United Nations A/HRC/54/25

General Assembly

Distr.: General
13 July 2023

Original: English

Human Rights Council
Fifty-fourth session
11 September–6 October 2023
Agenda item 3
Promotion and protection of all human rights, civil, political, economic, social and cultural rights, including the right to development

The toxic impacts of some proposed climate change solutions

Report of the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, Marcos Orellana

Summary

Pursuant to Human Rights Council resolution 45/17, the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, Marcos Orellana, presents to the Council his annual thematic report, in which he examines the toxic impacts of some proposed climate change solutions. Deep reductions of greenhouse gas emissions are urgent to tackle the global climate crisis. Decarbonization of the energy matrix and polluting sectors of the economy are indispensable to realizing the goals set out in the Paris Agreement. Yet, some climate technologies proposed in recent years may aggravate the toxic burden on people and planet. The Special Rapporteur puts forward recommendations aimed at accelerating decarbonization and detoxification strategies that are integrated and guided by human rights principles.

I. Introduction

1. Climate change poses an existential threat to humanity and the effective enjoyment of human rights. Addressing the climate emergency requires decisive action to decarbonize national economies and bring about reductions in greenhouse gas emissions. Acknowledging the risks posed by such climate action, the Paris Agreement reaffirms State obligations to respect, promote and consider human rights.

2. Pursuing the necessary decarbonization, States and companies are rallying to build new technologies and innovations to reduce greenhouse gas emissions and remove carbon from the atmosphere. Yet proposals for, and applications of, climate mitigation technologies are emerging that can exacerbate toxic pollution. This is particularly problematic given the human rights infringements resulting from intolerable levels of pollution around the world. Humanity cannot afford to aggravate the toxic burden of the planet.

3. The rapid mining of materials such as lithium, cobalt and rare earth elements to decarbonize the energy matrix, including for solar and wind energy sources and energy storage technologies, can cause water shortages and produce toxic mining wastes. These impacts are exacerbated where Governments waive environmental and social safeguards.

4. The transition towards the electrification of the transport sector is being undertaken without an adequate life-cycle assessment and often fails to account for the adverse impacts of extraction, use and generation of hazardous substances. For example, capacities for the sound environmental management of spent lithium-ion batteries in electric vehicles are yet to be designed and installed at scale.

5. Disinformation campaigns are downplaying the adverse human rights and climate impacts of certain climate mitigation technologies. Not only the fossil fuel and chemical industries,[1] but also the mining,[2] nuclear,[3] plastic and waste[4] industries, among others, are advancing false or misleading climate solutions.

6. The climate emergency does not justify action imposing toxic burdens on people and the environment that infringe on human rights. Decarbonization and detoxification strategies should be integrated and guided by human rights principles.

7. In the present report, the Special Rapporteur examines the interface between decarbonization and detoxification. It is informed by a broad consultative process in which he invited input from States Members of the United Nations, international organizations, non-governmental organizations, Indigenous Peoples, national human rights institutions and academics. He widely disseminated a call for input, in response to which he received numerous valuable submissions.[5] The Special Rapporteur also organized two online consultations in February 2023.[6]

8. The Special Rapporteur is grateful to those who shared their expertise, insights and perspectives in their written submissions and at online meetings; they have been incorporated into the findings of the report.

[1] A/HRC/48/61, para. 4.
[2] Submission by Transparency International.
[3] Derechos Humanos y Medio Ambiente and EarthRights International, *El rostro del litio y uranio en Puno: La cultura, salud, derechos de las comunidades y medio ambiente en riesgo* (Lima and Puno, 2022) (in Spanish), p. 37.
[4] A/76/207, para. 22; and submission by Global Alliance for Incinerator Alternatives.
[5] The submissions shared with the Special Rapporteur are available at www.ohchr.org/en/calls-for-input/2023/call-inputs-toxic-impacts-some-climate-change-solutions.
[6] On 27 February 2023 for Africa, Europe, Latin America and the Caribbean, and North America; and on 28 February 2023 for Asia and the Pacific.

II. Greenhouse gases and the toxification of the planet

A. Greenhouse gas emissions impair human health and the climate system

9. Greenhouse gas emissions from fossil fuel combustion, totalling 59.1 gigatonnes of carbon dioxide equivalent in 2019, have been categorically identified as the single main cause of climate change.[7] In 2023, the Intergovernmental Panel on Climate Change stated with "high confidence" that greenhouse gas emissions had "unequivocally" caused a 1.1°C temperature raise from preindustrial levels over the past decade.[8] Carbon dioxide, methane and nitrous oxide are the most prevalent,[9] while hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride are very powerful owing to their effectiveness in absorbing heat.[10]

10. Greenhouse gas emissions from the energy sector, the chemical industry and unsustainable consumption and production are fuelling the global climate emergency. This crisis exacerbates the intensity and frequency of extreme climatic events, such as hurricanes, droughts and heatwaves, causing loss and damage to people and nature. The injustice of the fact that the harm weighs most heavily on particularly vulnerable communities, which are also the lowest emitters, calls for redress.[11]

11. The climate emergency is in turn causing increasingly irreversible losses in natural ecosystems and biodiversity. Half of the species assessed to date have shifted towards colder areas, but such shifts have been insufficient, driving hundreds of other species towards extinction owing to glacier retreat, permafrost thaw, ocean acidification, sea-level rise, decreases in precipitation, desertification and land degradation. Half of all coastal wetlands have been lost over the past century.[12]

12. Greenhouse gas emissions causing climate change are also among the most serious air pollutants, severely impairing human health.[13] Ambient air pollution, including from greenhouse gases, caused between 4 and 5 million premature deaths in 2019,[14] while malnutrition, malaria, diarrhoea and heat stress resulting from climate-change related impacts on food, water and sanitation are expected to cause some 250,000 additional deaths per year between 2030 and 2050. This is estimated to impose costs of between $2 billion and $4 billion per year in direct health damages by 2030, mostly in developing countries.[15]

13. The United Nations Environment Programme (UNEP) has consistently warned that "the world is in a climate emergency" – "a code red for humanity" according to the Secretary-General. Keeping below the maximum temperature rise goal of 1.5° to 2°C above pre-industrial levels, set by the Paris Agreement, depends on reducing greenhouse gas emissions drastically, by 30 gigatonnes of carbon dioxide equivalent per year from 2021 to 2030. As the world's wealthiest 1 per cent of countries emit more than twice the amount of greenhouse gases as the poorest half combined, the responsibility for a rapid carbon transition lies with developed countries.[16]

---

[7] See www.unep.org/facts-about-climate-emergency.

[8] See https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_LongerReport.pdf, p. 6.

[9] UNEP, *Emissions Gap Report 2022: The Closing Window – Climate Crisis Calls for Rapid Transformation of Societies* (Nairobi, 2022), p. xii.

[10] Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis* (Cambridge University Press, 2007), p. 144.

[11] Intergovernmental Panel on Climate Change, *Synthesis Report of the IPCC Sixth Assessment Report,* pp. 6–17.

[12] Ibid., p. 15.

[13] World Health Organization (WHO), "Ambient (outdoor) air pollution: key facts", 19 December 2022. See also A/HRC/49/53 and A/HRC/33/41.

[14] See www.thelancet.com/action/showPdf?pii=S2542-5196%2822%2900090-0.

[15] See www.who.int/health-topics/climate-change#tab=tab_1.

[16] See www.unep.org/explore-topics/climate-action/what-we-do/climate-action-note/state-of-climate.html.

B. The chemicals industry contributes significantly to greenhouse gas emissions

14. The chemical sector is the largest industrial energy consumer and the third largest industrial carbon dioxide emitter.[17] It accounts for 10 per cent of the global energy demand and 30 per cent of industrial energy demand; it emits 7 per cent of global greenhouse gases and 20 per cent of industrial greenhouse gases.[18] Production of chemicals doubled between 2000 and 2017 and is expected to double again by 2030 and to triple by 2050, mostly in States that are not members of the Organisation for Economic Co-operation and Development (OECD).

15. Five chemical product groups are among the highest greenhouse gas emitters: olefins (ethylene and propylene), which form when petroleum oils are transformed into gasoline; ammonia, used as a fertilizer and in food processing; mixtures of benzene, toluene and three xylene isomers, which are aromatics and are by-products of oil refining; methanol, which is used to make other chemicals and as biofuel;[19] and adipic acid, a key component in the manufacturing of nylon (a kind of plastic), owing to its by-product, nitrous oxide emissions.[20]

16. Hundreds of millions of tons of toxic substances are released into air, water and soil annually,[21] which leads to the proliferation of "sacrifice zones" around the world, where contamination is severe and causes devastating health and environmental effects.[22] Pollution and toxic substances already cause at least 9 million premature deaths per year,[23] including those of 750,000 workers from exposure to toxic substances on the job.[24]

17. UNEP has concluded that the global goal to minimize the adverse impacts of chemicals and waste was not achieved by 2020.[25] In addition, a recent study has found that the safe planetary boundary for chemicals and pollutants, including plastics, has now been exceeded.[26]

18. Pollution and exposure to toxic chemicals have an adverse impact on various human rights. Environmental degradation threatens individuals and communities, poses health challenges and erodes opportunities to maintain bodily integrity.[27] The toxification of the planet is resulting in a massive, widespread and systematic denial of human rights for countless individuals and groups.

