Deep-Seabed Mining: A Pacific Environmental and Governance Challenge

1. Introduction

This paper has been prepared by the SPREP Secretariat as a review of the key known environmental issues and other challenges of deep-seabed mining (DSM) in the region. Several SPREP Pacific island Member countries have granted permits for DSM exploration within their territorial waters and the Cook Islands government recently officially launched the licensing phase of seabed minerals exploration in its Exclusive Economic Zone (EEZ). The Cook Islands, Kiribati, Tonga, and Nauru also act as sponsor states for exploration permits in the Clarion Clipperton Zone (CCZ) in the International Seabed Area in the eastern Pacific in accordance with UNCLOS regulations administered by the International Seabed Authority. However, there are also other positions on DSM taken by governments in the region, ranging from the ban by Palau on mining within its EEZ to a call for a moratorium on DSM activities by Fiji, PNG and Vanuatu. Civil society organisations in several Pacific countries have expressed opposition to DSM before environmental and social impacts are fully assessed and understood.

At the global level, in 2018 the European Parliament adopted a resolution on international oceans governance that calls on European states to stop sponsoring deep-sea exploration in international waters and to support a moratorium on deep-sea mining, a call echoed by the Environmental Audit Committee of the British House of Commons[1]. His Excellency Peter Thomson, UN Special Envoy on Oceans, called for a 10-year moratorium on DSM at the World Economic Forum in Davos in January 2019. He noted the relevance of such action in the context of the UN Decade for Ocean Science, which was agreed by 193 countries in the UN General Assembly in December 2017[2]. A 10-year moratorium on DSM with a focus on improving our scientific knowledge of deep-sea marine ecosystems would substantially improve the basis for decision-making on DSM activities including avoidance and mitigation of impacts. For the Pacific islands region, it would align with Strategic Priority 3 of the *Framework for a Pacific Oceanscape* adopted by Pacific Leaders in 2010: sustainable development, management and conservation of the ocean, and the Framework overall objective to "foster stewardship at scale – local, national, regional and international *to ensure in perpetuity the health and wellbeing of our ocean and ourselves*". It would also align with the Vemööre Declaration adopted at the High-level Segment of the 10th Pacific Islands Nature Conservation and Protected Areas Conference in 2020, which calls for: "Entrenching a precautionary approach to any proposed deep-sea and seabed mining activities. We acknowledge the imperative for responsible stewardship of deep-sea and seabed environments in our national jurisdictions and on the high seas".

The predicted impacts of DSM activities are, based on current knowledge, contrary to Sustainable Development Goal 14, especially 14.2: "sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration, to achieve healthy and productive oceans". Further, UN General Assembly Resolution 66/288: The Future We Want[3] adopted in 2012 is explicit in its statements on the ocean and on mining"

> *Oceans and seas*
>
> 158….We…commit to protect, and restore, the health, productivity and resilience of oceans and marine ecosystems, to maintain their biodiversity, enabling their conservation and sustainable use for present and future generations, and to *effectively apply an ecosystem approach and the precautionary approach in the management, in accordance with international law, of activities having an impact on the marine environment*, to deliver on all three dimensions of sustainable development.
>
> *Mining*
>
> 227…We acknowledge that countries have the sovereign right to develop their mineral resources according to their national priorities and a responsibility regarding the exploitation of resources, as described in the Rio Principles. We further acknowledge that mining activities should maximize

> social and economic benefits, as well as *effectively address negative environmental and social impacts*. In this regard, we recognize that governments need strong capacities to develop, manage and regulate their mining industries, in the interest of sustainable development.

The targets for SDG 14 can be met in the Pacific islands region only by strengthening implementation of commitments at national and regional levels to protect and manage the integrity of coastal and marine ecosystems. This will require a rethink of how to approach some national development priorities and issues, including the threat of impacts from deep-sea mining on marine ecosystems and their services[4].

2. Deep-sea Mineral Resources and Associated Ecosystems

There are three main types of deposits that are the targets of deep-seabed mining exploration to provide metals and rare earth elements (REE) (see Figure 1[5]):

1. *Polymetallic Manganese Nodules* (PMN) are found in very deep low sedimentation rate abyssal plains of the oceans (>3000m) such as the Clarion-Clipperton Zone (CCZ) an area of over six million km^2 in the eastern Pacific. PMN are rich in rare earth minerals, notably nickel, cobalt, copper and manganese, and can contain zinc, zirconium, lithium, platinum, titanium and other valuable elements. The areas of PMN reportedly contain more manganese, nickel, and cobalt than land-based reserves. PMN form by chemical accretion around nuclei, scavenging the minerals from the water column and sediments over millions of years. PMN fields are not homogenous areas but contain seamounts, channels and other topographic features. Unique fauna species live on the nodules and high biodiversity has been discovered in PMN fields[5]. Fish and marine mammals congregate around seamounts on the abyssal plains for shelter and/or to forage for food[6]. Killer whales spend time over seamounts with tracking data suggesting they use these areas for hunting[7]. Seamounts are used by a range of other species including sharks[8], tuna and billfishes[9], and deep-water snappers that in some areas are important fisheries[10].

