Comparative characteristics of the extractive industries of Ukraine and Greenland: main aspects and features

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Volodymyr Byba
National University "Yuri Kondratyuk Poltava Polytechnic", Ukraine
https://orcid.org/0000-0002-0949-206X

Larisa Zhukova
National University "Yuri Kondratyuk Poltava Polytechnic", Ukraine
https://orcid.org/0000-0003-2765-5544

Natalia Pinchuk
Polytechnic University of Bari, Italy
https://orcid.org/0000-0002-1720-5497

Javier L. Arnaut
University of Greenland - Ilisimatusarfik, Greenland
https://orcid.org/0000-0002-4508-9526

Introduction

The mining industry is one of the important sectors of the economy in both Ukraine and Greenland. In both regions, it plays (or will play) a key role in ensuring economic growth, creating jobs, and developing infrastructure. In Ukraine, the extractive industry is represented by various sectors, such as metal and mineral extraction. The country has rich natural resources, including coal, iron ore, and other minerals, which meet domestic needs and support exports. Greenland, in turn, has unique potential due to its vast reserves of minerals and oil. The gradual discovery of new deposits and the development of infrastructure, particularly ports and roads, open new opportunities for foreign investors. However, environmental concerns and the impact on local communities remain critical issues requiring attention.

Both countries face challenges in the extractive sector, including the need for technological modernization, reducing environmental impact, and adapting to global resource prices. The successful development of the extractive industry in both countries could be a key factor in their economic futures.

This extractive activity has both advantages and disadvantages, including consequences that countries must deal with. Problems may vary, but some share common patterns. Each country uses its own methods, practices, resources, and alternatives to address these issues. By comparing the experiences of Ukraine and Greenland, it is possible to evaluate the effectiveness of their approaches. The exchange of experiences and comparison of different situations provides deeper knowledge which in turn increases the prospects for successful outcomes in future initiatives.

Review of existing research and objectives

A substantial body of research by Ukrainian and international scholars has explored a wide range of issues related to the economy and economic development of Ukraine and Greenland. Special attention has been paid to the efficiency of resource use and management under global challenges that pose significant risks to the stability and sustainability of national economies.

Theoretical and practical aspects of this topic have been addressed by both domestic and foreign researchers, including S. Koshovyi, O. Alexandrov, A. Kykin, and O. Zaiats [1], O. Kachanovskyi [2], A. Tendliuk [3], Javier L. Arnaut [4], Jens Søndergård [5], Anne Merrild Hansen, Frank Vanclay, and Peter Croal [6], Jakob Taarup-Esbensen [7], Jesper Zeuthen, and Malayna Raftopoulos [8], T. Boersma, and K. Foley [9], P. Andersson [10], K. McGwin [11], W. Hickey [12], M. Bennett [13], and others [14].

These studies examine modern trends in the extractive industry, energy policy, environmental safety, and investment appeal. Researchers highlight the importance of adapting to changing market conditions, particularly in light of instability caused by global economic crises and climate change. These factors pose serious risks to the stability and sustainability of national economies [1; 4–7].

In addition, comparative analysis of resource management approaches in Ukraine and Greenland can reveal best practices that could be adapted to improve economic resilience. Thus, research in this field contributes to a deeper understanding of economic mechanisms and helps identify opportunities for improving resource management effectiveness in both countries—an essential aspect of ensuring their long-term stability and development.

This topic is particularly relevant in the context of wartime conditions in Ukraine, which necessitates the use of new management approaches by domestic enterprises. In times of instability, it is important to find effective strategies that will ensure resource management efficiency and overall economic resilience. The purpose of this study is to analyze and compare the methods and approaches used to address challenges in the extractive industries of Ukraine and Greenland. With this research, we aim to answer the following questions:

What are the consequences of extractive industry activities? How do countries address these consequences? And are the consequences unique to each of these countries?

The results of this research will make a significant contribution to understanding and comparing the challenges related to the extractive industries in Ukraine and Greenland. This will allow for a better analysis of the current state and development prospects of these sectors in both countries.

Findings and Results

Not all issues in the extractive sector are the same, some are quite distinct. Firstly, it is important to consider the common challenges faced by both countries. The most significant and pressing of these is environmental pollution. It is a widely accepted view that global economic development often comes with the unsustainable exploitation of natural resources. The consequences of such economic activities

negatively impact on the environment, leading to resource depletion, environmental degradation, and increased costs for restoring natural balance [1; 2].

