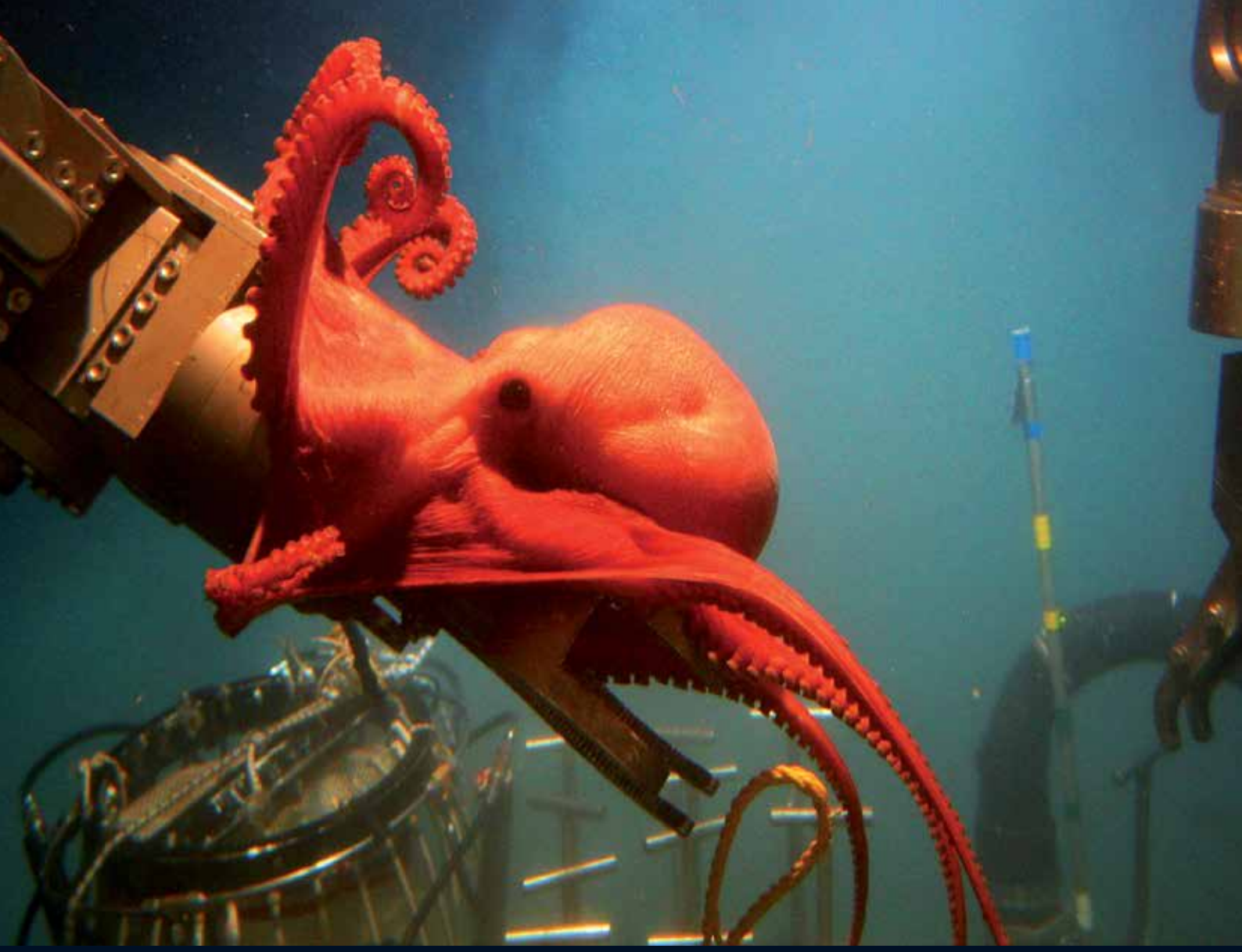


Solwara 1

Experimental Deep Sea Mining in the Bismarck Sea

History, Consequences, Resistance

fair oceans

Brot für die Welt

Imprint

Editors:
Society for Internationalism and Communication e.V.
(IntKom)
Bernhardstraße 12 - 28203 Bremen
www.fair-oceans.info

Bread for the World
Caroline-Michaelis-Straße 1 - 10115 Berlin
www.brot-fuer-die-welt.de

Editorial office:
Fair Oceans
Bernhardstraße 12 - 28203 Bremen
Fon: +49-152-295 170 04
E-mail: fair-oceans@gmx.info
www.fair-oceans.info

Concept, text and editing:
Kai Kaschinski, Christoph Spehr, Francisco Mari

Copy-editing, illustrations and design:
passage – Agentur WeltThemen, Frankfurt, Germany

Pictures: Fotos:
Harry Loges (S. 23, 27, 51), Thomas Lohnes (S. 18, 19,
30, 45, 58), Helge Bendl (S.25)

Printing:
PDF Version

Responsible regarding the press laws (V.i.S.d.P.):
Kai Kaschinski – IntKom

Translation:
König Communications, Nicole König, Erlenbach, Ger-
many; Christoph Spehr

Published in German 2018

English publication: 2019

Solwara 1

Experimental Deep Sea Mining in the Bismarck Sea

History, Consequences, Resistance

Content

New Developments - Five Years Later

When we finished this study early in 2019, mining the seafloor at Solwara 1 was an imminent threat. Deep-sea mining in the High Seas, on the other hand, was a looming possibility still far on the horizon. Five years later, early in 2023, the scene has changed.

Solwara 1 has failed before it could start. The insolvency of Nautilus Minerals Inc. led to the company's final dissolution. Papua New Guinea (PNG) lost a lot of money, but the coastal communities won. Although the extraction license for Solwara 1, given in 2019 with a 25-years-duration, was never cancelled, there is no foreseeable prospect that the mining project at this location could be revived.

After Nautilus had failed and died, the new star of the deep-sea frontline became The Metals Company, formerly DeepGreen Metals. The company acquired some of Nautilus' licenses and changed the direction of charging for the seafloor: From massive sulfides to polymetallic nodules, from mining in coast-near Economic Exclusive Zones (EEZ) to mining in the High Sea, under rules of the International Seabed Authority (ISA).

The conflict over deep-sea mining has shifted from local to global. In July 2021, Nauru triggered a showdown at the ISA by invoking the so-called two-year rule: If a country intends to submit a mining plan for a licensed area, the ISA must decide about it within two years, notwithstanding if the ISA has finished its regulatory framework or not. Meanwhile, the campaign for a ban or at least a moratorium on deep-sea mining is gathering pace, gaining the support of several governments from the Pacific, Latin America and Europe, and several multi-national companies, too.

It is most likely that the ISA will postpone the Nauru decision and simply ignore the two years deadline. This can be seen as a tacit acknowledgement that so far scientific knowledge is not sufficient to judge the ecological feasibility of deep-sea mining. Whether this will take the shape of a formal moratorium, if this moratorium will include EEZs as well, if the advocates of deep-sea mining will build enough pressure to force a first mining code approval in a year or two, or if we enter a phase of an undeclared, undated de-facto-moratorium, is completely open. The agreement on the High Sea Treaty, the legal framework on marine biodiversity beyond national jurisdiction (BBNJ), that was reached on March 4, 2023, may strengthen the prerequisite of sound environmental impact analysis before any new activity on the seafloor.

The aftermath of Nautilus

Nautilus Minerals had always needed fresh money to go along with Solwara 1. As the timeline moved further into the future and the business conditions became more and more unfavorable (especially since the contract with Tongling Inc. on the processing of the mined metals took away some of Nautilus' expected share of value added), the main investors, Russian company Metalloinvest and Osmani Mawarid/MB Holding, pulled the plug. On February 22, 2019, Nautilus Minerals declared insolvency and filed for restructuring at the Supreme Court of British Columbia. On August 9, 2019, a final meeting with the creditors took place under the auspices of Price Waterhouse Cooper (PWC). After the settlement, Nautilus would "have effectively no assets, and (…) will be liquidated."[1] The settlement was approved by the court. In January 2020, Nautilus was delisted from the stock exchange.

Ed Kopa, PNG's state-owned entity that co-owned the joint enterprise with Nautilus on Solwara 1, tried to be accepted as a creditor, but the court rejected the application.[2] This meant that PNG, having been forced to invest 120 million US dollars in Solwara 1, lost this amount completely - a very unpopular outcome to the PNG public and a warning signal to other Pacific Island countries.

Deep Sea Mining Finance (DSMF), a joint operation of Metalloinvest and Mawari/MB Holding, took over most of Nautilus' assets. In April 2020, DeepGreen Metals, another Canadian company specialized in deep-sea mining, acquired Tonga Offshore Mining Ltd. (TOML), initially set up by Nautilus, from DSMF. Through this acquisition, DeepGreen took over TOML's exploration contract with the ISA in the Clarion-Clipperton Zone (CCZ), along with "an intellectual property portfolio".[3] DeepGreen now owned three exploration contracts in the CCZ through joint ventures with sponsoring states

1 https://www.newsfilecorp.com/release/46603

2 https://resourceworld.com/nautilus-to-restrucure-sea-bed-mining-assets/

3 https://metals.co/deepgreen-acquires-third-seabed-contract-area-to-explore-for-polymetallic-nodules/

Five Years Later

from the Pacific Islands: TOML with Tonga, Marawa with Kiribati, and Nauru Ocean Resources Inc. (NORI) with Nauru. It is for the NORI project that Nauru invoked the two-year rule at the ISA.

The Metals Company: Building a better Nautilus?

There are close personal ties between Nautilus Minerals and DeepGreen Minerals, the company that in 2021 became The Metals Company. Gerard Barron, CEO of DeepGreen since 2017 and of The Metals Company since 2021, had been an early investor in Nautilus Minerals and steered its way to the stock exchange back in 2006 together with CEO David Heydon, who had joined Nautilus after 2001. At this time, the startup consisted of not much more than the exploration license on Solwara 1 that its founder, Julian Malnic, had acquired from PNG in 1997.[4] Instead of going through an Initial Public Offering (IPO), the start-up went public by buying an already listed company, Orca Petroleum, a method known as Reverse Takeover (RTO).[5]

Heydon stepped down as Nautilus' CEO in 2008, and Barron de-invested before the downslide of Nautilus' shares. In 2011, Heydon founded DeepGreen Metals, again with Barron as seed investor. Again, they brought DeepGreen public by a merger with an already listed company, Sustainable Opportunities Acquisition Corp (SOAC). SOAC had managed to do an IPO in 2020 as a Cayman-Islands-based Special Purpose Acquisition Company (SPAC), a "blank-cheque" shell company with the sole purpose of awaiting its first "initial business combination", providing another company access to the stock market without having to do an IPO itself.[6] By going public, DeepGreen Metals changed its name to "The Metals Company". In 2017, Gerard Barron became CEO, a position he holds until today.

Barron tried to learn from Nautilus' failures. The environmental argument, contributing to the low-carbon transformation by delivering crucial metals, had never been credible with Nautilus, as Solwara 1 was focused on mining gold and copper. Both are easily recyclable, copper is far from being scarce, and gold is replaceable. Drilling black smokers with heavy excavators had been totally obvious as a destructive activity, producing sediment plumes, polluting the ocean with toxic metals and effectively annihilating hotspots of deep-sea biological diversity. Going for coastal waters inevitably brought conflicts with communities, local fisheries, and meant taking a new industry into environmentally sensitive terrain.

Instead, DeepGreen aka The Metals Company focused on polymetallic nodules. According to Barron, this would allow for a smoother approach on mining: "Sulphides (…) require heavy equipment — big, angry rock grabbers that fill me with horror. By contrast, the machines we use are gentle giants."[7] E-mobility, a key factor for low-carbon transition, will need a lot of batteries; polymetallic nodules could deliver the additional nickel and cobalt used in batteries. Mining in the High Seas would seem far away from any neighbors. Any impact on communities would be very indirect and delayed.

However, the problems that The Metals Company is facing, have some resemblance to the story of Nautilus. Within a week after going public, the price of The Metal Company's shares started to fall, from 12 US dollars to about 1 US dollar now. The immediate reason was that the company lost trust when it became known that a major investor had not fulfilled its obligation to buy shares for 200 million dollars.[8] But since then, fear of the timeline has haunted the company like it had haunted Nautilus. The NORI project on which the company is focused hinges on the promise of getting an ISA-approved mining plan. In its financial reports, the company assures that its existing cash will be sufficient to reach autumn 2023, past the two years deadline at the ISA.

4 Robert Kunzig: Can Giant Robots Successfully Mine the Mile-Deep Seafloor, in: Discover, May 2009

5 Nautilus Minerals Inc.: Annual Information Form for the Fiscal Year 2014, Vancouver, 2015

6 Registration Statement, March 17th 2020, https://www.sec.gov/Archives/edgar/data/1798562/000121390020006690/fs12020_sustainable.htm

7 Robin Hicks: "We need to mine deep-sea metals to power the energy transition". Interview with Gerard Barron, in: eco-business.com, October 22, 2020, https://www.eco-business.com/news/we-need-to-mine-deep-sea-metals-to-power-the-energy-transition-deepgreen-ceo-gerard-barron/

8 Ortenca Aliaj: Deep sea mining group left in lurch after $200m disappears, in: Financial Times, October 20th, 2021

Five Years Later

Objections to The Metals Company's claims of being a better Nautilus build up, too. Electric car factories in China, including production sites of Tesla, start to install new generations of lithium batteries that substitute nickel and cobalt with iron phosphate. New research has shown that manganese nodules may represent a specific ecological niche and may have a relevant role in organic carbon degradation.[9] They have also great value as paleoclimate archives.[10] While nodule mining has less impact in depth than mining for sulphides, it has much more impact in width. Any commercially sound approach would call for huge areas to be harvested before reaching a break-even point.

The movement for a moratorium

On June 27, 2022, in a side event at the UN Oceans Conference (UNOC22), the Republic of Palau, the Deep Sea Conservation Coalition and the WWF presented thelLaunch of the Alliance of Countries for a Deep-Sea Mining Moratorium. Five years earlier, at UNOC17, there had been a similar side event that criticized seabed mining, organized by Pacific NGOs PIANGO and PANG, with participation of Bread for the World and Fair Oceans – in a small room, with NGOs, an attorney and a cardinal, but no states. This time the room was big and packed. The president of Palau, Surangel Whipps, and the prime minister of Fiji, Frank Bainimarama, called for a moratorium on deep-sea mining, supported by Samoa and accompanied by marine biologist Sylvia Earle. Three days later at the conference, French president Emmanuel Macron unexpectedly called for an outright ban on seabed mining. UNOC22 also saw presentations of the Pacific Parliamentarians Alliance and the Global Parliamentarians Declaration Calling for a Moratorium on Deep-Sea Mining, as well as other events supporting the moratorium.[11]

The French parliament voted on January 17, 2023, to stop seabed mining in French waters. In December 2022, the assembly of French Polynesia had done the same, exempting its 5 million square kilometers of water, the world's largest contiguous EEZ, from deep-sea mining. At the meeting of the ISA council in November 2022, Germany supported the call for a moratorium in the High Seas ("precautionary pause"), along with Spain, Panama and other countries. Chile, who currently holds the chair of the ISA council, has joined the moratorium coalition early. However, among the 36 members of the ISA council, strong opposition to the moratorium idea is represented, too.

