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FROM MINE TO BATTLEFIELD

Critical materials for the defence industry

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EXECUTIVE SUMMARY

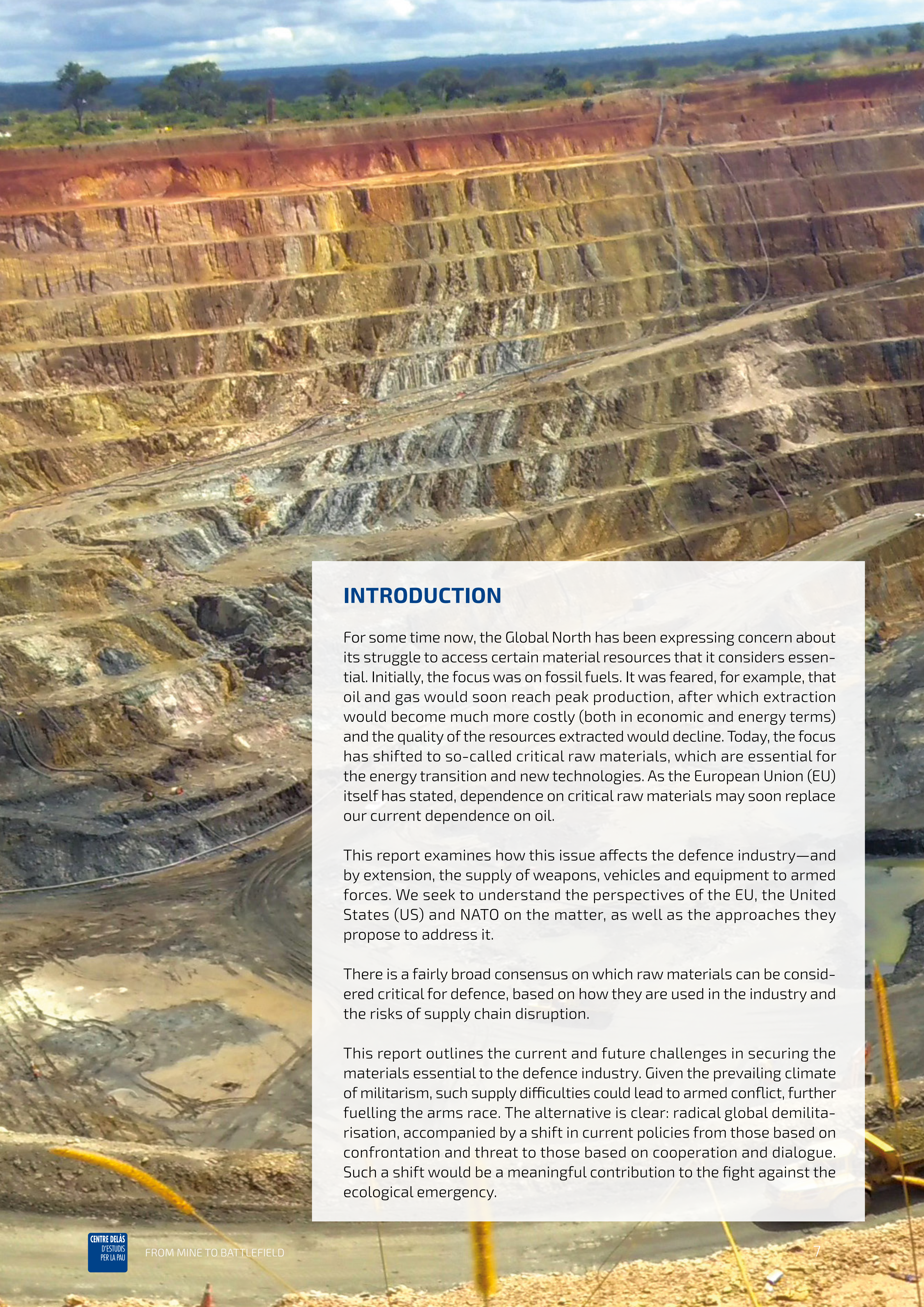
The energy transition and emerging technologies inevitably require certain materials for which there are currently no viable substitutes with the same level of efficiency. When these materials are scarce or not readily available, they are classified as critical. This report focuses on the needs of the defence industry for such critical materials. This is a pressing issue, as difficulties in accessing these materials could disrupt the supply of weapon systems to armed forces.

The first section of the report looks at the specific needs of the defence sector. It draws on official documents and statements from both the United States and the European Union, as well as reports from various research institutes.

The second section examines how the issue of access to critical materials is perceived by government agencies in the US and the EU. It also outlines the various strategies that have been proposed to deal with the problem, both from a governmental perspective and from the research institutes mentioned above. These strategies include military options, as set out in various security strategy documents.

The third section discusses the wider environmental and social impacts of mining, with a particular focus on some of the materials identified as critical.

The report concludes with a section containing several final considerations. It suggests that a drastic reduction in military spending, and therefore arms production, would ease the geopolitical tensions caused by supply problems in the military industry, not to mention diminish the environmental impact of militarism, ultimately making the world a safer and more sustainable place.



INTRODUCTION

For some time now, the Global North has been expressing concern about its struggle to access certain material resources that it considers essential. Initially, the focus was on fossil fuels. It was feared, for example, that oil and gas would soon reach peak production, after which extraction would become much more costly (both in economic and energy terms) and the quality of the resources extracted would decline. Today, the focus has shifted to so-called critical raw materials, which are essential for the energy transition and new technologies. As the European Union (EU) itself has stated, dependence on critical raw materials may soon replace our current dependence on oil.

This report examines how this issue affects the defence industry—and by extension, the supply of weapons, vehicles and equipment to armed forces. We seek to understand the perspectives of the EU, the United States (US) and NATO on the matter, as well as the approaches they propose to address it.

There is a fairly broad consensus on which raw materials can be considered critical for defence, based on how they are used in the industry and the risks of supply chain disruption.

This report outlines the current and future challenges in securing the materials essential to the defence industry. Given the prevailing climate of militarism, such supply difficulties could lead to armed conflict, further fuelling the arms race. The alternative is clear: radical global demilitarisation, accompanied by a shift in current policies from those based on confrontation and threat to those based on cooperation and dialogue. Such a shift would be a meaningful contribution to the fight against the ecological emergency.

1. WHAT MATERIALS ARE CRITICAL TO THE DEFENCE INDUSTRY?

The military industry requires large quantities of a wide range of materials to produce its assets, including aircraft, ships, tanks, radar systems, detection equipment, missiles and much more. Some of these materials are readily available, while others may pose significant challenges in the future.

A recent study[1] by *the Hague Centre for Strategic Studies* assesses the criticality of some forty raw materials used by the EU defence industry. The assessment is based on two key parameters. The first is impact, which measures how frequently a material is used within the defence industry—in other words, how many defence applications rely on it. A material that is used in many defence applications is considered to have a very high impact, as opposed to one that is used in only a few.

The second parameter is the likelihood of supply chain disruption. In the short term, the security of supply of a given material depends on whether its supply chain is diversified and whether its production centres are located in reliable countries with which good relations exist. If this is not the case, the risk of disruption is considered to be very high.

