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Policy Implications in Deep-Sea Mining: Opportunities and Challenges for Kiribati

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Abstract

This paper offers a policy overview of deep-sea mining and its implications for Kiribati. While deep-sea mining could help address global resource shortages and support clean energy, it remains untested and controversial due to uncertain environmental and social impacts. The International Seabed Authority (ISA) oversees efforts toward commercial mining but faces challenges in finalizing regulations and balancing competing priorities without a comprehensive legal framework while opposition to deep-sea mining is growing across sectors. For Kiribati, with one of the largest Pacific exclusive economic zones (EEZs), deep-sea minerals promise economic diversification but also pose risks to vital marine ecosystems that support fisheries, livelihoods and cultural heritage. Potential impacts like sediment plumes and habitat loss threaten both the environment and community well-being. This paper concludes that while deep-sea mining could reduce Kiribati's economic vulnerabilities, a precautionary approach grounded in rigorous science, strong regulation and careful consideration of environmental, social and cultural factors is essential, especially amid rising geopolitical tensions.

Keywords: Clean energy; Deer-sea mining; Economic development; Environmental and social impacts; Kiribati

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1. Introduction

Deep-sea mining involves the exploration, extraction, transportation and processing of mineral deposits from the ocean floor (Kaiku, 2022). These deposits, typically found at depths greater than 200 metres, exist in several forms but commercial interest focuses on three types: (i) polymetallic nodules-potato-shaped concretions lying on the seabed that contain multiple metals such as manganese, nickel, copper, cobalt and trace minerals; (ii) sulfide deposits, or polymetallic sulphides, located near active high-temperature hydrothermal vents and rich in base and precious metals like gold and silver; and (iii) ferromanganese crusts found on seamounts and underwater ridges, containing metals including rare earth elements. Polymetallic nodules and ferromanganese crusts are economically valuable for their manganese, cobalt, nickel and copper while sulfide deposits are prized for zinc, silver and gold (European Academies' Science Advisory Council, 2023). These minerals are increasingly viewed as essential to meeting future industrial demand and supporting the transition to renewable, low-carbon energy infrastructure. Although proponents argue deep-sea mining could offer a cleaner, more ethical alternative to terrestrial mining, concerns persist about the unknown environmental and social impacts (Lam and Aldred, 2024).

Interest in deep-sea mining dates back to the late 19th century, notably with the Challenger Expedition (1872–1876), led by the British warship HMS Challenger, which was among the first to map the ocean floor and identify potentially valuable polymetallic nodules in 1873 (International Seabed Authority, n.d.; Lodge, 2017). However, it took another century for economic and geopolitical interests to develop, as these vast deep-sea deposits were recognized for their potential to meet future global energy demands. Early economic initiatives were led by developed nations including Belgium, Canada, France, Germany, Italy, Japan and the United States. Recognizing the geopolitical stakes, smaller states like Malta began advocating in the 1960s for an international governance regime under the United Nations to prevent resource monopolization by technologically advanced countries and to designate the deep seabed as the "common heritage of mankind" (International Seabed Authority, n.d.). Since then, commercial interest has grown, driven largely by advances in deep-sea mining technology that could make extraction more economically viable.

Deep-sea mining interests are most pronounced in the Pacific, where scientific exploration has revealed rich seabed mineral deposits. As technology advances and global demand for these metals rises, attention has focused on Pacific island nations with extensive exclusive economic zones (EEZs). This has prompted governments to pursue mining proposals, aiming to develop a commercial deep-sea mining industry. However, opposition is growing from countries like Fiji, Samoa, Tuvalu, Vanuatu and Micronesian states including the Federated States of Micronesia (FSM), Marshall Islands and Palau, due to uncertainties over the full economic, social and environmental costs. Conversely, Cook Islands, Nauru, Tonga and Kiribati view deep-sea mining as a potential catalyst for development and are among the region's most active proponents.

This paper critically examines the opportunities, challenges, and policy implications of deep-sea mining for Kiribati, a small island developing State (SIDS) and least developed country (LDC) in the Pacific. Following this introduction, the paper first assesses the international regulatory frameworks governing deep-sea mining. It then analyzes, in sequence: (i) the economic dimensions; (ii) the environmental impacts; (iii) the social consequences; and (iv) the growing regional and global opposition to deep-sea mining. Subsequently, the paper evaluates the specific opportunities and risks facing Kiribati in pursuing deep-sea mining. Before concluding, it offers policy recommendations for Kiribati, with particular attention to the intensifying geopolitical dynamics surrounding seabed resource development.