At the December 2022 meeting of the ISA council, it became clear that there will be no completion of the ISA mining code before the two-year deadline for the Nauru will expire, in July 2023. Many member states, however, declared that they would not approve any mining plan before the mining code is completed, effectively calling to ignore the deadline. This included Norway, e.g., which is not in favor of the moratorium but also not willing to decide without a finished mining code. Nauru finally reduced pressure by stating that Nauru will not present a mining plan for NORI in July 2023. That means that the deadline will be passed without a decision.[12] As the adoption of a mining code would need consensus or at least a two-thirds majority in the council, there is a blocking minority of 13 votes.[13]

9 Massimiliano Molari et.al.: The contribution of microbial communities in polymetallic nodules to the diversity of the deep-sea microbiome of the Peru Basin (4130–4198 m depth), in: Biogeosciences, Volume 17, issue 12,

p. 3203–3222, 2020

10 X. D. Jiang et.al.: Abyssal Manganese Nodule Recording of Global Cooling and Tibetan Plateau Uplift Impacts on Asian Aridification, in: Geophysical Research Letters, Vol. 49, issue 3, February 2022

11 https://seas-at-risk.org/general-news/un-ocean-conference-creates-a-fair-wind-behind-deep-sea-mining-moratorium-campaign/

12 https://dsmobserver.com/2022/12/deep-sea-minings-rapid-technological-progress-is-met-with-increased-calls-for-a-precautionary-pause-at-the-closing-meeting-of-the-27th-session-of-the-international-seabed-authority/

13 Maurizio Guerrero: Opposition Grows Among Countries as Seabed-Mining Efforts Push Ahead, PassBlue, January 2, 2023, https://www.passblue.com/2023/01/02/opposition-grows-among-countries-as-seabed-mining-efforts-push-ahead/

Five Years Later

The next five years

It is unclear if there will be a moratorium on deep-sea mining, at the ISA or in the UN General Assembly. But the 2022 proceedings have demonstrated that the ISA process already has a built-in moratorium: If there is no broad majority for a head-start with deep-sea mining in the High Seas, there will be no decision, neither on a mining code nor on a mining plan submitted by a country. At the moment, the "it-takes-as-long-as-it-takes"-position seems to mark the kind of compromise that mirrors at least some general understanding that a precautionary approach is needed.

This may cause a new shift of focus for key investors looking for the best crack in the wall. EEZs may again become the focus of interest. A very important goal for the moratorium movement may be to convince more and more governments and regional country groups, like the EU, the Pacific Island Community or the Mercosur, to shut its waters against deep-sea mining.

The understanding of the fragile nature of marine biospheres and of the oceans' complicated contribution to carbon cycles is growing. There are only two serious concerns (apart from business concerns to miss the next wave of big money) that feed the seduction of deep-sea mining: The resources concerns, and the concerns of many countries in the Global South about their role in a world of economic unrest and mounting costs of self-protection against climate change. There will be no solution to the world's most pressing ecological problems without solutions to its development problems. The agreement on BBNJ contains the idea that sharing profits from knowledge may be an alternative to sharing profits from extraction. The next five years will show if this road is taken.

Bremen, April 2023

Small-scale and subsistence fishing are common along the entire coastline

Chapter 1

An Announcement

John Simoi, leader of an indigenous community on Bagabag Island, remembers well how he first learned about it. „I learned it through the newspaper. They published an announcement that they would be coming to mine the sea floor in the proximity of Bagabag Island. That was when we learned it all (...). We know that our island was formed through volcanic activity. Our first reaction was: this cannot be good, drilling into volcanoes on the seabed."[1]

His life was changed by this. Simoi read whatever he could find: about deep sea mining and Nautilus Minerals, the company that wanted to launch the world's very first commercial seabed mining project at Simoi's shore. Founded in 1987, Nautilus Minerals Inc. is a Canadian enterprise, mainly owned by Russian and Omani capital that specializes in deep sea mining.

Solwara 1, where the mining is planned to take place, is an area off the coast of Papua New Guinea (PNG). In 1997 Nautilus Minerals bought an exploration licence for this area from the state of PNG. In 2006 Nautilus Minerals applied for an exploitation licence. It was given in 2011. Nautilus Minerals formed a special subsidiary company for the Solwara 1 mine. The state of PNG holds a 15 percent interest in this subsidiary. The start of the mining operation had to be delayed many times, for technical, legal and financial reasons. The sea floor robots that would do the mining were built and ready. The support vessel, the ship that would take the ore on board, was put on hold by the Chinese shipyard where it was built, and the construction contract was cancelled because the buyer, a contracted partner of Nautilus Minerals, had failed to pay the rates. As of January 2019, the negotiations are ongoing. The starting date for the Solwara 1 mining operation has been delayed again. However, even if Nautilus Minerals should fail to solve its problems, this wouldn't necessarily mean that it is over. Other companies might be eager to step in, take over the licence and machines and finish the project.[2]

Simoi informed his community, then the people of their neighbouring communities and villages. He got in touch with groups in the city, above all the Bismarck Ramu Group (BRG) that has supported community organizing since the 1990s. BRG itself had led a resistance campaign against a mining company (Ramu Nickel Ltd.) that operated two mines close to Madang town. In June 2008, Simoi teamed up with several other groups and founded the „Bismarck Solomon Sea Indigenous People's Council", where he was elected the Council's Chair.[3]

This grew into a broad campaign of local communities, church congregations, women's organizations, NGOs in PNG as well as regional indigenous associations resisting the exploitation of the seabed, with PNG as a testing area for a new, untested technology. "Our government has given the ok for Nautilus to use us as guinea pigs, to experiment the first Sea Bed Mining", says Simoi. "We the Land Owners will not fold our hands and watch this happen!"[4] The PNG constitution guarantees indigenous communities special land rights over their traditional living areas. The communities consider the sea off their coast, that they travel and use daily, as a natural part of these land rights.

Solwara 1, the planned first seabed mine, lies only 19 miles off the coast at a depth of 1 mile. It is located between the northern islands of Papua New Guinea in the Bismarck Sea, one of the most biodiverse and ecologically significant maritime regions in the world. An ecsystem on which both life and food safety of the local communities directly depend: „Without the sea, there is no life," their representatives keep saying. It seems quite plausible that Nautilus Minerals chose this place in the hope of encountering little political resistance and low governmental control capacities. "Which country is weak? Which country has weak laws? (…) So when they made their analysis, they chose PNG" says Simoi.[5]

During recent years a real race for deep sea minerals has started. The Pacific Island states have issued lots of licences to companies planning new deep sea mining

1 Interview, 04/22/2016

2 Nautilus Minerals Inc.: Press release 12/2/2018. One possible new investor that is named is the Australian company DeepGreen: David Hutt: After the loss of a ship, deep sea mining plans for PNG founder, Mongabay 12/26/2018, https://news.mongabay.com/2018/12/after-the-loss-of-a-ship-deep-sea-mining-plans-for-png-founder/

3 https://intercontinentalcry.org/indigenous-communities-oppose-deep-sea-mining/; http://www.pireport.org/articles/2010/08/20/undersea-mining-called-threat-png-marine-life

4 https://ramumine.wordpress.com/2011/05/14/solwara-1-undersea-mine-rushed-by-the-government/

5 Interview, 04/22/2016

Chapter 1

projects. While the international community, within the framework of the United Nations Convention on the Law of the Sea (UNCLOS) and the International Seabed Authority (ISA), is struggling for rules and strategies for a just and responsible use of the seas, precedents are created off the coast of the Pacific islands. There is some resemblance between the local resistance against deep sea mining and the protests against nuclear power plants in Europe 40 years ago. Nuclear power, once presented as a solve-all solution for the energy problem, is now seen as a large-scale technology with uncontrollable risks that the world is painfully trying to overcome.

Today, we see the birth of a new large-scale technology. Its beginnings go back to the 1960s. But since 2000, this technology has become real. It has come into the focus of international investors. A single mine cannot reimburse the large investments needed to start deep sea mining. Solwara 1 is a starting point, the kick-off for the mining of many other areas of the sea floor. The Solomon Islands, Tonga, Kiribati and other Pacific Island states have issued licences for seabed mining, too. Other projects take place in the Red Sea. If it is not stopped by political decision, the new large-scale technology deep sea mining will change the face of the planet.

The advocates of this new large-scale technology put forward three main arguments: Deep sea mining is necessary to meet the growing global need for resources. It is a chance for the development of the local regions where it takes place. The ecological impact is lower than that of mining on land, making deep sea mining the more sustainable alternative.

As this study points out, none of these arguments hold. At the same time, the risks and the unavoidable consequences of this technology are much more alarming than the advocates concede. These risks and negative consequences extend to local fisheries and subsistence economies, the food security of affected populations, the sustainable local and regional development in the Pacific and the future of the biosphere sea as a whole. In addition, sea bed mining violates legitimate rights of indigenous communities. These are mainly traditional property rights and the right to free, prior and informed consent (FPIC) – indigenous rights that today are internationally acknowledged.

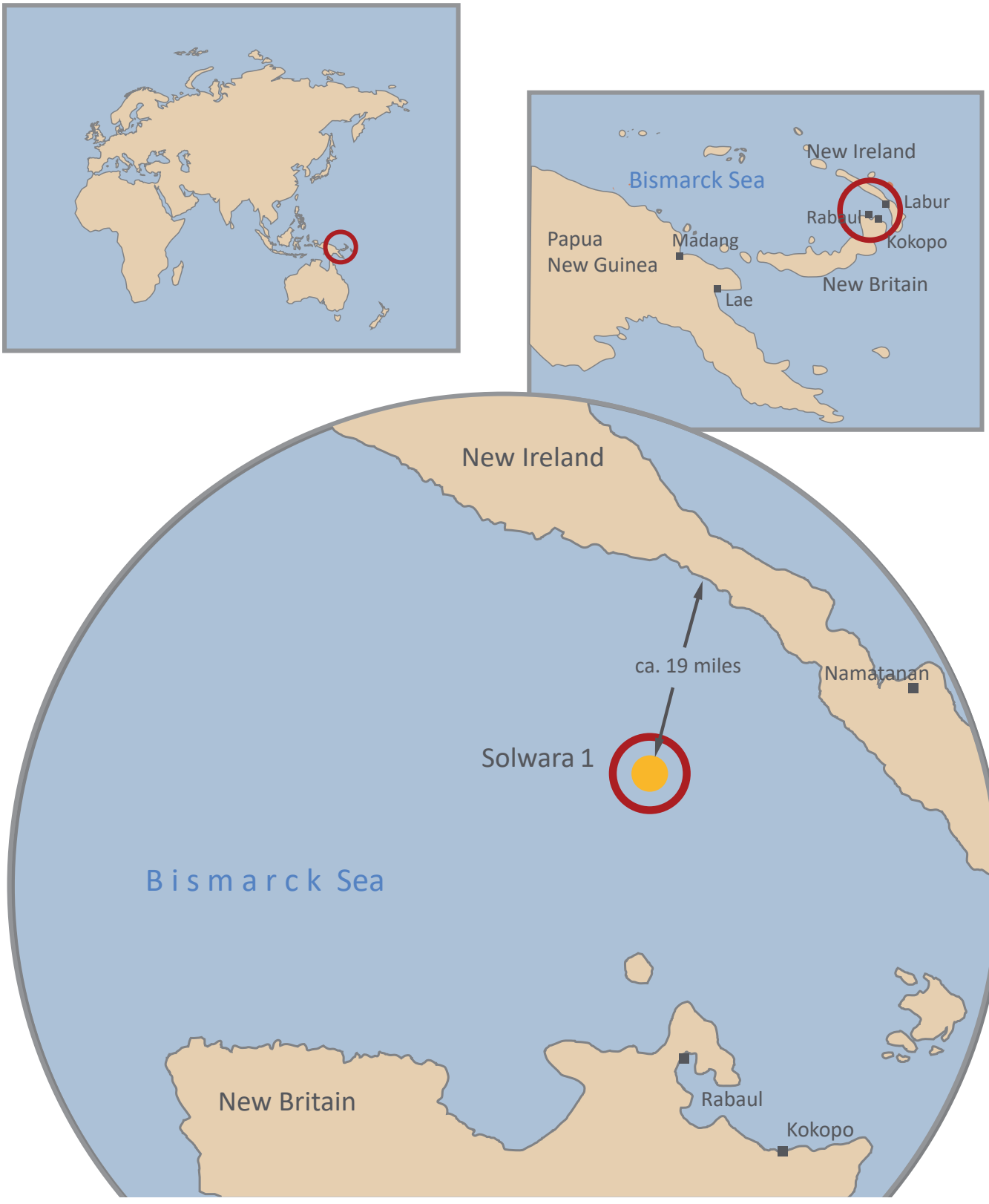
Solwara 1 has become a symbol in many ways. It is connected to many aspects of the future development of the global South: food security, artisanal fisheries, sustainable regional development, indigenous rights, human rights, the ecological precautionary principle, democracy. For the churches in the South Pacific region, deep sea mining and the social question it implies, have become a main issue.

Deep sea mining affects everyone. The consequences will not be limited to the Pacific Island region. The Solwara 1 case cannot be dissociated from the global debate on the transition from a destructive and unjust economic system to a sustainable solidary economy. It is part of a big decision: How do we want to treat the oceans? Shall we use natural resources in a just and responsible way? And, in taking this decision, who are we listening to?

* * *

For this study, 41 interviews with people concerned or involved in New Ireland, Duke of York islands, Madang and Karkar Island were conducted. The interviews took place in February 2016. The study uses the inputs and discussions of two workshops that were held in April 2016 at Madang, PNG, and in April 2017 at Suva, Fiji. The workshops were organized by Bismarck Ramu Group (BRG) and Bread for the World, with the participation of NGOs and community representatives from Papua New Guinea, from the Pacific Island states and from Germany.

Chapter 1



Geographical Location of Solwara 1

Chapter 2

Mining the Deep Sea

On the bottom of the ocean, you're basically talking about a desert. It is a very wet desert, but there's almost no life in the areas in question. (…) We're talking about areas where there is almost nothing on the bottom of the ocean. Really, the environmentalists should be cheering this.

Louis James, editor-in-chief of Casey Research, Interview with „The Gold Report"[6]

The deep ocean (…) constitutes the largest and least understood biological habitat on Earth. It's an Alice-in-Wonderland world of extremes, extraordinary adaptions, bizarre organisms, beauty and mystery.

Richard Steiner, Biologist and Oceanographer[7]

While 12 people have already set foot upon the Moon, only three people reached one of the deepest parts of the ocean at the Mariana Trench. The deep sea is the least explored part of the earth and its biosphere. Not even 0.0001 per cent of it is considered explored.

On average, the oceans are approximately 2.3 miles deep. About a quarter of the seabed lies deeper than 3 miles and is largely inaccessible to humans. About one sixth of the seabed lies about 1.2 miles deep and above; this is the fraction commercial utilization has focused on so far. It is roughly the depth the nets of deep-sea fisheries reach. 1.2 miles is also the depth down to which undersea cables can be dug into the ground; beyond that depth, the cables are let loose and fall to the seafloor.

The first offshore drilling took place towards the end of the nineteenth century. Since then, gas and oil production has accessed ever deeper marine areas. Of the 27 million barrels of crude oil that were produced offshore per day in 2015, 36 percent were produced from depths of more than 0.08 miles. Occasionally, production already reaches depths of up to 1.9 miles. Oil production, especially at greater depths, is considered a growth market in view of the increasing oil consumption worldwide. Deep sea mining has only been made use of in the shelf sea, i.e. the rather shallow maritime region above the continental shelf. The continental shelf is the submerged part of the land that is ended by a steep slope to the abyssal plain. Common examples of shelf sea mining are diamond extraction off the coast of Namibia and the production of sand and gravel. The ore deposits targeted by deep sea mining, usually lie below 1.2 miles deep. Hitting only the 1 mile mark, Solwara 1 would still be considered a project comparatively close to the surface.