2. *Polymetallic Sulphides* sometimes referred to as Seabed Massive sulphides (SMS) are mostly found along mid-oceanic ridges and associated with submarine volcanic vents or "smokers". These hydrothermal vent sites are usually under immense pressure, and are toxic environments due to the heat and chemicals discharged from the vents; yet the sites harbour unique biological communities which use sulphur dependent bacteria as the base of the food chain. These chemosynthetic communities have also been postulated as the source of all life on Earth. Many species are found only at these specific sites.

3. *Cobalt Rich Crusts* form on the bare rock on the sides of seamounts and other rocky features below 600 m with the thickest crusts found at 800 to 2,500m deep. They form very slowly, accreting at rates of millimetres per millions of years. Filter feeding animals that use the rich waters formed from currents flowing around seamounts grow on the crusts. Ecological assemblages on seamounts tend to be unique and associated with fisheries hotspots. Seamounts create these hotspots of biodiversity as deep oceanic currents are forced upwards and around them bringing nutrients to the photic zones which in turn attract cetaceans, sharks, seabirds and marine turtles[1,11].

All three of these mineral reserve types are found within Pacific island country and territory EEZs[1,12] and International Seabed Area (Figure 2[13]). While these resources have been known for over 50 years, it is the recent surge in demand for REE prompted by rapid economic development and an accelerating use of technologies dependent on REE that is driving the momentum towards commercialisation of these resources[1] and anticipated economic viability.

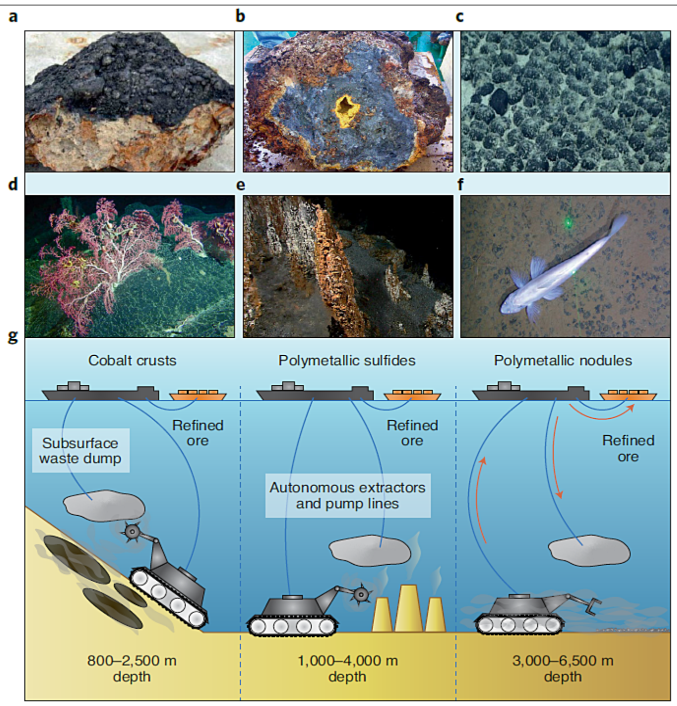

Fig. 1 | Examples of primary mineral resources, associated habitats and extraction mode schematic. a–f, Images of primary mineral resources (**a**–**c**) and associated habitats (**d**–**f**) targeted for deep-seabed minerals mining in international waters. **g**, Schematic of extraction mode. Shown are examples of cobalt-rich crusts on seamounts (**a**,**d**,**g** (left)); polymetallic sulfides at hydrothermal vents (**b**,**e**,**g** (middle)); and polymetallic nodules on abyssal plains (**c**,**f**,**g** (right)). Credit: Evelyn Mervine / SPC[94] (**a**); James Hein, USGS (**b**); NOAA Office of Ocean Exploration and Research (OER; **c**–**e**); Diva Amon and Craig Smith, University of Hawaii (**f**); schematic in **g** adapted from ref. [86], Oxford Univ.

