. Thus, cosmic extractivism is not a break from history but rather, a continuation, which extends the same imperialistic logic of appropriation to a new domain.

5.06: theoretical contributions: extending extractivism beyond Earth

The findings in this research contribute to expanding existing theoretical frameworks in the space domain by looking at how World-Systems Theory, Unequal Exchange and Extractivism frameworks show space exploration's workings within rather than beyond the existing structures of global inequality. The usage of CDA analysis with these frameworks have helped to uncover how language and power form the realities of REE extractivism and extractivism in general for space exploration. By applying political

ontology to space exploration, it reveals ontological conflicts that form when extractivist logic is applied to outer space rather than Earth. Space becomes another frontier for the usage of the “one-world world” that turns celestial bodies into resources for extraction, destroying alternative ways of thinking about cosmic environments before they can emerge. This research contributes by looking at how cosmic extractivism creates the same discursive mechanisms that legitimize terrestrial extraction, benefit framing, harm externalization and the silencing of affected voices while also looking at the new layer of techno-optimism and frontier narratives. It looks at cosmic resource appropriation as the potential next step in the evolution of the concept of extractivism, right after colonial plunder and state-led development projects.

In the end, the research shows that achieving proper sustainability in space exploration would need fundamental restructuring of stakeholder relationships and narrative framework to acknowledge the connections between space exploration and terrestrial justice. Without such a transformation, space resource usage risks repeating rather than resolving extractivist dynamics that characterize current global capitalism and create new frontiers for inequality rather than opportunities for genuine human advancement and flourishing.

Chapter 6. Conclusion

This thesis looked at how the growing demand for REE driven by space exploration technologies relates to unequal ecological exchange and capitalist extractivism. With an analysis that used both a theoretical framework and empirical research, this study shows the complex dynamics between space ambitions and terrestrial resource extraction.

6.01: answering the main research question

The main research question for this research is as followed: *How does the growing demand for rare earth elements driven by space exploration Initiatives in the U.S. exacerbate unequal ecological exchange and expand capitalist extractivism?*

The analysis shows that while the current impact of space exploration on REE extractivism and extractivism in general is limited compared to other sectors, the relationship between space technology and terrestrial extraction works within the same structures of global inequality as many other sectors. This research concludes that the growing demand for REEs driven by U.S. led space exploration initiatives directly expands and deepens capitalist extractivism because it perpetuates the mechanisms of UEE and reinforces the core-periphery structure of the world-system. Space exploration does not work outside of the core-periphery dynamics identified in the theoretical framework but actually extends them with new mechanisms of appropriation and externalization. The significance of this is not in the current scale of material usage but in how the U.S. led space initiatives have laid the technological and institutional groundwork for future expansion. . As space infrastructure scales up and programs advance, the demand for terrestrial REE extraction and extraction in general will grow which places extra pressure on existing extractive systems while keeping the same division between benefits that concentrate in the global north (specifically the U.S. as the frontrunner in space technology), and environmental costs that are externalized to the global south such as rural China and Sub-Saharan Africa where most of the required REEs come from.

6.02: integration of sub-questions

6.02.01: Stakeholder narratives and discursive legitimization

The first sub-question revealed systematic patterns of inequality in how different stakeholders frame the benefits and harms of REE mining for space exploration. The CDA analysis shows us that government and corporate narratives from the U.S. use strategic discourse to legitimize resource extraction while excluding community voices from space exploration planning. Government and corporate discourse emphasize benefits through economic growth, security and sustainability rhetoric while not talking about the harms of extraction that communities point out. Corporate discourse uses techno-optimism, space exceptionalism and fascination to hide their extractive relationships while communities mostly focus on the negative impacts like health problems, environmental degradation and social disruption. This discourse analysis shows how space exploration works with the same colonial governance structures that are used with terrestrial extractivism, where populations are excluded from the decision-making processes while they do suffer most of the environmental and social costs of extraction. This process is a form of ontological violence where dominant, core centric worldviews push other ways of knowing and being aside.