III. Some proposed decarbonization technologies

19. States have an obligation to mitigate climate change and prevent its negative impacts on human rights, including by taking action to reduce emissions in a "rapid, deep and in most cases immediate" manner.[28]

20. In recent years, several climate change mitigation technologies have been proposed. Many of them can improve air quality, reduce health impacts and even be cheaper than non-renewable energy sources, as well as creating jobs. Renewable energy, including from solar, wind, waste and geothermal sources, could potentially generate 90 per cent of the world's

---

[17] See www.iea.org/fuels-and-technologies/chemicals.
[18] See https://icca-chem.org/wp-content/uploads/2020/05/Technology-Roadmap.pdf, p. 6.
[19] Ibid., p. 12.
[20] See www.climateactionreserve.org/blog/2020/09/30/adipic-acid-production-protocol-adopted-by-reserve-board/.
[21] A/HRC/49/53, para. 6.
[22] Ibid., paras. 26–29.
[23] See www.thelancet.com/action/showPdf?pii=S2542-5196%2822%2900090-0.
[24] A/HRC/49/53, para. 5.
[25] UNEP, *Global Chemicals Outlook II: From Legacies to Innovative Solutions* (2019).
[26] See www.stockholmresilience.org/research/research-news/2022-01-18-safe-planetary-boundary-for-pollutants-including-plastics-exceeded-say-researchers.html.
[27] A/74/480.
[28] Intergovernmental Panel on Climate Change, *Synthesis Report of the IPCC Sixth Assessment Report*, p. 46.

energy by 2050.[29] Green hydrogen produced from renewable energy sources could save up to 830 million tons of carbon dioxide annually.[30] Modern bioenergy, which includes liquid biofuels from bagasse (the dry pulpy residue left after the extraction of juice from sugar cane) and other plants, biogas produced through anaerobic digestion of residues, and wood pellet heating systems, has the potential to complement non-carbon sources of energy. Bioenergy accounted for 10 per cent of global final energy consumption in 2015.[31]

21. Nevertheless, some greenhouse gas emissions reduction technologies can increase exposure to hazardous substances and wastes. Such climate technologies cannot be justified on account of their emissions reduction potential. Decarbonization strategies must also pursue detoxification pathways. Ultimately, a just transition towards a safe climate system requires integrated solutions that do not attempt to solve one environmental and human rights crisis by creating or aggravating another.

A. Mineral and metal extraction

22. Mining practices, including open pits, mine tailings and waste piles are some of the largest sources of mining-generated pollutants, which can contaminate soil, air and water.[32] The respiratory, neurological and systemic health impacts of exposure to heavy metals and mining-related dusts, fumes and waste tailings are well-documented.[33] Some types of contamination, such as radioactive contamination or acid mine drainage, can last long after mining operations have ceased.[34]

23. Many decarbonization technologies rely on mining to acquire transition minerals such as lithium, cobalt, nickel, graphite, manganese, copper, zinc, aluminium and rare earth elements.[35] Large quantities of these materials are needed in the production of some climate technologies, including electric vehicles, batteries, solar panels and wind turbines. Global demand for green transition minerals and metals is expected to rise significantly over the next two decades: 90 per cent for lithium, 60–70 per cent for cobalt and nickel, and 40 per cent for copper and rare earth elements.[36] These materials are often extracted without adequate environmental and social protections, with serious consequences for human rights.[37]

1. Lithium

24. Lithium is an alkali metal used in heat and electricity conduction. It is essential for the manufacturing of lithium-ion batteries for electric vehicles.[38]

25. Lithium extraction often demands huge quantities of energy or water and can generate large amounts of wastewater.[39] Lithium mining can lead to water loss, ground destabilization, biodiversity loss, increased salinity of rivers, contaminated soil and toxic waste.[40] Lithium mining is also associated with health issues such as increased respiratory problems and nervous system disorders.[41]

26. Australia is the main supplier of lithium, 55 per cent of which has been acquired by China through early investment. Approximately 58 per cent of the world's lithium reserves

[29] United Nations, "Renewable energy – powering a safer future".
[30] Iberdrola, "Green hydrogen: an alternative that reduces emissions and cares for our planet".
[31] International Renewable Energy Agency, "Bioenergy and biofuels".
[32] A/77/183.
[33] Occupational Knowledge International, "Environmental impacts of mining and smelting".
[34] Submission by Earthworks.
[35] Konstantin Born, "Energy transition minerals: what are they and where will they come from?", Economics Observatory, 9 November 2022. See also Business and Human Rights Resource Centre, "Transition minerals tracker".
[36] International Energy Agency, *The Role of Critical Minerals in Clean Energy Transitions* (2022).
[37] Business and Human Rights Resource Centre, "Transition minerals tracker".
[38] SAMCO Technologies, "What is lithium extraction and how does it work?".
[39] Ibid.
[40] See www.foeeurope.org/sites/default/files/publications/13_factsheet-lithium-gb.pdf.
[41] See https://wellcomecollection.org/articles/YTdnPhIAACIAGuF3.

lie beneath the salt flats of the so-called Lithium Triangle in South America, formed by Argentina, Bolivia (Plurinational State of) and Chile.[42]

2. Cobalt

27. Cobalt is a high melting point metal.[43] This property makes it useful in the manufacturing of lithium-ion batteries for electric vehicles, where it can prevent overheating and help to extend battery life.[44] Cobalt is scarce, rarely found independently, and most often associated with copper, nickel, arsenic, pyrite and uranium. It is extracted through open-pit mining, underground mining or a combination of the two. In addition, initiatives to explore deep-sea cobalt mining in manganese nodules are already under way.[45]

28. Cobalt extraction is energy-intensive and, depending on the method of extraction, can be water-intensive. Cobalt mining is often a subsistence livelihood based on hard labour in difficult conditions with many health hazards such as accidents, heat, overexertion, dust inhalation and exposure to toxic chemicals and gases.[46] There are multiple reports documenting the use of child labour in cobalt supply chains in the Democratic Republic of the Congo.[47] Cobalt mining associated with uranium can expose workers and communities to radiation, and can release it into the environment. Cobalt mining also destroys vast areas of jungle, forests and riverbanks, leaving wastelands of tailings and mining pits.[48]

29. The Democratic Republic of the Congo is the largest supplier of cobalt, producing 15 per cent of global demand as a by-product of copper through small-scale artisanal mining, followed by the Russian Federation.[49]

3. Nickel

30. Nickel has a high melting point and is key in manufacturing lithium-ion batteries for electric vehicles, allowing them to travel further by delivering high density energy. Nickel is the fifth most common element on earth,[50] and 70 per cent of its global demand is used for stainless steels. It is found naturally in laterite (soil rich in iron and aluminium) and sulphide deposits,[51] and extracted through open-pit or underground mining.[52]

31. Nickel extraction is energy-intensive and can result in air pollution, water contamination and habitat destruction.[53] Nickel exposure causes health issues such as allergies, cardiovascular and kidney diseases, lung fibrosis, lung and nasal cancer and even genetic alterations.[54] In Indonesia, nickel mining is expected to increase as a result of a 2019 approval of increased deep-sea tailings disposal, where waste is dumped directly into the

[42] See www.csis.org/analysis/south-americas-lithium-triangle-opportunities-biden-administration.
[43] Stanford Advanced Materials, "What is cobalt used in everyday life".
[44] See https://earth.org/cobalt-mining/.
[45] See www.isa.org.jm/exploration-contracts/cobalt-rich-ferromanganese-crusts/.
[46] Franklin W. Schwartz, Sangsuk Lee and Thomas H. Darrah, "A review of the scope of artisanal and small-scale mining worldwide, poverty, and the associated health impacts", *GeoHealth*, vol. 5, No. 1 (January 2021).
[47] See www.cbsnews.com/news/the-toll-of-the-cobalt-mining-industry-congo/; and www.amnesty.org/en/latest/press-release/2017/11/industry-giants-fail-to-tackle-child-labour-allegations-in-cobalt-battery-supply-chains/.
[48] A/HRC/51/35.
[49] See https://earth.org/cobalt-mining/.
[50] See https://nickelinstitute.org/en/about-nickel-and-its-applications/.
[51] IFP Energies Nouvelles, "Nickel in the energy transition: why is it called the devil's metal?", 29 March 2021.
[52] See www.agiboo.com/nickel/.
[53] CBC Radio, "Nickel is a key element of electric vehicles – but mining it takes an environmental toll", 25 June 2022.
[54] Giuseppe Genchi and others, "Nickel: human health and environmental toxicology", *International Journal of Environmental Research and Public Health*, vol. 17 (February 2020).