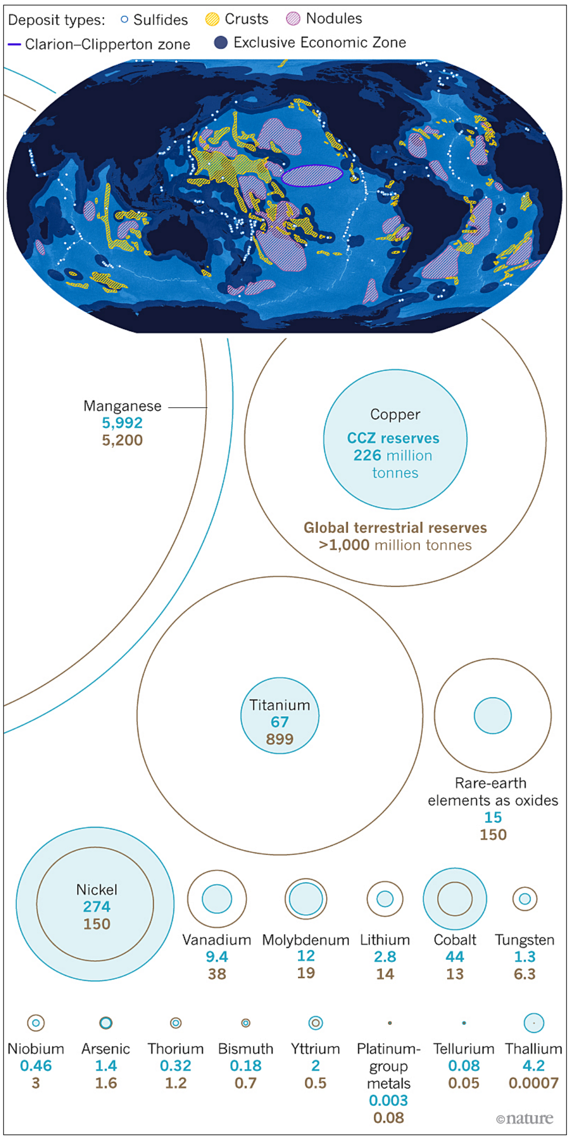

Figure 2: Global distribution of deep-sea minerals and estimated reserves compared to terrestrial reserves. Only marine reserves of manganese, nickel, cobalt and thallium are estimated to be in excess of terrestrial reserves.

3. Environmental Impacts

Five major environmental impacts are predicted to occur as a result of DSM[5]:

i. Direct removal of nodules, crusts and sulphides that provide substrates for unique biodiversity. For example, one study recorded 330 species in an area of 30km^2 in the CCZ, of which more than two-thirds were unknown to science[14]. Almost all the scientific data about the biology, ecology and biodiversity of deep seabed habitats comes from a few studies at small sites in the CCZ and scientists have sampled only 0.01 per cent of the area[15].
ii. Changes to the geochemical and physical properties of the seafloor.
iii. Sediment plumes created from the disturbance on the seafloor as well as from the return water that may cloud the water column or smother unmined seafloor areas. Recent research[16] suggests that DSM will generate sediment plumes and noise in the water column that may have extensive ecological effects in deep midwaters. Deep midwater ecosystems (200 m to 5 km) represent more than 90% of the biosphere[17] and contain fish biomass more than 100 times greater than the global annual fish catch[18].
    The deep seabed also receives massive amounts of carbon sediment known as deadfall carbon from biomass carbon, found in all marine vertebrates and deposited when they die, and from excrement. This material becomes incorporated into the sediments. While in the deep, this carbon deposit is thought to be largely stable but bringing it up to the surface together with other sediments potentially risks releasing large amounts of methane and carbon dioxide.
    More broadly, the marine carbon pump, is the ocean's biologically driven sequestration of carbon from the atmosphere and land runoff to the ocean interior and seafloor sediments. Data from the 'Disturbance and recolonization experiment' (DISCOL) conducted in 1989 suggests that if impacts on microbial productivity were extrapolated across multiple mining leases covering thousands of square kilometres of seabed the ability for the microbial driven biological pump to draw down carbon could be impacted further. "Coupled with the resuspension of carbon deposits from the seabed being released during extraction the ability of the Ocean to continue to absorb over 30% of the world's CO^2 emissions could be impacted".[19]
iv. Contaminant release and changes to water properties.
v. Increases in sound, vibration and light.

We already know how the effects of El Niño and La Niña can affect weather and surface water processes in the ocean, however, very little is known of midwater and deep-sea oceanographic processes and their periodic changes. Recent publications on seasonal underwater rivers flowing from continental shelfs of Australia into deep-sea[20], highlight how little is known of the connectivity between the coastal zone and the deep-sea. DSM exploration studies need to address these gaps and others regarding midwater mixing zones for modelling of sediment plumes to predict potential dispersal ranges of disturbed sediments including knowledge of predicted discharge rates from mining operations. This will require an understanding of how deep-sea currents flow and intermix at intersecting depths which can only be gained from data collected over multiple years.

The only long-term assessment of potential impacts of DSM is the '(DISCOL experiment, which simulated the removal of PM nodules from the abyssal plain east of Peru in the Pacific Ocean. The simple trial involved raking the centre of a roughly 11km^2 plot with an 8-metre wide plough. The simulated mining created a plume of disturbed sediment that eventually resettled and buried most of the study area, smothering fauna on the sea floor. The test revealed that the impacts of sea-bed mining reached further than anyone had imagined, but it did not actually extract any nodules from the seabed, which would have destroyed more marine life. The site has been repeatedly monitored since the trial and has never recovered, with ploughed areas as visible today as they were 31 years ago[21] [22] [23] with a four-fold reduction in microbial activity, suspension-feeder presence has remained significantly reduced in disturbed areas. A recent assessment[17] of the DISCOL impacts found “significantly lower heterogeneity diversity in disturbed areas and markedly distinct faunal compositions along different disturbance levels. If the results of this experiment at DISCOL can be extrapolated to the Clarion-Clipperton Zone, the impacts of polymetallic nodule mining there may be greater than expected, and could potentially lead to an irreversible loss of some ecosystem functions, especially in directly disturbed areas”.

A recent study[24] that used data on oceanographic and sediment characteristics from an exploration site in the CCZ modelled the behaviour of mining plumes for a proposed 1 to 4-day mining trial but did not include modelling for resuspension of sediments from eddies or other re-disturbance. The model predicted soft sediments could travel up to nine kilometres before resettling, affecting marine life over a much larger area than the direct impact area. Given commercial mining operations would last longer than a few days and cover larger areas resuspension of sediments due to physical disturbance by mining equipment or oceanographic processes would be more likely.