In many regards, the environmental conditions of the deep sea differ fundamentally from ecosystems on land and at the surface of the ocean. Going down from the surface, water pressure every 33 feet increases by an amount equivalent to the normal air pressure on land (1 bar). From as deep as 660 feet, it is mostly dark. Here photosynthesis ends; from this depth on, the growth of plants is no longer the basis of the food chain. Next comes the mesopelagic zone or twilight zone, reached by only 1 percent or less of surface light, extending to a depth of 0.6 miles. At a depth of 0.6 miles the water pressure equals the weight of 100 kg per cm^2. From 2.5 miles on, the temperature is near freezing. Other physical parameters such as oxygen content and water salinity also change within the different depth zones and with large regional differences.

Everywhere up to the greatest depths, there is life in the sea. Whales dive nearly as deep as 1.9 miles, fish are believed to be found in a depth of up to 5.1 miles. The flora and fauna of the seabed have developed ecosystems of their own which, unlike on land, are not based on sunlight as their ultimate source of energy. Black and white smokers, hot springs (hydrothermal vents) that issue from mineral cones, are an ecologically particularly rich type of biotope. The Solwara 1 production area is located in one such region.

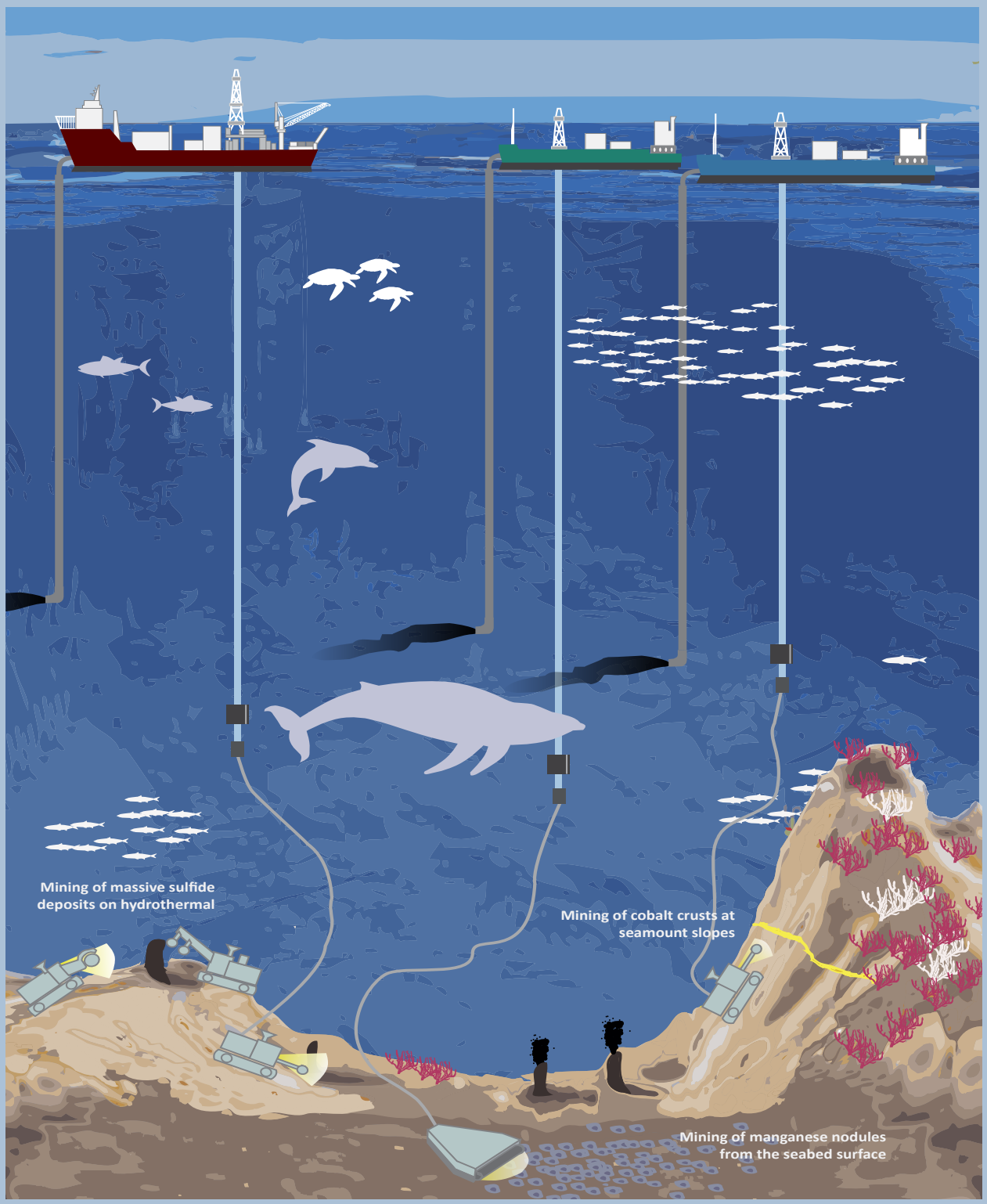
Mineral deposits on the seabed occur in various forms. One such is manganese nodules: ore concretions that contain traces of copper, cobalt, zinc and nickel as well as so-called rare earth elements which are important for advanced key technologies. They can be found directly on the surface of the seabed. The depth at which the deposits are located (mostly between 2.5 and 3.7 miles[8]) causes problems and currently impedes commercial use, as does the fact that it is the rare elements in particu-

6 January 4, 2008, seekingalpha.com/article/59059-louis-james-on-interesting-gold-companies. Casey Report is an investor magazine funded by U.S. speculator Doug Casey.

7 Richard Steiner: Deep Sea Mining as an Ocean Threat, Huffington Post Blog, October 20, 2015. From 1980 to 2000, Rick Steiner was a professor with the University of Alaska. Today he works for the NGO-oriented consulting firm Oasis Earth.

8 Federal Institute for Geosciences and Natural Resources: Newsletter Marine Resources 2016, p. 3

Chapter 2



The three mining technologies of deep sea mining

Mining of mineral resources from the deep sea is planned with different mining technologies for the different environments where the corresponding deposits are found.

Chapter 2

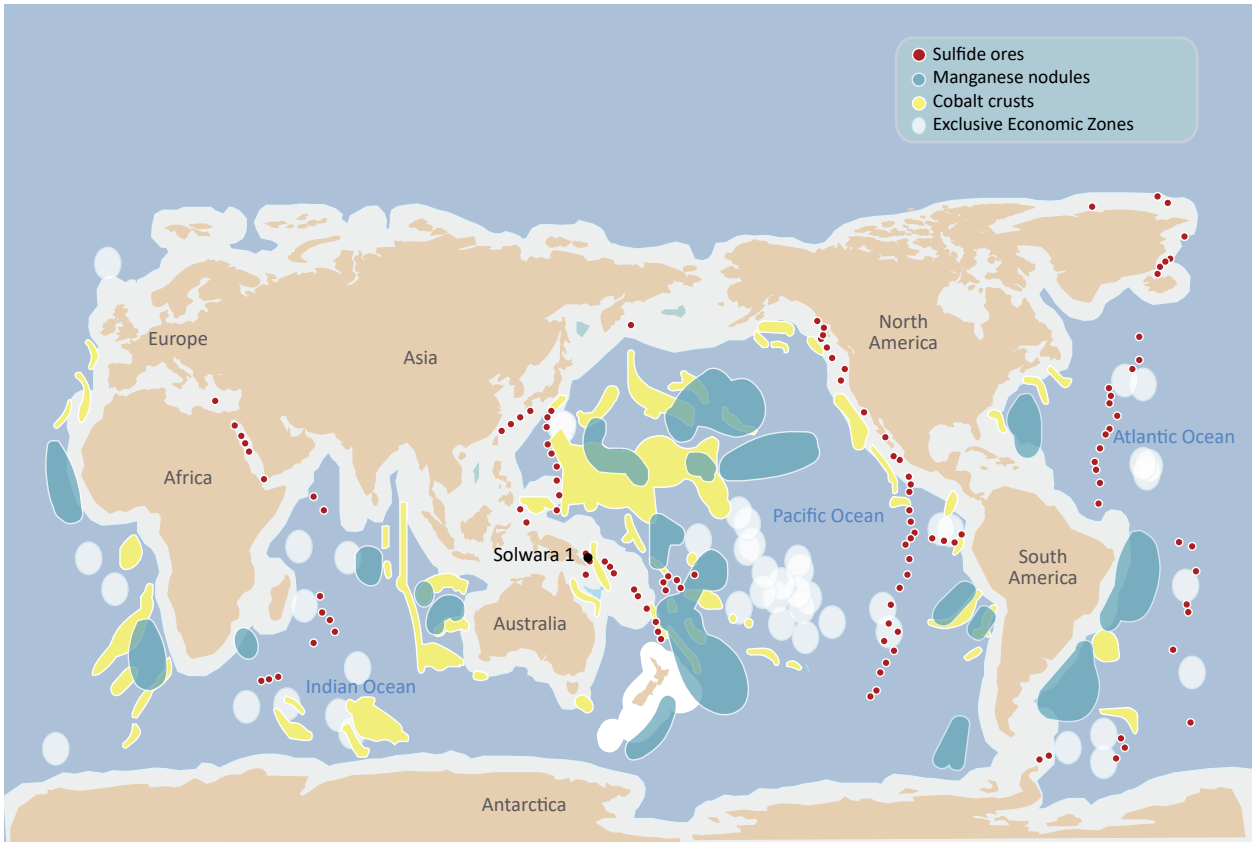
lar that can only be removed from the nodules by applying elaborate, energy-intensive techniques. Considering an annual production of 2 million tonnes and a production period of 20 years, profitability calculations regarding manganese nodule mining on a per-company basis estimate a land consumption amounting to 1,000 mi² ploughing up vast seabed areas. However, the public still assumes that deep sea mining is carried out by remote-controlled grippers carefully „picking up" nodules from the bottom of the sea.

The second type of deep sea minerals is cobalt crust that occurs on tens of thousands of seamounts and other submarine elevations at depths that range from 0.25 to 2.5 miles.[9] Within this range, metals having been carried away by currents fall out along open surfaces on the seamounts and form a crust which is several inches thick (approx. between 0.8 and 10 inches) and firmly attached to the rock surface. As with manganese nodules, their growth rate is extremely low and varies from 0.04 and 0.28 inches per one million years. Apart from manganese and iron, cobalt crusts primarily contain cobalt, nickel and rare-earth elements.

9 International Seabed Authority: Cobalt-Rich Crusts, https://www.isa.org.jm/files/documents/EN/Brochures/ENG9.pdf

The Technology of Solwara 1

Solwara 1 is about the third type of mineral deposits at seabed level: the seafloor massive sulfide deposits (SMS deposits) that occur in black smoker areas. When it comes to Solwara 1, commercial production focuses on copper, gold, silver and zinc. Production means mining in the literal sense because the ore is located below the seafloor. The cone-shaped deposit can be found 10 yards and more underneath the seafloor. The ‚chimneys' of black smokers, standing on the seafloor, are situated



Distribution of known mineral deposits in the deep sea

Chapter 2

above the deposit.[10] What appears to be smoke are actually clouds of particles. They emerge if hot, mineral-rich water leaks from fissures in the seafloor and cools down in the cold seawater. Black smokers are the visible sign of hydrothermal vents, hot springs at seafloor level. Areas with black smokers are called hydrothermal vent fields.

In an international collaboration with several companies from the maritime industry, Nautilus Minerals developed their own production system specifically for the Solwara 1 project. This system consists of the Sea Floor Production Tools (SPT) on the sea floor, the Riser and Lifting System (RALS) conveying the material through the body of water from the bottom of the sea to the ship and back, and the Production Support Vessel (PSV) on the surface of the sea. Accordingly, the production system does not only spread horizontally across the seafloor but also vertically between seafloor and surface, all along the water column. If the production system proves to be successful at Solwara 1, it may later form a significant element of corporate capital and know-how.

Mechanical ore mining at Solwara 1 is carried out with heavy machinery. The three Seafloor Production Tools, provided by UK-based Soil Machine Dynamics (SMD), are operated from the support vessel. The three special cables (each of them 1.6 miles long) necessary for the power supply and the controlling of the SPT were developed in Nordenham and manufactured by the Norddeutsche Seekabelwerke (NSW). A first excavator (Auxiliary Cutter - 17.3 yards long, 7 yards wide and 8.3 yards high, 250 tons) mills the seabed above the mineral layer and pumps out the waste. A second excavator (Bulk Cutter – 15.5 yds. long, 4.6 yds. wide, 7.4 yds. high, 310 tons) cuts the mineral layer and pumps it to a collection point. A third excavator (Collection Machine - 18 yds. long, 7 yds. wide, 8.3 yds. high, 200 tons) pumps the mineral material into the centrally located Subsea Slurry and Lift Pump (SSLP), forwarding the mineral sludge through a fixed riser pipe to the PSV.

On-board the 250 yds. long and 44 yds. wide ship, the sludge undergoes first processing. Up to 45,000 t of the obtained ore are put there into temporary storage. The wastewater is fed back into the riser pipe to be drained at a height of 27 to 55 yds. above the seabed. The Solwara 1 mining area is designated not to exceed 0.05 miles^2.

As the composition of marine ores varies from the composition of comparable ores that originate from land-based sources, the corresponding upgrading processes are different and in part not yet fully tried and tested. The extraction of metals of these ores takes place in China. The Chinese state-owned enterprise Tongling (Nonferrous Metals Group) signed a contract with Nautilus on 12/11/2015 (Tongling Sales Agreement) stipulating that Tongling purchases the ore ex ship. The ore that has been temporarily stored on the PSV will be directly transhipped to a bulk carrier operated by Tongling. The freight ship takes the ore to a port in China from where it will be forwarded by truck to one of the company‘s foundries on the Yangtse. So, in the end a Chinese company will offer the metals on the world market and decide on their disposition.