One of the most common environmental issues in Ukraine is the structural disruption caused by the extraction of large volumes of minerals. This results in the formation of underground voids beneath urban areas and around open-pit mines. Subsurface mining causes fractures in rock layers, collapses, and cave-ins, which can potentially damage national infrastructure and even lead to tragic outcomes.

Tailings ponds also pose a serious environmental risk. Contaminated water that accumulates in the lower layers of these reservoirs can leak into surrounding areas, polluting groundwater and saturating the soil. This greatly impacts regional ecological conditions. In Ukraine, such challenges are addressed by placing legal obligations on enterprises to limit pollution and requiring them to carry out land reclamation after projects are completed.

These obligations are covered in the legislation: for example, Article 34 of the Mining Law of Ukraine (1999) states that land reclamation must be carried out in a timely manner as part of mining activities. Article 50 of the Subsoil Code of Ukraine (1994) mandates that mining development projects include plans for restoring disturbed land and preserving soil cover.

Emissions and other environmentally harmful activities in Ukraine are also regulated under the Kyoto Protocol. Ukraine has significant potential to reduce greenhouse gas emissions and to trade emission allowances under international agreements. The Kyoto Protocol outlines three flexible mechanisms: emissions trading, joint implementation projects, and the clean development mechanism. To implement these provisions, Ukraine adopted regulatory acts and established the State Agency for Environmental Investments, which handles the distribution of carbon quotas.

Worsening ecological conditions in Ukraine have prompted the state and society to develop a new national environmental policy and implement effective legal mechanisms for developing environmentally sustainable technologies [3].

In Greenland, which is part of the Kingdom of Denmark, environmental issues are addressed in a similar manner. Since the 1970s, the Danish Centre for Environment and Energy (DCE) at Aarhus University has conducted environmental monitoring at mining sites in Greenland on behalf of the Greenlandic authorities. Over time, the responsible institutions have changed names—from the National Environmental Research Institute to the Greenland Environmental Research Institute and the Greenland Fisheries and Environment Research Institute. Monitoring reports have been made available to the public.

In the last decade, environmental monitoring has been conducted in cooperation with the Greenland Institute of Natural Resources (GINR). Historically, monitoring at active mining sites in Greenland involved self-reporting by mining companies (corporate self-regulation), combined with audit monitoring (environmental compliance auditing) by DCE and GINR on behalf of the authorities.

Self-monitoring (corporate self-regulation) included frequent sampling of water and tailings at the mine's discharge points. Audit monitoring (or environmental compliance auditing) was typically conducted annually and involved broad sampling in the mining area and adjacent territories. Following the closure of mining operations, monitoring was previously carried out entirely by DCE and GINR, but more recently, consulting firms (third parties) hired by the mining companies have taken over part of this task [5; 6; 10].

Certainly, environmental degradation is not the only reason for the opposition to these projects. Mineral extraction brings numerous other issues, primarily felt by ordinary people. These include social tensions that are often difficult to resolve. The social impact of extractive projects can be controversial and complex. Projects may generate wealth but also harm local livelihoods. They can create jobs, roads, schools, and other infrastructure, but the distribution of benefits and costs is often uneven. If communities feel they are being treated unfairly or inadequately compensated, such projects may cause social tension or violent conflict. Therefore, the nature of extractive activities and the socio-economic context in which companies operate have direct implications for human rights. Mining often requires access to key land areas and water, which are vital to local livelihoods. Land acquisition and the resulting displacement or relocation of communities can violate human rights and lead to severe social and environmental consequences. Thus, the way natural resource management is carried out affects local populations, particularly regarding their human rights [7].

In addition, the location of the mines generates difficulties. Most are situated far from major settlements, which creates additional logistical challenges for companies. These challenges include the need to construct and maintain complete infrastructure systems, such as roads, energy supplies, telecommunications, and water and sewage connections.

As one project proposal notes, "there is no infrastructure on the site, so all necessary infrastructure and supporting facilities must be developed as part of the project." This requirement entails substantial additional investment, which raises the risk of financial loss and may reduce the project's attractiveness to investors. However, such investments also contribute to the development of essential infrastructure, creating benefits for both the company and the host country.

Climate change is also impacting infrastructure development. The anticipated opening of new shipping routes is expected to improve accessibility and reshape supply chains, as extraction sites remain ice-free for longer periods [3]. Many of the challenges associated with mining in Greenland can be attributed to the fact that the sector remains in an early stage of development. In contrast, Ukraine has already begun to address similar issues, with many conflicts between local authorities and mining companies having been partially resolved. However, it is important to recognize that the mining sector is inherently prone to instability.