All these impacts, singularly or combined, pose not only the risk of direct biodiversity loss but also disruption to marine species migration patterns and loss of connectivity that could lead to deep ocean extinctions[5] across the Pacific Ocean. Several endangered, threatened or vulnerable species migrate across the Pacific (for example see Figures 3 and 4[1]) including through EEZs and International Seabed Area subject to DSM exploration and potential exploitation. Mineral reserve deposits also overlap with Ecologically or Biologically Significant Marine Areas identified by Pacific island countries as part of their commitment to the Convention on Biological Diversity[25]. The mesopelagic zone above the CCZ has already been designated as an Important Bird and Biodiversity Area and is a designated EBSA.

Van Dover et al.[26] argue that application of the four-stage mitigation hierarchy to ameliorate biodiversity loss normally applied by financial and regulatory frameworks is overall unattainable in the case of DSM:

i. *Avoidance*: loss of biodiversity unavoidable because mining directly destroys habitat and indirectly degrades large volumes of the water column and areas of the seabed through generation of sediment plumes enriched in bioavailable metals.
ii. *Minimisation*: innovative engineering design could reduce or minimize some risks to near- and far-field biodiversity.
iii. *Remediation*: in deep ocean species are often slow to recruit and recolonize disturbed habitats and recovery could be on the scale of decades to centuries, compounded by the large spatial scales of mines for certain mineral resources.
iv. *Offset*: this will not work if offsets cannot be located where impacted biodiversity is found, and where affected biodiversity is important for geographically restricted functions such as connectivity; protecting biodiversity in other locations or ecosystem types cannot compensate for loss of endemic species.

The region has the greatest dependency on fisheries in the world[27]. The Pacific region supplies half the world’s tuna[28], and the tuna fishing industry is worth billions of dollars annually (Figure 5[1]). The potential impacts of DSM on the marine environment needs to be comprehensively investigated. Tuna, as well as other species, make extended deep dives to 1,000 metres below the surface and deeper and could be exposed to mine waste discharged at any point in the water column, and are dependent on the availability of prey species that could also be affected by pollution and disturbance caused by DSM. The predicted changes to the distribution of tuna populations from the western to the eastern Pacific as a consequence of climate change warmer water in the Western Pacific will shift the spawning grounds for tropical tuna (skipjack, yellowfin and big eye) to the central and eastern equatorial regions of the Pacific[23]. This and other climate change impacts highlight the need for a precautionary approach to activities that will potentially compound impacts on marine ecosystems and species.

The COVID-19 crisis has also renewed interest in sourcing health solutions that can be found in the deep sea: organisms discovered at extreme depths are used to develop treatments for cancer, inflammation, nerve damage and for the detection of COVID-19, among others[29] [30]. Scientists estimate that we have discovered only 20 percent of all marine species[31] and The unique nature of many of the deep-sea communities means there is the potential to destroy these important genetic resources through mining activities before they have been studied. Also, in relation to human health, without proven deep-sea mining technology, it is possible that the discharge of mining material will result in dissolved heavy metals being released to the water column, in turn impacting the safe consumption of seafood.

The International Seabed Authority produced *Draft Regulations on Exploitation of Mineral Resources in the Area*[32] in 2018, which are still to be adopted. The regulations specify requirements for contractors to implement EIAs and Environmental Monitoring and Management Plans. They also specify that the ISA, states and contractors will "apply the precautionary approach, as reflected in principle 15 of the Rio Declaration on Environment and Development, to the assessment and management of risk of harm to the Marine Environment from Exploitation in the Area". However, the regulations do not state how the precautionary approach will be applied and what the consequences will be of any application of the approach.

4. Environmental Governance and National Risk

Closely aligned to environmental impact avoidance are governance issues related to mining in the region. In any consideration of DSM the poor track record of terrestrial mining in the region provides no confidence that environmental, social and equity considerations will be adequately addressed in the marine domain. For example, mining contributes almost a quarter of the Papua-New Guinea GDP and employs over 20,000 people. However, it has experienced decades of environmental degradation and social conflict as consequence of mining for copper and gold[33], and more recently at the Ramu nickel mine. Despite the monetary benefits generated from mining and other natural resource extraction PNG still struggles to provide the social and economic benefits of development to its people and after decades still sits on the low human development index in the annual UN Human Development Report[34].

The environments in Nauru and Banaba island in Kiribati have been devastated by phosphate mining and Angaur island in Palau has also been damaged as a result of historic phosphate extraction. The Solomon Islands is in the process of further developing its mineral resources but has also had major environmental, social and economic issues at the Gold Ridge gold mine, and more recently as a consequence of the grounding the bulk bauxite carrier *Solomon Trader* off Rennell Island. In 2019 the national Environmental Advisory Committee revoked the development consent given to a mining company by the Solomon Islands government to mine bauxite over 60 percent of Wagina Island following court action by the community. The company, Solomon Bauxite Limited, appealed this decision but the Minister of Environment has rejected the appeal.

The World Bank noted in a recent report that most nations for which DSM is a potential industry have no previous experience in overseeing large-scale terrestrial mining sector activities let alone DSM. "Under these circumstances there is need for caution, giving special attention to protecting the marine environment and the people who value it. A sound precautionary approach, which does not preclude the option of 'no development' is needed to avoid or minimize temporary or lasting harm to the environment, to the people and to the economy"[35].