2. Regulating deep-sea mining

A modern legal framework to regulate deep-sea mining began to emerge in the late 1950s with the United Nations' first Conference on the Law of the Sea (UNCLOS I) in 1958, followed by UNCLOS II in 1960. While these early conferences addressed state rights and obligations concerning maritime activities, it was the third conference (UNCLOS III), held between 1973 and 1982, that marked a milestone for deep-sea mining. UNCLOS III produced the United Nations Convention on the Law of the Sea (UNCLOS), also known as the Law of the Sea Convention or Treaty, establishing a comprehensive legal framework for all marine and maritime activity (Gales, 2023). The Convention came into force in 1994 and included specific provisions to govern mineral resources beyond national jurisdiction. It also created the International Seabed Authority (ISA), an intergovernmental organization responsible for managing the Convention, including issuing contracts for exploration and exploitation and distributing a share of profits to developing countries (Pecoraro, Lily and Singh, 2024).

The ISA became fully operational in 1996 as an autonomous body with 167 member states plus the European Union, all parties to UNCLOS. Its primary role is to regulate the exploration and exploitation of deep seabed minerals in "the Area," the seabed and subsoil beyond national jurisdiction, covering over 50 per cent of the Earth's seabed (Lodge, 2017; Pecoraro, Lily and Singh, 2024, p.699). Activities in the Area require contracts with the ISA, which issues licenses to both public and private entities; the latter must be sponsored by a UNCLOS member State and meet technological and financial criteria. All activities are governed by the principle of the "Common Heritage of Mankind," mandating equitable sharing of economic benefits, especially with developing countries, primarily through royalties collected by the ISA and redistributed accordingly (Gales, 2023; Pecoraro, Lily and Singh, 2024).

While the ISA has established a regulatory regime for exploration, it has yet to finalize one for exploitation. To date, it has issued 31 exploration contracts across the Clarion-Clipperton Zone (CCZ), Indian Ocean, Mid-Atlantic Ridge and Northwest Pacific, with China holding the most (five) contracts (International Seabed Authority, 2024; Keating-Bitonti, 2024). No exploitation contracts or activities have commenced. Since 2014, the ISA has been developing draft exploitation regulations through expert workshops, studies and consultations, reviewed by its governing bodies including the Legal and Technical Commission (International Seabed Authority, n.d.).

Pressure to move from exploration to exploitation intensified in July 2021 when Nauru invoked the UNCLOS "two-year rule," requiring the ISA Council to finalize exploitation regulations within two years or consider exploitation applications under existing draft rules (Singh, 2022). The initial deadline expired in July 2023, with negotiations extending it to July 2025. The ISA insists exploitation should not proceed without finalized regulations but uncertainty remains over the legal bindingness of the extension. This regulatory gap risks exploitation beginning before a comprehensive framework is in place, especially as companies like The Metals Company (TMC) signal imminent applications, raising concerns about prioritizing commercial interests over legal and environmental safeguards (Jackson and Karan, 2024; Singh, 2022).

In April 2025, the new U.S. administration issued an executive order directing the National Oceanic and Atmospheric Administration (NOAA) to expedite deep-sea mining permits in the United States and international waters, motivated by economic, national security and strategic concerns, including reducing dependence on critical minerals and countering China's influence. Following this, TMC announced plans to seek mining permission via a U.S. subsidiary. However, the United States has not ratified UNCLOS and cannot sponsor companies for ISA contracts, complicating this approach. Alternatively, domestic legislation such as the Deep Seabed Hard Minerals Resources Act of 1980 allows NOAA to regulate U.S. citizens' deep-sea mining activities in the Area. While NOAA has authorized exploration permits, none of them have been issued. These developments have alarmed environmentalists, who warn that deep-sea mining could harm fisheries and impair the oceans' ability to absorb carbon dioxide, exacerbating climate change (Keating-Bitonti, 2024; The Guardian, 2025; The White House, 2025). This evolving legal and regulatory landscape highlights tensions between advancing commercial deep-sea mining and ensuring robust environmental protections and equitable benefit-sharing under UNCLOS and the ISA framework.

3. The economics of deep-sea mining

Commercial interest in deep-sea mining has increased significantly in recent decades, driven by technological advances that have improved the feasibility of mining and processing deep-sea deposits, alongside rising demand for critical minerals. Modern society's reliance on mobile phones, tablets, laptops, batteries, the Internet and streaming television has heightened pressure on supply chains, as these technologies require large quantities of metals-especially critical minerals (World Ocean Review, 2021). This demand has spurred commercial interest in polymetallic nodules, which are rich in manganese, nickel, copper and cobalt, all essential for producing information and communication technologies (ICTs), electric vehicles (EVs) and high-quality steel (World Ocean Review, 2021).

Polymetallic nodules are also considered vital for meeting future battery technology needs. Cobalt, manganese and nickel enhance battery performance, lifespan and energy density while copper serves as a crucial current collector in nearly all electricity-related technologies (Lèbre *et al.*, 2023). Historically, these metals have been sourced mainly from the Democratic Republic of the Congo (DRC) but deep-sea deposits are estimated to surpass all known land-based reserves. The growing production of digital technologies, including artificial intelligence (AI), machine learning and potentially quantum computing, will further intensify demand for these minerals, as will the global shift to clean energy and efforts to combat climate change. Materials such as lithium, cobalt and graphite are indispensable for manufacturing EV batteries, wind turbines, solar panels and other low-carbon technologies that increasingly power the world's energy systems (Ashford *et al.*, 2024). Some forecasts project global metal demand to rise from 25 million tonnes annually by 2030 to between 45 and 75 million tonnes by 2050 (European Academies' Science Advisory Council, 2023).