6.02.02: Future demand projections

The second sub-question looked at how future space exploration programs will increase the demand for REE's. this analysis confirmed that space technologies are depended on REE's across many application. From magnet motors to radiation-resistant electronics. While the current usage is modest, the expansion of space programs will increase demand for the extraction of REE's. The technical barriers to space-based mining make sure that we will continue to rely on REE's and other critical minerals that are mined here on Earth. All while the same institutional frameworks that are used for mining on Earth are being extended to space with international agreements, such as the U.S.-led Artemis Accords, which will allow spacefaring nations to gain the benefits of space based extraction in the future. This is a key mechanism of core state power in the world-system, shaping the rules to ensure more accumulation in the future. This prospect will also push other nations to develop their own space programs which once again puts more pressure on terrestrial extraction sites.

6.03: The emergence of cosmic extractivism

Based on the stakeholder narratives and future demand projection, this thesis introduces the concept of “cosmic extractivism”, the potential extension of extractivist logic beyond the boundaries of Earth. This is conceptually similar to green extractivism, where space resources and territories are appropriated under the guise of sustainability and human advancement. Cosmic extractivism can be understood as the final frontier of global extractivism, using the same terrestrial logic of accumulating resources for core markets on celestial bodies. It builds on the mechanisms of green extractivism by using narratives of human progress to legitimize the taking of resources. While cosmic extractivism remains largely speculative, this thesis provides evidence for the structural foundations that would allow it to emerge. The concentration of space-faring nations and corporations in the Global North, together with the dependence of Global South extraction, shows us that space resource utilization would most likely intensify terrestrial inequalities rather than solve them.

6.04: Final conclusions

This thesis concludes that the growing demand for REE's driven by space exploration technologies works well within and even strengthens the existing patterns of unequal ecological exchange and capitalist extractivism. While the current impact is minimal compared to other sectors, the trajectory that the current space programs are on in terms of expansion will demand an increase in terrestrial extraction, which places more pressure on communities and ecosystems that currently bear the costs of global extraction. The research shows that space exploration, rather than solving terrestrial inequalities, is currently extending them with new mechanisms of appropriation and externalization. The concept of cosmic extractivism shows us a potential future where the colonial logics of resource extraction are used beyond the boundaries of Earth, keeping the same patterns of concentrating the benefits in the global north and the costs in the global south.

The significance of this research is in showing the present dynamics of extraction and showing the structural similarities that connect terrestrial and cosmic extractivism. As humanity's expansion into space grows, the risk of reproducing rather than resolving global inequalities grows. This makes the critical analysis of these dynamics important for achieving proper sustainable and just space exploration.

Chapter 7. limitations

This research acknowledges several constraints in method and concept that are important when looking at the boundaries within findings should be interpreted.

7.01: Temporal and resource constraints

The roughly seven month timeframe to write this thesis made it important for me to prioritize some points over others and choose specific contexts over broader ones, limiting the dept of comparative analysis across multiple spacefaring nations and the proper inclusion of non-English sources. This time constraint also restricted my ability to track the evolution of the stakeholder discourse over time.

7.02: Geographical and cultural scope

The research uses a U.S. centric focus for government and corporate analysis. That limits the global representativeness although the central role of the U.S in space exploration does justify the decision. This focus on the U.S. may create a certain level of political bias towards western policy frameworks and underrepresentation of other global approaches to space resource governance. Also, language barriers have restricted me from accessing non-western perspectives and other knowledge systems.

7.03: Methodological constraints of Critical Discourse Analysis

The interpretive nature of CDA makes it vulnerable to researcher subjectivity even when actively using a reflexive stance. Strategic coding during moments of controversy may put too much focus on conflict while not looking at more neutral data. The contextual nature of these findings does limit it in its statistical use.

7.04: Speculative elements and future projections

My third research question involves speculation about the future demand of REE in space technology and space program expansion, which contains inherent uncertainty because of its evolving technologies, geopolitical shifts and the potential discovery of other materials. These projections should be seen as informed assessments rather than definitive predictions.