PNG is the only country that has proceeded to the mining licence stage of DSM with its investment in the Nautilus Minerals Mining Company Solwara 1 project to mine hydrothermal vents on the floor of the Bismarck Sea. The project failed, the company went into liquidation and the PNG government lost its US$125 million investment. The then Prime Minister O'Neill reflected that PNG had underwritten the Solwara 1 project "in a deal that should not have happened in this country and as a result it has cost us a lot of money"[36].

Sir Arnold Amet, former chief justice of PNG, who was Governor of Madang Province and an MP when Solwara 1 was approved stated in 2019: "Let's recognise this failed investment in the upcoming budget and ensure we don't enter into seabed mining joint ventures in the future or issue any more seabed exploration or mining licences. We now know how deep-sea mining companies attempt to manipulate governments according to their own narrow profit motives without any conscience. We look to PM Marape to stand up for Papua New Guineans against the pressure exerted by these corporations"[37]. The Nautilus Minerals case provides an example of the financial, social and reputational risks associated with DSM in the region.

National risk is not confined to DSM operations in national marine domains. The Cook Islands, Kiribati, Tonga, and Nauru act as sponsor states for exploration permits in the CCZ. Private or public companies can engage in mining activities in the area provided they are sponsored by a State Party to the United Nations Convention on the Law of the Sea (UNCLOS). However, by sponsoring a contractor, a Party is responsible for ensuring compliance with provisions of UNCLOS and can be held liable under international law if environmental harm occurs in circumstances in which the state does not fulfil due diligence obligations to prevent harm.[30] [38] In its submission in 2011[39] to the International Tribunal for the Law of the Sea to seek an advisory opinion on a number of specific questions regarding the responsibility and liability of sponsoring States, Nauru made the following pertinent observations:

"Nauru, like many other developing States, does not yet possess the technical and financial capacity to undertake seafloor mining in international waters.

Not only do some developing States lack the financial capacity to execute a seafloor mining project in international waters, but some also cannot afford exposure to the legal risks potentially associated with such a project.
Liabilities or costs could, in some circumstances, far exceed the financial capacities of Nauru (as well as those of many other developing States). Unlike terrestrial mining, in which a State generally only risks losing that which it already has (for example, its natural environment), if a developing State can be held liable for activities in the Area, the State may potentially face losing more than it actually has."

There is also concern about the inherently contradictory role of the International Seabed Authority as an entity responsible for both issuing DSM licences and regulating environmental protection of the seabed in the DSM context and ensuring that international waters are managed as the Common Heritage for all of humanity[1].

5. Recommendation: Need for Application of the Precautionary Approach

Deep-sea mining as an issue is a complex composite of environmental, economic, policy, governance, international, regional and community concerns (see Figure 6). On the one hand, DSM offers the prospect of increasing access to relatively scarce mineral resources that can be used to support development of sustainable energy solutions. On the other, it is entails high environmental costs and economic risk for countries in the region.

Fundamentally, there is a conflict between the objectives of regional and global commitments by Pacific island countries to protect and sustainably manage the ocean and the proposed industrial scale exploitation of deep-sea minerals. As noted above, countries have committed to Sustainable Development Target 14.2: "sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration, to achieve healthy and productive oceans". The first value underpinning the Framework for Pacific Regionalism is: "we value and depend upon the integrity of our vast ocean and our island resources". The Paris Agreement on climate change notes "the importance of ensuring the *integrity of all ecosystems, including oceans*, and the protection of biodiversity…when taking action to address climate change".

The threats and uncertainties of deep-sea mining summarised in this paper reinforce the need for SPREP Members to apply the precautionary approach adopted by countries in the Rio Declaration in 1992:

> "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

The uncertainty around predicting the extent of impacts and reliably mitigating DSM has also led the European Commission to endorse the EU Biodiversity Strategy for 2030 with the following commitment:

> "In international negotiations, the EU should advocate that *marine minerals in the international seabed area cannot be exploited before the effects of deep-sea mining on the marine environment, biodiversity and human activities have been sufficiently researched, the risks are understood and the technologies and operational practices are able to demonstrate no serious harm to the environment, in line with the precautionary principle* and taking into account the call of the European Parliament. In parallel, the EU will continue to fund research on the impact of deep-sea mining activities and on environmentally friendly technologies. The EU should also advocate for more transparency in international bodies, such as the International Seabed Authority."[40]

It is the view of the SPREP Secretariat that SPREP should support the 10-year moratorium on DSM proposed by some Pacific island member countries. Such a moratorium would enable:

i. A comprehensive assessment of environmental, social and economic risks.
ii. It can be demonstrated that DSM can be implemented with effective management of the marine environment and biodiversity protected.
iii. Review of the International Seabed Authority to ensure that it applies a transparent, accountable, inclusive and environmentally responsible decision-making and regulatory process.
iv. Time to develop and strengthen a global circular economy that can ensure recycling of scarce mineral resources (for example, 160 million mobile phones are thrown away every single year in Europe that contain REE and metals to be sort from DSM[41])