Although studies indicate no immediate shortage of terrestrial mineral resources, questions remain about how best to meet future demand and responsibly scale up mining and processing while minimizing environmental and social impacts (Ashford *et al.*, 2024). Land-based mining faces mounting challenges, including declining ore grades, stricter environmental regulations and rising production costs. In contrast, seabed deposits are abundant and often of higher quality (Epikhin *et al.*, 2024). Assessing deep-sea mineral resources is also more straightforward, as polymetallic nodules are visible on the seafloor, unlike terrestrial deposits buried at varying depths. For example, the CCZ, one of the most studied regions under the ISA, is estimated to contain 21.1 billion dry metric tonnes of polymetallic nodules. These nodules represent up to 600 per cent of existing terrestrial cobalt reserves, 340 per cent of nickel, 100 per cent of known manganese and 30 per cent of copper (Lèbre *et al.*, 2023). The CCZ is just one of several nodule-rich areas, with other zones near shore potentially offering substantial and more accessible resources.

The abundance of deep-sea deposits is seen by some as a means to reduce the environmental and social costs associated with terrestrial mining. Increased extraction from land-based sources is expected to exacerbate risks to biodiversity and human rights, as well as a range of other environmental and social impacts (Lèbre *et al.*, 2023). For instance, terrestrial mining is the fourth largest driver of deforestation, after agriculture, infrastructure and urban expansion, and mining-related deforestation nearly doubled in the 2010s compared to the previous decade (Amadi and Mosnier, 2023). Other negative impacts include air pollution, water contamination and toxic waste production, along with displacement, land use changes and health risks for local communities.[2] Weak regulation, enforcement and political will can further exacerbate these social costs, including child labour and conflict arising from uneven income distribution (Lèbre *et al.*, 2023). The DRC, which supplies 70 per cent of global cobalt, remains among the world's poorest nations, with local communities seeing few benefits from mining activities (Prasad and Hardy, 2023).

Despite these apparent needs, substantial uncertainty surrounds the full economic benefits of deep-sea mining. This is partly due to the difficulties of achieving industrial-scale mining at great ocean depths. Current technologies, mainly remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), are not yet capable of operating effectively under high pressures, freezing temperatures, low light, corrosive seawater and high turbidity (World Ocean Review, 2021). Recent trials in the Pacific encountered significant technological challenges, even at small scales, with one trial resulting in uncontrollable spills (International Seabed Authority, 2023; Shukman, 2021). With only 25 per cent of the seafloor mapped, doubts remain about whether current technologies can operate efficiently and safely, as much equipment has not been tested at full scale or even manufactured (Dobush and Warner, 2024). Consequently, the true operational costs of deep-sea mining remain unknown.

Beyond technological and operational barriers, the economic potential of deep-sea mining may be overstated. Estimates of ocean-floor mineral reserves often exceed what can realistically be mined. High-interest projections are based on mineral resources, not reserves, and do not account for limited extraction efficiencies and recovery rates, often less than 100 per cent. Many metals will mix with significant quantities of waste during extraction and refinement, making them unrecoverable due to high costs. Recovery rates vary by metal, and some, such as lithium, are present in such low concentrations that deep-sea sources are unlikely to compete with terrestrial alternatives on price. Research indicates that deep-sea mining would reliably supply only a few metals (cobalt, manganese and nickel) while many rare earth elements remain economically impractical to extract (Manhart and McLennan, 2023). Thus, only a fraction of potential reserves may hold commercial value, with others remaining unviable until technological advances lower costs or market conditions improve.

Some experts question whether deep-sea minerals are even necessary for the clean energy transition, noting that this shift does not depend on any single source or deep-sea metals (Deep Sea Conservation Coalition, 2023). For example, lithium-ion batteries used in EVs require more metals and minerals than are available from polymetallic nodules, and ongoing research into battery chemistry is likely to yield alternatives, such as sodium-ion batteries (Manhart and McLennan, 2023). This highlights a broader trend: economic projections for deep-sea mining often fail to account for technological advances that could reduce demand for deep-sea minerals.

Deep-sea mining companies are beginning to recognize that demand uncertainty could undermine their business models (Dobush and Warner, 2024). According to the World Ocean Review (2021), deep-sea mining is unlikely to be commercially viable at current metal prices. While rising demand could change this, increased supply from deep-sea mining may eventually lower market prices, perpetuating the risk of unprofitability both before and after exploitation begins. As a result, the economic viability of deep-sea mining remains years away.