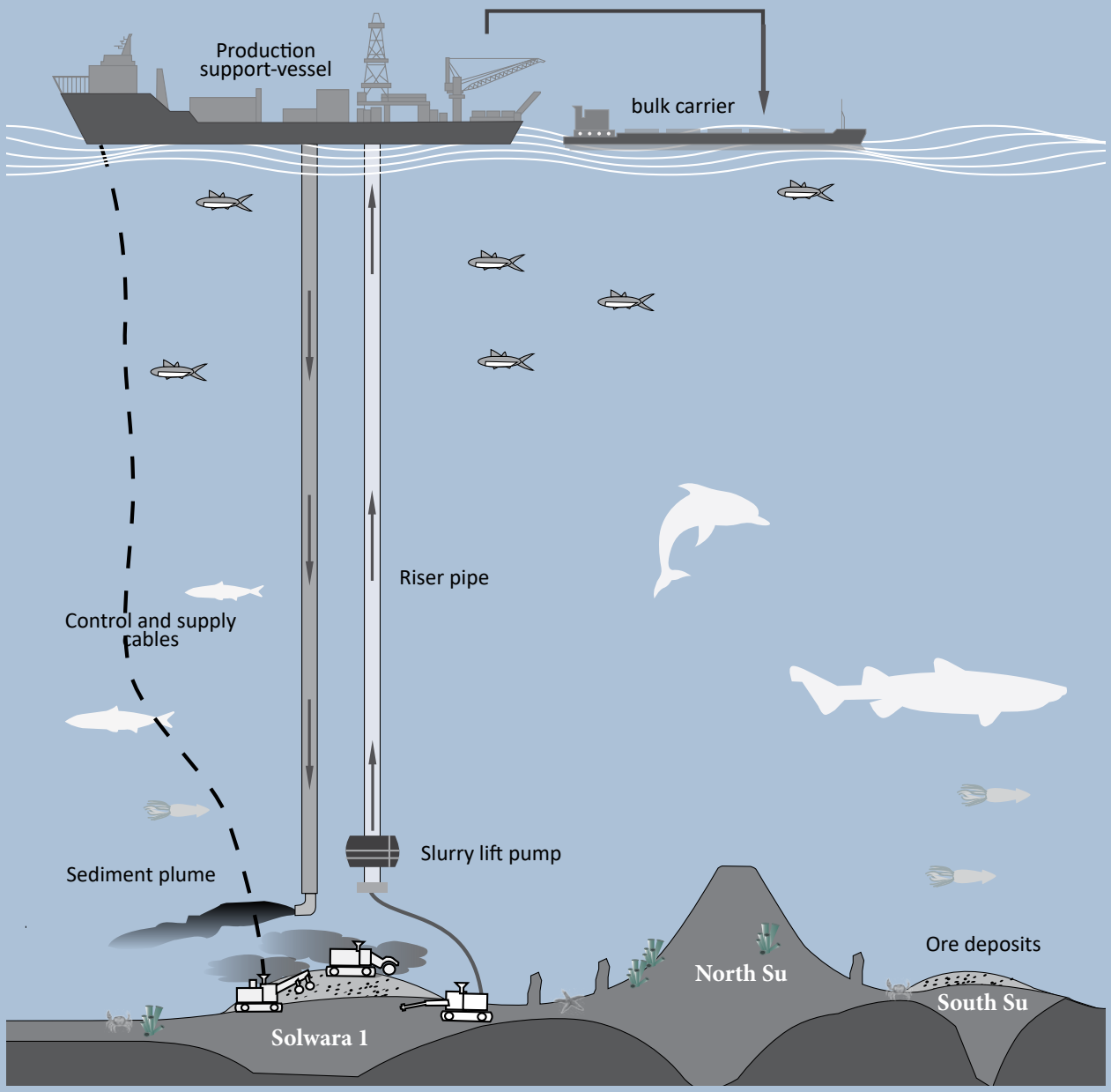
At first, the Bremen-based German shipping company Harren und Partner held talks to design and operate the ship. However, Nautilus decided otherwise. Nautilus now intends to charter the PSV from Dubai-based Marine Assets Corporation (MAC) at a fixed daily rate amounting to USD 199,910, after MAC has completed the PSV according to Nautilus’ specifications.

The ship‘s electrics will be provided by Siemens (Shanghai) while the ship‘s engine will be provided by Rolls Royce Marine (Norway). A special crane system is designed to lift the Seafloor Production Tools from ship to sea and back, the Launch and Recovery System (LARS); its components come from Poland, Korea and Norway. Other ship equipment will be provided by two companies from Norway and one company from Italy.

The design of the PSV currently under construction at the Culu Island shipyard run by the Chinese state-owned Fujian Mawei Shipbuilding Ltd. (FMSL) has changed considerably in recent years. While initially a large land-based infrastructure was planned, the Production Support Vessel will now operate largely autonomously. The crew consisting of 180 seamen and miners will not only work on-board, they will be accommodated and catered for there as well. The technology necessary for ore mining and the initial processing can also be found on the ship.

10 Nautilus Minerals Inc.: Annual Information 2015, pp. 40 ff.

Chapter 2

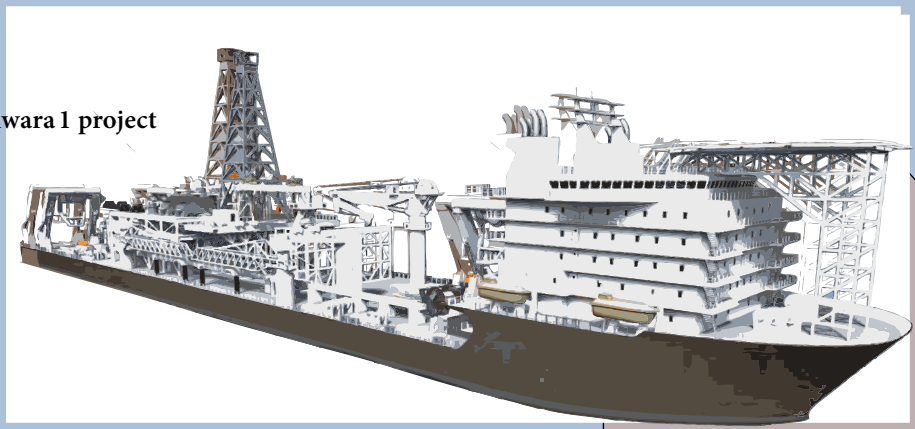


Project design of the planned mining project Solwara 1

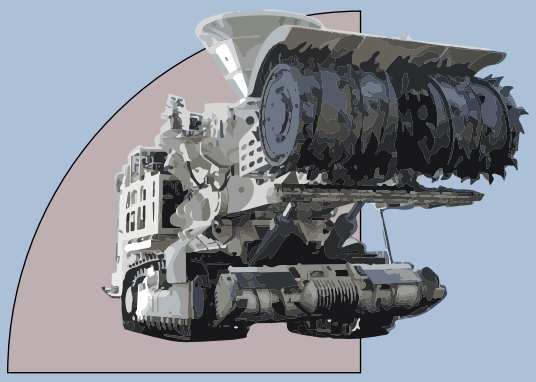
The mining of massive sulfide deposits destroys the small-scale ecosystems of hydrothermal vent fields composed of active and inactive smokers, along with their multitude of endemic species.

Chapter 2

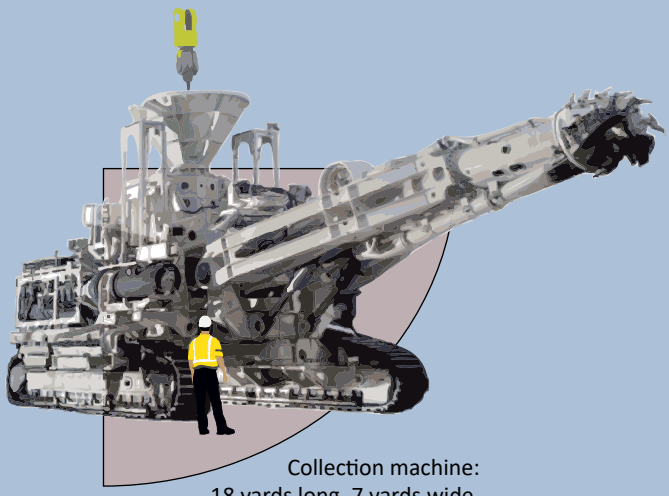
Mining equipment for the Solwara 1 project



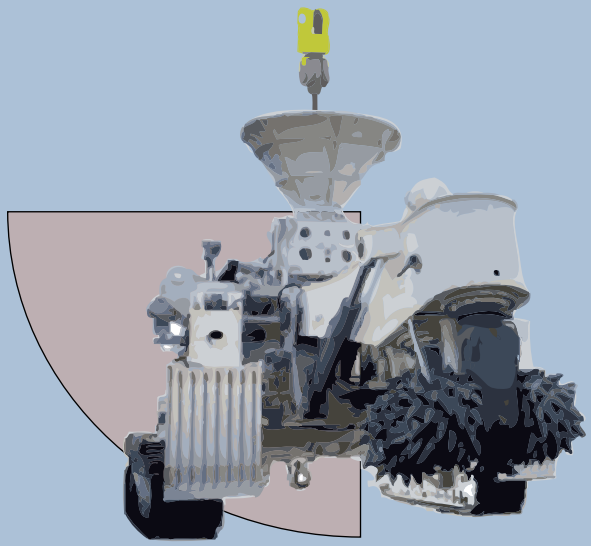
Production support vessel:
248 yards long, 44 yards wide,
45,000 tons storage capacity,
accommodation for up to 180 people



Auxiliary cutter:
17.3 yards long, 7 yards wide,
8.3 yards high, 250 tons



Collection machine:
18 yards long, 7 yards wide,
8.3 yards high, 200 tons



Bulk cutter:
15.5 yards long, 4.6 yards wide,
7.4 yards high, 310 tons

Chapter 2

Thus, Nautilus Minerals has increased the mobility of its mining facilities. The operation is now intended to work fully separated from PNG and the regional economy. There will be no on-land job offers and local revenues from the project. There will be no on-land sites that can be targeted by local protests, too.[11]

Exclusive Economic Zones: The ‚Wild West' of Deep Sea Mining

The growing interest in the exploitation of the seafloor and the chances of commercial success are intrinsically linked to the development of commodity prices. In response to the soaring commodity prices in the 1960s and 1970's, companies and Government institutions in particular from Germany, France and the USA, have invested in deep sea mining.[12] After a historic price peak for minerals during the first oil crisis (1973), prices began to decline from 1980 on. It was not until the period between 2000 and 2005 that the price decline of mineral commodities came to a halt.[13] With that recovery, it was no longer unimaginable to consider seabed mining as profitable. In 1997 Nautilus Minerals acquired a licence for the exploration of the seabed at Solwara 1. This seafloor massive sulphite deposit had been discovered and named by the Australian research institution CSIRO, 'Solwara' meaning 'sea' or literally 'saltwater' in Tok Pisin ('Pidgin English'). In 2006, Nautilus filed an expression of interest for commercial mining in this area.

For the seabed resources, two different regulatory frameworks exist; a national and an international one. The first 200 nautical miles from the coastline make up a country's „Exclusive Economic Zone" (EEZ).[14] Although the actual sovereignty of nation states is limited to within the first 12 nautical miles, the nation state enjoys preferential rights to resources on the sea floor and in the water column beyond that line, throughout the entire length of the EEZ, including the granting of licences for their use. That way, more than a third of the surface of the world's marine areas become subject to national use and regulation.

Beyond the 200 nautical miles lies what we legally call the high seas, and here the seabed is subject to a unique system of international regulation. In 1982 and partly due to the high interest in deep sea mining in the years prior, the United Nations Convention on the Law of the Sea (UNCLOS) was adopted. It became legally binding in 1994, and until today more than 160 states have ratified the treaty.[15] Per the UN Convention, resources on and inside the seabed outside the EEZ are considered „common heritage of mankind". This so-called area ("the area") is supervised by the International Seabed Authority (ISA). States may obtain temporary licences to explore certain stretches of the seafloor. Once a state has completed the exploration of its licence area, it can apply for a temporary economic use for half of its surface; the other half will be offered to developing nations to ensure equal access to the resources of the seabed for all countries. However, in practice, this resulted in indirect privatizations against the initial intention of UNCLOS: private, multinational business groups acquire licences for the ISA areas from states that do not possess the appropriate technology. Nautilus Minerals also holds licences for six seabed areas of the Pacific Island nation of Tonga in the Clarion Clipperton Zone, the main allocation area for ISA licences.[16]

11 Nautilus Minerals Inc.: Project Overview, Seafloor Production Equipment Status, Annual Report 2014; Nautilus: Seafloor Production tools http://www.nautilusminerals.com/irm/content/seafloor-production-tools.aspx?RID=333; Nautilus, Annual Information Form 2015, p. 36. A video visualizing the planned extraction process is available at http://www.nautilusminerals.com/irm/content/video-gallery.aspx?RID=421

12 G. P. Glasby of the Oceanographic Institute New Zealand estimates the total sum of investments made during this phase at about 650 million dollars. G. P. Glasby: Economic Geology: Lessons Learned from Deep-Sea Mining, Science, Vol. 289, Issue 5479 (July 28, 2000), pp. 551-553.

13 Bräuninger, Leschus and Rossen: Causes of price peaks, drops and trends in mineral resources. Study carried out by the HWWI (Hamburg Institute of International Economics) on behalf of the Federal Institute for Geosciences and Natural Resources (BGR), DERA information on commodities 17, Berlin 2013.

14 EEZ = Exclusive Economic Zone. In cases in which the continental shelf reaches further, states can seek to expand the scope of their EEZ beyond 200 nautical miles. (200 nautical miles = 230 statute miles, 12 nautical miles = 13.8 statute miles.)

15 The 15 non-signatories include the U.S., Turkey, Israel, Venezuela and the Vatican. A further 14 States including Iran have signed but so far not ratified the Convention.

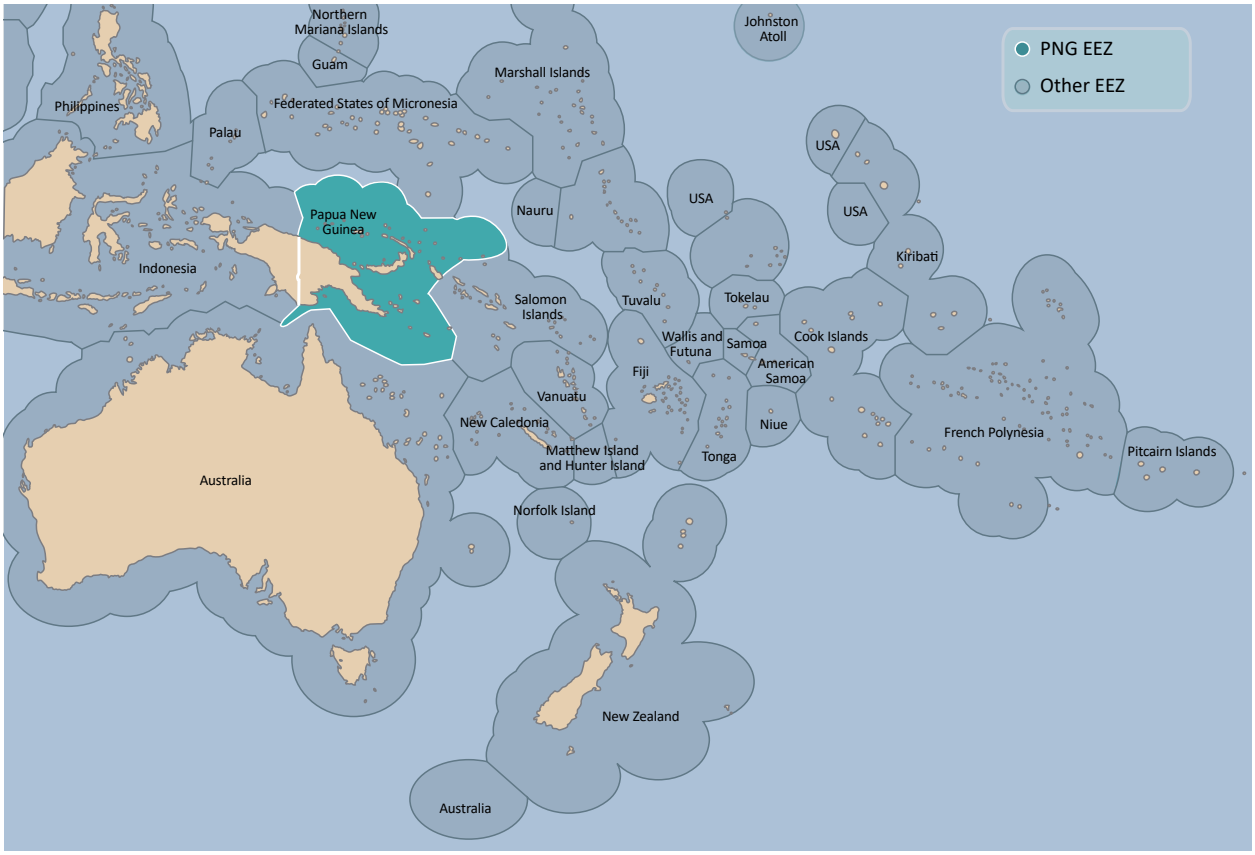
16 Nautilus Minerals Inc.: Annual Information Form for the Fiscal Year ended December 31, 2015, presented March 2016.