7.05: Conceptual and theoretical limitations

The integration of World-Systems Theory, Unequal Exchange and Extractivism frameworks can create conceptual tensions. Although I did address the critiques of each framework, the theoretical foundations still originate from global north academic ways of thinking, which can contain epistemic biases. The critical realist approach may not fully capture alternative epistemologies and ways of knowing.

7.06: Ethical and representational considerations

The research risks repeating extractivist academic practices by extraction data from global south sources. My position as a global north researcher analyzing global south experiences can create power imbalances in interpretation and representation.

These limitations define boundaries for the interpretation of this research while not underselling its core contribution to understanding the relation between space exploration, rare earth element extraction and global inequalities.

7.07: Recommendations for further research

To further this research I recommend looking into possible government frameworks and policy that would help to offset the mechanisms of UEE that currently underpin the space industry.

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Appendices

Appendix1: code quantity per stakeholder group

	communities Gr=82; GS=2	corporation Gr=78; GS=3	government Gr=99; GS=3	Totals
○ benefit framing: advancing the next generation Gr=8	0	8	0	8
○ benefit framing: commodification Gr=14	0	14	0	14
○ benefit framing: economic growth & security Gr=85	12	24	44	80
○ benefit framing: Greenwashing Gr=20	3	2	15	20
○ benefit framing: increased infrastructure Gr=6	5	0	0	5
○ benefit framing: international cooperation Gr=31	1	8	22	31
○ benefit framing: job creation Gr=22	9	2	9	20
○ benefit framing: national security Gr=11	0	0	11	11
○ benefit framing: resource security Gr=24	0	3	21	24
○ benefit framing: space exceptionalism Gr=17	0	12	5	17
○ benefit framing: sustainability rhetoric Gr=32	3	6	23	32
○ benefit framing: Techno-optimism Gr=39	0	19	20	39
○ extrac & ineq: colonial resource governance Gr=5	1	1	1	3

○ extrac & ineq: knowledge asymmetry Gr=3	1	0	0	1
○ extrac & ineq: resource dependency Gr=1	0	0	1	1
○ extrac & ineq: temporal framing Gr=6	1	2	1	4
○ harm externalization: decoupled sustainability (no terretrial linkage) Gr=4	0	3	1	4
○ harm externalization: procedural exclusion (no community consultations) Gr=5	0	0	0	0
○ harm externalization: spatial disparities (benefit in north, harm in the south) Gr=3	0	1	2	3
○ harm minimalization: inadequate counter measures Gr=7	0	0	0	0
○ harm minimalization: labor externalization Gr=7	2	0	2	4
○ harm minimalization: operational risk prioritization Gr=3	2	0	0	2
○ harm minimalization: strategic omissions Gr=11	0	6	3	9
○ harm minimalization: terrestrial dependency Gr=2	0	2	0	2
○ narrative strategies: exceptionalism Gr=3	0	3	0	3
○ narrative strategies: downplaying harms and costs Gr=11	0	0	0	0
○ narrative strategies: economic system critique Gr=4	0	0	4	4
○ narrative strategies: externalization Gr=2	1	0	0	1

○ narrative strategies: fascination Gr=13	0	13	0	13
○ narrative strategies: frontier framing Gr=13	0	13	0	13
○ narrative strategies: shifting blame Gr=1	0	0	0	0
○ narrative strategies: technical solutionism Gr=3	0	3	0	3
○ preceived challange: technological advancement Gr=4	0	1	3	4
○ preceived harm: epistemicide Gr=5	1	0	0	1
○ preceived harm: land devaluation Gr=11	6	0	0	6
○ preceived harm: resettlement Gr=6	6	0	0	6
○ preceived harm: structural damage Gr=3	2	0	0	2
○ preceived harms: economic struggle Gr=17	11	0	0	11
○ preceived harms: environmental degradation Gr=21	13	0	3	16
○ preceived harms: generational sufferage Gr=1	1	0	0	1
○ preceived harms: health problems Gr=23	18	0	2	20
○ preceived harms: increased criminality Gr=2	0	0	0	0
○ preceived harms: land expropriation Gr=8	6	0	0	6
○ preceived harms: noise pollution Gr=1	1	0	0	1