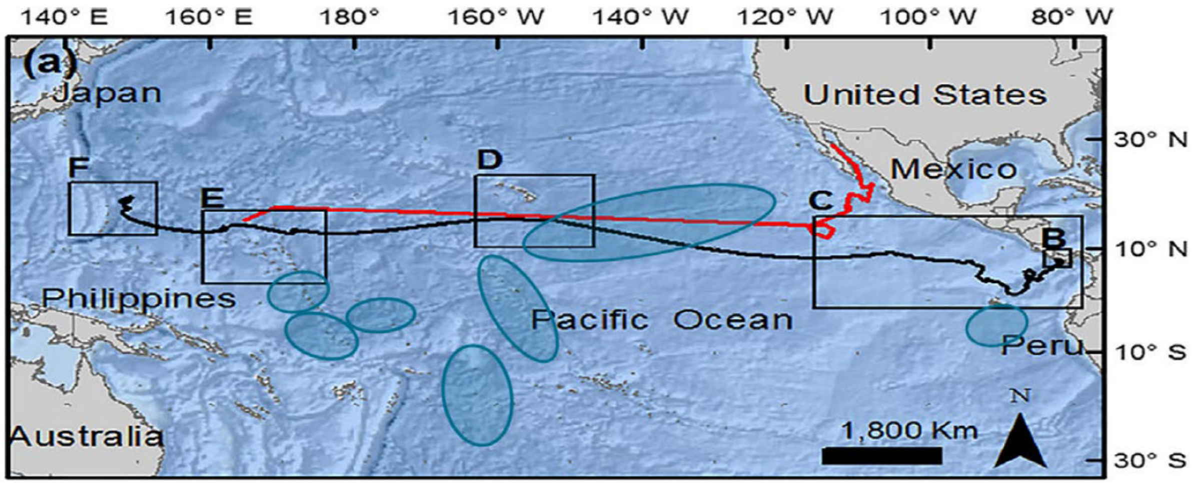

Figure 3 MIGRATIONS OF WHALE SHARKS ACROSS THE PACIFIC.
Lines show migrations in 2011 and tracked from Panama to the Mariana Islands (black route) and another whale shark tagged in 1995 which migrated from Mexico to the Marshall Islands (red route) Guzman *et al.* 2018 (3). Blue ovals indicate location of nodule fields.

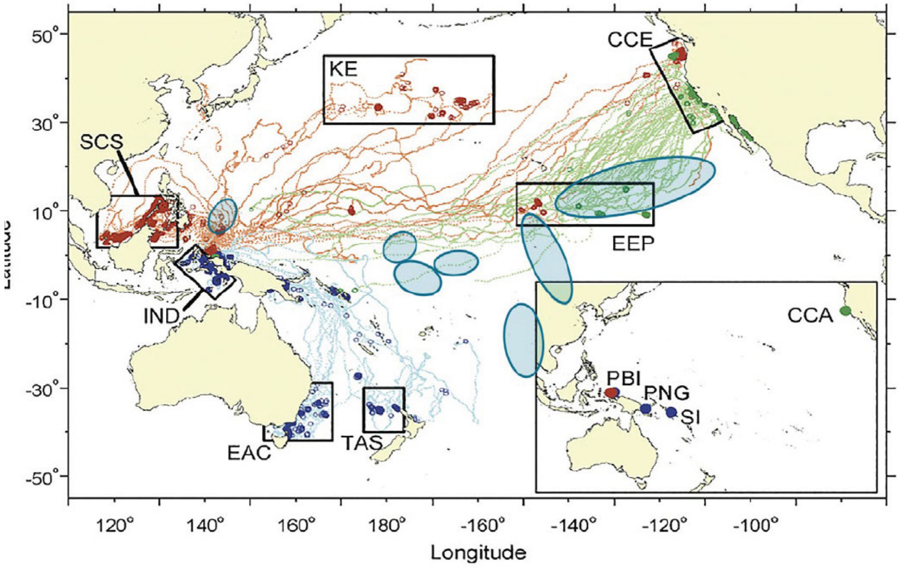

Figure 4 THE MIGRATION MOVEMENT OF LEATHERBACK TURTLES (*Dermochelys coriacea*) including traverses across the CCZ from Benson *et al.* (5). Colour of track indicates deployment season: red = summer nesters, blue = winter nesters, green = deployments at Central California foraging grounds. Inset shows deployment locations: PBI = West Papua, Indonesia, PNG = Papua New Guinea, SI = Solomon Islands, CCA = Central California, SCS = South China Sea. Black boxes represent eco-regions for which habitat associations were quantitatively examined: Sulu and Sulawesi Seas, IND = Indonesian Seas, EAC = East Australia Current Extension, TAS = Tasman Front, KE = Kuroshio Extension, EEP = Equatorial Eastern Pacific and CCE = California Current Ecosystem. Blue ovals indicate general areas of nodule mining interest.