Chapter 2

At the same time, more than 60 states are trying to expand their EEZs with a special UNCLOS provision and stake everything on the national rather than the international card. The Commission on the Limits of the Continental Shelf (CLCS) in New York is the point of contact for states to refer to this treaty and apply for spatial extent, expanding their entitlement to marine natural resources off their coast. For this purpose, they are to submit data that verifies that in accordance with the legal definition of the Convention, both the shelf sea and the continental shelf off their coast outreach the stipulated 200 nautical miles. The Commission may then grant permission to harvest deep sea minerals, and only those up to a maximum of 350 nautical miles off the coast. This permission extends only to resources on the seafloor. Resources to be found in the body of water in areas that outreach the 200-nautical mile limit are public domain. Other states do not have to seek permission e.g. to fish there.

This way, states have already been awarded hundreds of thousands of additional square miles. This is another stage for the race to marine resources. The extension of EEZ is often an attempt to circumvent international agreements in favour of focusing on the deregulation of international maritime policy.

On the one hand, UNCLOS paved the way for using the bottom of the ocean below the high seas as a common heritage of humankind. On the other hand, it nationalized in parts the usage rights for the seas by establishing the EEZs. When it comes to deep sea mining, this resulted in two parallel development processes with incoherent regulation. While the ISA is still working on extensive regulations to comply with concerning the exploitation of the seafloor, the EEZ underlie no other regulation than the one applying to the individual state in question. For a long time and in many cases, this used to mean: no regulations at all. Specific acts and regulations

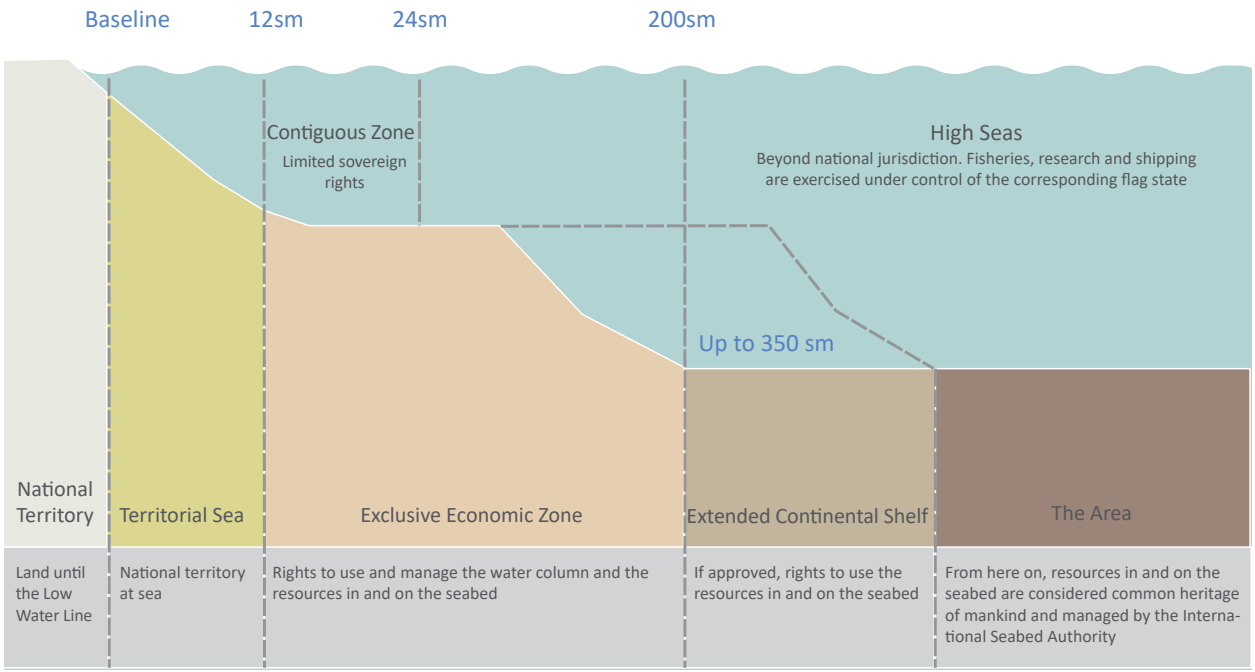


Exclusive Economic Zones in southwestern Pacific

The Exclusive Economic Zones (EEZ) are usually several times larger than the land mass of the corresponding states in Oceania, especially of the Small Island States.

Chapter 2

on deep sea mining haven't been developed by several Pacific Island states until recent years. Unlike the high seas, where the drafting of detailed regulations by the ISA is a requirement for any commercial use, within the EEZ, the lack of regulation is no obstacle for licensing. The EEZs of Pacific Island states can be considered the ‚Wild West' of the seabed. Companies such as Nautilus Minerals take advantage of this situation.



Maritime zones and territorial rights according to the United Nations Convention on the Law of the Sea (UNCLOS)

Chapter 3

Traditional Economy and Mining Industry

The PNG Constitution emphasized the importance of ecological sustainability, grass-roots economic viability, and respect for customary ways of life. As a postcolonial nation it recognized a continuing ‚prehistory'. (…) Unlike, for example, France, the USA, and Australia, the country was not legally conceived as a nation of individuals.[17]

In several aspects, Papua New Guinea (PNG) is a remarkable country. It is considered one of the most culturally diverse countries in the world, with over 850 known languages[18] and a high persistence of small-scale cultural traditions. There is hardly a continental state in which the proportion of the urban population is as low as in PNG (13 percent according to the World Bank 2015). Three quarters of the estimated 8.1 million people work in agriculture and fisheries, most of them in largely self-sufficient communities. The population density is low, with only 47 people per mi^2.[19] Due to the favourable climatic conditions, the food situation in the subsistence economy is far better than, say, in sub-Saharan Africa.

97 per cent of PNG land is owned by indigenous communities. In recent years, however, a gradual process of privatization has taken place by way of hereditary leasehold; approximately 10 per cent of the country is leased to private corporations as „Special Agricultural and Business Leases (SABLs)" with maturities of up to 99 years. The property rights of indigenous communities are enshrined in the Constitution, as are their traditional laws, particularly their traditional usage rights and the right to traditional cultural practices.

The Constitution of 1975 (the year of independence) defines the traditional right of use and property (custom) as:

„the customs and usages of indigenous inhabitants of the country existing in relation to the matter in question at the time when and the place in relation to which the matter arises, regardless of whether or not the custom or usage has existed from time immemorial"

Traditional law applies[20] and is one of the legal sources listed in the Constitution. It is local, taking into account the diversity of traditional customary rights. In case of dispute, its interpretation is up to the courts. The tension between a non-written codified traditional „underlying law" and the laws and regulations to be adopted by political bodies, characterizes the legal system of PNG and has been discharged in a variety of relevant judgements[21].

The Constitution explicitly confirms the law of recognition of traditional rights (Customs Recognition Act), which was adopted in 1963, pre-independence. It states, in the section „civil cases":

„Custom may be taken into account (...) in relation to (a) the ownership by custom of or of rights in, over or in connexion with customary land (...) (b) the ownership by custom of rights in, over or in connexion with the sea or a reef, or in or on the bed of the sea or of a river or lake, including rights of fishing (…)"

The seabed may therefore be subject to traditional indigenous rights, if the areas concerned are associated with traditional uses and cultural practices, irrespective of whether such uses are of economic or spiritual nature.

17 James, Nadarajah, Haive and Stead: Sustainable Communities, Sustainable Development. Other Paths for Papua New Guinea, Honolulu 2012 p. 2f.

18 Tok Pisin, Hiri Motu and English are the common bridge languages.

19 Annual official estimate of July 2018. PNG ranks as number 214 of 254 countries and territories by population density, close to New Zealand, Saudi Arabia or Argentina.

20 There are six explicit restrictions stipulated in the Customs Recognition Act of 1963 that regulate the following: inconsistency with the Constitution and other laws with constitutional validity, or general principles of international humanitarian law; furthermore, statutes under the Act shall not be contrary to public interest, or lead to the perpetration of injustice, and must establish the best interests of a child under 16 years of age.

21 See, for example, Jean Zorn: Women, Custom and State Law in Papua New Guinea, Third World Legal Studies, Vol. 13, Article 7, 1995; the same: Making Law in Papua New Guinea. The Influence of Customary Law on Custom Law, Pacific Studies, Vol. 14, No. 4, 1991; Owen Jessep: The Elusive Role of Custom in the Underlying Law of Papua New Guinea, Melanesian Law Journal, Vol. 26, 1998

Chapter 3

Fishery and Food Security

Food security in PNG is mainly based on the sea. The annual yield of artisanal fisheries is estimated between 35,000 and 70,000 tons of fish and seafood. Artisanal fisheries operate primarily close to the coast but may regularly stray up to 20 or 30 nautical miles away from it as well, catching big and small fishes alike and selling them at nearby markets or directly to restaurants and hotels.

PNG has a high per capita consumption of fish and other seafood. FAO's annual consumption estimate for 2007 lies at 17.7 kg per capita whereas other studies suggest up to 25 kg per year. Fish is not only the main source of animal protein, but also the most important source of income for the coastal communities in the PNG

Fish market in Madang

provinces East New Britain (ENB) and New Ireland Province (NIP). During periods of poor land harvests (yam, sago, taro and banana are the most important plants in PNG's subsistence economy), the sea offers additional economic security. „During the long dry season the sea has kept us. It provided food for us when food on land died", said Moses Tapit, a fisherman from Danu, New Ireland. „Danu is never short of fish and other food from the sea."

The fishing grounds of the fishermen from East New Britain and New Ireland comprise the Solwara 1 area. The fishermen are worried that the access to these fishing grounds could be denied them in the future. Small-scale fishermen catch tuna and reef fish, among others, in the nearby reefs such as the Paradise Reef. This fact was corroborated in the course of the present study not only by the interviewed fishermen themselves, but also during interviews with representatives of the local Administration, such as Mosley Barbate, fishery councillor for East New Britain Province. The provincial administrator of the New Ireland Province confirmed in an interview that Solwara 1 is located on the migratory route of tuna. He assumes that this route may be altered by noise and other emissions from the mining process and appeals for an adequate management strategy concerning tuna.

The export of fishery products and the granting of fishing permits are other key factors in the maritime economy. The total catch of fish and seafood from fisheries and aquaculture amounted to 496 million tons to the value of 2 billion Kina (630 million USD) in the year 2014. The contribution of the fishery sector to the national economy, however, has been limited by insufficient processing capacities. The value added (output minus imported intermediate inputs) accounted for 733 million Kina (230 million USD), representing 1.7 percent of PNG gross domestic product. Commercial tuna fishing in the Bismarck Sea, including processing, export and granting of fishing permits for tuna, is of particular importance to PNG. In terms of value, tuna constitutes the largest component of commercial fishing. The largest quantity of tuna, however, is caught predominantly by foreign fishing boats holding fishing permits and is neither included in the national catch nor in PNG's gross domestic product. There are licence agreements with Taiwan, Korea, the Philippines, China and the United States. PNG earned approximately 85 million US dollars from licence fees in 2014, an amount by no means commensurate with the real value of the catches. According to the Bank of PNG, the country's own export of fishery products resulted in 1.6 per cent of the nation's export volume for 2014.[22]

In recent years PNG has been determined to closely link the granting of fishing permits to foreign investment on land as well as in fish processing, in order to create local jobs and higher value-added manufacturing. The coun-

22 Gillett, Robert: Fisheries in the Economies of Pacific Iceland Countries and Territories, Noumea 2016, Chapter 14: Papua New Guinea, pp. 184-214

Chapter 3

Fishing vessels for tuna at Vidar harbor, Madang (Papua New Guinea)

try has made recent investments in the development of „snap freezing" technologies - a method which allows the rapid freezing at extremely low temperature of tuna caught by the long liners, which then can be dispatched to the sashimi markets in Japan and Korea.

This orientation towards higher value-added production and local job-creation would be endangered if the migration routes of tuna changed due to seabed mining. The members of a fishing cooperative in Kokopo (East New Britain), currently consisting of 76 fishermen and a total of 300 beneficiaries, are worried, too, about their investments in superior boats and a planned local fish market. „We are investing a significant amount of money that will be at risk if Solwara 1 damages the marine environment."[23]

Mining and Testing

In terms of export revenues mining continues to be the defining economic sector of PNG. It makes up approximately half of the total export turnover. PNG has vast deposits of gold, copper, silver, nickel, cobalt, oil and gas. At the same time, however, the country's experience with mining is characterized by conflicts, environmental destruction, human rights violations and ultimately, by a limited contribution to the local economy and development of its infrastructure.

Gold was found on Sudest Island in Milne Bay, in 1888. This marked the beginning of the first „gold rush" which brought about the exploitation of easily accessible deposits like the famous Edie Creek Field, which was first worked by small groups of miners but later saw the influx of large mining companies. The real gold mining in terms of extraction of gold from rock layers took place from the 1930s onwards.

The discovery of large deposits of gold and copper on the Island of Bougainville[24] in 1963 set off the third phase in the development of the country's mining industry, which in turn was characterized by heavy confrontations between local population and central government, escalating into armed conflict. International investors opened the mines of Panguna (1972), Ok Tedi (1984), Misima (1989), Porgera (1990) and Lihir (1997). The mine of Panguna on Bougainville used to be one of

23 Interview with the cooperative's managers, February 2016

24 The island was named after the French navigator and explorer Louis Antoine de Bougainville after whom the plant Bougainvillea was also named .

Chapter 3

the largest copper mines in the world. It was operated by Bougainville Copper Ltd. whose shareholders were the British-Australian mining group Rio Tinto / CRA together with the State of PNG. The Panguna mine and its operations triggered the ten-year long civil war on Bougainville.

Economically speaking, the inhabitants of Bougainville benefited very little from the mine. The state failed to implement the commitment made to the island population of allowing them to participate in the profits. Most of the workers employed in the mines came from mainland PNG, not from Bougainville. At the same time, the operating company created severe environmental damage from the mine. Wastewaters containing heavy metals were simply piped into the Kawerong river, thus contaminating a land area of 1,800 hectares. The inhabitants responded by blocking access to the mine. This resulted in the armed conflict between the local population and the central government in 1988. When the latter hired Sandline - a British-South African mercenary company - to crush the resistance in Bougainville, mass demonstrations in Port Moresby, the capital city of PNG, forced the government to resign. In 1998, a peace treaty was signed. In 2001 Bougainville was declared an autonomous province. The prospect of a Bougainville independence referendum constituted an integral part of the said peace treaty and is scheduled for 2019. The mine remains closed. Since Rio Tinto gave up its company shares, it is currently under debate whether the mine in Bougainville should recommence its operation.