ocean.[55] Environmental and human rights abuses relating to nickel mining have been reported in Papua New Guinea.[56]

32. Indonesia is the largest supplier of nickel, followed at a distant second by the Philippines. Together, they account for about 44 per cent of global production. Eighty-three per cent of global reserves are distributed between Indonesia, Australia, Brazil, the Russian Federation, Cuba, the Philippines and South Africa.[57]

4. Graphite

33. Graphite is a crystalline form of the element carbon. It has strong heat and electrical conductivity, high energy density and a high melting point.[58] These properties make it a key element for the manufacturing of lithium-ion batteries for electric vehicles.[59] It is found naturally in metamorphic and igneous rocks, and can be synthetically manufactured from petroleum coke.[60] Natural graphite is extracted through open-pit or underground mining.[61]

34. Some methods of graphite extraction, such as hard rock extraction, are highly water-intensive. Other methods, such as volatilization and synthetic production, are energy-intensive. In some regions, graphite processing is associated with drinking water contamination.[62] Exposure to natural graphite causes health issues such as decreased pulmonary function and also affects the cardiovascular system. Exposure to synthetic graphite can have similar effects.[63] Dust emissions and chemicals used to purify battery-grade anode graphite can be harmful to both health and the environment.[64]

35. In 2022, China was the largest supplier of graphite at 65 per cent, followed by Madagascar, Mozambique, Brazil and the Republic of Korea.[65] Thirty-four per cent of this supply is used for electrodes, 4 per cent for batteries and 24 per cent for other uses,[66] such as solar panels and rotor blades for wind turbines.[67]

5. Manganese

36. Manganese is the fifth most abundant metal on earth. It has good heat and electrical conductivity, high energy density and a high melting point. It is used primarily in the production of steel. Several low-carbon technologies, including wind turbines and electric vehicles, rely heavily on steel and thus also on manganese.[68]

37. Manganese can be extracted from ore using pyrometallurgical, hydrometallurgical or electrometallurgical processes that can threaten both water quality and human rights. Manganese mining is sometimes undertaken without community compensation or consent

[55] Rabul Sawal, “Red seas and no fish: nickel mining takes its toll on Indonesia’s spice islands”, Mongabay, 16 February 2022.

[56] Joint submission by Jubilee Australia Research Centre and Bismarck Ramu Group.

[57] IFP Energies Nouvelles, “Nickel in the energy transition”.

[58] See www.imerys.com/minerals/graphite.

[59] SGL Carbon, “High-quality graphite material for lithium-ion battery anodes”.

[60] See www.imerys.com/minerals/graphite.

[61] Abhinna Investments, “A comprehensive guide about graphite extraction process”, 17 May 2022.

[62] See www.washingtonpost.com/graphics/business/batteries/graphite-mining-pollution-in-china/.

[63] See www.ncbi.nlm.nih.gov/books/NBK224564/.

[64] Robert Pell, Phoebe Whattoff and Jordan Lindsay, “Climate impact of graphite production”, Minviro, 1 July 2021.

[65] See https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-graphite.pdf, p. 1, and https://investingnews.com/daily/resource-investing/battery-metals-investing/graphite-investing/top-graphite-producing-countries/.

[66] Allah D. Jara and others, “Purification, application and current market trend of natural graphite: a review”, *International Journal of Mining Science and Technology*, vol. 29, No. 5 (2019), pp. 671–689.

[67] Hebestreit, “Why the renewable energy industry requires carbon and graphite”.

[68] United States Geological Survey, “Manganese”, Mineral Commodity Summaries, January 2022; and Alejandro González, “Manganese matters”, Centre for Research on Multinational Corporations, 16 June 2021.

and has been repeatedly linked with toxic contamination.[69] In South Africa, communities near manganese mines reported respiratory illnesses, panic attacks, heart problems, vision problems and hearing loss. In Ukraine, manganese mining is associated with impaired growth and skeletal deformities in children.[70] Exposure to manganese can also have undesirable neurobehavioral effects.[71]

38. Manganese ore is mined mainly in China (35 per cent), South Africa (16 per cent), Australia (13 per cent) and Gabon (9 per cent). South Africa hosts about 75 per cent of the world's identified manganese resources and about 24 per cent of the world's reserves.[72]

6. Copper

39. Copper is a versatile metal known for its high melting point and excellent electrical conductivity, second only to silver. It is highly ductile and malleable and can therefore be shaped easily into materials such as foil or electrical wiring. These properties make copper a cornerstone of electricity-related technologies, including electric vehicles.[73] It is key in the production of lithium-ion batteries for electric vehicles, which contain more copper than traditional vehicle combustion engines.[74]

40. Copper ore mining is energy-intensive and sometimes water-intensive. Some copper processing methods, such as pyrometallurgy, can emit volatile organic compounds, tar and ash.[75] These processes are associated with sulfur dioxide emissions, which can pollute the air and threaten human health. They can also emit acids, metals and other pollutants into the environment, contaminating land and drinking water.[76] Some methods of copper recycling can also be dangerous to human and environmental health. In Ghana, for example, electronic cables are burned for copper extraction at Agbogbloshie, one of the largest e-waste dumps in the world.[77]

41. Chile is the largest supplier of copper in the world, accounting for 27 per cent of global production, followed by Peru with 10 per cent. The world's two largest copper mines, Escondida and Collahuasi, are located in Chile.[78]

7. Aluminium

42. Aluminium is the most abundant metal in the Earth's crust. It has high thermal conductivity, strong corrosion resistance and can be easily machined and formed. It is also lightweight, non-magnetic and non-sparking.[79] These properties make it a strong candidate for automotive manufacturing, where it is used in casting. In electric vehicles in particular, it is used to produce sheet battery enclosures that can increase a vehicle's driving range.[80] Pure

---

69 Charlie Hoffs, "Challenges and opportunities in mining materials for energy storage lithium-ion batteries", Union of Concerned Scientists, 22 December 2022.

70 Ykateryna D. Duka, "Impact of open manganese mines on the health of children dwelling in the surrounding area", *Emerging Health Threats Journal*, vol. 4 (2011).

71 See www.atsdr.cdc.gov/toxprofiles/tp151.pdf.

72 South Africa, Department of Mineral Resources, "South Africa's manganese industry developments, 2004–2011" (Pretoria, 2013).

73 International Energy Agency, *The Role of Critical Minerals in Clean Energy Transitions.*

74 International Copper Association, "The electric vehicle market and copper demand", June 2017.

75 See www.ncbi.nlm.nih.gov/pmc/articles/PMC8953818/.

76 Mike Holland, "Reducing the health risks of the copper, rare earth and cobalt industries", issue paper prepared for the Green Growth and Sustainable Development Forum, Paris, OECD, 26 and 27 November 2019.

77 Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, statement at end of visit to Ghana, 13 December 2022, available at www.ohchr.org/sites/default/files/documents/issues/toxicwaste/statements/2022-12-12/20221213-eom-ghana-sr-toxics-en.pdf.

78 Bruno Venditti, "Which countries produce the most copper?" World Economic Forum, 12 December 2022.

79 See www.rsc.org/periodic-table/element/13/aluminium#:~:text=It%20has%20low%20density%2C%20is,and%20the%20sixth%20most%20ductile (Uses and properties).

80 See www.mdpi.com/1996-1944/14/21/6631.

aluminium does not occur naturally and must be refined through complex production processes.