Launching new mining projects can contribute to job creation, addressing some local employment challenges. However, the industry remains highly susceptible to technological change. Advancements in automation and extraction technologies may significantly reduce the demand for labor, potentially resulting in job displacement. In addition, mineral resources are finite, and their eventual depletion will render continued extraction unfeasible. As a result, mining operations will cease, and affected workers may face unemployment.

The primary source of instability in the mining sector stems from its dependence on external markets. Significant declines in mineral prices can render operations unprofitable. While such risks are inherent to all economic sectors, not just mining—they tend to impact individual companies more than the industry as a whole. Still, Ukrainian mining firms have demonstrated notable resilience to external shocks and have, in many cases, managed to mitigate these risks effectively.

Relations between local authorities and mining companies in Ukraine have been generally cooperative and free of major conflicts, as emerging issues are typically resolved in compliance with Ukrainian legislation. Moreover, the substantial tax revenues generated by these mining companies provide local governments with increased financial capacity to address community needs and facilitate local development [2].

Leading Ukrainian mining companies contribute not only through tax payments but also by implementing comprehensive corporate social responsibility (CSR) programs. These initiatives include internal measures such as social and medical support for employees, as well as external activities like sponsorships and charitable projects aimed at improving community well-being.

Coal mining represents a critical pillar of Ukraine's fuel and energy complex, serving as the only energy resource the country can supply entirely from domestic production. Geologically, Ukraine holds the second-largest coal reserves in Europe—surpassed only by Germany—and ranks eighth globally. This endowment offers significant potential not only to satisfy internal energy requirements but also to support coal exports [14].

Despite its advantages, Ukraine's mining industry is currently experiencing a period of significant decline. The ongoing crisis and armed conflict in Eastern Ukraine have had a particularly detrimental effect on coal production. Most of the country's economically viable coal mines are situated in the conflict zone, and their disruption has had severe consequences for key sectors such as heavy industry, rail transport, and energy generation. In 2014, the shortage of domestic coal forced Ukraine to import coal and energy supplies through Russia, while reserve capacities were substantially reduced.

The Russian military invasion further exacerbated these challenges. Ukraine lost control over a considerable portion of its economy in the occupied Donbas region, including vital productive assets and infrastructure. Industrial facilities, agricultural land, state-owned properties, and social infrastructure were seized. In total, 388 state enterprises, 4,500 state-owned facilities, and more than 100 major private enterprises were either lost or rendered inoperable. It is estimated that around 50% of the Donbas region's industrial capacity was lost. Some industrial equipment was transported to Russia, while other assets were dismantled and sold as scrap. Based on open-source data, including 413 financial reports, the economic losses from dismantled and relocated equipment are estimated at $300,000.

The occupation also significantly weakened Ukraine's financial system. In 2014 alone, widespread account closures and deposit withdrawals in the occupied territories reduced the national banking system's resource base by approximately $2.5 billion.

Coal production in the Donetsk and Luhansk regions declined sharply, falling from nearly 64 million tons in 2013—equivalent to 76% of Ukraine's total output—to just 19 million tons, or 47%, by 2015. By 2017, the production of anthracite coal had ceased entirely. This specific type of coal had previously powered seven of Ukraine's 14 thermal power plants. The dynamics of coal production in Ukraine from 2010 to 2021 (in million tons) are illustrated in Figure 1.