The people of East New Britain still remember the Wild Dog Mine on Mount Sinivit, located on Baining land. The Baining claimed their rights as customary landowners but the operating company (the New Guinea Gold Corporation NGG, registered in Canada) ignored them. When NGG abandoned the mine after a lawsuit in 2014, improperly disposed chemicals contaminated the water. The Warangoi River, whose waters are used for drinking in times of drought, is still deemed polluted with cyanide.

Mining sites in Papua New Guinea
Mining is one of the essential economic sectors of Papua New Guinea

Chapter 3

Decades of nuclear tests in the Pacific represent another important historic factor leading to the conflicts for Solwara 1 and deep sea mining in this area. Between 1946 and 1996 the islands of the South Pacific, including but not limited to the Marshall Islands (Bikini Atoll), Kiribati and Mururoa were systematically subjected to nuclear abuse by the USA, France and Great Britain as „proving ground" or „testing ground" for nuclear weapons. France alone detonated 193 nuclear bombs in the South Pacific, the United States 106. The three nuclear powers refused to accept any responsibility whatsoever for the health impairment and environmental damage incurred by the island inhabitants and their land as a result of exposure to radiation.

For this reason, many activists and residents stress the experimental nature of the planned deep sea mining on Solwara 1. The Pacific Island world will once again be transformed into a testing ground for new and high-risk technologies. It is even suggested that the Bismarck Sea, as a highly biodiverse, near-coast area, was deliberately chosen for experimental deep sea mining to better evaluate the environmental impacts and learn from it for future follow-up projects.

Land mining and nuclear testing have raised the awareness of many inhabitants of the Pacific Islands and New Guinea concerning the problematic repercussions of such large-scale projects controlled and managed from afar. They fear that they will have to bear the brunt of the unabated increase in demand for raw materials that is caused not by the Pacific Islands, but by the industrialized and emerging countries worldwide.

Extraction Economy Versus Sustainable Economy

Extractive industries that involve the extraction of raw materials from natural deposits, have long been branded dubious practices in terms of postcolonial development strategies. It is not without reason that some of the countries with bountiful raw materials located in the Southern Hemisphere are plagued by civil wars, warlords, authoritarian regimes and corruption. Extractive industries generate government revenues and high private profits while bypassing the local population. Such industries are not contingent on the overall economic trends and contribute little to the technical and social infrastructure of the host country, or the development of a skilled domestic labour-force. Despite all the relevant environmental issues and health risks for the miners, mining in developed countries has always been associated with the creation and development of manufacturing industries as well as general economic upturn. This has seldom been the case in the developing world. The less complicated it is to extract and to transport raw materials and the more remote the location of the operating mine from the rest of the economic outlets, the more likely it is that revenues from raw materials might cripple the country's economic development and its commitment to create cooperative and integrated political structures.[25]

PNG is aware of these issues and has prompted the formulation of official strategic documents with the main objective of reducing the country's dependence on extractive industries and to stimulate the development of sustainable production sectors: "The challenge therefore is, 'How do we shift an economy that is currently dominated by the mining and energy sectors, to one that is dominated by agriculture, forestry, fisheries, eco-tourism and manufacturing, between 2010 and 2050?'"[26] „This new thinking challenges the view that economic growth built on the back of the extraction and export of raw natural resources - minerals, logs, marine resources is the only development model, and it introduces an alternative development paradigm and redirects the focus of planning towards economic development that is more appropriate and responsible in a future that is changing."[27]

For this very reason, PNG's central government is focusing on the accelerated set-up of specialized regional zones or „hubs" - Port Moresby as commercial and administrative centre, Lae as centre of the manufacturing

25 Cf. Federal Agency for Civic Education: Dossier on Domestic Conflicts, Bonn 2012. Abundant natural resources, in and of themselves, are not the real reason for domestic conflicts or lopsided development. But they are an easy way to perpetuate these paths over a long period of time.

26 National Strategic Plan Task Force: Papua New Guinea Vision 2050, Port Moresby 2009, p.3

27 Department of National Planning and Monitoring: National Strategy for Responsible Sustainable Development for Papua New Guinea, Port Moresby 2014, p.28

Chapter 3

industry, Mount Hagen focusing on agricultural production, and Kokopo in East New Britain a tourist centre.[28] As a result, PNG's designated tourist centre will be located in the immediate vicinity of Solwara 1.

The tourism sector, which until recently has played a subordinate role in the country's economy, is currently deemed as a field with serious growth potential[29] and can assume an even more significant role as a stepping stone to a more adequate sustainable development of the island nation. Tourism is one of the largest economic branches worldwide, with revenues amounting to more than one trillion US dollars. It corresponds to 3 per cent of the global gross domestic product and is characterized by intensive growth and high employment.[30] While roughly half of all travel worldwide is attributed to leisure and recreational trips, only 26.5 per cent of visits to PNG were holiday trips in 2014. The main tourist appeal of PNG is directly related to the island's intact coastal ecosystems and marine biosphere. Two thirds of all tourists come to PNG on diving vacation, relishing the biodiversity of its seas.

Recent investments in the tourist infrastructure of Kokopo are beginning to bear fruit already. New construction of contemporary buildings, redevelopment of already existing accommodations, and the set-up of a new marketplace together with new stores with a wide range of products, has been completed. Cruise ships dock in Kokopo. Both Kokopo and Kavieng offer sea ecotourism, which contributes to the regional economy and the income of local communities. There are various cooperation projects between Kokopo Beach Bungalow (KBB) Resort and the surrounding settlements which help generate additional income for the residents of the said settlements in an environmentally sound manner. Such projects still have enormous potential.

The bay of Kokopo is the breeding ground of an entire school of hundreds of dolphins that raise their young there. As a form of non-invasive tourism, KBB offers guided tours to this spectacle of nature to small groups of visitors. Since both dolphins and whales have highly sensitive sonar systems, drilling activities on the ocean floor could have negative impact on similar tourist packages.

Expanding the extraction economy on PNG's seabed is in direct conflict not only with the local sustenance fishing, but also with two other major national sectors which hold the key to the conversion to a sustainable economy, namely the fishing industry and tourism.

Until now it has not been possible to decrease PNG's focus on the extraction of non-renewable raw materials by promoting new economic sectors. Although the contribution on the part of the extracting industry to the GDP dropped from 30 per cent in the late 90s to 10 - 15 per cent after the year 2000, it has registered an increment thanks to the introduction of liquid gas production once again.[31]

It is obvious that the economic benefits for PNG generated by large-scale projects tend to be diminished by the use of modern mining technologies. Mining on land, at least for a limited time span, used to offer jobs and a substantial participation in revenues, both for the state and the neighbouring communities. The new technologies of extraction are technologically and financially much more sophisticated, shifting the bulk of the jobs to research and development and the profits to the investors. Liquid natural gas production has produced very few local jobs, and for these jobs, trained professionals are needed that PNG cannot really offer.[32]

The PNG LNG Project is a joint venture between ExxonMobil and Oil Search Ltd., where the State of PNG holds 17.6 per cent of the shares. It stands to reason that, given

28 http://www.businessadvantagepng.com/tourism-potential-in-kokopo-rabaul-huge-if-infrastructure-needs-are-met/; Opening Address by the Prime Minister Peter O'Neill to the PNG Investment Conference, September 9, 2013, http://www.pngadvantageconference.com/wp-content/uploads/2013/05/Prime-Minister-Opening-of-the-PNG-International-Investment-Summit-09.09.2013.pdf

29 World Bank: Pacific Possible - Tourism, 2016

30 The number of employees in the tourism industry is estimated to be more than 100 million people worldwide. Both leisure travel and business trips are considered tourism. This proportion increases if one includes the indirect economic and employment effects as well.

31 Asian Development Bank: Country Partnership Strategy Papua New Guinea 2016-2020, Executive Summary, https://www.adb.org/sites/default/files/linked-documents/cps-png-2016-2020-ea.pdf

32 Asian Development Bank: Country Diagnostics Study: Papua New Guinea - Critical Development Constraints, Mandaluyong 2012, https://www.adb.org/sites/default/files/publication/29776/png-critical-development-constraints.pdf. The study also points out that the government incurs economic risks regarding the potentially high investment costs for the port expansion, as its capacities are nearly exhausted.

Chapter 3

Village community on one of the numerous small islands in the Bismarck Sea

the structure of the project, the lion's share of all revenues will be realized outside PNG and that the country will be unable to prevent the resulting whisking away of profits. Since Solwara 1 has a very similar structure from an economic point of view, it is doubtful whether PNG will be able to obtain any long-term economic benefits from this undertaking.

Chapter 4

German New Guinea: The impact of Colonization

The three executed should, after their death, at least contribute to the progress of science.[33]

The Bismarck Sea represents both the starting point and the centre of the former German colonial empire in the South Pacific. The administrative headquarters of German New Guinea was in Madang (Friedrich-Wilhelmshafen) originally, then moved to Kokopo (Herbertshoehe) in 1899, and finally to Rabaul (Simpsonhafen) in 1907. While the western part of New Guinea became part of the Dutch Empire in 1828, the eastern part of New Guinea was divided into German and British spheres of influence at the Conference in London in 1895. In 1899 German New Guinea became a formal German colony ("protectorate"). German New Guinea included the north-eastern part of New Guinea together with the Bismarck Sea, New Britain (Neupommern), New Ireland (Neumecklenburg), the North Solomons, the Northern Mariana Islands, the Carolines, Palau, Nauru and the Marshall Islands.

German colonial policy in the Pacific was stipulated by the interests of German commercial and financial capital. The Hamburg-based trading company Godeffroy set up their branch offices in the Pacific as early as 1857 and opened their office in East New Britain in 1875. They were followed by Hernsheim & Co. who established their branch office in Makada (Duke of York islands) in 1876. The German trading posts in the Bismarck Sea were concentrated on the north coast of New Britain, also referred to as „Gazelle Peninsula", and on the Duke of York islands (Neulauenburg), all of them dispersed at approximately 50 km from the present-day Solwara1 mining site.

Initially, the trading company Godeffroy together with all its possessions in the Pacific merged with the German Sea Trade Society (Deutsche Seehandelsgesellschaft) - a joint-stock company - in 1878. Among the shareholders of the German Sea Trade Society was the Disconto-Gesellschaft, the largest German banking house at the time.[34] The attempt from 1880 to secure the German Sea Trade Society through a state guarantee as well as an additional state grant (the Samoa Bill) was refuted by the German parliament. Thus, the owner of the Disconto-Association, financier Adolph von Hansemann, drafted a secret memorandum titled „German interests in the South Sea", pushing for a more forceful German colonial policy in the Pacific, thus bypassing the will of the German public. The German Sea Trade Society was reorganized and became the Deutsche Handels- und Plantagengesellschaft (DHPG). Hansemann initiated the establishment of the New Guinea Consortium, which also included Gerson von Bleichröder, nicknamed „Bismarck's banker", together with the banking house Oppenheim Jr. from Cologne. The trading company Hernsheim & Co. was contacted to be commissioned with large-scale land acquisitions in the South Sea. After their refusal, Hansemann put Otto Finsch, director of the Ethnological Museum of Bremen at the time, in charge of the expedition to New Guinea in 1884.

Convoyed by two German warships and escorted by Gustav von Oertzen, the German vice-consul to Samoa, the Finsch expedition claimed northern New Guinea and the islands in the Bismarck Sea as German territory. This claim was backed by fraudulent treaties concluded with representatives of the coastal inhabitants. The Administration was transferred to the private New Guinea Consortium on May 17, 1885 with the help of a charter of protection. As of 1889, the Administration of the territories was carried out by imperial officials, who were to draw their salaries from the Consortium. In the end, the German Reich bought the sovereign rights over New Guinea from the Consortium for the sum of 4 million Reichsmarks on October 7, 1898, making German New Guinea a formal German colony administered by the German Reich.[35] Only from this point onwards was the DHPG able to make profits from its speculative colonial investment. „The company", as the DHPG was called in German New Guinea, at times held control over half of

33 Wilhelm Wendland: In Papua's Wonderland. The experiences of a German colonial physician in the South Seas, Berlin 1939, p.190, quoted by Margarete Brüll: German Colonies in the Pacific, in: Eva Gerhards and Edgar Dürrenberger (eds.): When Freiburg Discovered the World. 100 years Museum

34 In 1929, the Disconto-Gesellschaft merged with the Deutsche Bank, the Rheinische Kreditbank and the A. Schaaffhausen'sche Bank Association, to form together the "Deutsche Bank und Disconto-Gesellschaft". From 1937 on, the "Deutsche Bank und Disconto-Gesellschaft" changed its name to solely "Deutsche Bank". The annual reports of the Disconto-Association in the period between 1853 and 1928 are available at http://www.bankgeschichte.de/de/content/2448.html

35 Brüll, loc. cit.

Chapter 4

the colony's cultivated agricultural land.[36] The annually distributed dividends to the shareholders enjoyed a continuous steady increase and reached 28 per cent by 1909.[37]

The German Pacific colonies had plantation economies as a business model. The first commodities to be cultivated were coconut trees and cocoa, followed by copra and tobacco. Workers' wages were kept to a bare minimum by exploitation of the subsistence economy.[38] The local population refused to work on the plantations. The colonial administration reacted by increasingly applying pressure on the people, first through an aggressive and violent recruiting policy, followed by the introduction of a poll tax in 1907. In addition, Chinese and Malay workers were recruited and, together with their families, brought to New Guinea. Due to the poor health care, a quarter of the 100,000 employed plantation workers died during the colonial period.

Forced labour and violent land grabbing fuelled multiple violent conflicts. From 1899 on, the German military conducted an ever growing number of punitive expeditions. Villagers living in the vicinity of Madang planned an uprising in 1904 aimed at the expulsion of the Germans from New Guinea. The German colonial administration retaliated with exiling and executing the insurgents. Members of the Baining community attacked a mission station in 1906. Three of the leaders of the unrest were executed and their skulls were sent to the University of Freiburg.[39] The military subdued an uprising on the Carolines in 1911.

The phosphate deposits discovered in Palau in 1908 were exploited by the Bremen-based German Südseephosphat-Aktiengesellschaft. This joint-stock company was established by a Consortium founded in 1907 consisting of the Norddeutscher Lloyd (North German Lloyd), the German National Bank in Bremen, Tellus AG, as well as Wilhelm Müller & Co. „For the extraction and processing of phosphate, the company employs approximately 800 to 900 natives which we recruit with the help of a private steamer in the eastern and western Carolines. Around 70 to 90 Chinese work on the Island of Angaur as craftspeople. Since phosphate is deposited on the surface, its mining and extraction is easy. The phosphate is dug from the ground as from a sand pit, using hoes and shovels."[40] The company paid dividends of 6 per cent in 1912 and of 11 per cent in 1913.

Lowei village in Papua New Guinea

In 1866, German Protestant missionary societies (the Neuendettelsau Mission and the Rhenish Missionary Society Barmen) started missionary work in New Guinea. Catholic missionary societies (like the Herz Jesu Mission) followed from 1899 on. Many of the missionaries were women. The 1912 census in German New Guinea counted 478,843 natives and 772 Germans. Among the 280 German women, 108 were missionary sisters.[41]

The German colonial era ended with the outbreak of World War I. New Guinea together with the Bismarck Archipelago were conquered by Australian troops by the end of 1914; the rest of the islands that belonged to the German colonial territory were taken over by

36 Jürgen Ritter: The Unspoiled Island, Spiegel Online from June 11, 2008, http://www.spiegel.de/einestages/deutsche-kolonialgeschichte-a-946982.html

37 German Colonial Encyclopedia, Volume I, pp. 300 f., http://www.ub.bildarchiv-dkg.uni-frankfurt.de/Bildprojekt/Lexikon/php/suche_db.php?suchname=Deutsche_Handels-_und_Plantagen-Gesellschaft

38 The plantation workers were almost completely male, as far as is known. At the same time, the work load of the women doubled because they had to run the domestic subsistence economy alone.