○ preceived harms: social disruption Gr=22	14	0	0	14
○ preceived harms: supply chain instability Gr=15	0	0	15	15
○ preceived harms: unemployment Gr=2	1	0	0	1
○ resistance & agency: counter narratives Gr=4	2	0	0	2
○ resistance & agency: extractive contradictions Gr=9	6	0	0	6
○ resistance & agency: marginalized voices Gr=4	1	0	0	1
Totals	130	146	208	484

Appendix2: code quantity per document

Attachment 2: section 1

	health impacts of industrial mining african countries by Leuenberger et al. 2021 Gr=43	harmfull or beneficial mining in China by Yang and Ho Gr=39	USGS-Critical- Minerals- Review-2022 Fortier et al. 2022 Gr=26	Lockheed Martin's Water- Based Lunar Architecture Novella White Paper Gr=56
○ benefit framing: advancing the next generation Gr=8	0	0	0	4
○ benefit framing: commodification Gr=14	0	0	0	9
○ benefit framing: economic growth & security Gr=85	4	8	12	13
○ benefit framing: Greenwashing Gr=20	3	0	2	1
○ benefit framing: increased infrastructure Gr=6	5	0	0	0
○ benefit framing: international cooperation Gr=31	0	1	4	6
○ benefit framing: job creation Gr=22	1	8	1	1
○ benefit framing: national security Gr=11	0	0	2	0
○ benefit framing: resource security Gr=24	0	0	7	2
○ benefit framing: space exceptionalism Gr=17	0	0	0	6
○ benefit framing: sustainability rhetoric Gr=32	3	0	1	4

○ benefit framing: Techno-optimism Gr=39	0	0	3	14
○ extrac & ineq: colonial resource governance Gr=5	1	0	0	0
○ extrac & ineq: knowledge asymmetry Gr=3	1	0	0	0
○ extrac & ineq: resource dependency Gr=1	0	0	0	0
○ extrac & ineq: temporal framing Gr=6	1	0	1	1
○ harm externalization: decoupled sustainability (no terrestrial linkage) Gr=4	0	0	0	3
○ harm externalization: procedural exclusion (no community consultations) Gr=5	0	0	0	0
○ harm externalization: spatial disparities (benefit in north, harm in the south) Gr=3	0	0	0	1
○ harm minimalization: inadequate counter measures Gr=7	0	0	0	0
○ harm minimalization: labor externalization Gr=7	0	2	0	0
○ harm minimalization: operational risk prioritization Gr=3	1	1	0	0
○ harm minimalization: strategic omissions Gr=11	0	0	2	4
○ harm minimalization: terrestrial dependency Gr=2	0	0	0	2
○ narrative strategies: exceptionalism Gr=3	0	0	0	1
○ narrative strategies: downplaying harms and costs Gr=11	0	0	0	0

○ narrative strategies: economic system critique Gr=4	0	0	1	0
○ narrative strategies: externalization Gr=2	0	1	0	0
○ narrative strategies: fascination Gr=13	0	0	0	13
○ narrative strategies: frontier framing Gr=13	0	0	0	6
○ narrative strategies: shifting blame Gr=1	0	0	0	0
○ narrative strategies: technical solutionismGr=3	0	0	0	2
○ preceived challange: technological advancement Gr=4	0	0	0	0
○ preceived harm: epistemicide Gr=5	1	0	0	0
○ preceived harm: land devaluation Gr=11	3	3	0	0
○ preceived harm: resettlement Gr=6	3	3	0	0
○ preceived harm: structural damage Gr=3	2	0	0	0
○ preceived harms: economic struggle Gr=17	6	5	0	0
○ preceived harms: environmental degradation Gr=21	5	8	2	0
○ preceived harms: generational sufferage Gr=1	1	0	0	0
○ preceived harms: health problems Gr=23	15	3	2	0
○ preceived harms: increased criminality Gr=2	0	0	0	0