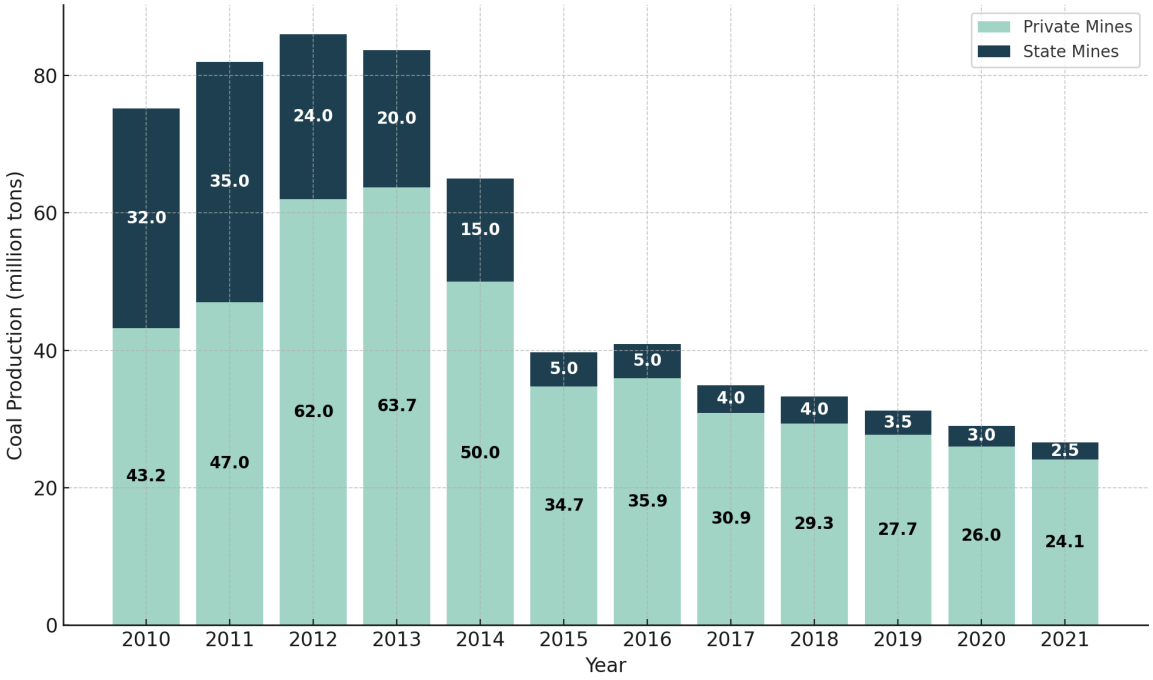

Figure 1. Coal Production (millions of tons) in Ukraine by mine ownership, 2010-2021
Source: Ministry of Energy of Ukraine, data for 2021 includes indicators for January – November

As a result of Russian aggression, Ukraine has lost not only parts of its territory—where key industrial enterprises were located—but also significant mineral deposits. This has already caused a sharp decline in the export of critical raw materials such as limestone, iron ore, and titanium ore. Following the occupation of parts of Donetsk and Luhansk in 2014, Ukraine experienced a severe coal shortage. According to analytical reports, the war has also disrupted the extraction of titanium-bearing ores and the production of titanium-based goods, leading to a drop in export volumes by over 40%. The 2022 occupation of Mariupol further exacerbated the crisis by creating major logistical bottlenecks, which contributed to a collapse in exports across the entire mining and metallurgical complex. As a result, domestic metal consumption fell by 55%.

Looking ahead, Ukraine's long-term economic development will be difficult to sustain without access to the resources currently located in combat zones or temporarily occupied areas. Only after the liberation of these territories can their full resource potential be reintegrated into the national economy. This reintegration will not only support the resumption of production but also help attract investment in infrastructure, industry, and other strategic sectors.

Reestablishing control over these key resource areas is also crucial for reshaping Ukraine's energy policy—particularly in reducing import dependence and securing domestic energy supply.

The occupation of eastern Ukraine has inflicted widespread damage on the national economy and financial system, resulting in the destruction of housing, industrial infrastructure, and essential public services. These losses, combined with the sharp decline in coal production, have directly undermined Ukraine's energy security. Many thermal power plants (TPPs) have been left without adequate fuel, which is critical for meeting peak electricity demand in the mornings and evenings.

Ongoing military actions have also devastated coal mining and transport infrastructure. Numerous mines have been either shut down or flooded, and much of the equipment has been looted and sold for scrap.

In addition, the occupation has generated severe environmental consequences, including contamination of surface and groundwater with coal residues, gas emissions, soil subsidence, and structural damage to buildings [14].

At the same time, global warming has facilitated access to Greenland's vast mineral resources. The island possesses significant reserves of coal, zinc, copper, gold, iron ore, tungsten, vanadium, and titanium. Notably, its uranium reserves are considered among the largest globally; the Kvanefjeld deposit alone is estimated to contain approximately 228,000 tons of raw material, making it the fifth-largest deposit in the world according to some developers. These assets have attracted considerable interest from China, motivated by geopolitical strategy, energy security, emerging Arctic maritime routes, and climate-related factors [9; 12].