43. Aluminium production is energy-intensive and produces a significant amount of greenhouse gas emissions, as the industry is currently dominated by coal power. The process of refining alumina into aluminium also produces large quantities of caustic mud. These processes can contaminate both water and air and threaten human health. In Guinea, for example, bauxite mining could lead to widespread destruction and loss of agricultural land within 20 years. In Pará State in Brazil, several legal complaints regarding alleged contamination of waterways in the Amazon basin as a result of bauxite mining are ongoing.[81] Exposure to high levels of aluminium may result in respiratory and neurological problems.[82]

44. Guinea has the world's largest bauxite deposits and produces roughly 22 per cent of the global market share of aluminium. Guinea is also the biggest exporter of bauxite to China, which produces the majority of the world's aluminium. Bauxite is also mined in Australia, Brazil, India and several other countries.[83]

8. Zinc

45. Zinc is a naturally abundant and versatile metal. It is primarily used to protect other metals from rusting through a process called galvanization.[84] This can play a key role in transportation, infrastructure and renewable energy. For example, zinc can be used to extend the life of both solar panels and wind turbines.[85] Zinc can also be used to produce non-flammable batteries. These batteries are particularly promising for application in electric vehicles due to their energy density, low cost and inherent safety.[86] Zinc is 100 per cent recyclable, meaning it can be recovered and reused without a loss in quality. Currently, 30 per cent of all zinc produced worldwide originates from recycled or secondary zinc.[87]

46. Mining of zinc ore produces pollutants and consumes high amounts of energy.[88] Most zinc enters the environment as the result of mining, steel production, coal burning and purifying of zinc, lead and cadmium ores. These activities can increase zinc levels in the atmosphere. Industrial waste streams can also contaminate water sources by discharging zinc into local waterways.[89] Moreover, zinc ores are usually found in combination with lead. Exposure to lead is dangerous, particularly for children, and can cause damage to the brain and the nervous system.[90]

47. Zinc is mined in over 50 countries worldwide.[91] China is the largest producer of zinc, accounting for 33 per cent of the global market share, followed by Peru (12 per cent), Australia (10 per cent), India (6 per cent) and the United States of America (6 per cent).

---

81 Human Rights Watch and Inclusive Development International, *Aluminium: The Car Industry's Blind Spot – Why Car Companies Should Address the Human Rights Impact of Aluminium Production* (2021).

82 United States of America, Agency for Toxic Substances and Disease Registry, "Aluminium ToxFAQs" (September 2008).

83 Human Rights Watch and Inclusive Development International, *Aluminium: The Car Industry's Blind Spot.*

84 Natural Resources Canada, "Zinc facts", 17 April 2023.

85 Bruno Venditti, "Zinc is critical for the low-carbon economy. Here's why", World Economic Forum, 13 April 2022.

86 Jie Zhang and others, "Zinc-air batteries: are they ready for prime time?", *Chemical Science,* vol. 10, No. 39 (October 2019).

87 Venditti, "Zinc is critical".

88 Yuke Jia and others, "Exploring the potential health and ecological damage of lead-zinc production activities in China: a life cycle assessment perspective", *Journal of Cleaner Production,* vol. 381, No. 1 (December 2022).

89 United States Agency for Toxic Substances and Disease Registry, "Public health statement for zinc" (August 2005).

90 See www.cdc.gov/nceh/lead/prevention/health-effects.htm.

91 Peter Russell and Tharsika Tharmanathan, "Zinc", University of Waterloo Earth Sciences Museum.

Australia, China, the Russian Federation, Mexico and Peru are among the nations with the largest zinc reserves.[92]

9. Rare earth elements

48. The rare earth elements are a set of 17 metallic elements or specialty metals: scandium, yttrium and the 15 lanthanides.[93] Contrary to what their name suggests, these elements are relatively abundant in the Earth's crust, but are often found in low concentrations and are difficult to separate from other elements. Rare earth elements have many applications in advanced technologies, including as magnets, batteries, phosphors and catalysts, making them essential components of many decarbonization technologies such as wind turbines, solar panels, electric vehicles and storage batteries.[94]

49. The separation of rare earth elements requires the use of leaching pools laden with chemicals that risk contaminating groundwater, eroding soil and polluting the air. These methods produce high levels of waste (some 2,000 tons of waste per ton of rare earth element produced) – including dust, waste gas, wastewater and radioactive residue – with a high risk of environmental and health hazards.[95]

50. China currently accounts for 63 per cent of the world's rare earth mining, 85 per cent of rare earth processing and 92 per cent of rare earth magnet production. The largest rare earth element mine in the world is Bayan Obo, located in Inner Mongolia Autonomous Region; it accounted for 45 per cent of global production in 2019. There is talk of expansion of rare earth elements mining by and in countries such as Australia, Canada, India, Malawi, the Russian Federation, South Africa, the United States of America, Viet Nam and Zimbabwe in coming years.

B. Electrification and battery production

51. Electrification of energy demand presents significant potential in mitigating emissions and decarbonizing energy supply chains. This is because the efficiency of electric technologies is generally much higher than fossil-fuel based alternatives with similar energy services.[96] Global electricity demand is expected to more than double between 2020 and 2050 and is projected to account for around 20 per cent of total emissions reductions achieved by mid-century.[97] Still, at present, most electricity is generated by burning fossil fuels. The emissions reduction benefits from electrification will depend on the growth of renewables used for electricity supply.[98]

52. Manufacturing of electric batteries for electric vehicles or as storage for solar or wind energy sources requires minerals, metals and rare earth elements. Techniques and substances employed to extract them generate toxic wastes. Scrap produced at the end of their life cycle also contains harmful and toxic elements for human health and the environment.[99]

53. Widespread electrification will require an increase in battery production, power and usage. Efforts to meet quickly rising demands do not come without risks, particularly those associated with the rapid extraction of battery materials. Battery recycling also poses toxic challenges. The absence of standards regarding battery recycling across jurisdictions presents a barrier to reuse. This includes standards for the performance and durability of electric

---

[92] See https://natural-resources.canada.ca/our-natural-resources/minerals-mining/minerals-metals-facts/zinc-facts/20534.

[93] American Geosciences Institute, "What are the rare earth elements, and why are they important?".

[94] Renee Cho, "The energy transition will need more rare earth elements. Can we secure them sustainably?", State of the Planet, Columbia Climate School, 5 April 2023.

[95] Submission by AidWatch; and Jaya Nayar, "Not so 'green' technology: the complicated legacy of rare earth mining", *Harvard International Review*, 12 August 2021.

[96] International Energy Agency, "Electrification: analysis", September 2022.

[97] See https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf, p. 70.

[98] International Energy Agency, "Electrification: analysis".

[99] Submission by Comisión de Derechos Humanos de la Ciudad de México (in Spanish).

vehicle batteries, criteria for what constitutes end-of-life, standards for handling used batteries and labelling of battery composition.[100]

C. Nuclear power generation

54. Nuclear energy is the energy in the core, or nucleus, of an atom. Modern technology primarily harnesses nuclear energy through nuclear fission, in which atomic nuclei are split and energy is released.[101] This energy can be used to create zero-carbon electricity. However, claims by the European Union that such energy is "green" have been denounced as greenwashing.[102]

55. The production of nuclear energy presents both environmental and health risks. Nuclear power plants are most often powered by a rare type of uranium, uranium-235.[103] A typical nuclear reactor uses about 200 tons of uranium every year.[104] Uranium mining can expose workers to high levels of radon gas, which has been associated with an increased risk of lung cancer, as well as producing radioactive and toxic by-products and contaminating groundwater. These risks weigh particularly heavily on Indigenous Peoples, as 70 per cent of global uranium mining occurs on Indigenous lands.[105]

56. Nuclear energy production poses further risks in the form of radioactive by-products. These by-products can be extremely toxic and can cause burns and increase the risk of cancers, blood diseases and bone decay. Materials that come into contact with these by-products are considered radioactive waste and can remain radioactive for thousands of years.[106] One clear illustration of the potentially catastrophic impacts of nuclear power is the 2011 disaster in Fukushima, Japan.[107]

57. Nuclear power currently produces roughly 10 per cent of the global electricity supply, and this number is declining.[108] According to scenarios from nuclear lobby associations, doubling the capacity of nuclear power worldwide by 2050 would only decrease greenhouse gas emissions by around 4 per cent. Nevertheless, reaching this 4 per cent reduction would require bringing 37 new nuclear reactors to the grid every year from now until 2050.[109]

D. Biofuels and bioenergy

58. Bioenergy is a form of renewable energy derived from organic materials, including plants and algae, known as biomass.[110] It is the largest source of renewable energy globally, accounting for 55 per cent of total renewable energy use and over 6 per cent of the global energy supply. Bioenergy is considered a near zero-emission fuel source because the plants that are used to make biofuels – such as corn, sugar cane and soy beans – absorb carbon dioxide as they grow and may offset upstream carbon dioxide emissions released during

[100] Elsa Dominish, Nick Florin and Rachael Wakefield-Rann, "Reducing new mining for electric vehicle battery metals: responsible sourcing through demand reduction strategies and recycling", report prepared for Earthworks by the Institute for Sustainable Futures, University of Technology Sydney, April 2021.

[101] Andrea Galindo, "What is nuclear energy? The science of nuclear power", International Atomic Energy Agency, 15 November 2022.

[102] See www.dw.com/en/austria-files-case-over-eus-green-gas-and-nuclear-label/a-63395083.

[103] Union of Concerned Scientists, "How nuclear power works", 29 January 2014.

[104] *National Geographic*, "Nuclear energy".

[105] A/77/183, paras. 21 and 22.

[106] *National Geographic*, "Nuclear energy".