4. Environmental impacts

The environmental impact of deep-sea mining is considered unavoidable (Secretariat of the Pacific Community, 2012). For much of history, the deep sea was thought to be barren but recent explorations

[2] Just one example of this was the collapse of a tailings dam at an iron ore mine in Brazil that tragically resulted in hundreds of deaths (Chung, Scheyder and Trainor, 2023).

have revealed it as one of the most pristine and biodiverse ecosystems on Earth, home to countless unique and newly discovered species. These ecosystems are fragile and highly sensitive to disturbance, raising significant concerns about the impact of mining on biodiversity and marine resources (Jenner *et al.*, 2023). The full extent of potential damage and the prospects for ecosystem recovery remain unknown but deep-sea mining activities can overwhelm marine species, impede juvenile settlement and larval dispersal and disrupt species and population connectivity (European Academies' Science Advisory Council, 2023).

The nature and scale of disruption depend on the mining method. Polymetallic nodules, for example, can be collected with relatively less disruption since they are not attached to the seafloor. However, they are found in deep basins rich in endemic species with long life cycles and limited dispersal abilities, making them particularly vulnerable to even minor disturbances. Mining ferromanganese crusts involves scraping large seamount surfaces, destroying slow-recovering, fragile habitats. Hydrothermal vent mining threatens rare and unique ecosystems, with recolonization rates varying based on vent stability. Both forms of mining alter sediment composition, disrupt ocean currents and impact biodiversity, with potentially long-term ecological consequences (European Academies' Science Advisory Council, 2023). Seamounts, in particular, are biodiversity hotspots supporting a wide array of marine life from whales and migratory fish to deep-sea corals and sponges. These ecosystems take centuries to form and are extremely vulnerable to disturbance (Deep Sea Conservation Coalition, 2024).

Mining also disturbs seafloor sediments, generating plumes of suspended particles whose spread and ecological impact are uncertain. Models suggest these plumes could disperse over tens of thousands of square kilometres, exposing marine ecosystems to sediment levels far exceeding their natural tolerance and potentially smothering or disrupting species well beyond the immediate mining zones (Deep Sea Conservation Coalition, 2024). All faunal classes, from microorganisms to megafauna, are at risk. While some mobile species may flee, others cannot escape and high sediment concentrations can disrupt feeding, respiration and reproduction, threatening marine life across multiple ecosystems (Leal Filho *et al.*, 2021).

Noise and light pollution from mining operations present additional risks. Many deep-sea organisms rely on sound, echolocation or bioluminescence for communication and navigation. Noise from machinery can disrupt behaviour, hinder communication and foraging efficiency and drive species away from essential habitats. Artificial lighting in otherwise dark environments may cause temporary blindness or interfere with bioluminescence. These threats remain understudied and largely overlooked. Mining may also compromise vital ecosystem services such as climate regulation and carbon storage; studies show that carbon cycling in abyssal plain ecosystems remains disrupted even 26 years after simulated mining (Deep Sea Conservation Coalition, 2024; Leal Filho *et al.*, 2021).

Despite academic research into various mineral processing techniques, no commercial-scale deep-sea mining operation has yet been implemented (Dobush and Warner, 2024). It is estimated that mining polymetallic nodules or ferromanganese crusts could generate 1–3 million tons of tailings annually (Wiltshire, 2017). Mitigation strategies for these environmental impacts are still in early development. Experts warn that achieving "no net loss of biodiversity" is unrealistic due to the lack of effective large-scale remediation methods and insufficient data for biodiversity offsets (Gardner *et al.*, 2013, p.1254). Current research indicates that deep-sea biodiversity is rich, endemic and slow to recover, making restoration efforts significantly more expensive and challenging than in shallower waters (Kung *et al*., 2021).

Ocean ecosystems already face pressures from pollution, plastic waste, overfishing and climate change (Mining Watch Canada, 2019). Industrial-scale seabed mining could exacerbate these stressors, further impairing the ocean's ability to regulate climate, store carbon and support biodiversity. Such disruption could undermine global climate commitments under the Paris Agreement, with potentially irreversible consequences for biodiversity, ecosystem functioning, marine food webs and human health (Hurber *et al.*, 2014; Jones *et al.*, 2017; Levin *et al.*, 2016; van Dover *et al.*, 2017; Wedding *et al.*, 2015). These cascading effects are particularly concerning for Pacific nations, where marine ecosystems are central to social, cultural and economic life, including food security.

Given the potential for irreversible environmental change, a precautionary approach is essential. This should include rigorous environmental impact assessments, adaptive management and mitigation strategies. Countries like Kiribati will need to carefully balance economic benefits against ecological costs to safeguard marine biodiversity and dependent communities. International cooperation and responsible governance are crucial to ensuring sustainable resource management and preventing environmental crises (Jenner *et al.*, 2023; Katona *et al.*, 2023; van Dover *et al.*, 2017).