Despite high expectations, efforts to engage Chinese mining investors in Greenland have lacked coordination. While many stakeholders—including the investors themselves—anticipated support from the Chinese state, there is little evidence of official pressure on companies to invest or to respond to environmental and social concerns raised by Greenlandic and Danish authorities. This absence of state-level initiative may have reduced the attractiveness of Chinese investment. Interestingly, the controversy surrounding Chinese involvement may stem more from political narratives than from China's actual activities. Greenlandic politicians seeking greater independence have used China's interest as leverage to bolster their case. In contrast, Danish officials have highlighted potential security risks linked to China to justify continued oversight of Greenland's natural resource governance [11–13].

At the same time, China is increasingly directing its strategic focus toward the Arctic region. Although geographically distant—located nearly 3,000 kilometers from the Arctic Circle—Beijing has begun to characterize itself as a "near-Arctic" state. As part of this emerging Arctic posture, China has acquired or leased several icebreakers, including nuclear-powered vessels, with the intention of developing new shipping routes through Arctic waters. Within this framework, Greenland is viewed as a strategically important location along China's proposed "Polar Silk Road."

Equally significant is the presence of the U.S. Pituffik Space Base (formerly Thule Air Base) in Greenland. As one of NATO's critical outposts, it plays a central role in reinforcing the alliance's strategic positioning

in the Arctic and across the North Atlantic. The base also serves as a key element in deterring Russian and Chinese activity in the region.

In recent years, neither the United States nor Denmark has made substantial investments in Greenland, leaving the island's capital, Nuuk, relatively underdeveloped. Although Denmark provides an annual subsidy to support Greenland's budget, investments in critical infrastructure have remained limited. Currently, Nuuk is accessible only by small propeller aircraft. However, this is set to change: the Greenlandic government has approved the construction of three international airports capable of accommodating large passenger planes. Notably, Chinese firms have submitted bids for the construction contracts.

This development has sparked concern in Denmark about growing Chinese involvement in Greenlandic affairs. While some Inuit leaders and local residents view Chinese interest as a potential driver of economic development, Danish authorities perceive it as a challenge to national influence. Given Greenland's considerable mineral wealth—including rare earth elements—interest from global powers such as China is expected to intensify.

In response, Denmark has sought to reaffirm its economic and strategic presence in Greenland, often emphasizing the geopolitical risks posed by foreign state actors. These dynamics have implications not only for Denmark-China relations but also for broader international competition in the Arctic. Even though China's current presence in Greenland is limited, the perception of strategic intent has prompted increased scrutiny and defensive policymaking by Denmark and its allies [7; 8].

China's global strategy to expand its presence in resource-rich and geostrategic regions has triggered growing unease among Western actors, including the United States and the European Union. For Denmark, Greenland holds particular importance—not only due to its natural resources (such as oil, gas, and rare earth metals), but also because of its geographic location and autonomy within the Kingdom of Denmark. Danish policymakers are likely aware that even small-scale, non-military Chinese investments could gradually strengthen Beijing's influence in Greenland, potentially undermining Danish authority in the long term. As a result, Chinese initiatives are often met with suspicion and framed as potential threats, reflecting Denmark's broader strategy to safeguard its interests in the Arctic.

At the same time, the issue of Chinese investment raises deeper questions about Greenland's political future. For a territory seeking greater autonomy—or eventual independence from Denmark—foreign capital may be seen as an opportunity to stimulate economic growth and reduce dependency on Danish subsidies. Denmark, however, remains wary that such developments could diminish its leverage over Greenland's economic resources and geopolitical orientation.

However, systematically assessing the degree of coordination between Denmark and Greenland lies beyond the scope of this paper. Instead, our brief analysis has focused on how the *perception* of Chinese interest—rather than China's concrete actions on the ground—may be strategically used to justify Denmark's continued involvement in Greenland's natural resource governance. In this context, such perceptions may play a more significant role in shaping controversy around Chinese investments than the investments themselves.

Conclusions

While both Ukraine and Greenland are expanding their extractive industries, they do so under markedly different conditions. Economically, the sector is vital for both countries: it generates employment, enhances energy security, and contributes to national and local revenues. However, Greenland's mining sector remains underdeveloped, largely due to insufficient investment and persistent social challenges that are complex and resource-intensive to address.

Ukraine, by contrast, has made progress in overcoming some of these social and institutional obstacles. Yet, it now faces urgent and destabilizing challenges—chief among them, the ongoing conflict with Russia. The war has severely impacted the extractive sector, particularly in Eastern Ukraine, where much of the country's mineral production is concentrated. Disruptions have included damage to infrastructure, logistical barriers, and threats to worker safety. Additionally, financial resources that might have supported sectoral development have been redirected toward defense spending.