Overall criticality is assessed by combining these two parameters, allowing materials to be classified into four categories: (1) very high criticality materials; (2) high criticality materials; (3) medium criticality materials; and (4) low criticality materials. Table 1 lists the materials analysed, classified according to their criticality.

This study does not cover materials related to cybersecurity or space technologies. The analysis focuses on the EU defence industry, but the findings are likely to be broadly applicable to the US and UK industries, given the similarities in both the products involved and the potential strategic rivals and alliances.

1. Girardi, B.; Patrahau, I.; Cisco, G.; Rademaker, M. (2023) *Strategic raw materials for defence. Mapping European industry needs*. The Hague Centre for Strategic Studies. Available at: https://hcss.nl/wp-content/uploads/2023/01/Strategic-Raw-Materials-for-Defence-HCSS-2023-V2.pdf

Table 1. Materials classified according to their criticality

criticality	material
very high	aluminium, graphite
high	cobalt, germanium, neodymium, samarium, tantalum, tungsten, vanadium, yttrium, dysprosium, lanthanum, platinum, praseodymium, silicon metal, terbium, beryllium, chromium, copper, iron/steel, nickel, titanium
medium	barium, borates, cadmium, gallium, indium, lead, manganese, molybdenum, silver, niobium, thorium, tin, zinc, zirconium, lithium
low	gold, hafnium, selenium

Source: Authors' own work with data from *The Hage*, 2023

1.1 VERY HIGH CRITICALITY MATERIALS

The materials in question are aluminium and graphite. These are the most widely used materials in the defence industry and have a high probability of supply disruption.

They are found in aircraft (fighter jets, transport aircraft, maritime patrol aircraft and unmanned aerial vehicles), helicopters (both combat and multi-role), aircraft carriers, amphibious assault ships, corvettes, patrol vessels, frigates, submarines, tanks, infantry fighting vehicles, artillery systems and missiles. These materials are used in various components such as the airframes and propulsion systems of helicopters and aircraft, as well as the on-board electronics of aircraft carriers, corvettes, submarines, tanks and infantry fighting vehicles. As such, any disruption to their supply would have a very significant impact, given the wide range of defence applications involved.

Europe is dependent on China for the supply of both materials. China is the world's leading producer of graphite,[2] accounting for 77% of world production, followed by Madagascar and Mozambique with 6% each. For aluminium, China remains the world's largest producer,[3] but with a smaller share (60%), followed by India (6%) and Russia (5%).

China and the EU are already engaged in a series of tit-for-tat trade sanctions. If the situation deteriorates further and imports of graphite and aluminium from China are disrupted, the EU would struggle to find alternative suppliers to make up the shortfall, given China's dominant position in the global market for both materials. If tensions between Europe and China escalate, the likelihood of supply chain disruptions is high.

That is why aluminium and graphite are classified as very high criticality materials, given both the high impact of these materials (due to their widespread use) and the likelihood of supply disruption.

1.2 HIGH CRITICALITY MATERIALS

Cobalt, germanium, neodymium, samarium, tantalum, tellurium, tungsten, vanadium and yttrium are materials subject to considerable geopolitical risk, although their use in the defence industry is moderate.

Yttrium, germanium, neodymium, tellurium and tantalum are mainly used in the electronics of infantry fighting vehicles, armoured personnel carriers and both self-propelled and towed artillery. Vanadium's primary application is in the on-board electronics of submarines, while tungsten is mainly found in the propulsion systems of aircraft, helicopter carriers, amphibious assault ships, corvettes, offshore patrol vessels and frigates. Cobalt and samarium are mainly used in cobalt-samarium alloys for aircraft, helicopters and missile propulsion systems.

The supply risks associated with these materials again stem from China's dominant position in their global production, in some cases more than 80%. For example, China produces 93% of the world's germanium,[4] 80% of its tungsten[5] and 68% of its rare earths,[6,7] all of which present the same risks discussed above.

The case of cobalt is different, with 73% of the world's production coming from the Democratic Republic of the Congo (DRC),[8] followed by Indonesia (5%) and Australia (3%). However, 15 of the 19 cobalt mines in the DRC are either owned by Chinese companies or have significant Chinese financial involvement. This, combined with the country's internal instability, heightens the risk of a cobalt supply disruption.

2. Government of Canada (2025), «Graphite facts», *Natural Resources Canada*. Available at: https://natural-resources.canada.ca/minerals-mining/mining-data-statistics-analysis/minerals-metals-facts/graphite-facts Accessed on 19/02/25
3. Harbor Aluminum. (2025). «Aluminum Production by Country». Available at: https://www.harboraluminum.com/en/top-aluminum-producing-countries Accessed on 19/02/25
4. Statista. (2025). «Germanium global production share by country». Available at: https://www.statista.com/statistics/1445497/germanium-share-of-production-worldwide-by-country/ Accessed on 19/02/25
5. Arora, A. (2024). «Top-10 Tungsten Producing Countries in the World». *Current Affairs Adda 247*. Available at: https://currentaffairs.adda247.com/top-10-tungsten-producing-countries-in-the-world/ Accessed on 19/02/25
6. Rare earths are a group of 17 chemical elements in Group 3 of the Periodic Table, comprising the lanthanides (lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium), scandium and yttrium.
7. Zhu, Kayla. (2024). «Visualizing Global Rare Earth Metals Production (1995-2023)», *Visual Capitalist*. Available at: https://www.visualcapitalist.com/visualizing-global-rare-earth-metals-production-1995-2023/ Accessed on 19/02/25
8. MINING.COM. (2023). «Ranked: The world's top cobalt producing countries», *Visual Capitalist – Elements*. Available at: https://www.mining.com/web/ranked-the-worlds-top-cobalt-producing-countries/ Accessed on 19/02/25

The DRC is also the leading producer of tantalum,[9] accounting for 41% of global production, followed by Rwanda (22%) and Brazil (15%). The internal instability of these countries makes the supply chain for this material highly vulnerable, with few viable alternatives in the event of a disruption among the main producers.

The use of dysprosium, lanthanum, platinum, praseodymium, silicon metal and terbium in military applications is extremely limited. Dysprosium is mainly used in propulsion systems and airframes for aircraft and missiles. Praseodymium is used exclusively in aircraft propulsion and electronic systems, platinum in submarine and aircraft propulsion systems, and silicon metal *in missile radomes* (the protective housing for antennas).

However, the supply chains for these materials are highly exposed to geopolitical risks. Dysprosium, terbium, lanthanum and praseodymium are all rare earth elements, most of which are mined in China, which accounts for 68% of global production. Silicon metal is also largely mined in China (77%).[10] In contrast, platinum is mainly mined in South Africa (71%), followed by Russia (12%) and Zimbabwe (7%). South Africa is seen as an unreliable supplier and with Russia as the second largest producer, the risk of platinum supply disruption is high.

The reliability of producers of these materials is generally low, raising the likelihood of geopolitical risks and security of supply issues to a high level.