[107] Office of the United Nations High Commissioner for Human Rights, "Japan: UN experts say deeply disappointed by decision to discharge Fukushima water", 15 April 2021.

[108] International Energy Agency, *Nuclear Power in a Clean Energy System* (Paris, 2019).

[109] Mehdi Leman, "6 reasons why nuclear energy is not the way to a green and peaceful world", Greenpeace International, 18 March 2022.

[110] See www.energy.gov/eere/bioenergy/bioenergy-basics.

production and use.[111] Global demand for biofuel is expected to grow by 20 per cent between 2022 and 2027.[112]

59. Biofuel production can be resource intensive, requiring large amounts of water and land.[113] Globally, this could contribute to significant biodiversity loss. Biofuels also often rely on raw materials that require fertilizers for their production, the overuse of which may risk water contamination, although ethanol by-products may be used in place of traditional mineral fertilizers.[114] The production and use of biofuel can also generate airborne pollutants, including particulate matter, carbon monoxide, nitrogen oxides, hydrocarbons and volatile organic compounds, some of which are associated with increased morbidity and mortality from cardiovascular and respiratory diseases and some cancers.[115] Moreover, any reductions in greenhouse gas emissions achieved from use of biofuels may come at the expense of other environmental impacts, such as acidification, as seen with ethanol production in Brazil, or eutrophication, as seen with biodiesel production in Europe.[116]

60. Ultimately, the environmental consequences of biofuel production will depend on what crops or materials are used, where and how these feedstocks are grown, how the biofuel is produced and used, and how much is produced and consumed.[117] More efforts are needed to ensure bioenergy production does not incur negative social and environmental consequences, including through good agricultural management practices, such as ensuring no expansion of cropland or conversion of existing forested land for biofuel crop production.[118]

E. Non-hydro renewables

61. Non-hydro renewables – including solar,[119] wind[120] and geothermal energy (energy produced and stored within the Earth's crust)[121] – will play a critical role in the clean energy transition. Nevertheless, the production and management of renewable energy technologies present several risks if not managed appropriately.

62. Non-hydro renewable technologies are incredibly resource-intensive and can have toxic impacts. Solar panels, for example, rely on heavy metals (silver, cadmium, chromium, manganese, lead, indium, tellurium and zinc)[122] and batteries (lithium, cobalt, nickel, manganese, iron, chromium and copper)[123] that can leach into soils and waterways, leading to heavy metal contamination of the environment and surrounding communities. Incineration of these materials releases harmful dioxins and heavy metals, which have been associated

[111] International Energy Agency, "Bioenergy: analysis", September 2022.

[112] See www.iea.org/fuels-and-technologies/bioenergy#.

[113] Food & Water Watch, "The case against carbon capture: false claims and new pollution", Issue Brief (March 2020).

[114] Submission by Brazil.

[115] Joint submission by iCure Health International and Citizen Outreach Coalition; Christopher W. Tessum, Julian D. Marshall and Jason D. Hill, "A spatially and temporally explicit life cycle inventory of air pollutants from gasoline and ethanol in the United States", *Environmental Science & Technology*, vol. 46, No. 20 (October 2012); and Harish K. Jeswani, Andrew Chilvers and Adisa Azapagic, "Environmental sustainability of biofuels: a review", *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, vol. 476, No. 2243 (November 2020).

[116] Jeswani, Chilvers and Azapagic, "Environmental sustainability of biofuels"; and Jikke van Wijnen and others, "Coastal eutrophication in Europe caused by production of energy crops", *Science of the Total Environment*, vol. 511, 1 April 2015, pp. 101–111.

[117] United Nations Educational, Scientific and Cultural Organization, Scientific Committee on Problems of the Environment and UNEP, "Biofuels and environmental impacts: scientific analysis and implications for sustainability", Policy Brief, No. 9 (June 2009).

[118] International Energy Agency, "Biofuels: fuels and technologies".

[119] Union of Concerned Scientists, "Environmental impacts of solar power", 5 March 2013.

[120] Union of Concerned Scientists, "Environmental impacts of wind power", 5 March 2013.

[121] Union of Concerned Scientists, "Environmental impacts of geothermal energy", 5 March 2013.

[122] Guiomar Calvo and Alicia Valero, "Strategic mineral resources: availability and future estimations for the renewable energy sector", *Environmental Development*, vol. 41 (March 2022).

[123] Wojciech Mrozik et al., "Environmental impacts, pollution sources and pathways of spent lithium-ion batteries", *Energy & Environmental Science*, vol. 14, No 12 (December 2021), pp. 6099–6121.

with higher cancer burdens in surrounding communities.[124] Inappropriate handling and landfilling of lithium-ion batteries is also a common cause of toxic fires.[125] Like solar power, wind power is resource intensive, requiring 8,000 components that rely on rare earth elements, with the associated risks.[126] For geothermal energy extraction, air and water pollution are major risks. Most geothermal power plants require a large amount of water for cooling or other purposes and steam released at the surface may contain hydrogen sulfide, ammonia, methane and carbon dioxide. Moreover, dissolved solids discharged from geothermal systems include sulfur, chlorides, silica compounds, vanadium, arsenic, mercury, nickel and other toxic heavy metals.[127]

63. Some of these risks have manifested themselves in Ceará, Brazil, for example, where local communities complain that energy transition projects, such as wind and solar farms, have had severe environmental impacts,[128] including as a result of the hazardous substances contained in wind turbines and solar panels.[129] In French Guiana, the Centrale Electrique de l'Ouest Guyanais project – which combines photovoltaic solar power and a storage unit in the form of hydrogen – is having an impact on the Kali'na people.[130]

F. Shipping industry

64. Maritime shipping accounts for between 80 and 90 per cent of international trade by volume.[131] The large majority of this activity – well over 90 per cent – is fuelled by oil, rendering the industry a significant source of greenhouse gas emissions, approximately 2.8–3 per cent of global emissions.[132]

65. Decarbonizing international shipping will require scaling up low-carbon fuels.[133] While the use of liquified natural gas has been presented as a temporary solution, there are concerns over related methane emissions and energy-intensity of liquid natural gas transport.[134] Furthermore, natural gas-based fuels are expected to be inadequate to meet stringent decarbonization goals in the long term.[135] Possible alternatives include electrification, liquid biofuels, hydrogen, methanol and ammonia. Alternative fuels, though, can present a number of toxic challenges. Hydrogen, for example, is easily ignitable and poses a flammability risk.[136] Ammonia is corrosive and highly toxic if inhaled in high concentrations.

66. The phasing out of energy-intensive ships may increase stress on shipbreaking yards that are already notorious for the risks they pose and harm they do to human rights and the environment. During dismantling through "beaching", which refers to grounding a ship on a

[124] Javier García-Pérez and others, "Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste", *Environment International*, vol. 51, January 2013, pp. 31–44.
[125] Submission by Earthjustice.
[126] Institute for Energy Research, "Big wind's dirty little secret: toxic lakes and radioactive waste", 23 October 2013.
[127] United States Fish & Wildlife Service, "Geothermal energy", available at www.fws.gov/node/265252#:~:text=Air%20and%20water%20pollution%20are,waste%2C%20siting%20and%20land%20subsidence.
[128] Camilla Lima, "Projeto de parques eólicos no mar do Ceará ameaça o sustento de pescadores", Brasil de Fato, 17 November 2022 (in Portuguese).
[129] Submission by Conectas Direitos Humanos and Latin American Climate Lawyers Initiative for Mobilizing Action.
[130] Submission by Association "Village Prospérité" and others.
[131] International Renewable Energy Agency, *A Pathway to Decarbonise the Shipping Sector by 2050* (Abu Dhabi, 2021).
[132] Ibid. and Estela Morante, "Roadmap to decarbonize the shipping sector: technology development, consistent policies and investment in research, development and innovation", Transport and Trade Facilitation Newsletter, No. 96 (United Nations Conference on Trade and Development, 2022).
[133] International Energy Agency, "International shipping: analysis".
[134] Submission by Friends of the Earth, Ghana.
[135] Intergovernmental Panel on Climate Change, *Climate Change 2022: Mitigation of Climate Change*.
[136] Richard B. Kuprewicz, "Safety of hydrogen transportation by gas pipelines", report prepared for Pipeline Safety Trust by Accufacts, 28 November 2022.

tidal mudflat, substances are washed away, thus polluting waters and harming birds, fish and mammals.[137] Once persistent chemicals are in the ocean, they can travel to different regions, making beaching a global issue. Ships often contain toxic antifouling paints, asbestos, polychlorinated biphenyls and other toxic materials that threaten the lives and health of workers and local communities.[138]

G. Carbon capture and storage

67. Carbon capture, utilization and storage refers to technologies that either enable the mitigation of carbon dioxide emissions from large point sources such as refineries, power plants and other industrial facilities, or remove existing carbon dioxide from the atmosphere.[139] Demand for these technologies is expected to rise significantly over the coming decades.