○ preceived harms: land expropriation Gr=8	1	5	0	0
○ preceived harms: noise pollution Gr=1	1	0	0	0
○ preceived harms: social disruption Gr=22	5	9	0	0
○ preceived harms: supply chain instability Gr=15	0	0	6	0
○ preceived harms: unemployment Gr=2	1	0	0	0
○ resistance & agency: counter narratives Gr=4	2	0	0	0
○ resistance & agency: extractive contradictions Gr=9	1	5	0	0
○ resistance & agency: marginalized voices Gr=4	1	0	0	0
Totals	68	62	46	93

Attachment 2 : section 2

	FCAB National Blueprint Lithium Batteries 0621_0 Gr=55	Artemis-Accords-signed-13Oct2020 Gr=18	A Detailed Study of Space X Vs. Blue Origin Vs. Virgin Galactic by Pallathadka et al. 2022 Gr=11	mission blue and spaceX Gr=11
○ benefit framing: advancing the next generation Gr=8	0	0	2	2
○ benefit framing: commodification Gr=14	0	0	5	0
○ benefit framing: economic growth & security Gr=85	25	7	5	6

○ benefit framing: Greenwashing Gr=20	13	0	1	0
○ benefit framing: increased infrastructure Gr=6	0	0	0	0
○ benefit framing: international cooperation Gr=31	5	13	1	1
○ benefit framing: job creation Gr=22	8	0	0	1
○ benefit framing: national security Gr=11	9	0	0	0
○ benefit framing: resource security Gr=24	12	2	1	0
○ benefit framing: space exceptionalism Gr=17	0	5	3	3
○ benefit framing: sustainability rhetoric Gr=32	17	5	1	1
○ benefit framing: Techno- optimism Gr=39	16	1	0	5
○ extrac & ineq: colonial resource governance Gr=5	1	0	0	1
○ extrac & ineq: knowledge asymmetry Gr=3	0	0	0	0
○ extrac & ineq: resource dependency Gr=1	1	0	0	0
○ extrac & ineq: temporal framing Gr=6	0	0	1	0
○ harm externalization: decoupled sustainability (no terrestrial linkage) Gr=4	0	1	0	0
○ harm externalization: procedural exclusion (no community consultations) Gr=5	0	0	0	0

○ harm externalization: spatial disparities (benefit in north, harm in the south) Gr=3	2	0	0	0
○ harm minimalization: inadequate counter measures Gr=7	0	0	0	0
○ harm minimalization: labor externalization Gr=7	2	0	0	0
○ harm minimalization: operational risk prioritization Gr=3	0	0	0	0
○ harm minimalization: strategic omissions Gr=11	1	0	1	1
○ harm minimalization: terrestrial dependency Gr=2	0	0	0	0
○ narrative strategies: exceptionalism Gr=3	0	0	0	2
○ narrative strategies: downplaying harms and costs Gr=11	0	0	0	0
○ narrative strategies: economic system critique Gr=4	3	0	0	0
○ narrative strategies: externalization Gr=2	0	0	0	0
○ narrative strategies: fascination Gr=13	0	0	0	0
○ narrative strategies: frontier framing Gr=13	0	0	3	4
○ narrative strategies: shifting blame Gr=1	0	0	0	0
○ narrative strategies: technical solutionism Gr=3	0	0	0	1
○ preceived challange: technological advancement Gr=4	3	0	0	1
○ preceived harm: epistemicide Gr=5	0	0	0	0