Beryllium, chromium, copper, iron/steel, nickel and titanium are all used significantly in the defence industry—albeit to a lesser extent than graphite and aluminium—and are found in numerous applications in all three military domains: air, sea and land. Their wide range of applications makes them critical materials. However, as the primary producers of these resources are countries with good relations with the EU, the risk of supply disruption is considered low. They are therefore classified as high-risk materials.

For example, the US produces 64% of the world's beryllium,[11] although China follows with 26%. Copper production is well diversified,[12] with Chile accounting for 24%, DRC 11% and Peru 11%. The leading producers of iron/steel are Australia (38%) and Brazil (16%),[13] while China is the largest producer of refined materials, including both copper (43%) and iron/steel (61%).

1.3 MEDIUM CRITICALITY MATERIALS

Barium, borates, cadmium, gallium, indium, lead, manganese, molybdenum and silver are considered less problematic as they have fewer military applications than the materials discussed above. The risk of supply chain disruption for these materials is only moderate, as their production is diversified and the supplying countries have good relations with the EU.

Niobium, thorium, tin, zinc and zirconium have relatively limited military applications. Although there may be some risk of supply disruption, they are also included in this medium-risk group.

Lithium is mainly used in lithium-ion batteries for electric motors. While global demand for lithium is largely driven by civil commercial applications, the diversity of supply sources means that security of supply is considered to be of medium impact.

1.4 LOW CRITICALITY MATERIALS

Of the materials analysed, only three used in the defence industry are considered to have a low risk in their supply chains: gold, hafnium and selenium.

The supply of gold is well diversified and many of its producers are reliable partners of the EU. As a result, the likelihood of supply chain disruption is minimal.

Naturally, the criticality vary between the different military domains—land, air and sea—as each relies on different materials in different proportions. Table 2 shows the level of criticality associated with each material in different military applications, providing a useful point of reference.

9. Pistilli, M. (2024). «Top 5 Tantalum-mining Countries (Updated 2024)». *Nasdaq*. Available at: https://www.nasdaq.com/articles/top-5-tantalum-mining-countries-updated-2024 Accessed on 19/02/25
10. CRM Alliance. (n.d.). «Silicon Metal». Available at: https://www.crmalliance.eu/silicon-metal Accessed on 19/02/25.
11. European Commission (2025). «Beryllium». *RMIS – Raw Materials Information System*. Available at: https://rmis.jrc.ec.europa.eu/rmp/Beryllium Accessed on 19/02/25.
12. European Commission (n.d.). «Copper». *RMIS – Raw Materials Information System*. Available at: https://rmis.jrc.ec.europa.eu/rmp/Copper Accessed on 19/02/25.
13. European Commission (n.d.). «Iron & Steel». *RMIS – Raw Materials Information System*. Available at: https://rmis.jrc.ec.europa.eu/rmp/Iron%20&%20Steel Accessed on 19/02/25.

Table 2. Criticality of raw materials in military applications

	Fighter jets	Tanks	Missiles	Submarines	Corvettes	Artillery	Ammunition	Torpedoes	Assault rifles
Very high criticality	aluminium, graphite	aluminium, graphite	aluminium	aluminium, graphite	aluminium, graphite	aluminium, graphite	aluminium, graphite	aluminium	
High criticality	beryllium, chromium, cobalt, copper, dysprosium, germanium, iron/steel, lanthanum, nickel, neodymium, platinum, praseodymium, samarium, tantalum, titanium, tellurium, terbium, tungsten, vanadium, yttrium	beryllium, chromium, copper, germanium, iron/steel, neodymium, nickel, tantalum, tellurium, titanium, tungsten, vanadium, yttrium	chromium, cobalt, copper, dysprosium, iron/steel, neodymium, nickel, praseodymium, samarium, silicon metal, tantalum, titanium, tungsten	chromium, cobalt, iron/steel, platinum, samarium, titanium, tungsten, vanadium	cobalt, chromium, copper, iron/steel, nickel, samarium, titanium, tungsten	beryllium, chromium, copper, germanium, iron/steel, neodymium, nickel, tantalum, tellurium, vanadium, yttrium	beryllium, copper, germanium, neodymium, tantalum, tellurium, titanium, yttrium	chrome	iron/steel, vanadium
Medium criticality	barium, borates, cadmium, gallium, indium, lead, lithium, manganese, molybdenum, niobium, silver, tin, thorium, zinc, zirconium	borates, cadmium, gallium, indium, manganese, molybdenum, selenium, thorium, zinc	borates, lead, lithium, niobium, molybdenum, zirconium	barium, lead, lithium, manganese, niobium, silver	barium, lead, lithium, molybdenum, manganese	cadmium, molybdenum, manganese, indium	cadmium, indium	lead, lithium, manganese, zirconium, silver	
Low criticality	gold, hafnium, selenium	hafnium		hafnium	gold				

Source: Authors' own work with data from *The Hage*, 2023

2. PERCEPTIONS OF THE ISSUE AND PROPOSED RESPONSES

2.1 PERCEPTION AND PROPOSED RESPONSES: THE UNITED STATES

The United States Energy Act of 2020 . defines a "critical mineral" as a non-fuel mineral or mineral material that is essential to the economic or national security of the country and whose supply chain is vulnerable to potential disruption. The White House and the Department of Defense (DoD) consider critical materials to be vital to national security.[14]

In the defence context, critical materials refer to elements, metals and other substances that are not sufficiently available from domestic sources, but are essential to weapons systems. The DoD maintains a strategic stockpile of such materials. Despite their importance, many of these materials are outsourced from countries that are US competitors—a situation that is considered a risk to national security.

Rare earths and other critical materials such as tantalum and tungsten have no equivalent substitutes that can perform at the same level.

Most of these materials are mined and processed in China, leaving DoD weapon system programmes vulnerable to supply chain disruptions imposed by a rival state.

For instance, China dominates the mining and processing of rare earths. These are critical materials with unique magnetic and heat-resistant properties that are highly valuable to DoD weapons systems. One example is neodymium, a rare earth element used to make magnets that are exceptionally strong, retain their magnetic force at high temperatures and perform reliably under extreme conditions, such as those encountered in combat.

Rare earth mining capacity in the US has declined over the past 40 years, owing to the emergence of low-

14. U.S. Government Accountability Office. (2024). *Critical materials: Action needed to implement requirements that reduce supply chain risks*, Q&A Report to Congressional Committees, *No. GAO-24-107176*. Available at: https://www.gao.gov/products/gao-24-107176 Accessed on 19/02/25

er-cost suppliers in other countries, such as China, and the significant environmental impact of mining operations. According to DoD officials, the US enforces stricter environmental regulations than China, allowing the latter to mine and process rare earths and certain other critical materials at a lower cost.

Between 2019 and 2022, the US imported more than 95% of the rare earths that it consumed, with nearly three-quarters of those imports coming from China. If China were to stop selling to the US. the latter would lose access to these materials and be forced to find alternative options.