5. Social consequences

There is increasing concern that the environmental impacts of deep-sea mining-including effects on fish, water and air quality and noise-will have significant consequences for people. These social costs are expected to be felt disproportionately by Pacific communities, which are closest to proposed industrial-scale mining and are already contending with the challenges of climate change and pollution. Deep-sea mining could compound these existing stressors by altering local and broader environments, causing species loss, habitat destruction and potentially irreversible damage to deep-sea ecosystems. The noise from mining machinery disrupts wildlife, seabed scraping kills marine organisms and sediment plumes can smother life across ocean zones (Kung *et al.*, 2021; van den Broek *et al.*, 2024). For coastal communities, these impacts may limit or prevent the harvesting of "living marine resources upon which their livelihoods depend" (United Nations Environment Programme Finance Initiative, 2022, p.16).

Tuna is especially vital for Pacific island communities, serving as a primary food source, a foundation of local economies and a cornerstone of regional trade and cultural identity. However, tuna populations are already depleted by overfishing, and climate change is expected to drive them further from the jurisdiction of Pacific island nations into the high seas or other territories (McIlgorm, 2010). Deep-sea mining is anticipated to exacerbate these pressures, as sediment plumes, toxic metals, waste and other mining by-products can suffocate open-water fish and invertebrates-including tuna-damaging their respiratory and feeding structures. One study estimates that deep-sea mining will directly overlap with at least 10 per cent of tuna catch areas for SIDS, rising to over 40 per cent in some parts of the Pacific (van der Grient and Drazen, 2021). As a highly migratory species, the impacts on tuna will be felt far beyond the immediate mining sites, threatening the economic stability of communities dependent on fisheries, especially those with limited income and access to external markets, who rely on subsistence activities such as fishing. Irreversible damage to marine resources would further marginalize these communities, undermine traditional ways of life and exacerbate existing vulnerabilities (Reeves, 2021; United Nations Environment Programme Finance Initiative, 2022).

Deep-sea mining could also intensify broader development challenges for SIDS in the Pacific, which already face issues related to urbanization, pollution, poor sanitation, limited freshwater resources and competition for land (Campbell and Warrick, 2014). Increased demands on ports, power, communications and related infrastructure could drive up housing costs and strain essential services. Land acquisition for onshore processing, waste facilities and increased shipping has historically led to habitat loss, disproportionately affecting coastal communities most dependent on marine resources. Research shows that these communities often bear the brunt of negative social impacts from extractive industries while profits are typically realized elsewhere (Ashford *et al.*, 2024; Mills, 2022; Roche and Bice, 2013; United Nations Environment Programme Finance Initiative, 2022). These pressures on local resources and services, coupled with the loss of livelihoods, may force younger generations to migrate, resulting in cultural erosion and weakened intergenerational ties.

For Pacific island communities, the ocean is more than a resource; it is integral to their identity, culture and survival (Greenpeace Australia Pacific, 2025; Reeves, 2021). The prevailing scientific consensus is that deep-sea mining will cause significant and lasting damage to ocean ecosystems, and the resulting degradation will undermine human rights, including the rights to a clean, healthy and sustainable environment and cultural expression. The loss of these rights will likely be felt most acutely by vulnerable groups, such as indigenous communities and subsistence fishers (McCorquodale, Orellana and Boyd, 2024; Office of the United Nations High Commissioner for Human Rights, 2023). However, little research exists on Pacific island communities' perspectives on deep-sea mining or on strategies to mitigate human rights impacts. Future research should consider the effects on women, youth and marginalized groups. In theory, revenues from taxes, licensing fees and royalties could benefit developing countries if equitably distributed and invested in infrastructure, healthcare and education (Roche and Bice, 2013). However, the extensive and time-consuming nature of such research means that understanding and addressing social impacts may only happen incrementally, making it difficult to assess these impacts in advance (Kung *et al.*, 2021; Roche and Bice, 2013).

Finally, there is a troubling lack of legal certainty for Pacific island communities likely to be affected by deep-sea mining, particularly regarding rights, claims and avenues for redress. The legal standing to bring claims for environmental damage under the "common heritage of mankind" principle is ambiguous, as "mankind" is not clearly defined in international law (Pecoraro, Lily and Singh, 2024). While the ISA can pursue claims, non-state actors such as affected communities often lack direct access to primary dispute resolution forums like the Seabed Disputes Chamber (Craik *et al.*, 2018; Davenport, 2019). As a result, local communities that bear the primary social and environmental risks may have limited recourse, raising concerns about equitable compensation and the fair distribution of mining revenues. Historically, mineral extraction has rarely led to sustainable development in the Global South, often fueling community divisions and conflicts over land and resources. Economists therefore question its role in promoting equitable growth, given the legacy of lasting environmental and social harm associated with resource extraction (Boldt, 2020).