○ preceived harm: land devaluation Gr=11	0	0	0	0
○ preceived harm: resettlement Gr=6	0	0	0	0
○ preceived harm: structural damage Gr=3	0	0	0	0
○ preceived harms: economic struggle Gr=17	0	0	0	0
○ preceived harms: environmental degradation Gr=21	1	0	0	0
○ preceived harms: generational sufferage Gr=1	0	0	0	0
○ preceived harms: health problems Gr=23	0	0	0	0
○ preceived harms: increased criminality Gr=2	0	0	0	0
○ preceived harms: land expropriation Gr=8	0	0	0	0
○ preceived harms: noise pollution Gr=1	0	0	0	0
○ preceived harms: social disruption Gr=22	0	0	0	0
○ preceived harms: supply chain instability Gr=15	9	0	0	0
○ preceived harms: unemployment Gr=2	0	0	0	0
○ resistance & agency: counter narratives Gr=4	0	0	0	0
○ resistance & agency: extractive contradictions Gr=9	0	0	0	0
○ resistance & agency: marginalized voices Gr=4	0	0	0	0
Totals	128	34	24	29

Attachment 2: section 3

	Mbachu company vs community Nigeria Gr=51	Totals
○ benefit framing: advancing the next generation Gr=8	0	8
○ benefit framing: commodification Gr=14	0	14
○ benefit framing: economic growth & security Gr=85	5	85
○ benefit framing: Greenwashing Gr=20	0	20
○ benefit framing: increased infrastructure Gr=6	1	6
○ benefit framing: international cooperation Gr=31	0	31
○ benefit framing: job creation Gr=22	2	22
○ benefit framing: national security Gr=11	0	11
○ benefit framing: resource security Gr=24	0	24
○ benefit framing: space exceptionalism Gr=17	0	17
○ benefit framing: sustainability rhetoric Gr=32	0	32
○ benefit framing: Techno-optimism Gr=39	0	39
○ extrac & ineq: colonial resource governance Gr=5	2	5
○ extrac & ineq: knowledge asymmetry Gr=3	2	3

○ extrac & ineq: resource dependency Gr=1	0	1
○ extrac & ineq: temporal framing Gr=6	2	6
○ harm externalization: decoupled sustainability (no terretrial linkage) Gr=4	0	4
○ harm externalization: procedural exclusion (no community consultations) Gr=5	5	5
○ harm externalization: spatial disparities (benefit in north, harm in the south) Gr=3	0	3
○ harm minimalization: inadequate counter measures Gr=7	7	7
○ harm minimalization: labor externalization Gr=7	3	7
○ harm minimalization: operational risk prioritization Gr=3	1	3
○ harm minimalization: strategic omissions Gr=11	2	11
○ harm minimalization: terrestrial dependency Gr=2	0	2
○ narrative strategies: exceptionalism Gr=3	0	3
○ narrative strategies: downplaying harms and costs Gr=11	11	11
○ narrative strategies: economic system critique Gr=4	0	4
○ narrative strategies: externalization Gr=2	1	2
○ narrative strategies: fascination Gr=13	0	13

○ narrative strategies: frontier framing Gr=13	0	13
○ narrative strategies: shifting blame Gr=1	1	1
○ narrative strategies: technical solutionism Gr=3	0	3
○ preceived challange: technological advancement Gr=4	0	4
○ preceived harm: epistemicide Gr=5	4	5
○ preceived harm: land devaluation Gr=11	5	11
○ preceived harm: resettlement Gr=6	0	6
○ preceived harm: structural damage Gr=3	1	3
○ preceived harms: economic struggle Gr=17	6	17
○ preceived harms: environmental degradation Gr=21	5	21
○ preceived harms: generational sufferage Gr=1	0	1
○ preceived harms: health problems Gr=23	3	23
○ preceived harms: increased criminality Gr=2	2	2
○ preceived harms: land expropriation Gr=8	2	8
○ preceived harms: noise pollution Gr=1	0	1
○ preceived harms: social disruption Gr=22	8	22

○ preceived harms: supply chain instability Gr=15	0	15
○ preceived harms: unemployment Gr=2	1	2
○ resistance & agency: counter narratives Gr=4	2	4
○ resistance & agency: extractive contradictions Gr=9	3	9
○ resistance & agency: marginalized voices Gr=4	3	4
Totals	90	574