39 Brüll, loc. cit.

40 German Colonial Encyclopedia, Volume I, pp. 313 and following, http://www.ub.bildarchiv-dkg.uni-frankfurt.de/Bildprojekt/Lexikon/D/Deutsche_S%C3%BCdseephosphat-Aktiongesellschaft_in_Bremen.html

41 Marianne Bechhaus-Gerst and Mechthild Leutner (eds.): Women in the German Colonies, Berlin 2009, p. 42

Chapter 4

the Japanese army. The 110 German civil servants and administration employees were arrested and, between September 1914 and May 1915, transported back to Germany. 95 civilians were deported to Australia and stayed interned until 1919/1920. The remaining 180 settler families were expropriated in 1921.[42]

As with the other German colonial territories, the Federal Republic of Germany has assumed no responsibility for the crimes and exploitation committed in the South Pacific. The authorities have provided no compensation. Whereas Australia has agreed, in the course of a legal action brought against it before the International Court in 1993, to provide compensation to the amount of 107 million USD for the exploitation of phosphate in Nauru during the colonial era[43], a planned lawsuit of Palau against Germany did not come to pass.[44]

During the c. 40 years of its duration, the German colonial regime over Papua New Guinea committed murder by punitive expeditions and executions, murder by forced labour and theft of national resources. These are the obvious crimes. The decades of foreign rule and the violent disruption of indigenous development, however, also had structural consequences whose connection with colonial rule is less obvious.

One of these consequences was the patriarchal formation of social relations that impaired the status of women in PNG in a long-lasting way. The interpretation of pre-colonial gender relationships has been disputed to date. There is evidence that the high diversity in language and culture among the many local ethnic groups included a high diversity of gender relationships, too. The colonizers, however, acknowledged only men as representatives for trade and other negotiations and as the only owners of land and property rights.[45] The under-representation of women in PNG's democratic bodies is to this day dramatic[46], signifying a patriarchal structure in society that was at least massively encouraged during the time of colonization. "Both colonization and development have been major contributors to the decline in the status of women."[47]

Another long-term effect of German and Australian colonization can be seen in the general weakness of organized civil society in PNG, as indicated by the instability of political parties and parliamentary groups as well as the highly personalized character of political and economic power. For the development of social organization and of transparent public structures, the 100 years between colonization and final independence represent lost time. Corruption and violence are grave and persistent problems in PNG.[48] The distance between the official political system and the local communities is vast.

Against this background, the church organizations in PNG developed into an important factor in terms of public politics, informed opinion and social empowerment (especially for women). Today, the connection between national level and local communities is better represented by the churches than by the political parties. The clear stance of PNG churches against Solwara 1 and deep sea mining in general are therefore political signals of high importance.

The German colonial regime in the South Sea, almost forgotten by the German public, is one main reason why Papua New Guinea today is in many ways more vulnerable to mistreatment by foreign investors than many other countries. The German denial of responsibility, reparation and solidarity had a similar effect. It is high time this indifference was overcome.

42 https://de.wikipedia.org/wiki/Deutsch-Neuguinea, retrieved January 2019

43 Hans Schuh: From the Idyll of the South Sea to a Lunar Landscape, Die Zeit, June 2, 2005, http://www.zeit.de/2005/23/Nauru

44 Norddeutscher Rundfunk, December 22, 2003, http://www.presseportal.de/pm/6561/511949

45 Elizabeth Brouwer, Bruce Harris and Sonomi Tanaka: Gender Analysis in Papua New Guinea, World Bank, Washington D.C. 1998, pp. 3 and following

46 Only one woman was elected to the National Parliament during the parliamentary elections in 2007. In the 2012 elections, three women were elected as representatives in the Parliament. In the 2017 elections, no woman was elected although more female candidates had been nominated than ever before. Since independence, only seven women have held a seat in PNG's national parliament.

47 Government of Papua New Guinea: 2009a. Report on the Status of Women in Papua New Guinea and the Autonomous Region of Bougainville, Waigani 2008, quoted after: Papua New Guinea Country Gender Assessment 2011-2012, 2012, p. 5

48 Cf. the regular reports by Transparency International and Human Rights Watch

Chapter 5

Indigenous Rights and Local Resistance

Today, the rights of indigenous communities are not just a fuzzy promise. They form an integral part of international law. There are international treaties that make the rights of indigenous communities binding for national laws and that define standards for „free and prior informed consent".

Julian Aguon, Blue Ocean Law[49]

Nautilus set up its headquarters in Madang at first. Our campaign drove them away from there. After that they went to Kokopo, but we drove them away from there as well. Then they went to New England. Now they want to work only from the ship. But this won't help them, too.

John Simoi[50]

Indigenous rights, the explicit legal expression of the rights of indigenous groups, has been one of the most dynamic trends in international law over the last 20 years. There has been a radical break in attitude and perspective. "Indigenous peoples' societies were often regarded as 'backward, primitive and uncivilized', where their 'development' was understood to be their assimilation into the so-called 'civilized world'."[51] This has now been refused. The newly coined formula „Indigenizing Development"[52] states that indigenous groups should be able to determine their own way of life in a diverse global society, and that the achievements and potentials of this way of life have to be fully valued as a contribution to global society.

Apart from this human rights approach which interprets indigenous populations as particularly vulnerable groups, a new, 'functional' viewpoint has gained ground recently. It emphasizes the active role of indigenous people concerning the conservation of biodiversity, food security, climate protection and sustainable ways of life.[53] At the same time, new general categories and legal bases have been introduced, or canonized in new ways, un-

49 Interview 4/22/2016

50 Interview 4/22/2016

51 ECOSOC Permanent Forum on Indigenous Issues: Indigenous peoples: Development with culture and identity: Articles 3 and 32 of the United Nations Declaration on the Rights of Indigenous Peoples, Report of the international expert group meeting, 2010, p. 6 f.

52 UNDP: Indigenising Development. Poverty in Focus No. 17, May 2009

53 Maria Ormaza: Re-thinking the Role of Indigenous Peoples in International Law. New Developments in International Environmental Law and Development Cooperation, in: Goettingen Journal of International Law, No. 4, 2012, pp. 263-290

Protest against seabed mining near Madang

Chapter 5

der international law.[54] Presently, indigenous rights represent the most elaborate case studies in human rights of the third generation, i.e. collective human rights of self-determination, cultural autonomy and intact environment.

The UN Declaration on the Rights of Indigenous Peoples (UNDRIP) adopted in 2007 is considered to be the central and ground-breaking step in this direction. It was preceded by ILO Convention 169 (Indigenous and Tribal Peoples Convention) adopted in 1989 and the "General Recommendation No. 23: Indigenous Peoples" of the U.N. Committee on the Elimination of Racial Discrimination (UNCERD) adopted in 1997. UNDRIP recognizes the right of indigenous peoples to self-determination; the right to freely determine their political system and the nature of their economic, social and cultural development; the right to maintain their cultural and religious traditions and their political, economic and social institutions.

FPIC, Land Rights and Maritime Rights

UNDRIP states that indigenous groups must be involved in all decision-making processes that may affect them, and this means: through representatives that they themselves have chosen (article 18). Before adopting legal or administrative decisions that may affect them, the state has to obtain their "free, prior and informed consent" by cooperating with their own representative institutions (article 19). This right to "free, prior and informed consent" (FPIC) has since become a central guideline to be regarded as a minimum condition in safeguarding indigenous rights, and subject to a narrow interpretation.[55] FPIC is neither obtained by *random* forms of participation nor by inviting the public's *general* participation. In a series of decisions, the Inter-American Commission on Human Rights (IACHR) has specified the requirements for FPIC.[56]

UNDRIP encompasses a very broad understanding of the land rights of indigenous peoples. Article 26 defines indigenous land rights as "the right to the lands, territories and resources which they have traditionally owned, occupied or otherwise used or acquired", which expressly implies "the right to own, use, develop and to control" these lands. Two Articles in the Declaration make clear that indigenous land rights may also extend to marine areas. Article 25 affirms the right of indigenous peoples to "maintain and strengthen their distinctive spiritual relationship with their traditionally owned or otherwise occupied and used lands, territories, waters and coastal seas and other resources and to uphold their responsibilities to future generations in this regard." Article 32 affirms their right to FPIC with respect to "any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources."

In 2004, the controversy between the New Zealand government and the Māori over the Foreshore and Seabed Act set a precedent. The law denied in principle that indigenous property rights extended beyond the mean high waterline; instead it laid out that the foreshore and seabed were the inalienable property of the state. The Māori had already questioned this position earlier and sought judicial clarification. The UN Committee on the Elimination of Racial Discrimination (UNCERD) issued an "early warning" criticizing "the apparent haste with which the legislation was enacted", concluding that it "appears […] to contain discriminatory aspects against the Māori, in particular in its extinguishment of the possibility of establishing Māori customary title over the foreshore and seabed".[57]

The policy pursued by the Labour-led government prompted Associate Māori Affairs Minister Tariana Turia to resign and triggered the establishment of the

54 Alexandra Xanthaki: Indigenous Rights in International Law over the Last 10 Years and Future Developments, in: Melbourne Journal of International Law, Vol. 10, 2009

55 In its „Operational Manual 4.10 on Indigenous Peoples" from 2005, The World Bank referred merely to „free, prior and informed consultation" but has now adopted the more rigid and internationally accepted formulation „consent". See World Bank: Environmental and Social Framework, adopted on August 4, 2016, p. 21

56 Blue Ocean Law and Pacific Network on Globalization (PANG): Resource Roulette. How Deep Sea Mining and Inadequate Regulatory Frameworks Imperil the Pacific and its Peoples, Hagåtña and Suva, 2016

57 CEDAR: Decision 1 (66), New Zealand Foreshore and Seabed Act 2004, adopted on March 11, 2005

Chapter 5

Māori Party. Thousands of Māori joined two protest marches (hikoi) in opposition to the Act. The UN Special Rapporteur on the rights of indigenous peoples concluded that the law ought to be repealed or amended by parliament, and that the Government ought to take up negotiations with the Māori to recognize their customary rights to the foreshore and seabed.[58]

Violation of Indigenous Rights in the Context of Solwara 1

The mining license granted to Nautilus Minerals for the Solwara 1 project area violates indigenous rights in multiple ways. The Government made no attempt to obtain the FPIC of the indigenous communities in New Ireland and East New Britain. PNG's deputy state solicitor took the view that there were no landowners who could claim rights to the area of Solwara 1. The New Ireland Provincial government is aware that there are landowners claiming rights to the sea but holds that there is no legal basis for such claims. The Department of Fisheries acknowledged there are "sea owners" but did not initiate any FPIC procedure.

The coastal residents, drawing on their traditional understanding of the Pacific Island countries as a "liquid continent" where the land is part of the sea and there are no distinct borders between the land and the sea, regard the marine regions they use as falling under their land rights. Managing both the region's natural marine and land-based resources is considered a community task.[59]

In an interview, fishermen in Kono Kulagunan and Erebahen (New Ireland) condensed this view into the formula: "Our land goes as far as our canoes go." They reject the Government's position, according to which their rights would merely extend to 6 m below the water surface, pointing out the fact that they catch fish well below that depth.

The consultations with the indigenous population launched by Nautilus in no way meet the requirements of FPIC. Since being granted the license, Nautilus has been carrying out such consultations on a half-yearly basis because they form part of the obligations included in the mining lease. They are funded both by Nautilus and the Government and moderated by the Department of Mining. Villagers in New Ireland report that during the consultations there is no clear distinction drawn between the Government and Nautilus. The population is not provided with independent information on the risks of deep sea mining in the Bismarck Sea.

Nautilus also conducted a survey on New Ireland, contacting 1,500 households. According to reports from residents, the survey insinuated that a negative response to Solwara 1 would exclude them from future financial compensation benefits. "They asked us all sorts of questions about how we live, what we eat, how much money we make and so on and at the very end they asked if we wanted the Solwara 1 Project and we had to answer yes or no. Most of us ticked 'yes'. Then they left and two weeks ago came back and told us we are not part of the project, but we said 'yes' already."[60]

In interviews, New Ireland inhabitants expressed a wide range of concerns regarding Solwara 1. Small-scale fishermen are concerned that they will be denied access to their fishing grounds around Solwara 1, that deep sea mining might affect fish stocks, or that seafood might be contaminated. The East New Britain Provincial government stated it was aware that "communities have been jumping up and down about the project."[61] Many inhabitants expected the National Fisheries Authority to speak out against Solwara 1.

Small-scale fishermen have been consistently emphasizing that the Solwara 1 project area would be located near

58 ECOSOC: Report of the Special Rapporteur on the situation of human rights and fundamental freedoms of indigenous people, Rodolfo Stavenhagen, March 13, 2006, p.21

59 Glenine Hamlyn: A New Voyage: Pacific People Explore the Future They Want. The second consultation of Bread for the World partners in the Pacific, Bread for the World Dialogue No. 11, Berlin, 2013

60 Interview with Roswitha Mekai, Komolobuo and Eliap Lavin, Kono, New England

61 Interview with a representative of East New Britain Province government.

Chapter 5

Subsistence fisheries in the Bismarck Sea

an important tuna spawning site, the "Magado Square".[62] This theory is not backed by scientific evidence. Research on the reproductive behaviour of tuna is still limited. Only the spawning areas of a small number of tuna species have been recorded. A number of tagging projects have set out to understand the geography of tuna migration and reproduction. Bluefin tuna and the southern Bluefin tuna are for instance known to have permanent spawning areas. The Pacific Community assumes that spawning sites for tuna are closely linked to water temperatures and currents (and are therefore also affected by climate change).[63] The Conference of the Parties to the UN Convention on Biological Diversity held in Cancun in 2016 adopted a list of marine biodiversity hotspots that includes spawning grounds for tuna.[64]

The position held by the PNG Fisheries Authority – "spawning grounds for tuna are not confined to a particular area. According to current research, tuna spawn throughout the Pacific"[65] – is therefore hardly up-to-date. Nevertheless, even on the basis of up-to-date scientific research it remains impossible to predict how deep sea mining will affect not only the migration routes, but also the reproduction of tuna species in the Bismarck Sea, and how it will impact indigenous small-scale fisheries. What can be considered certain, however, is that the vast interventions in the marine environment that will be caused by Solwara 1 –noise and light emissions, water pollution, a decline in biomass on the ocean floor – will produce changes that are profound.