6. Growing opposition

These environmental and social impacts, combined with economic concerns, have fueled growing opposition to deep-sea mining from a wide range of stakeholders, including governments, scientists, coastal communities, indigenous groups, segments of the business and financial sectors and numerous international and civil society organizations. The United Nations Environment Programme (UNEP) Finance Initiative, for example, has questioned the business rationale for deep-sea mining, urged caution and strongly recommended against investment (Dobush and Warner, 2024). Few countries actively support deep-sea mining or permit such activities within their national waters. Between June 2022 and November 2023, 24 countries publicly announced positions opposing deep-sea mining, and there has been increasing criticism of countries leading the push for exploitation, as seen in the domestic and global condemnation of Norway's efforts to permit seabed mining (Fietta, 2024). France is among the nations calling for a ban, while others, such as the European Union, are advocating for a moratorium. Countries where deep-sea mining exploration has occurred or was previously planned, such as Fiji and Vanuatu, have also declared moratoria (Dobush and Warner, 2024). To date, over thirty states have called for a moratorium on deep-sea mining (Fietta, 2024).

Calls for a moratorium have become more widespread within the international community. In 2021, the International Union for Conservation of Nature (IUCN) World Conservation Congress called on states to establish a moratorium on deep-sea mining until the economic, environmental, social and cultural risks are fully understood and effective marine protections are in place. At COP15 of the Convention on Biological Diversity in 2022, states were urged to ensure that the impacts on the marine environment and biodiversity are thoroughly researched and risks comprehensively understood before mining proceeds and to follow the best available science and the traditional knowledge of indigenous peoples and local communities, with their free, prior and informed consent. Similarly, a 2024 resolution at COP14 of the Convention on Migratory Species urged countries to refrain from deep-sea mining activities until robust scientific data can confirm that such exploitation would not harm migratory marine species, their prey or ecosystems (Fietta, 2024).

Within the private sector, resistance is also mounting. There is a notable lack of interest from the world's largest mining companies, including Rio Tinto, the world's second-largest metals and mining company, which publicly opposed deep-sea mining in 2023 (Dobush and Warner, 2024; Rio Tinto, 2023). Companies across the financial, energy, automotive and technology sectors have also committed not to invest in deep-sea mining or to source minerals from the deep sea and have pledged to prevent such minerals from entering their supply chains (Dobush and Warner, 2024). This list includes some of the world's largest corporations, such as BMW, Google, Philips, Rivian, Salesforce, Samsung and Volkswagen, among 39 companies that have formally declared their positions in writing. Notably, Maersk and Lockheed Martin, two companies that had previously supported deep-sea exploitation, have recently reversed their support for the industry.

7. Deep-sea mining for Kiribati: Opportunities and risks

Kiribati, a SIDS in the Northern Pacific, comprises 33 islands, 20 of which are inhabited-stretching 4,000 kilometres along the equator. With a population of about 120,000, Kiribati commands the largest EEZ in Micronesia and one of the largest in the Pacific (Department of Foreign Affairs and Trade, n.d.). The World Bank (2024) classifies Kiribati as a lower-middle-income country, and it remains among the Pacific's smallest and least developed countries, facing high poverty rates, limited infrastructure and significant isolation from global markets (Asian Development Bank, 2024; ILO, 2024; Moody's Analytics, 2024; Tanielu, 2013; World Bank, 2024).

Economic contexts and uncertainties

Kiribati lacks significant terrestrial mineral resources and relies heavily on fisheries, especially tuna, which in 2020 accounted for 70 per cent of fiscal revenue through fishing licenses and access fees (International Monetary Fund, 2023; Monaco and Abe, 2023). However, much of this value is lost offshore due to limited local processing. Economic development is further constrained by labour market challenges and urban migration to the capital, Tarawa (International Labour Organization, 2024; International Monetary Fund, 2024).

Driven by the need to diversify its economy and reduce dependence on a single resource, Kiribati has become one of the Pacific's most vocal proponents of deep-sea mining (Farran, 2022). The government sees seabed mining as a potential new revenue stream to foster economic growth, create jobs and enhance resilience against global shocks, such as those experienced during the COVID-19 pandemic (Department of Foreign Affairs and Trade, 2020). Additionally, Kiribati's vast maritime zone offers it a platform to influence global seabed resource governance and assert itself diplomatically (Kaiku, 2022).

Despite the promise, the economic benefits of deep-sea mining for SIDS like Kiribati are highly uncertain. Deep-sea mining is capital-intensive, requiring significant investment, advanced technology and specialized skills, most of which are sourced internationally (Mainstream Economics and Policy, 2016). Studies indicate that Kiribati might gain as little as US$ 3 billion in corporate taxes over 30 years, a modest return given the risks and potential liabilities, especially as policies to attract investors may further reduce public revenues (Sumaila *et al.*, 2023; The University of British Columbia, 2023).

Experience from similar projects in Fiji and Papua New Guinea shows that most economic benefits accrue to foreign investors, with limited local employment and minimal supply chain development. The bulk of capital equipment is imported, and local communities may see little direct benefit from mining activities (Mainstream Economics and Policy, 2016).

Environmental risks and fisheries impacts

Deep-sea mining poses significant threats to marine ecosystems. Sediment plumes, toxic metals and mining waste can spread over vast distances, smothering habitats, degrading water quality and threatening biodiversity (Environmental Justice Foundation, 2023). For tuna, sediment plumes may inhibit feeding and alter migration patterns, as these species avoid turbid waters and may ingest toxins that bioaccumulate up the food chain, potentially making them unsafe for human consumption (Ashford *et al.*, 2024; Chin and Hari, 2020; van der Grient, 2023). Even a small reduction in tuna catch rates could have outsized economic and social impacts, with cascading effects on processing and employment (Binney and Fleming, 2016; Boldt, 2020; Chin and Hari, 2020).