So what is the DoD doing to reduce its reliance on China and secure critical material supplies? First, it is undertaking several initiatives to reduce its dependence on rival nations for critical materials. It is also taking steps to encourage the expansion of domestic mining, processing and production of these materials. Since 2020, the DoD has committed over $439 million to build domestic supply chains for rare earth elements.[15]

The DoD also maintains a strategic stockpile of materials deemed essential to national defence and civilian life. A 2019 act prohibits sales from this stockpile to certain adversaries, unless such sales are deemed to be in the national interest. However, the DoD has not fully implemented this legislation.

Adam Burstein, a senior official in the Office of the Assistant Secretary of Defense for Industrial Base Policy, said in January 2025 that the focus must be on increasing domestic mining and processing[16]. The US currently has only one active rare earth mine. Last year, the US awarded several grants to projects in Canada, which have also received funding from the Canadian government. These initiatives, said Burstein, are aimed at bolstering the security of supply of key materials such as cobalt, graphite and tungsten.

In *a* 2024 report,[17] the Carnegie Endowment for International Peace assessed the situation and offered several considerations and potential actions to help mitigate the problem.

15. Todd Lopez, C. (2024). «DOD Looks to Establish 'Mine-to-Magnet' Supply Chain for Rare Earth Materials», *U.S. Department of Defense*. Available at:https://www.defense.gov/News/News-Stories/Article/Article/3700059/dod-looks-to-establish-mine-to-magnet-supply-chain-for-rare-earth-materials/ Accessed on 19/02/25
16. Vergun, D. (2025). «Securing Critical Minerals Vital to National Security, Official Says». *U.S. Department of Defense*. Available at: https://www.defense.gov/News/News-Stories/Article/Article/4026144/securing-critical-minerals-vital-to-national-security-official-says/ Accessed on 19/02/25
17. Wischer, G. (2024). «The U.S. Military and NATO Face Serious Risks of Mineral Shortages». *Carnegie Endowment for International Peace*. Available at: https://carnegieendowment.org/research/2024/02/the-us-military-and-nato-face-serious-risks-of-mineral-shortages Accessed on 19/02/25

Both the United States and Europe are heavily dependent on mineral imports, including from rival powers such as China, which supplies graphite, rare earths and other minerals, and Russia, which supplies aluminium, nickel and titanium.

The US and its allies are struggling to secure supplies of critical minerals in a global context where China dominates mineral production and NATO countries are at a relative disadvantage. There are three main risks that could lead to mineral shortages: export controls; growing military demand as global power competition intensifies (including the potential for conflict between the US and China); and disruptions to maritime trade routes.

First, export controls are a pressing challenge. In 2021, China effectively banned graphite exports to Sweden, and by the end of 2023 it introduced export restrictions on gallium, germanium and graphite to all countries. Most US imports of these minerals come from China, and indeed Chinese exports of gallium and germanium have fallen sharply. In December 2023, Beijing also banned the export of technology used to make rare earth magnets. China could potentially extend export controls to other minerals such as bismuth, tantalum and rare earth elements.

The second risk stems from the surge in production of both defence platforms and munitions—an increase primarily aimed at replenishing stockpiles depleted by support for Ukraine.

The third risk emanates from rising tensions and the potential for conflict in the Taiwan Strait, which would disrupt maritime trade routes carrying minerals from East Asia, a key supply region for the US and other NATO members. Japan and South Korea are major mineral producers with substantial reserves, and the US and NATO would struggle to gain access to these resources if conflict broke out in East Asia. The same is true for Australia. In 2023, the US Department of Defense estimated that there would be shortages of 69 materials in the event of a large-scale conventional conflict between the US and China.

The DoD is working to expand domestic mineral production in the United States by providing funding to local producers. This entails building new refineries, expanding existing facilities and reactivating dormant sites. Mining projects require significant upfront capital to get off the ground and take years to generate a return on investment, discouraging companies from committing millions to such ventures. Governments in the US and allied countries should therefore step in to fill this private-sector gap by providing capital to support these projects

The US Congress is authorising and appropriating funds for new purchases of materials for the National Defense Stockpile. Both the US and NATO need to step up these efforts.

Materials produced in the US and allied countries should be stockpiled. Governments could even consider pre-paying for these materials to help finance exploration projects. Such stockpiles could be financed by higher tariffs on minerals imported from China and Russia.

2.2 PERCEPTION AND PROPOSED RESPONSES: NATO

NATO Ministers of Defence approved a supply chain security roadmap at their June 2024 meeting.[18] The roadmap outlines specific opportunities for collective and/or multinational cooperation to protect allied supply chains from potential disruptions that could undermine NATO's deterrence and defence capabilities.

For NATO, the responsiveness, strength, resilience and security of supply chains are essential to protecting allied industry and ensuring that the Alliance can develop military capabilities free from the hostile influence of potential adversaries.

NATO has identified 12 critical raw materials that are essential to the production of advanced defence systems and equipment.[19] They are: aluminium, beryllium, cobalt, gallium, germanium, graphite, lithium, manganese, platinum, rare earths, titanium and tungsten. In reality, the number is higher because the rare earths category includes several elements. NATO regards the secure availability and supply of these materials as vital to maintaining its technological edge. Disruptions in their supply could hinder the production of essential defence equipment. The roadmap identifies a number of key actions: identifying critical materials as a first step in building stronger, better protected supply chains; making recommendations for strategic stockpiling; identifying opportunities for recycling and substituting key strategic materials; and establishing a NATO community of interest focused on the defence supply chain.

2.3 PERCEPTION AND PROPOSED RESPONSES: THE EU

The EU 2020 report on critical raw materials [20] identifies seven emerging technologies as important for European defence: advanced batteries, fuel cells, photovoltaics, robotics, unmanned vehicles, 3D printing, and information and communication technologies.

A total of 39 raw materials are identified as the most necessary for the production of alloys and composites, and thus for the production of defence subsystems and components. Of these 39 raw materials, 22 are considered critical to the EU economy. The EU is the world's leading supplier of only one of them: hafnium. These materials are listed in Table 3.

Table 3. Essential and critical raw materials for the EU, according to the 2020 report.

Essential raw materials	Aluminium, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, rhenium, thorium, tin, zinc, zirconium, silver, gold, selenium
Critical raw materials	Indium, tantalum, gallium, lithium, titanium, barium, germanium, magnesium, tungsten, cobalt, beryllium, hafnium, niobium, vanadium, platinum, boron, dysprosium, samarium, neodymium, yttrium, praseodymium, other rare earth elements

Source: Authors' own work

A particular challenge for the European defence industry is the supply of processed materials, including the associated knowledge and processing capabilities. The EU has limited capacity to produce special composite materials. In some cases, the defence sector requires special steels or alloys, often with a higher degree of purity than those used in civil applications. The EU is totally dependent on imports for 13 of the 39 identified raw materials (boron/borates, dysprosium, gold, magnesium, molybdenum, neodymium, niobium, praseodymium, samarium, tantalum, titanium, yttrium and other rare earth elements). Overall, more than two-thirds of these materials have an import rate above 50%.