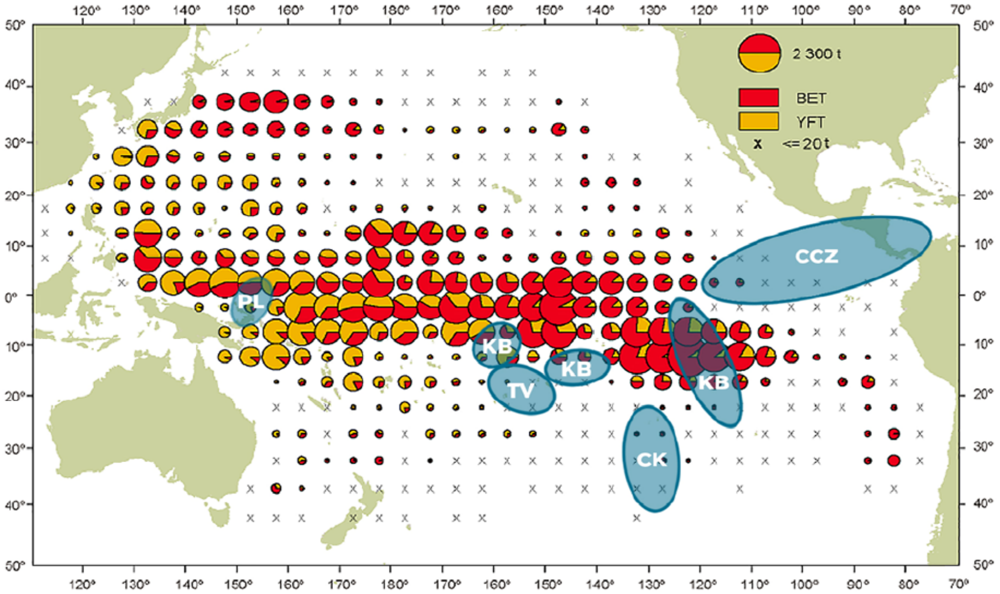

Figure 5 AVERAGE ANNUAL CATCHES OF BIGEYE AND YELLOW TUNA by longline vessels from China, Chinese Taipei, Japan and Republic of Korea between 2013 and 2017. Circle size denotes amount of tuna caught. Blue ovals represent the Clarion Clipperton Zone (CCZ) and the Peru Basin (PB), and the general area of the EEZs with nodule presence: the Cook Islands (CK), Kiribati (KB), Palau (PL), and Tuvalu (TV) (1). Tuna catch data from IATTC 2019 (8).

Figure 6: Summary of deep-sea mining issues and considerations[42]

Seabed exploitation will bring high uncertainties, high stakes and irreversible changes to marine ecosystems. There is an urgent need for discussion among the global community on what we stand to lose, ways to improve governance of the deep seabed and alternatives to mining.

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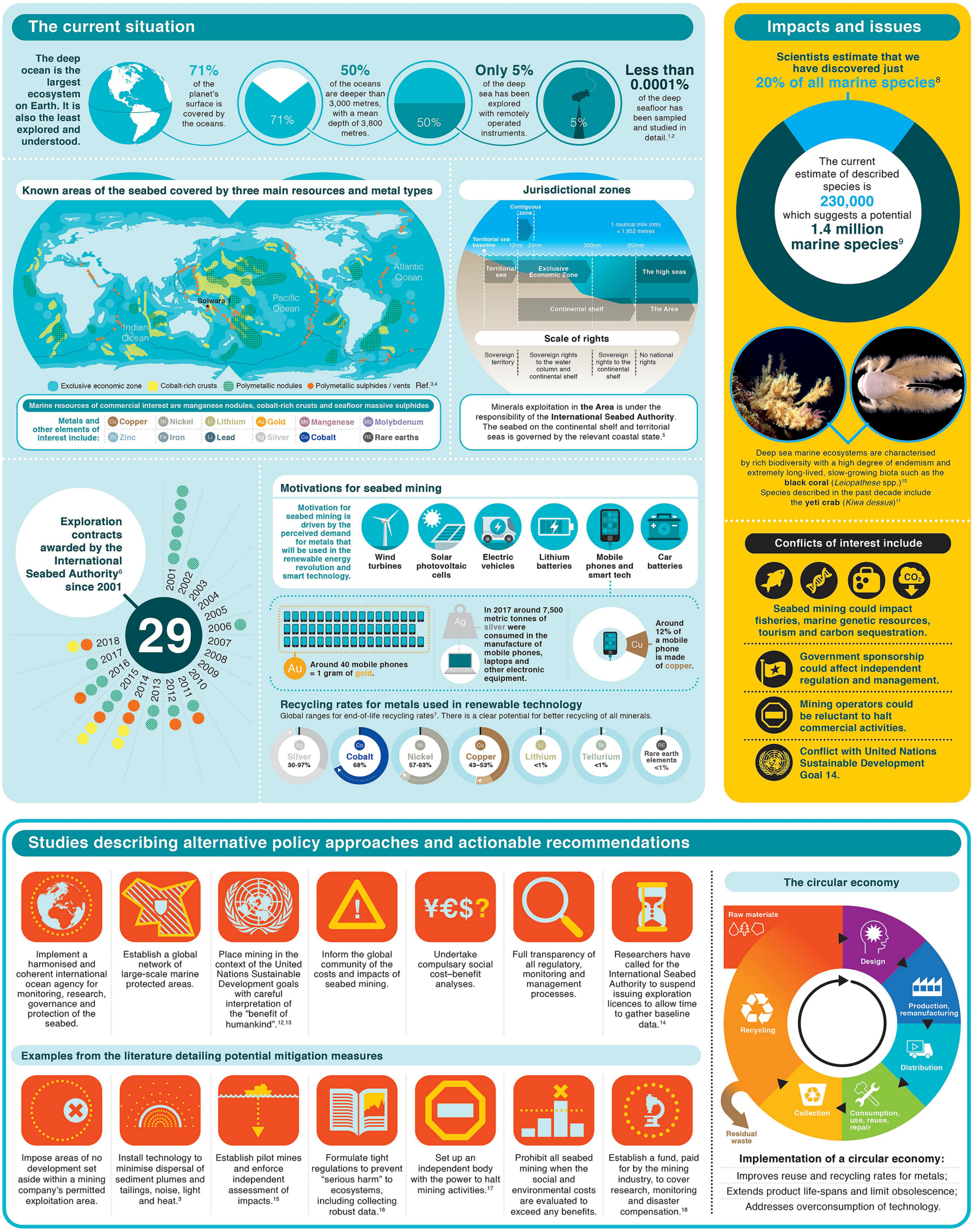