The impacts extend beyond fisheries. Surface plumes can block sunlight, reducing primary productivity and affecting marine mammals and birds. Deep-sea species, which are slow to regenerate, could take decades or centuries to recover from habitat destruction (Ashford *et al.*, 2024; SPREP Secretariat, 2021). Climate change further compounds these risks by already shifting tuna stocks away from Kiribati's jurisdiction (SPREP Secretariat, 2021; van der Grient and Drazen, 2021).

Social and cultural costs

Kiribati's history with extractive industries, notably phosphate mining on Banaba Island, highlights the potential for devastating social impacts. Phosphate extraction rendered much of Banaba uninhabitable, forcing the Banaban people to relocate, despite large profits for foreign companies (Mcdonald, 2021).

Today, overexploitation of fisheries has already led to near-collapse in some stocks, threatening livelihoods, nutrition and food security, especially for vulnerable and indigenous communities, who rely on fish for up to 70 per cent of animal protein and subsistence needs (Cisneros-Montemayor *et al.*, 2016; Gillett, 2016; United Nations Environment Programme Finance Initiative, 2022). Any negative impacts from deep-sea mining would disproportionately affect these groups, curtailing rights to health, food, water and work (Chin and Hari, 2020; United Nations OHCHR, 2023).

Long-term, loss of livelihoods may drive increased migration, cultural erosion and fragmentation of traditional practices and community ties. Kiribati already faces high migration pressures and has planned for staged international relocation due to climate change (Campbell and Warrick, 2014). Deep-sea mining could further threaten intangible underwater cultural heritage and the Pacific islanders' identity as ocean custodians (Chin and Hari, 2020; Environmental Justice Foundation, 2023; Mining Watch Canada, 2019; Prasad and Hardy, 2023; Tanielu, 2013).

Geopolitical and regulatory dimensions

Kiribati's pursuit of deep-sea mining also has significant geopolitical implications. After ending its agreement with The Metals Company in 2025, Kiribati has sought new partnerships, including with China, which offers financial and technological support for seabed resource development (Discovery Alert, 2025; RNZ, 2025). This aligns with China's broader strategy to secure critical minerals for green technologies and expand its influence in the Pacific, raising concerns among regional neighbours and international observers about environmental governance and regulatory capacity.

International law, particularly the UNCLOS, grants states rights over seabed minerals but also imposes strict environmental protection duties. Kiribati currently lacks comprehensive regulatory frameworks for deep-sea mining, underscoring the urgent need for robust policies, enforcement and community engagement to ensure sustainable and equitable outcomes (Boldt, 2020; SPREP Secretariat, 2021).

While deep-sea mining offers Kiribati the prospect of economic diversification and increased global influence, it carries substantial environmental, social and economic risks. The experience of past extractive industries in the Pacific suggests that promised benefits often fail to materialize for local communities, while costs, environmental degradation, loss of livelihoods and cultural erosion, are borne by the most vulnerable. There is a pressing need for more research, transparent governance and precautionary approaches to ensure that any move toward deep-sea mining truly serves the long-term interests of Kiribati and its people.

8. The future of deep-sea mining and recommendations for Kiribati

While the economic potential of deep-sea mining offers Kiribati an opportunity to diversify its revenue base and stimulate economic growth, comprehensive research and robust regulatory frameworks are essential to guide and govern such activities. This necessity is underscored by Kiribati's substantial liabilities as a sponsoring state and its obligations under the UNCLOS to protect the marine environment, adopt a precautionary approach and apply best environmental practices, especially amid scientific uncertainty surrounding deep-sea mining (Environmental Justice Foundation, 2023). States cannot evade liability by relying solely on contractor compliance with ISA regulations, which may fall short of international standards; they must actively regulate and oversee contractors under their jurisdiction (Poisel, 2012; United Nations, n.d.). Concerns persist about Kiribati's limited technical, financial and institutional capacity to effectively regulate multinational parent companies sponsoring contractors and enforce rulings, particularly given the potential lack of control over such operations. Kiribati could face reparations for environmental harm, with liabilities possibly exceeding its financial capacity or the income generated from mining activities.

A precautionary approach should be central to sustainable seabed mineral development, guided by UNCLOS, which provides a global legal framework for responsible ocean stewardship. Kiribati should engage actively with bodies like the ISA to shape global governance frameworks, ensure representation of its interests and establish strong regulatory frameworks for deep-sea mining activities aligned with existing global standards. This approach is vital for equitable benefit-sharing and to ensure that economic gains from seabed mineral extraction contribute to Kiribati's sustainable development and citizen welfare. A robust regulatory framework, supported by global governance, must be complemented by societal considerations to ensure deep-sea mining reflects the interests of Kiribati's communities, especially those most impacted. Integrating traditional knowledge, community engagement and public education is key to aligning mining activities with cultural values and aspirations. Addressing potential impacts on local livelihoods and social dynamics is imperative to foster inclusive development and maintain social cohesion.