68. Carbon capture and storage is comprised of three phases: capture, transport and storage (or usage) of carbon dioxide. Carbon can be captured by post-combustion, pre-combustion and oxy-fuel combustion. Once captured, carbon dioxide is compressed into a liquid and transported by pipeline, ship, rail or road to depleted oil and gas reservoirs, unmineable coal seams or deep saline reservoirs, where it is then injected and permanently stored, usually at depths of 1km or more.[140] These processes can be highly energy-intensive.[141]

69. These technologies present health and safety risks. Amine-based solvents[142] are often used to capture carbon dioxide from industrial facilities. This process relies on large amounts of chemicals and can release significant quantities of highly toxic ammonia into surrounding communities.[143] At high concentrations, carbon dioxide is a toxic gas and an asphyxiant, which can cause circulatory insufficiency, coma and death.[144] There are also risks relating to leakage during transport, injection and long-term storage.[145] Leakage to adjacent geological formations may cause geochemical reactions, including stimulation of seismic activity, and mobilization of potentially polluting elements, such as heavy metals, which can contaminate drinking water.[146] Underground storage also involves the risk of pipeline rupture, during which highly hazardous compressed carbon dioxide could be released.[147]

70. The inseparable link between carbon capture and storage and the use of fossil fuels underlines the risks posed by this technology to human rights. Carbon capture technology risks locking in place fossil fuel-reliance and the associated environmental injustices.[148]

---

137 A/HRC/12/26, para. 8.

138 A/HRC/54/25/Add.2.

139 Grantham Research Institute on Climate Change and the Environment, “What is carbon capture, usage and storage (CCUS) and what role can it play in tackling climate change?”, 3 March 2023.

140 Ibid.

141 International Energy Agency, “Carbon capture, utilisation and storage: fuels and technologies”.

142 Louise B. Hamdy and others, “The application of amine-based materials for carbon capture and utilisation: an overarching view”, *Materials Advances*, vol. 2, No. 18 (2021), pp. 5843–5880.

143 A/HRC/5/5, para. 14; and European Environment Agency, *Air pollution impacts from carbon capture and storage (CCS)* (Copenhagen, 2011), p. 10.

144 See www.everycrsreport.com/reports/RL33971.html, pp. 16 and 17.

145 Food & Water Watch, “The case against carbon capture”.

146 International Resource Panel, *Green Energy Choices: The Benefits, Risks and Trade-Offs of Low-Carbon Technologies for Electricity Production* (UNEP, 2016), p. 103; and Center for International Environmental Law, “Carbon capture and storage”, available at www.ciel.org/issue/carbon-capture-and-storage/.

147 Richard B. Kuprewicz, “Accufacts’ perspectives on the state of federal carbon dioxide transmission pipeline safety regulations as it relates to carbon capture, utilization, and sequestration within the U.S.”, report prepared for Pipeline Safety Trust by Accufacts, 23 March 2022.

148 Submission by Center for International Environmental Law.

H. Climate-altering engineering

71. Climate engineering is "large-scale, deliberate intervention in the Earth system to counteract climate change".[149] Such interventions are primarily considered as options to compensate for lagging international efforts to mitigate climate change. There is a lack of scientific certainty about the efficiency of climate-altering engineering technologies, such as solar radiation modification, and they can have a wide range of potential impacts on the effective enjoyment of human rights. Pinning humanity's hopes on future technologies should not be used to justify insufficient action to reduce greenhouse gas emissions and phase out fossil fuels.

IV. Human rights affected by some proposed climate change solutions

72. Some proposed technologies to mitigate climate change aggravate the toxic burden on people and planet, and they may adversely affect the effective enjoyment of human rights. The adverse impacts weigh heavily on persons and groups in vulnerable situations.[150] This situation undermines progress towards the Sustainable Development Goals to end poverty and hunger, to ensure healthy lives, clean water, decent work and sustainable consumption, and to protect and conserve lands and waters.[151]

A. Right to a clean, healthy and sustainable environment

73. After five decades of debate, starting at the United Nations Conference on the Human Environment, held in 1972, the right to a clean, healthy and sustainable environment has been recognized by the Human Rights Council[152] and the General Assembly.[153] This right is intimately related to the rights to life and personal integrity, among others, and to international environmental principles such as prevention of environmental damage, the precautionary principle and the duty to cooperate, among others.[154]

74. The fulfilment of the right to a healthy environment can be undermined by some proposed technologies to mitigate climate change. Technologies that increase pressure to extract metals and minerals, where adequate social and environmental safeguards are lacking or inadequate, can exacerbate human rights infringements. Unsound management of hazardous substances relating to decarbonization, such as inadequate electric vehicle battery recycling, plastic-to-fuel generation, nuclear energy, and carbon capture and storage, among others, can also compromise the effective enjoyment of the right to a clean, healthy and sustainable environment.

75. Some proposed climate technologies may generate air and water pollutants, such as fine particles and dust, heavy metals, toxic chemicals, hazardous materials and ionizing radiation, among others. These hazardous substances may bioaccumulate through the food chain and contribute to the proliferation of sacrifice zones. Exposure may cause birth defects, neurological, respiratory, heart, gynaecological, nephrological, immune, skin and other chronic illnesses and even cancer, as has been the case in sacrifice zones located in Argentina, Australia, Bolivia (Plurinational State of), Canada, Chile, China, the Democratic Republic of the Congo, Guatemala, Guinea, Indonesia, Mexico, Papua New Guinea, Peru, the

---

149 Oxford Geoengineering Programme, "What is geoengineering?".
150 A/77/183.
151 Sustainable Development Goals 1–3, 6, 8, 12, 14 and 15.
152 Human Rights Council resolution 48/13.
153 General Assembly resolution 76/300.
154 Inter-American Court of Human Rights, Advisory Opinion OC-23/17 of 15 November 2017.

Philippines, the Russian Federation, South Africa, Tonga, the United States of America, Viet Nam and Zambia, and in New Caledonia, among other countries and areas.[155]

76. Some climate technologies may negatively, and often irreversibly, affect critical ecosystems such as tropical forests, wetlands and their extraordinary biodiversity. This exacerbates the very climate crisis which such proposed solutions are supposed to alleviate.[156]

B. Right to life, in conjunction with the rights to clean air, safe water and nutritious food

77. The right to life has been recognized in universal[157] and regional[158] human rights treaties. The right to life includes the right to a dignified life.[159] The conditions that enable people to live a dignified life include clean air, safe water and nutritious food, among others. The Inter-American Court of Human Rights has reasoned that failure to uphold international standards regarding clean water, food and health amounts to a violation of the right to a dignified life.[160] This reasoning is also applicable to the physical components of the right to a clean, healthy and sustainable environment, underlining the intimate connections between that right and the right to life.

78. For Indigenous Peoples in particular, the right to a dignified life, in conjunction with the rights to clean air, safe water and nutritious food, is undermined by the toxic impacts of some of the technologies to mitigate climate change that have been proposed in recent years. This is due to the direct relationship between the physical environment in which Indigenous Peoples live and the rights to life, security and physical integrity, which are directly affected by pollution.[161] For example, mineral and metal extraction often generates intolerable toxic pollution and biofuels use large amounts of fertilizers, pesticides and other chemicals. The increased carbonization and toxification seriously affects livelihoods and daily lives[162] by threatening food safety, polluting soil, surface and ground water, and generating wastewater.[163] Their cumulative effects also reduce the contributions of climate change adaptation measures.[164]

155 Submissions by AidWatch, Catherine Murupaenga-Ikenn, Center for International Environmental Law, Comisión de Derechos Humanos de la Ciudad de México, Earthjustice, Earthworks, Global Alliance for Incinerator Alternatives, and Oxfam International; and joint submissions by iCure Health International and Citizen Outreach Coalition, and Jubilee Australia Research Centre and Bismarck Ramu Group.

156 Submissions by Association "Village Prospérité" and others, AidWatch, Association of Reintegration of Crimea, Azerbaijan and Earthworks; joint submissions by iCure Health International and Citizen Outreach Coalition and WALHI South Sulawesi and Southeast Sulawesi and Friends of the Earth Japan; and Jan Morrill and others *Safety First: Guidelines for Responsible Mine Tailings Management* (Earthworks, MiningWatch Canada and London Mining Network, 2022).

157 International Covenant on Civil and Political Rights, art. 6 (1).

158 Convention for the Protection of Human Rights and Fundamental Freedoms (European Convention on Human Rights), art. 2 (1); American Convention on Human Rights, art. 4 (1); African Charter on Human and Peoples' Rights, art. 4; Arab Charter on Human Rights, art. 5; and Association of Southeast Asian Nations Human Rights Declaration, art. 11.