The current situation

The deep ocean is the largest ecosystem on Earth. It is also the least explored and understood.

71% of the planet's surface is covered by the oceans.

50% of the oceans are deeper than 3,000 metres, with a mean depth of 3,800 metres.

Only 5% of the deep sea has been explored with remotely operated instruments.

Less than 0.0001% of the deep seafloor has been sampled and studied in detail.[1,2]

Known areas of the seabed covered by three main resources and metal types

- Exclusive economic zone
- Cobalt-rich crusts
- Polymetallic nodules
- Polymetallic sulphides / vents

Ref.[3,4]

Marine resources of commercial interest are manganese nodules, cobalt-rich crusts and seafloor massive sulphides

Metals and other elements of interest include: Cu Copper, Ni Nickel, Li Lithium, Au Gold, Mn Manganese, Mo Molybdenum, Zn Zinc, Fe Iron, Li Lead, Ag Silver, Co Cobalt, RE Rare earths

Jurisdictional zones

Scale of rights

Sovereign territory	Sovereign rights to the water column and continental shelf	Sovereign rights to the continental shelf	No national rights

Minerals exploitation in **the Area** is under the responsibility of the **International Seabed Authority**. The seabed on the continental shelf and territorial seas is governed by the relevant coastal state.[5]

Exploration contracts awarded by the International Seabed Authority[6] since 2001

Motivations for seabed mining

Motivation for seabed mining is driven by the perceived demand for metals that will be used in the renewable energy revolution and smart technology.

- Wind turbines
- Solar photovoltaic cells
- Electric vehicles
- Lithium batteries
- Mobile phones and smart tech
- Car batteries

Around 40 mobile phones = 1 gram of gold.

In 2017 around 7,500 metric tonnes of silver were consumed in the manufacture of mobile phones, laptops and other electronic equipment.

Around 12% of a mobile phone is made of copper.

Recycling rates for metals used in renewable technology

Global ranges for end-of-life recycling rates[7]. There is a clear potential for better recycling of all minerals.

Silver	Cobalt	Nickel	Copper	Lithium	Tellurium	Rare earth elements
30-97%	68%	57-63%	43–53%	<1%	<1%	<1%

Impacts and issues

Scientists estimate that we have discovered just 20% of all marine species[8]

The current estimate of described species is **230,000** which suggests a potential **1.4 million marine species**[9]

Deep sea marine ecosystems are characterised by rich biodiversity with a high degree of endemism and extremely long-lived, slow-growing biota such as the **black coral** (*Leiopathese* spp.)[10] Species described in the past decade include the **yeti crab** (*Kiwa dessus*)[11]

Conflicts of interest include

- Seabed mining could impact fisheries, marine genetic resources, tourism and carbon sequestration.
- Government sponsorship could affect independent regulation and management.
- Mining operators could be reluctant to halt commercial activities.
- Conflict with United Nations Sustainable Development Goal 14.

Studies describing alternative policy approaches and actionable recommendations

- Implement a harmonised and coherent international ocean agency for monitoring, research, governance and protection of the seabed.
- Establish a global network of large-scale marine protected areas.
- Place mining in the context of the United Nations Sustainable Development goals with careful interpretation of the "benefit of humankind".[12,13]
- Inform the global community of the costs and impacts of seabed mining.
- Undertake compulsary social cost–benefit analyses.
- Full transparency of all regulatory, monitoring and management processes.
- Researchers have called for the International Seabed Authority to suspend issuing exploration licences to allow time to gather baseline data.[14]

Examples from the literature detailing potential mitigation measures

- Impose areas of no development set aside within a mining company's permitted exploitation area.
- Install technology to minimise dispersal of sediment plumes and tailings, noise, light and heat.[3]
- Establish pilot mines and enforce independent assessment of impacts.[15]
- Formulate tight regulations to prevent "serious harm" to ecosystems, including collecting robust data.[16]
- Set up an independent body with the power to halt mining activities.[17]
- Prohibit all seabed mining when the social and environmental costs are evaluated to exceed any benefits.
- Establish a fund, paid for by the mining industry, to cover research, monitoring and disaster compensation.[18]

The circular economy

Implementation of a circular economy:

Improves reuse and recycling rates for metals;

Extends product life-spans and limit obsolescence;

Addresses overconsumption of technology.

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