According to the criticality ratings assigned to these 22 critical raw materials and their use in specific sub-sectors, the aerospace and electronics industries

18. NATO. (2024). «Defence-Critical Supply Chain Security Roadmap». *Factsheet July 2024*. Available at: https://www.nato.int/nato_static_fl2014/assets/pdf/2024/7/pdf/240712-Factsheet-Defence-Supply-Chain-Ro.pdf Accessed on 19/02/25
19. NATO. (2024). «NATO releases list of 12 defence-critical raw materials». *Newsroom*. Available at: https://www.nato.int/cps/en/natohq/news_231765.htm Accessed on 19/02/25

20. European Commission (2020). *Critical Raw Materials for Strategic Technologies and Sectors in the EU: A Foresight Study*. Luxembourg Publications Office of the European Union. Available at: https://rmis.jrc.ec.europa.eu/uploads/CRMs_for_Strategic_Technologies_and_Sectors_in_the_EU_2020.pdf

are most vulnerable to potential supply constraints. Given the strategic importance of the defence and aerospace sectors to Europe's security, it is essential that the associated manufacturing industries operate without interruption. To this end, the European defence industry needs to ensure the continuous supply of certain raw materials from international sources, maintain its world leadership in the production of high-performance alloys and special steels, and further develop its capabilities in the production of special composite materials.

The aerospace sub-sector in particular requires a large number of highly specialised and complex materials, including certain composites and alloys as well as titanium, graphite and fibreglass. The most important are: aluminium alloys, steel alloys, titanium alloys, superalloys, composites and other materials such as ceramics, GLARE (a laminate of fibreglass and aluminium with epoxy resin), magnesium and special alloys. Traditional materials are constantly being replaced by new lightweight alternatives such as titanium alloys, composites (particularly glass and carbon fibre) and high-temperature plastics. These materials offer increased strength and reduced weight. In the defence industry, this means improved manoeuvrability and extended range (through reduced fuel consumption) for fighter jets. However, the EU lacks major producers of aerospace-grade carbon fibre, which is currently produced mainly in Japan and the US. At present, there is a low-to-medium bottleneck in the supply chain of aerospace materials and other semi-finished products used by the EU defence industry.

2.4 MATERIALS USED IN SPACE APPLICATIONS

A marked increase in the satellite population is expected in the coming decades. This could affect the availability of certain advanced materials—including carbon fibres, resins and special alloys—for European space projects (spacecraft, satellites, launchers, etc.) in the same time frame.

The European Space Agency (ESA) has published information on the raw and advanced materials needed in the space sector:

- There are concerns about the availability of high-modulus carbon fibre composites for space applications. There is only one producer (based in Japan) and the European industry has access to only a limited part of its production, the majority being reserved for the US market.

- European resin production capacity is limited (one or two companies).

- There is some concern about the availability of high-strength aluminium alloys, given the small quantities required by the market.

End-of-life recycling remains a challenge. ESA has investigated the use of recycled germanium in solar arrays. Beyond that, recycled materials are not currently considered for most space applications, which rely exclusively on virgin materials. The recovery of materials at the end of a mission is unrealistic due to the current design of space missions, which results in the systematic dispersal of materials either in space or during atmospheric re-entry.

For the seven emerging technologies mentioned above, supply chain bottlenecks are obstructing raw material sourcing and final assembly. This is particularly true for lithium-ion and fuel cell batteries, but also, to a lesser extent, for drones. The EU's dependence on imported raw materials for these emerging technologies is extremely high. On average, the EU produces only around 3% of the total raw materials needed for these technologies (excluding digital technologies). China dominates global production, supplying more than half of the raw materials, with the rest coming from many small suppliers. In terms of components, solar photovoltaic technologies and robotics are the most vulnerable, although there are also supply risks for lithium-ion batteries and drones. The supply of processed materials has proven to be particularly critical for lithium-ion batteries.

The main suppliers of raw materials used in the defence sector are China (58%), South Africa (8%), Chile (8%) and the US (2%), with the remaining 24% sourced from other countries.

A number of measures need to be taken to improve the security of supply of raw and processed/semi-finished materials for the European defence and aerospace industries, including:

- Supporting R&D programmes focused on developing advanced, high-tech materials;

- Strengthening the supply chain for these materials, in particular for processed materials, together with the associated knowledge and processing capabilities; and

- Improving the knowledge base on the materials used, for example by promoting the exchange of information between all relevant stakeholders.

With regard to the supply risk of materials for emerging defence and aerospace technologies, it is vital that the EU reduces its dependence and increases security by diversifying its supply of both raw materials and components. In addition to boosting domestic production, other strategies include substituting critical materials, recycling and identifying alternative suppliers. Stockpiling could also be an option to mitigate short- and medium-term supply disruptions in times of crisis.

The latest EU report on critical materials, published in 2023, provides further insights.[21] It cites the OECD's forecast that overall global demand for materials will double from over 79 billion tonnes today to 167 billion tonnes by 2060. Competition for resources is expected to become fierce over the next decade. Dependence on critical raw materials may soon supersede our current dependence on oil. Critical raw materials are often produced and consumed in relatively small quantities, but have special properties that make them essential components of products in strategic sectors such as aerospace and defence technologies.

The EU mines 34% of the world's strontium (Spain), 14% of its feldspar (Italy, Spain, France, the Czech Republic, Germany, etc.) and 3% of its tungsten (Austria, Portugal and Spain). The EU also processes and refines 49% of the world's hafnium (France), 18% of its antimony (Belgium, France, Spain and many other countries), 17% of its cobalt (Finland, Belgium and France), 7% of its germanium (Germany and Belgium), 5% of its silicon metal (France, Spain and Slovakia) and 4% of its nickel (Finland, Greece and France). In 2023, Belgium was the EU's main supplier of arsenic (59%), Finland provided 38% of the EU's nickel consumption, Qatar was the leading supplier of helium (35%) and South Africa was the main source of manganese (41%).

China is the world's and the EU's largest supplier of most critical raw materials, including barite, bismuth, gallium, germanium, magnesium, natural graphite, all rare earth elements, tungsten and vanadium.

The EU has increased its use of recycled raw materials. More than 50% of certain metals (iron, zinc, platinum, etc.) is recycled, covering more than 25% of EU consumption. However, for others, in particular rare earths, gallium and indium, secondary production plays only a marginal role.

Where data are available, the report assesses both phases of the supply chain: the extraction phase (including the production of minerals, concentrates or wood) and the processing phase (including the separation, refining and chemical or metallurgical transformation of raw materials).

The 2023 report proposes 34 raw materials as critical for the EU. The list includes those considered strategic, i.e. materials that rank highest in terms of strategic importance, projected growth in demand and difficulty of increasing production.