159 Inter-American Court of Human Rights, *"Street Children" (Villagrán Morales et al.) v. Guatemala*, Judgment, 19 November 1999, para. 144.

160 *Yakye Axa Indigenous Community v. Paraguay*, Judgment, 17 June 2005, paras. 160–176. See also submission by Friends of the Earth Ghana; and Committee on Economic, Social and Cultural Rights, general comments No. 26 (2022), No. 24 (2017), No. 15 (2002), No. 14 (2000) and No. 12 (1999).

161 Inter-American Court of Human Rights, *Kuna Indigenous People of Madungandi and Embera Indigenous People of Bayano and Their Members v. Panama*, Report No. 125/12, Case No. 12.354, para. 233.

162 Submission by Oxfam International.

163 A/HRC/40/55; A/HRC/46/28; A/76/179; submissions by Earthworks, Interamerican Association for Environmental Defense (in Spanish), Catherine Murupaenga-Ikenn, World Nuclear Association and Global Alliance for Incinerator Alternatives; and joint submissions by Jubilee Australia Research Centre and Bismarck Ramu Group, WALHI South Sulawesi and Southeast Sulawesi and Friends of the Earth Japan, and iCure Health International and Citizen Outreach Coalition.

164 Submission by Transparency International.

V. Human rights should guide the integration of decarbonization and detoxification pathways

79. Human-rights principles should guide the integration of decarbonization and detoxification pathways. These principles inform a human rights-based approach and are centred on non-discrimination, transparency, participation and accountability. This approach places particular emphasis on protecting groups in vulnerable situations. With regard to the sound management of hazardous substances and wastes, the human rights-based approach also encompasses key environmental principles, such as the principle of prevention of harm, a chemically safe circular economy and the polluter-pays principle.

A. Rights of access to information, participation and justice in environmental matters

80. The fulfilment of the right of access to information in environmental matters is key to empower members of the public, particularly local communities and groups in vulnerable situations.[165] Adequate and timely information is indispensable to enable people to exercise their right to meaningfully participate in decision-making.[166] Access to independent technical experts is important for the realization of the rights to information and participation.[167] No less important is the right of access to remedies, which allows members of the public to seek legal and other redress in cases of human rights infringements, including with respect to environmental damage.[168]

81. The human rights to information and participation encompass the right to access independent technical expertise,[169] as the public attempts to assess the enhanced toxic impacts of some climate change mitigation technologies. These rights correlate with the State's obligation to protect the public against disinformation campaigns and misleading information disseminated by the promotors of such technologies.[170]

B. Right to science in climate action

82. The International Covenant on Economic, Social and Cultural Rights, among other human rights instruments, recognizes the right of everyone to enjoy the benefits of scientific progress and its applications (art. 15 (b)). Respect for this right requires alignment between regulatory policies and the best available scientific evidence.[171]

83. The right to science is essential to face and overcome the climate emergency. It requires States to take action to reduce greenhouse gas emissions in a manner that avoids toxic impacts. The right to science is also an indispensable antidote against disinformation campaigns and misleading information spread for political or ideological interests, or economic interests, including those employing mercenary or conflicted scientists, that stand to profit from polluting energy and industrial production and consumption patterns. Science provides the necessary facts, knowledge and evidence for the design of integrated decarbonization and detoxification policies. This right also requires States to protect climate activists and scientists as human rights defenders.

[165] A/HRC/49/53; and submissions by AidWatch, Catherine Murupaenga-Ikenn, and Pipeline Safety Trust.

[166] A/HRC/49/53.

[167] Submission by Earthworks.

[168] A/HRC/49/53, para. 25; and submissions by AidWatch, Catherine Murupaenga-Ikenn, and Pipeline Safety Trust.

[169] Submission by Earthworks.

[170] A/HRC/48/61.

[171] Ibid.

C. Protecting particularly vulnerable groups

1. Indigenous Peoples

84. International human rights instruments and jurisprudence recognize human rights that are specific to Indigenous Peoples, such as the right to free, prior and informed consent, and to culture, land and natural resources.[172] Protecting these rights is critical to avoid perpetuating the structural injustices and unsustainable economic development patterns that have resulted in the contamination of Indigenous Peoples' lands, waters, food, wildlife and plants, and the climate crisis.[173]

85. The toxic impacts of some climate mitigation technologies could cause irreversible harm to ancestral sites, water, medicines and culturally important wildlife,[174] as well as deforestation,[175] soil degradation, limited crop production for years to come, water shortages, biodiversity loss and acid-mine drainage, contaminating downstream water sources and depleting ecosystem health, while worsening global warming.[176] The lack of respect for free, prior and informed consent and inadequate environmental impact assessments[177] are examples of the systemic and systematic barriers[178] that need to be urgently addressed to ensure Indigenous Peoples' rights.

86. These structural barriers also affect ethnic minorities and persons of African descent.[179] The Inter-American Court of Human Rights has recognized that tribal communities of African descent have the same rights as Indigenous Peoples.[180] Such decisions are consistent with some recent national judicial decisions concerning mining, environmental, social and climate justice, and persons of African descent.[181]

2. Human rights defenders

87. Climate activists are raising public awareness about the climate crisis and spurring Governments and business enterprises to take ambitious climate action. In doing so, they seek to protect communities around the globe and the ecosystems on which humans depend to thrive. In the light of the adverse human rights impacts of the climate emergency, activists mobilizing to protect the climate system should be regarded and protected as authentic human rights defenders.

88. As a result of their activism, climate human rights defenders, including those participating in the sessions of the Conference of the Parties to the United Nations Framework Convention on Climate Change, have been harassed or persecuted.[182] In some cases, climate human rights defenders have been killed.[183] In others, police repression has quashed their opposition against carbonization and toxification.[184] In other situations, they have been prevented from pursuing their activism owing to the lack of safety for them, their families and their communities.[185]

---

[172] A/77/183, paras. 51–80.
[173] Ibid.; and submissions by Plastic Pollution Coalition and Global Alliance for Incinerator Alternatives.
[174] Submission by Earthworks.
[175] Submission by Association "Village Prospérité" and others.
[176] Joint submission by iCure Health International and Citizen Outreach Coalition.
[177] Ibid.; and joint submission by Jubilee Australia Research Centre and Bismarck Ramu Group.
[178] Submission by Catherine Murupaenga-Ikenn.
[179] Submission by the Center for International Environmental Law.
[180] *Saramaka People v. Suriname*, Judgment, 28 November 2007; and *Punta Piedra Garifuna Community and Its Members v. Honduras*, Judgment, 5 October 2015.
[181] See, e.g., Colombia Constitutional Court, *Center for Social Justice Studies et al. v. Presidency of the Republic et al*., Judgment T-622/16, 10 November 2016.
[182] See, e.g., A/76/222.
[183] See www.climateandcommunity.org/_files/ugd/d6378b_b03de6e6b0e14eb0a2f6b608abe9f93d.pdf.
[184] Submission by Association "Village Prospérité" and others.
[185] Joint submission by WALHI South Sulawesi and Southeast Sulawesi and Friends of the Earth Japan.

89. State obligations regarding human rights defenders have been recognized in international human rights instruments.[186] The Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean (Escazú Agreement) is the first international treaty to specifically protect environmental human rights defenders (art. 9), which include climate activists.[187] According to the Inter-American Court of Human Rights, State obligations regarding human rights defenders include protection from threats to their life and personal integrity, as well as from persecution and repression.[188]

D. Integrating decarbonization and detoxification

1. Accelerating decarbonization and detoxification of the economy

90. Decarbonization will require slashing greenhouse gas emissions, while detoxification means slashing pollution and waste. Realizing these two goals will require a new sense of urgency in implementing policies that aim to decouple economic growth from resource use.[189] Such policies should aim to achieve the targets of phasing out fossil fuel energy sources, replacing them with clean energy sources, in what is called the energy transition. Accelerating this transition will require sustainably managing and efficiently using natural resources, preventing the release of toxics to avoid adverse impacts on human health and the environment, and ensuring the sound management of waste, including reduction at source.[190]

91. Decarbonization and detoxification policies are key to attaining Sustainable Development Goal 12, to ensure sustainable consumption and production patterns. This goal can be achieved fully only if Governments and businesses focus on solutions that effectively integrate decarbonization and detoxification strategies. This includes avoiding hazardous chemicals that are touted as solutions to the climate emergency, such as the case of per- and polyfluoroalkyl substances, also known as forever chemicals because of their persistence in the environment. Instead, strategies should address the root causes of the serious adverse impacts on human health and the environment. This is key to preventing further and continued human rights infringements and abuses.