In Greenland, the geopolitical dynamics are more subtle but no less significant. China's growing interest in Greenland's mineral wealth has sparked both opportunities and concerns. While Chinese investment could accelerate development and alleviate local constraints, it also raises questions about long-term sovereignty and strategic influence. Although Greenland maintains formal diplomatic and investment ties with China, these remain limited. As the island's resource potential becomes more visible, it may attract further international attention and competition.

Both Ukraine and Greenland are equally concerned with the environmental consequences of mining. Each is exploring ways to reduce ecological harm and adopt more sustainable practices. However, the broader challenges they face—geopolitical pressures in Ukraine, and social and investment-related barriers in Greenland—are shaped by distinct national contexts, including geography, legal frameworks, and regional alliances. Ukraine has previously demonstrated an ability to manage extractive sector risks effectively, though the war has introduced new threats that require rapid policy adaptation and significant investment. Greenland, meanwhile, is still in the early stages of developing its mining industry, and must navigate emerging pressures associated with growth, external actors, and sustainability.

Ultimately, while their trajectories differ, both countries are working toward responsible and sustainable resource governance. Their experiences highlight the need for context-specific strategies to balance economic development with environmental protection and political resilience.

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Volodymyr Byba, PhD in Technical Sciences, Docent, Associate Professor at the Department of Management and Logistics, National University «Yuri Kondratyuk Poltava Polytechnic».

Larysa Zhukova, Doctor of Economic Sciences, Associate Professor at the Department of Management and Logistics, National University «Yuri Kondratyuk Poltava Polytechnic».

Natalia Pinchuk, PhD in Technical Sciences, Associate Professor, Department of Architecture, Construction and Design, Polytechnic University of Bari, Italy.

Javier L. Arnaut, Associate Professor of Economics, Program Coordinator of Business Economics, Department of Arctic Social Science and Economics, Ilisimatusarfik, Greenland.

Comparative characteristics of the mining industry of Ukraine and Greenland: main aspects and features

Abstract. The article examines the role of the mining industry in the economies of Ukraine and Greenland, emphasizing its impact on economic growth, job creation, and infrastructure development. Ukraine has rich resources, in particular coal and iron ore, which provide domestic needs and exports. Greenland, on the other hand, shows potential due to its mineral and oil reserves, but faces environmental challenges and needs for infrastructure upgrades. Both countries face challenges such as the environmental impacts of extraction, which require adaptation of technologies and resource management strategies. The article also analyzes the research of Ukrainian and international scientists who investigate the effectiveness of resource management in the face of global challenges. Comparing the approaches of Ukraine and Greenland may reveal best practices for improving economic sustainability. The study focuses on the need to adapt to new conditions, particularly in the context of wartime conditions in Ukraine, and aims to find out how countries cope with the consequences of the extractive industry. The paper highlights the importance of balancing economic benefits and environmental risks, highlighting the need for new management strategies to ensure long-term sustainability. The occupation of the Eastern part of Ukraine significantly affected the country's economy and its financial system, which led to large material losses due to the physical destruction of housing, infrastructure, as well as social and industrial facilities. The decrease in the volume of coal production negatively affected the energy security of Ukraine, a significant part of our thermal power plants (TPPs) was left without the necessary fuel. Damage to coal mining and transport infrastructure, as well as the closure and flooding of mines as a result of hostilities. The occupation has serious environmental consequences, such as water pollution and destruction of buildings. At the same time, global warming has opened new opportunities for minerals in Greenland, sparking China's interest in controlling the region. However, the interests of Chinese investors turned out to be uncoordinated and limited, as the Chinese authorities do not put pressure on them to invest in ecology. China is also seeing the Arctic as an important new region for economic presence, which could lead to increased tensions with Denmark and the US. In addition to insufficient investment by the US and Denmark in Greenland, Chinese investment can be presented as an opportunity for economic development of the island, but at the same time raises fears in Denmark about the loss of control over natural resources. Greenland is trying to balance its desire for autonomy with Denmark's interests, while Ukraine faces geopolitical challenges due to its conflict with Russia. Both countries are developing mining industries, but have different challenges, including environmental, social and political. However, after the start of the war, new problems arose that required large capital investments and quick decision-making.

Keywords: extractive industry, Ukraine, Greenland, natural resources, ecology, investments, structural changes of the economy.