The materials are as follows (strategic materials in italics): aluminium/bauxite, antimony, arsenic, barite, beryllium, *bismuth*, *boron*/borate, *cobalt*, coking coal, feldspar, fluorspar, *gallium*, *germanium*, hafnium, helium, *dysprosium*, *erbium*, *europium*, *gadolinium*, *holmium*, *lutetium*, *terbium*, *thulium*, *ytterbium*, *yttrium*, *lithium*, *cerium*, *lanthanum*, *neodymium*, *praseodymium*, *samarium*, *magnesium*, *manganese*, *natural graphite*, niobium, *iridium*, *palladium*, *platinum*, *rhodium*, *ruthenium*, phosphorite, *copper*, phosphorus, scandium, *silicon metal*, strontium, tantalum, *titanium*, tungsten, vanadium i *nickel*.[22]

Table 4. Materials considered critical according to the 2023 EU report

aluminium/bauxite, antimony, arsenic, barite, beryllium, *bismuth*, *boron*/borate, *cobalt*, coking coal, feldspar, fluorspar, *gallium*, *germanium*, hafnium, helium, *dysprosium*, *erbium*, *europium*, *gadolinium*, *holmium*, *lutetium*, *terbium*, *thulium*, *ytterbium*, *yttrium*, *lithium*, *cerium*, *lanthanum*, *neodymium*, *praseodymium*, *samarium*, *magnesium*, *manganese*, *natural graphite*, niobium, *iridium*, *palladium*, *platinum*, *rhodium*, *ruthenium*, phosphorite, *copper*, phosphorus, scandium, *silicon metal*, strontium, tantalum, *titanium*, tungsten, vanadium i *nickel*

Source: European Commission (2023). Strategic materials in italics

China is the world's leading supplier of critical raw materials and the primary source for 21 of them. These include both light and heavy rare earth elements, refined cobalt, natural graphite, nickel and other critical materials, namely antimony, arsenic, barite, bismuth, coking coal, refined copper, fluorspar, gallium, germanium, phosphate rock, phosphorus, scandium and silicon metal. In addition to China, other countries play a key role in the global supply of certain materials. For example, South Africa and Russia are the world's top suppliers of platinum group metals. The same is true of the DRC for cobalt and tantalum, the US for beryllium and Brazil for niobium.

21. European Commission (2023). *Study on the critical raw materials for the EU 2023*. Publications Office of the European Union. Available at: https://op.europa.eu/en/publication-detail/-/publication/57318397-fdd4-11ed-a05c-01aa75ed71a1

22. Copper and nickel do not meet the threshold for critical materials, but are considered strategic.

3. CHINA'S ROLE IN THE PRODUCTION OF CRITICAL MATERIALS

China is the world's largest producer of many critical materials essential to the defence industry. Table 5 shows the top three global producers of those materials considered to be very highly (in red) or highly (in orange) critical, as described in the relevant sections. Data are from the EU Raw Materials Information System.[23]

These figures refer to the production of refined materials rather than the extraction of raw materials through mining. In many cases, the country extracting the material is not the same as the country producing the refined product, as refining processes often take place in different locations. For example, the world's leading country in terms of copper extraction is Chile (25%), followed by the DRC (11%) and Peru (11%). However, in terms of refined copper production, China leads with 43%, followed by Chile (8%) and the DRC (7%).

It should also be noted that the data in Table 5 do not all pertain to the same year and may therefore differ from figures found in other sources. Nevertheless, it serves the purpose of providing a broad overview of the current global situation.

From the data presented in Table 5, it is clear that China plays a dominant role in the production of most refined critical materials. It is the world's largest producer of 18 of the 23 critical materials listed. In 10 of these cases, its production exceeds 60% of global output, in some instances reaching levels that could be considered monopolistic. Furthermore, in two of the five cases where China is not the world's leading producer, it is the second largest.

This means that if China were to stop exporting any of these 18 materials, it would be impossible to replace that supply. There would be no viable substitute.

23. European Commission (n.d.). «RMIS – Raw Materials Information System». Available at: https://rmis.jrc.ec.europa.eu/rmp/ Accessed on 19/02/25

Table 5. Leading global producers of materials classified as very highly (in red) and highly (in orange) critical

	leading producer	second largest producer	third largest producer
aluminium	China 58%	India 6%	Russia 6%
graphite	China 91%	Japan 6%	Germany 1%
cobalt	China 78%	Finland 8%	Canada 3%
germanium	China 94%	Russia 4%	Japan 1%
neodymium	China 62%	Myanmar 14%	US 11%
samarium	China 49%	Myanmar 26%	Australia 10%
tantalum	DRC 50%	Nigeria 17%	Rwanda 12%
tellurium	China 73%	Japan 10%	Russia 6%
tungsten	China 76%	Vietnam 16%	Russia 2%
vanadium	China 68%	Russia 18%	South Africa 8%
yttrium	China 42%	Myanmar 29%	Australia 21%
dysprosium	China 40%	Myanmar 31%	Australia 20%
lanthanum	China 57%	US 20%	Myanmar 11%
platinum	South Africa 74%	Russia 10%	Zimbabwe 9%
praseodymium	China 64%	US 12%	Myanmar 12%
silicon metal	China 80%	Brazil 5%	Norway 4%
terbium	China 57%	Myanmar 23%	Australia 14%
beryllium	US 64%	China 27%	Mozambique 28%
chrome	Kazakhstan 40%	India 23%	Finland 9%
copper	China 43%	Chile 8%	DRC 7%
iron/steel	China 61%	India 9%	Japan 6%
nickel	Indonesia 37%	China 27%	Japan 5%
titanium	China 37%	Canada 5%	Mozambique 8%

Source: Authors' own work from *Raw Materials Profiles* https://rmis.jrc.ec.europa.eu/rmp/, except for graphite, for which data were taken from the International Energy Agency (2024) report.

It is therefore not surprising that both the EU and the US are seeking alternatives to this situation. However, despite ongoing efforts, the short-term outlook is unlikely to change much. In a recent report,[24] the International Energy Agency (IEA) analysed the evolution of the market for materials essential to the energy transition and projected future demand and production. China is projected to remain the world's leading producer of graphite in 2040, with a 92% share of global supply, virtually unchanged from today. It is also expected to continue to dominate production of rare earths (78%, slightly down), cobalt (75%, little change), lithium (58%, slightly down) and copper (49%, slightly up). In short, the IEA estimates that China will still hold a dominant position in global production of critical materials in 2040.

Critical materials have long played a role in the ongoing trade war, primarily between the US and China. Both sides have consistently imposed export restrictions on certain products and materials with the aim of weakening the other's competitive position. A policy of confrontation has long since replaced one of cooperation. Below we review some of the key decisions on critical materials.

In November 2023,[25] China revised its technology export control catalogue. Among other measures and changes, it introduced a requirement for rare earth exporters to report the specific types of metals being exported and their intended destinations. Soon after, a new law came into force requiring prior approval for the export of graphite and gallium, a critical component in semiconductors. According to China, this move was in response to export restrictions imposed by the US and its allies on semiconductors and related technologies destined for China.

24. International Energy Agency (2024). *Global Critical Minerals Outlook 2024*. IEA, Paris. Available at: https://www.iea.org/reports/global-critical-minerals-outlook-2024

25. Brancaccio, Lucia. (2024). « China's Catalogue for Prohibited and Restricted Export Technologies: Latest Revisions» *China Briefing, From Dezan Shira and Associates.* Available at: https://www.china-briefing.com/news/technologies-subject-to-export-control-in-china-prohibited-restricted-export-catalogue/Accessed on 19/02/25

In December 2024,[26] China banned exports to the US of the critical minerals gallium, germanium and antimony, all of which have broad military applications. The move came a day after Washington introduced tough measures against China's chip sector. The Chinese order also required stricter verification of the end-use of graphite materials exported to the US.