(a) Creating a circular economy for climate mitigation technologies

92. Countries need to redouble their concerted efforts to modernize and diversify critical industrial sectors. This could be achieved by establishing "green zones", such as industrial parks, in settings with logistical and infrastructural advantages. In these zones, some proposed climate change mitigation technologies could be developed based on the latest science and innovation, using responsibly sourced materials, renewable energy sources and sustainable means of transportation, and not relying on the intensive use of natural resources. These good practices would minimize greenhouse gas emissions and waste generation throughout the entire supply chain.[191]

(b) Reducing the need for material sourcing and increasing material recovery

93. Technological change alone will not be sufficient to decarbonize and detoxify the economy. It will need to be coupled with reductions in material resource extraction and use. This includes designing more efficient products, extending product lifetime and establishing mandatory recovery rates through disassembling and recycling product components.

94. Some examples of these decisive cuts would be making smaller electric vehicle batteries and extending their lifetime. Another example would be recovering transition minerals and metals from end-of-life electric vehicle batteries and housing materials.

[186] Declaration on the Right and Responsibility of Individuals, Groups and Organs of Society to Promote and Protect Universally Recognized Human Rights and Fundamental Freedoms, arts. 10, 11 and 18.
[187] *Baraona Bray v. Chile*, Judgment, 24 November 2022, para. 76 (in Spanish).
[188] Ibid.; and *Kawas-Fernández v. Honduras*, Judgment, 3 April 2009, para. 145.
[189] See www.resourcepanel.org/file/400/download?token=E0TEjf3z.
[190] Sustainable Development Goal 12, targets 12.2, 12.4, 12.5 and 12.8.
[191] Submission by Azerbaijan.

Integrated policies, such as on sustainable public transport systems, would also reduce the need for manufacturing new electric vehicles and electric vehicle batteries.[192]

2. Mandatory environmental and human rights due diligence and supply chain transparency

95. Governments should require businesses to conduct adequate environmental and human rights due diligence through the entire upstream and downstream chains of all transition materials, based on the Guiding Principles on Business and Human Rights.[193] This means ensuring that the four elements of a due diligence process are present in every proposed climate change mitigation technology, namely, assessing actual and potential human rights impacts, integrating and acting upon the findings, tracking responses and communicating how impacts are addressed.[194]

96. Conducting such environmental and human rights due diligence on some proposed technologies to mitigate climate change should focus on potential human rights infringements concerning supply and value chains. Due diligence should make sure that members of the public have access to adequate and timely information and meaningful opportunities to participate in decision-making regarding proposed climate change technologies. Due diligence should also be geared to ensuring that groups in vulnerable situations, such as climate activists, are not subjected to any form of retaliation.[195]

3. Preventing toxic impacts from the unsound management of chemicals and waste

97. The design and implementation of technologies to mitigate climate change should avoid replicating the polluting pathways of the fossil fuel industry. States and businesses must vigorously pursue zero pollution and the elimination of toxic substances, rather than merely trying to minimize, reduce and mitigate exposure to these hazards.[196]

98. Specifically with regard to transition minerals and metals, the feasibility of proposed new mines should be considered only after programmes are put in place that require recovery or recycling of such materials from end-of-life products. No new mineral extractions should proceed without effective prevention measures against the toxic risks of exposure to chemicals, waste and pollution generated by such mining.[197]

VI. Conclusions and recommendations

99. **Deep reductions of greenhouse gas emissions and carbon removals from the atmosphere are urgent to tackle the global climate crisis. Decarbonization of the energy matrix and polluting sectors of the economy are indispensable to realizing the goals established in the Paris Agreement. Some climate actions, such as replacing coal-fired power plants by solar or wind energy facilities, will contribute to such decarbonization.**

100. **Yet, some climate technologies proposed in recent years may aggravate the toxic burden befalling people and planet, exacerbating the human rights infringements caused by exposure to hazardous substances. The extraction of so-called transition minerals and metals can aggravate the toxic impacts of mining. Solar panels and wind turbines to generate electricity can impose considerable waste management challenges. Mislabelling nuclear energy generation as "green" downplays the acute challenges of radioactive waste disposal.**

101. **Disinformation campaigns have pushed misleading and false solutions for the energy transition. For example, tapping natural gas to replace other fossil fuels does not**

[192] Submission by Earthworks.
[193] A/HRC/42/41, paras. 37 and 38; and A/HRC/48/61, paras. 95 and 96.
[194] Guiding Principles on Business and Human Rights, principles 18–21.
[195] See www.climateandcommunity.org/_files/ugd/d6378b_b03de6e6b0e14eb0a2f6b608abe9f93d.pdf, p. 10.
[196] A/HRC/49/53.
[197] See, inter alia, Public Health Association of Australia, "Rare earth elements", Policy Position Statement, 23 September 2021.

account for emissions of methane and ultimately delays the necessary investments in decarbonization. Blue and grey hydrogen may actually increase greenhouse gas emissions given the amounts of energy their production requires. Also, unsound waste management technologies, such as incineration of plastics, add to the growing greenhouse gas emissions of the chemical industry.

102. **Decarbonization and detoxification strategies should not be pitted against each other. Climate action will not be legitimate or sustainable if it exacerbates toxic pollution and the concomitant human rights infringements. The climate change threat should not be used as an excuse or pretext by certain Governments or businesses to further aggravate the toxic burden on humanity.**

103. **In order to reach the 1.5°C global climate goal and protect communities adversely affected by toxics, decarbonization technologies should be integrated with detoxification strategies. Policies based on the best available climate and chemical science will allow governments to favour climate mitigation technologies that integrate decarbonization and detoxification strategies.**

104. **This integration, and the transition towards a circular economy that is both chemically and climate-safe, should be guided by human rights principles. Product and technology life cycles should be assessed to ensure actual decarbonization. Capacities for sound, circular management of chemicals and wastes generated by the climate transition should be installed to ensure detoxification. Human rights due diligence standards along the supply chain for climate change mitigation technologies should be mandatory. Environmental and human rights safeguards should be strengthened and enforced, instead of dismantled to purportedly favour the energy transition.**

105. **The Special Rapporteur recommends that States:**

(a) **Integrate decarbonization and detoxification strategies, guided by a human rights-based approach;**

(b) **Adopt mandatory standards on environmental and human rights due diligence and supply chain transparency to address the impacts of proposed climate action;**

(c) **Enforce and strengthen environmental and social safeguards, instead of exempting some proposed climate change mitigation technologies;**

(d) **Establish climate change mitigation technology clusters to modernize and diversify industrial sectors that are critical for the energy transition;**

(e) **Establish mandatory recycling and recovery rates for materials that are critical for the energy transition, as a prerequisite for considering the feasibility of new mines;**

(f) **Assess not only the greenhouse gas reduction potential of climate action, including energy sources, fuels, products and technologies, but also a full life-cycle assessment, including the impacts of materials extraction, pollution released during manufacturing, chemical exposure from use, and waste management and disposal;**

(g) **Install science-based capacity to enable circular management of chemicals and waste;**

(h) **Respect the right to and obtain free, prior and informed consent from Indigenous Peoples in regard to climate change mitigation technologies that directly or indirectly affect them;**

(i) **Ensure the protection of environmental human rights defenders, including climate and chemicals activists;**

(j) **Implement carbon pricing policies such as taxes and levies on greenhouse gas emissions to incentivize sectors and companies to reduce their carbon emissions;**

(k) **Protect and restore natural habitats, such as forests, mangroves and wetlands, to conserve and enhance biodiversity and reduce carbon emissions;**

(l) **Promote sustainable agriculture practices that reduce greenhouse gas emissions, avoid hazardous chemicals and sequester carbon in the soil;**

(m) **Promote the use of public transportation and active transportation, such as walking and cycling, to reduce carbon emissions;**

(n) **Implement waste reduction strategies, such as composting, to reduce the amount of waste sent to landfills and promote the use of biodegradable materials;**

(o) **Educate individuals and raise awareness about the importance of environmental protection and the impact of human activities on the planet.**

106. **The Special Rapporteur recommends that business enterprises, including financial institutions:**

(a) **Invest in innovation and uptake of climate mitigation technologies that also reduce toxic impacts;**

(b) **Implement environmental and human rights due diligence and supply chain transparency;**

(c) **Invest in climate change mitigation technology clusters to modernize and diversify industrial sectors that are critical for the energy transition;**

(d) **Invest in recycling facilities for materials that are critical for the energy transition;**

(e) **Divest from fossil fuel extraction or combustion projects;**

(f) **Refrain from conducting disinformation campaigns regarding misleading or false climate solutions;**

(g) **Conduct continuous monitoring and evaluation of climate technologies;**

(h) **Decrease the toxic burdens on communities that have long suffered from them;**

(i) **Retain and do not weaken environmental impact assessment and public participation requirements, to facilitate climate response.**