Looking ahead and in light of intensifying geopolitical competition and the recent US administration's policy change in commercial deep-sea mining, Kiribati should consider the following policy recommendations:

- Strengthen regulatory frameworks: Develop and enforce comprehensive legal and regulatory systems governing deep-sea mining, ensuring environmental protection, equitable benefit-sharing, adherence to international standards and robust accountability for businesses.

- Foster international cooperation: Proactively engage with international organizations such as the ISA and other nations involved in deep-sea mining to collaborate on global standards, share best practices, address transboundary environmental issues and align with agreements protecting marine biodiversity; promote collaboration among governments, academia, industry and civil society to enhance resource management.

- Encourage research and knowledge exchange: Support ongoing scientific and economic research on deep-sea mining technologies, commercial feasibility, ecosystem impacts and biodiversity.

- Enhance environmental impact assessments (EIAs): Prioritize rigorous, transparent EIAs conducted by independent experts with public consultation to ensure credible and inclusive evaluation of ecological impacts.

- Build institutional capacity: Strengthen Kiribati's local capacity for deep-sea mining management through training programmes for government officials, scientists and industry personnel covering environmental monitoring, resource management and safety protocols.

- Enhance commitment to human rights: Respect, protect and fulfill the human rights to a clean, healthy and sustainable environment, safeguarding future generations' rights to enjoy such an environment.

- Monitor and address social impacts: Assess and monitor social effects on local communities, particularly regarding livelihoods, cultural practices and social cohesion; implement mitigation measures and ensure mining contributes positively to social development.

- Promote community engagement and participation: Actively involve local communities and indigenous groups in decision-making, respect traditional knowledge and practices and ensure communities are informed, consulted and benefit from mining activities.

- Enhance public awareness and education: Launch campaigns and initiatives to inform citizens about deep-sea mining's potential benefits and risks, foster public understanding and support for sustainable practices and guarantee access to information and participation on environmental and human rights issues.

By adopting these recommendations, Kiribati can position itself as a responsible steward of its ocean resources, safeguard its long-term interests amid shifting geopolitical dynamics and ensure that any future engagement with deep-sea mining aligns with the well-being of its people and environment.

9. Conclusions

There is a significant lack of knowledge about deep-sea ecosystems, species traits and the impacts of future mining technologies on the ocean and dependent communities. While deep-sea mining offers economic potential by supporting renewable energy supply chains and easing pressure on land resources, its precise benefits remain uncertain. High extraction costs, fluctuating metal prices and technical challenges raise doubts about its long-term financial viability. Moreover, profits may be concentrated among a few corporations and sponsoring states while environmental and socioeconomic costs could be widespread.

Environmental concerns include habitat destruction, biodiversity loss, sediment plumes spreading toxins, disruption of carbon sequestration and impacts on fisheries critical to food security, especially for small island states like Kiribati. Deep-sea species are often rare, slow to reproduce and dependent on habitats that mining would destroy, potentially causing extinctions and slow ecosystem recovery. The full scale of these impacts is not well understood, highlighting the urgent need for more research and a precautionary approach.

Deep-sea mining also poses serious social risks, particularly for coastal and indigenous communities relying on marine ecosystems for livelihoods, food security and cultural identity. Potential impacts include disruption of fishing, loss of traditional ways of life and threats to rights related to health, food, water, housing and self-determination. These communities often face marginalization in decision-making, with limited transparency and consultation, raising concerns about violations of their social, cultural and economic rights. Unequal distribution of benefits and risks may worsen global inequalities, making inclusive governance and meaningful community engagement essential.

Rising geopolitical tensions are intensifying concerns as countries compete for control over critical minerals vital for clean energy and security. The U.S. move to fast-track deep-sea mining to counter China's dominance has sparked an international backlash over bypassing established regulatory processes and deepening divisions among nations and between Global North and South actors. Some advocate moratoria or bans, while others push for rapid exploitation.

For Kiribati, deep-sea mining presents both opportunities and risks. Economically, it could diversify the economy and reduce reliance on fishing, remittance and aid. However, Kiribati's dependence on marine health for food security and livelihoods means ocean harm could severely impact its people and social fabric. As a sponsoring state, Kiribati may face liabilities for environmental damage beyond its financial capacity, making precaution essential. Experience in the Pacific and Global South shows short-term mining gains often fail to bring long-term prosperity, underscoring the need to balance economic benefits with environmental and social protections through science-based, precautionary and globally aligned regulations.

Deep-sea mining holds promise but is fraught with financial, ecological and social uncertainties. A cautious, well-regulated approach grounded in scientific evidence is critical to avoid unsustainable costs to marine ecosystems and coastal communities like Kiribati.

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