In a context of tension and confrontation with China, its dominant role in the refined critical materials market could lead to supply disruptions. This would hamper the energy transition and efforts to end dependence on fossil fuels (the difficulties faced by the defence industry are not our concern). All these challenges would vanish if relations with China were to move towards cooperation and mutual support. Until that point is reached, the problem could be partially alleviated by relocating refining processes to countries other than China. Of course, this would not be possible in cases where China is also the main primary producer, i.e. the country where the raw material is mined. However, it would be feasible in the few cases where China is not the leading extractor. For example, 69% of cobalt is mined in the DRC, while 78% of refined cobalt is produced in China. Similarly, iron/steel is mainly mined in Australia (38%), while China accounts for 61% of the refined product.[27] Although these cases are few, targeted investment to expand the number of countries involved in mineral refining could weaken China's dominant position. Increased recycling of raw materials would also help to reduce dependence on Chinese supply.

26. Lv, Amy; & Munroe, Tony. (2024). «China bans export of critical minerals to US as trade tensions escalate». *Reuters*. Available at: https://www.reuters.com/markets/commodities/china-bans-exports-gallium-germanium-antimony-us-2024-12-03/ Accessed on 19/02/25

27. European Commission (n.d.). «RMIS – Raw Materials Information System» Available at: https://rmis.jrc.ec.europa.eu/rmp/ Accessed on 19/02/25

4. EU AND NATO SECURITY STRATEGIES

Beyond the wide range of measures already under way or planned for the future, it is important to recall that other, far more militaristic responses are also being considered. Both NATO and the EU state in their respective security strategy documents that the scarcity of fossil fuels poses a threat to energy security.[28] Oil, gas, coal, uranium and critical materials have become matters of national security. Neither has ruled out the use of military intervention to ensure their energy security. Such potential military action would in turn lead to greater demand for weapons, increased production, more raw material extraction and greater environmental impact.

EUROPEAN UNION

The *EU's 2008 Global and Security Strategy* identified climate change as a driver of future natural disasters and droughts—especially in poor countries—and as a trigger for unrest, political instability and social conflict, all of which could lead to large-scale migration and further exacerbate global tensions. The EU stresses that access to energy is vital to security. Any disruption of essential resources by third parties can be seen as a threat and potentially justify a military response.

28. Bohigas, X., Brunet, P., de Fortuny, T., Montull Garcia, A., & Ortega, P. (2024). *Transnacionals, bellicisme i emergència climàtica (Informe 55).* Centre Delàs. Available at: https://centredelas.org/publicacions/bellicismeiemergenciaclimatica/

NATO

At the NATO Summit in June 2022, the Alliance outlined the threats it must be prepared to face. These include climate change, pandemics and food insecurity, all of which have the potential to spark conflict, which in turn could lead to irregular migration. Cyberattacks or hostile actions targeting critical infrastructure and energy supply chains could also be treated as an armed attack, triggering a military response from NATO members.

In short, the West is prepared to defend its way of life—even though it is largely responsible for the environmental and energy crises—by strengthening its military capabilities to secure access to all the raw materials it needs.

5. ENVIRONMENTAL IMPACT OF MINING

5.1 ENVIRONMENTAL IMPACT

Mining is one of the most significant industrial activities in terms of environmental impact when its full life cycle is considered.[29] This life cycle includes the disposal of waste and toxic materials from mines, acid mine drainage and energy consumption, not to mention the associated greenhouse gas emissions.

Mining accounts for between 8% and 10% of global energy consumption. Of this, 17% is used for transport, with a significant proportion also used for ventilation and pumping, particularly in underground mining.

29. Valero, A.; Valero, A.; y Calvo, G. (2021); *Thanatia, límites materiales de la transición energética*; Prensas de la Universidad de Zaragoza.

Open-pit mining is currently the dominant method. It is far more damaging to the environment than underground mining, as it involves the removal of much larger volumes of material and a greater reliance on heavier, larger machinery.

As ore concentrations in mines diminish, increasing amounts of material must be removed to maintain the same mineral yield, exacerbating the environmental impact. Energy, water and material consumption are also rising steadily. The likelihood of discovering new mineral deposits with high element concentrations is very low, so the environmental impact of mining is expected to become increasingly severe.

Mining operations affect the soil in a number of ways. In open-pit mining, the first step is to remove the top layer of soil not containing ore. Large quantities of material are displaced and piled up as waste. This process alters the original composition of the soil, increases erosion and can degrade water quality due to high levels of suspended solids. Underground mining, by comparison, creates voids in the subsoil that can lead to ground collapse.

Mining also has long-term environmental impacts. Among them is the strain it places on a vital resource: water. Both open-pit and underground mining can alter local watercourses and pollute nearby water sources. Water quality is affected by mine discharges, effluent from mining facilities and drainage water. When ore concentrations are low, more water is needed. In fact, the relationship between diminishing ore concentration and water demand is exponential. Water in the vicinity of a mine may contain low concentrations of metals and toxic residues from separation processes. Certain element concentrations can be extremely harmful to aquatic ecosystems and agriculture. In underground mining, groundwater is pumped to facilitate extraction, which can reduce the flow of nearby rivers. The large footprint of mines—including the excavation pit, processing plants, tailings ponds and mineral stockpiles—can also disrupt natural watercourses.

Extracting lithium from brine is very water intensive.[30] According to the IEA, an average of 330,000 litres of water is required to produce one tonne of lithium from brine. Other studies suggest that this figure could be as high as two million litres. This huge waste of water is only expected to increase. Indeed, the IEA predicts that demand from the electric vehicle and battery sectors will increase thirtyfold between 2020 and 2040—inevitably leading to a much higher demand for lithium. This type of lithium extraction is found, for example, in the salt flats of the Andes region.

In metal mining (iron, copper, tin, zinc, lead, gold, silver, etc.), once the ore has been extracted, it has to be processed and separated in processing plants. These activities generate waste that, if accumulated and left unmanaged, can cause water acidification. This is due to the high levels of sulphides found in mines, which, when exposed to oxygen in the air and water, produce leachate that lowers the pH of the water. This leachate-contaminated water forms large, highly acidic and toxic ponds or flows into rivers or underground water sources. Water acidification leads to soil nutrient depletion and often causes metals from various soil layers to become mobilised and dispersed, further polluting the environment.

Metal processing has harmful effects. The smelting process uses a reducing agent and a solvent to facilitate the reaction and requires high temperatures, achieved by burning fossil fuels, most commonly coal. The reducing agent is usually coking coal and the solvent, limestone. This whole process releases large amounts of CO_2, along with other pollutants such as sulphur dioxide. These gases can also produce smog, ozone, nitrogen and sulphur oxides, carbon monoxide and suspended particulate matter, all of which pollute the soil, air and waterways. The production of many metals requires large quantities of sulphuric acid, which can lead to acid rain. The slag produced during smelting contains significant amounts of heavy metals such as cadmium, lead, arsenic, nickel, copper and zinc. Proper treatment is essential to prevent these particles from polluting the air and water. According to the US Toxics Release Inventory. the metal mining industry is responsible for 9% of the country's mercury emissions. As mercury (a highly toxic element) is dispersed, it contaminates soil and water, reaching concentrations hundreds of times higher than recommended levels in some places.

5.2 SOCIAL IMPACT OF MINING

The health of people living near mining sites can be harmed by emissions and soil, water, and air pollution.

Mining also has other negative impacts, including socio-environmental conflicts, forced population displacement and the issue of illegal mining.

In Latin America, a region rich in mineral resources, all these problems are particularly acute. This has prompted the creation of the *Observatory of Mining Conflicts in Latin America*, which features a map pinpointing the location of every documented conflict.

Colombia has one of the highest rates of forced displacement in the world, a problem exacerbated by mining. The areas most affected are those inhabited by rural communities, indigenous peoples and Afro-descendants.

Illegal mining, particularly of gold, is widespread. Between 80% and 90% of gold production in Venezuela comes from illegal mining, as does 80% in Colombia, 77% in Ecuador, and 30% in Bolivia. Illegal gold mining not only displaces local communities, but also pollutes water sources through the use of mercury in the extraction process. This mercury is burned in an uncontrolled manner, destroying ecosystems.

In addition, some mining operations in Latin America fail to comply with the International Labour Organization's Convention 169 concerning Indigenous and Tribal Peoples in Independent Countries. Under the convention, affected communities must be con-

30. Observatori del Deute en la Globalització (2023). *La mina, la fàbrica, la botiga*. Available at: https://odg.cat/wp-content/uploads/2023/07/La-mina-la-fabrica-la-botiga.pdf

sulted to determine whether their interests would be harmed before anyone is allowed to explore or exploit resources on their land.

Another initiative that examines conflicts caused by mining is the Global Atlas of Environmental Justice .[31] The atlas allows users to filter conflicts based on raw material (commodity) and conflict type, including water use and degradation, biodiversity loss, waste management and population displacement. It also highlights the scale and severity of the problem.

31. Global Atlas of Environmental Justice (2025). Available at: https://ejatlas.org/ Accessed on 19/02/25

The negative impacts of mining are not limited to Latin American populations. One example alone illustrates the scale of the problem. The book *Cobalt Red: How the Blood of the Congo Powers Our Lives*[32] describes the conditions of near-slavery in the cobalt mines of Katanga, a region in the south-east of the DRC. The miners work without any protective equipment. When parents are seriously injured or suffer from lung disease caused by the dust they inhale, they are replaced by underage children. Some teenage girls even work with babies or very young children strapped to their backs.

32. Valiente, D. (2024), «El Congo se desangra para que tú te conecte**»**, *Librújula*. Available athttps://librujula.publico.es/el-congo-se-desangra-para-que-tu-te-conectes/ Accessed on 19/02/25

6. CONCLUSIONS

Today's military industry relies on a wide range of materials—many of which have never been used before—to make its vehicles, weapons and equipment. Without these materials, the manufacture of most modern military products would be impossible. They enable the creation of alloys with improved properties, smaller and more efficient devices, and the integration of many features that rely on electronic components. Many of these materials are also essential in the civil sector for developing technologies associated with the energy transition to a fossil-free system.

Due to potential supply challenges, some of these materials are classified as "critical". From the perspective of both the EU and the US, there is a group of such materials that are vital to the military industry and carry a high risk of supply disruption. If such a disruption were to occur, the production of certain weapons systems would be jeopardised.

The main problem for the EU and the US is that the production of these materials is concentrated in a small number of countries—many of which are seen as rivals and competitors, notably China. In most cases, neither the EU nor the US has sufficient domestic mineral resources to cope with a supply disruption. In addition, in many cases there are no viable substitutes for the production of certain components. To mitigate the risk of supply disruption, the EU and the US could seek alternative producers, although this is not always feasible, and increase recycling efforts. However, such measures would be unlikely to fully compensate for a supply disruption.

Securing a supply of critical materials essential to the military industry can lead to serious geopolitical tensions that may escalate into armed conflict. This is because both the EU and NATO, according to their defence policy documents, do not rule out the use of military force to guarantee access to resources deemed essential for the development of their member states.

The documents we reviewed clearly reflect the concern shared by both the US and the EU over the possibility that China (as the main producer) might disrupt or suspend exports of certain materials.

The EU currently views China as an economic competitor and a systemic rival.[33] But it should reconsider this stance and move towards a relationship based on dialogue, mutual understanding and cooperation. There is much to be gained from such an approach. It would also prevent the EU from being drawn into the economic and geopolitical disputes between the US and China.

For the US China is now its main rival in the struggle for global geopolitical and economic dominance. This antagonism could hinder US access to Chinese raw materials. The new US administration is unlikely to ease the situation. It is deeply worrying that the US and NATO are treating China as a threat to their security. If China were to cut off supplies of certain materials, how would the US respond? Would it resort to armed force? The threats are persistent. As we have noted in the case of the EU, the relationship between the US and China should also shift from one based on confrontation and threat to one based on cooperation and mutual support.

Given the close relationship between Europe's political leaders and the defence industry, it cannot be ruled out that sooner or later the industry will succeed in securing regulations that give it priority access to critical raw materials over the civilian sector. The defence industry's argument is easy to anticipate: the fundamental role of security in general and as a prerequisite for sustainable development in particular. This is the line that it is currently taking in order to be recognised as a sustainable sector and thus gain access to the EU's sustainable financing mechanisms. Such a scenario would pose an additional challenge to civilian sectors involved in energy transition and fossil fuel phase-out policies.

Political and economic power is increasingly driving the global trend towards militarisation—and the data confirm this. According to the Stockholm International Peace Research Institute (SIPRI), global military expenditure hit $2.44 trillion in 2023.[34] This represents an increase of 6.8% over 2022 and the highest year-on-year growth rate since 2009. It also reflects nine consecutive years of rising global military spending.

Demand for arms is therefore likely to increase, as is the environmental impact of mining the materials needed by the defence industry. Most of these critical materials are extracted from open-pit mines, and their extraction and refining processes are highly polluting, releasing huge amounts of greenhouse gases. To make matters worse, many of the countries that produce these materials have very lax environmental, labour and human rights regulations.

All of this leads us to the following conclusion: a drastic reduction in military spending, and therefore arms production, would undoubtedly ease the geopolitical tensions caused by supply problems in the military industry, not to mention diminish the environmental impact of militarism, ultimately making the world a safer and more sustainable place.

33. European External Action. (n.d.). «EU-China relations: Factsheet». *European Union*. Available at: https://www.eeas.europa.eu/eeas/eu-china-relations-factsheet_en

34. Stockholm International Peace Research Institute (SIPRI). (2024). «Global military spending surges amid war, rising tensions, and insecurity». *SIPRI for the media*. Available at: https://www.sipri.org/media/press-release/2024/global-military-spending-surges-amid-war-rising-tensions-and-insecurity Accessed on 19/02/25

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