Shark Calling

Shark calling, a traditional, ritual fishing practice, is maintained exclusively on New Ireland, the Duke of York islands and the Tabar islands.[66] In an outrigger canoe, the fisherman heads out onto the sea, where he uses a rattle to call a shark. The shark (usually a Mako or reef shark) is trapped with the help of a special instrument (kasaman), a rope with a sling attached to a wood-

62 The Magado Square was suggested as a possible target area for marine conservation activities under the REDD+ Progamms, in: NIP Office of Climate Change and Development: Provincial Consultation Feedback Report 2011, Port Moresby, 2011, p. 17

63 Secretariat of the Pacific Community: SPC Factsheet Tuna, 2014

64 The Benham Plateau (the Philippines) and the spawning grounds of blue fin tuna near Kyushu (Japan). Convention on Biological Diversity: Marine and coastal biodiversity: ecologically or biologically significant marine areas (EBSA), decision adopted at the Conference of the Parties to the Convention on December 17, 2016

65 National Fisheries Authority: Papua New Guinea Tuna Fishery, Flyer

66 Not to be confused with the mythical practice of Shark Calling from Nasaqalau on Lakeba (Fiji), in which the shark caller, submersed in the water, baits the shark by calling it; the last time this practice took place was apparently in 1948.

Chapter 5

en float. The shark caller traps the shark by slipping the noose over its head, or by beckoning it to swim through the loop. The noose is then tightened. The float prevents the shark from diving back down again. After a while the shark falls into a torpor and is then pulled onto the canoe and brought ashore.

Shark calling is a spiritual practice in which communication with sharks, the observance of ritual rules, the caller's discipline, the sharing of the catch and thus the community's social cohesion play a central role. As a tradition, it reflects the special spiritual relationship that these indigenous groups have with the sea. A man's first hunt for a shark is considered an initiation rite. The annual Shark Calling Festival, first held in 2000, also attracts tourists.[67]

The Madak rejected Solwara 1 from the outset. The Barok initially supported it, but then revised their position and today also reject Solwara 1. Members of the Madak and the Barok in Kono and Kolagunan reported that they feared they would be denied access to their traditional fishing grounds because of Solwara 1, and that mining activities in the sea would destroy the practice of shark calling.

The Karkum Statement

From June 25 to June 27, 2008, representatives of various indigenous groups met in Karkum, northwest of Madang, to agree on their position on deep sea mining and Solwara 1. They established the Bismarck Solomon Seas Indigenous Peoples Council and adopted the Karkum National Seabed Mining Forum Statement. It declares:

"We, Indigenous people of the Bismarck-Solomon Sea declare our rights to Free Prior Informed Consent over anything potentially impacting our land or sea resources, and that this right arises from our customary law and is outlined in the UN Declaration on Indigenous People. (…) We declare and reaffirm our customary rights and connections to the Bismarck and Solomon Seas including economic, cultural, social, political and religious rights. Our livelihood and culture is based around these oceans, and it is an inseparable part of our culture, identity and way of life. Our lives are interconnected with the cycles of the sea […]

There has been a lack of any meaningful consultation of the indigenous people of the Bismarck Solomon's sea regarding the effects of this mining activity. (…) There has been a lack of adequate research to understand the seabed environment, the currents, the ecology and its true value. The impacts and changes to the environment from this activity cannot be accurately predicted. (…)

We don't want our health, livelihood and resources to be subjected to a large-scale experiment. (…) [We] do not consent to the seabed mining activities in our waters and seas. (…) We therefore call on the Government and companies involved to cease any and all operations until all our concerns above are addressed and resolved to our full satisfaction."[68]

The statement was supported by a number of civil society organizations. In New Ireland, both the West Coast Development Foundation and Ailan Awareness spoke out against Solwara 1. In East New Britain, the Wide Bay Conservation Association and the East New Britain Social Action Committee took action. Joining forces with BRG (Madang), they held three public forums on deep sea mining between 2010 and 2012. From this initiative emerged the East New Britain Anti-Seabed Mining Coalition which in 2011 launched a public information campaign and toured the west coast of New Ireland. The Forum in 2011 adopted a petition that was handed over to the Province's government, but the authorities failed to reply.

The petition was signed by 26,000 supporters mainly from Bagabag, Karkar and Madang, as well as 6,000 supporters from other Pacific Island countries. In 2009, Nautilus Minerals moved their office from Madang first to Kokopo, then to New Ireland. Activists involved in the campaign interpreted this decision as an attempt to evade public pressure.

67 Numerous video documentations, which can be found on the Internet, corroborate the existence of this practice in the Province of New Ireland. There is no comprehensive documentation or relevant monograph on the tradition of Shark Calling.

68 Karkum National Sea Bed Mining Forum Statement, quoted after John Schertow: Indigenous Communities Oppose Deep Sea Mining, July 10, 2008, https://intercontinentalcry.org/indigenous-communities-oppose-deep-sea-mining/; also documented at: http://www.mpi.org.au/issues/deep-sea-mining/deep-sea-mining-png/

Chapter 5

The Position of the Churches

The church organisations in PNG reject sea bed mining in this region. This position is very consistent and has become quite pointed in recent years.

In 2012, the Catholic Bishops' Conference of the Solomon Islands and PNG expressed concerns over Solwara 1 and called for a stop to seabed mining in PNG.[69] In 2013, the Pacific Conference of Churches (PCC) endorsed a resolution calling to stop deep sea mining, at their General Assembly in Honiara (Solomon Islands).[70] In 2014, the synod of the Evangelical Lutheran Church of Papua New Guinea (ELCPNG) at Karkar Island took the same position and addressed the Government on this issue.[71] ELCPNG head bishop Giegere Wenge had issued a statement "No to experimental deep sea mining in PNG" in January 2014.[72] His successor Jack Urame expressed the same commitment: "The Lutheran Church is totally against the Government's proposed seabed mining and we stand united with our sister Catholic Church in the country."[73] The PCC "Statement on Seabed Mining" of May 2017 was very clear: "To mine the ocean is a deliberate destruction to our people and the future generation (…) We call on all the people and the governments of the Pacific to stand together in solidarity to 'Ban Seabed Mining' in PNG and the Pacific."[74] In August 2017, the Executive Committee of the Federation of Catholic Bishops Conferences of Oceania, meeting in Auckland, New Zealand, declared: "We are heartened to learn of the systematic and coordinated opposition to seabed mining which turns the ocean floor into a stage of exploitative destruction of ocean habitats."[75]

At the end of 2016 Pope Francis made John Ribat Archbishop of Port Moresby and president of the Federation of Catholic Bishops' Conferences of Oceania, the first Cardinal coming from PNG. Since the end of 2017, Ribat has also been a member of the Dicastery for Promoting Integral Human Development of the Roman Curia. Ribat is an outspoken critic of deep sea mining and uses his position to communicate the PNG communities' concerns to the global public. He joined the UN Oceans Conference held in New York in June 2017. In 2018, he met with members of the U.S. Congress and has written articles for U.S. magazines.[76]

About 95 percent of the population of PNG are Christians. According to the 2011 census, 26 percent are Roman Catholic and about 60 percent are members of one of several Protestant churches, the Evangelical Lutheran Church of Papua New Guinea (ELCPNG) being the largest, representing 18.4 percent of the population. The Pacific Conference of Churches (PCC), founded in 1966, is an ecumenical organization with Evangelical Lutheran, Roman Catholic, Methodist, Anglican and many other churches as members. In PNG, PCC represents about 60 percent of the population.

The churches' opposition to seabed mining has grown out of their close link to the coastal communities, addressing threats to the communities' livelihood from pollution and the decline of fish stocks. Over the years, this opposition has developed into a principal stand against deep sea mining as a form of environmental destruction and a driver of climate change.

Food Security, Climate, Biodiversity

The United Nations Food and Agriculture Organization (FAO) is among the organizations that in recent years have emphasized the significance of indigenous rights for global strategies focusing on food security, climate protection and sustainable development. According to the deputy FAO Assistant-Director General René Castro Salazar, the issue of indigenous rights is therefore criti-

69 https://www.thenational.com.pg/deep-sea-mining-stand/

70 https://ramumine.wordpress.com/tag/pacific-council-of-churches/; http://paraumaitai.over-blog.com/article-pcc-2013-honiara-mahana-maa-09-no-mati-116568654.html

71 http://actnowpng.org/content/pacific-churches-back-lutheran-opposition-experimental-seabed-mining

72 https://www.scidev.net/asia-pacific/environment/news/png-seabed-mining-restarts-following-dispute-settlement.html

73 http://www.thenational.com.pg/respect-the-ecosystem/

74 https://img1.wsimg.com/blobby/go/02782530-6bef-4109-8319-1b17dfeefac5/downloads/1c6dos79j_700753.pdf

75 http://www.scoop.co.nz/stories/CU1708/S00189/catholic-bishops-urge-care-for-sea-people-of-west-papua.htm

76 John Ribat: A Christian Obligation to Confront Climate Change, Washington Examiner 3/22/2018

Chapter 5

cal" for the success of climate policy initiatives.[77] Indigenous groups "are the primary innovators and custodians of a majority of the world's agricultural diversity and its related biological and knowledge diversity."[78] They are key players in the "sustainable management of land, water and genetic resources, nutrition and biodiversity and forestry development."[79] Not only can their specific knowledge of sustainable and integrated forms of using renewable resources contribute to the preservation and dissemination of economic practices that halt climate change. It also represents a key resource for strategies to sustainably use natural resources whose status is already critical because they are under environmental stress.

Indigenous groups are growing increasingly confident in underlining this revised role as "custodians" of biodiversity, traditional knowledge and the world's last non-industrialized environmental spheres, and they are using it to oppose land grabbing and ocean grabbing. The Buala Declaration of the Melanesian Indigenous Land Defence Alliance (MILDA), adopted in April 2016, for instance states: "We are custodians of the land and sea". It critically opposes the "continued and increasing severity of threats to customary land and sea systems, posed by the land reforms, and deep sea exploration and seabed mining and other foreign development agendas".[80]

Like customary use rights and unrestricted access to natural resources, intact ecosystems, too, are essential to preserving subsistence economies and a non-industrial approach to exploiting natural resources. Both the increased disputes over access to the sea and its resources and trends favouring the privatization of resources are currently jeopardizing these coastal livelihoods on a massive scale. In light of the intensification of land grabbing and ocean grabbing, the FAO has adopted two guidelines aimed at taking into account the situation of coastal communities and small-scale fisheries in order to protect them: the "Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication" of 2015, and the "Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security" of 2012. However, coastal indigenous communities had to fight for their situation to be included in the FAO guidelines. Across the world, small-scale fishing organizations and NGOs have urged that their concerns be included in order to highlight the relationship between land grabbing and ocean grabbing. For many international processes, the ocean's social and developmental dimensions are in fact new territory. For a long time, the oceans' role in reducing hunger and poverty has been ignored. Even today, efforts repeatedly fail to balance marine conservation measures, interests in the industrial development of marine resources and the protection of coastal populations dependent on artisanal subsistence economies.[81]

At this point, the protection of indigenous rights in PNG is closely linked to decisions that will shape the region's future economic development. A continued focus on extractive industries will not only threaten the rights and livelihoods of indigenous groups. It will also destroy their ways of life, their knowledge systems and genetic resources that may be crucial for a shift towards sustainable development and an ecological economy. The more this potential is deteriorated, the more difficult this shift will be. Solwara 1 is the current culmination of this scenario.

Recent Developments

In December 2017, several coastal communities, represented by the Centre for Environmental Law & Community Rights (CELCOR), filed a lawsuit against the PNG government. They requested the release of to date disclosed documents on the procedures of licensing for the Solwara 1 mine, like the environment permit.[82] The case fundamentally questioned the legitimacy of the project Solwara 1. If the public had no access to critical documents that were relevant for the assessment of the

77 FAO: Indigenous peoples central to efforts to combat climate change, July 21, 2016, http://www.fao.org/news/story/en/item/426406/icode/

78 Carol Kalafatic: Indigenous peoples' sustainable livelihoods, FAO thematic brief, p.8

79 FAO Policy on Indigenous and Tribal Peoples, Rome 2010, p. 8

80 http://actnowpng.org/blog/blog-entry-seabed-mining-threat-indigenous-and-customary%C2%A0rights

81 Carsten Pedersen et al.: The Global Ocean Grab - A Primer. TNI Agrarian Justice Program, Masifundise, Africa Contact, 2014

82 https://www.edonsw.org.au/png_deep_sea_mining_case; https://www.australianmining.com.au/news/local-community-launches-legal-action-png-govt-nautilus-deep-sea-project/

Chapter 5

project, a free, prior and informed consent (FPIC) by the local indigenous communities would have been impossible. Without this consent, however, the project would be illegal.

Politicians are more and more undecided on Solwara 1. Jonathan Turke, the new Mining Minister, stated in December 2017 that the Government would still be committed to Solwara 1.[83] In January 2018, Arnold Amet, former Papua New Guinean Attorney General and Minister for Justice, called for the PNG Government not to renew the license for Solwara 1 and instead to terminate its joint partnership agreement with Nautilus and reclaim all payments made by PNG to Nautilus.[84] Garry Juffa, governor of the Northern (Oro) Province 2012-2017, called for a ban on seabed mining in June 2017. Juffa said he supported Cardinal Ribats position on deep sea mining.[85] At the 2017 election, Juffa was re-elected as member of the 10th PNG parliament.

There is no mentioning of deep sea mining in the declaration adopted at the UN Oceans Conference that was held in New York, June 2017. The controversy over deep sea mining took place in the conference's side event program. PIANGO and the UN Major Group Pacific, supported by other partner organizations including Bread for the World and Fair Oceans and presenting John Ribat among other speakers, conducted a workshop on deep sea mining called "Voices from the Blue Frontier". At the same time, Nautilus Minerals took part in the side event program, too. The workshop "Perspectives on Deep Seabed Mining" was organized by Kingdom of Tonga, Mexico, the International Seabed Authority and UNDESA, "and with the support of TOML/Nautilus Minerals Ltd."[86]

83 https://www.radionz.co.nz/international/pacific-news/346213/png-mining-minister-says-govt-committed-to-deep-sea-mining

84 http://www.deepseaminingoutofourdepth.org/the-writing-is-on-the-wall-for-solwara-1-png-should-withdraw/

85 https://postcourier.com.pg/ban-deep-sea-mining-papua-new-guinea-says-juffa/

86 UN Oceans Conference, Programme of Side Events, 01 June 2017. TOML means Tonga Offshore Mining Limited, a subsidiary of Nautilus Minerals Ltd.

Chapter 6

The Role of the State

Go back and try first in your home country!

Julienne David, teacher, Nabual, Duke of York Islands

The choice of a deep sea mining area depends on the State. To date, there are only two cases in which a state approved a commercial exploitation project for mineral ore mining on the seabed within its EEZ. One of them is Solwara 1.[87]

New Zealand rejected two such requests. In June 2014, New Zealand's Environmental Protection Agency (EPA) decided against the project of Trans-Tasman Resources (TTR) to mine iron sand on the seabed of South Taranaki Bight, referring to the potential impact on the ocean floor and other ecosystems, the fishing industry, indigenous rights of the affected Maori groups (Iwi) and on marine mammals.[88] In February 2015, the EPA rejected the request of Chatham Rocks Phosphates Ltd. to mine phosphate rock on the seabed off the coast of Canterbury. In their decision, the EPA referred mainly to the fact that this is an area with many environmental protective rights applying, and that the habitat would become permanently changed without any perspective to return it to its previous state.[89] A renewed application by Trans-Tasman Resources was approved by the EPA in 2017 but the decision was cancelled by the New Zealand High Court in August 2018. In December 2018, the company announced that they would appeal the Court's decision.[90]

In March 2012, the Australian Province Northern Territory issued a three-year moratorium on seabed mining, which was extended for another three years in 2015. The plans of Northern Minerals (today's NTM Gold Ltd.) to mine manganese ore off Groothe Eylandt were stopped. In 2013, Namibia adopted a similar moratorium, which led to domestic political controversies with the fishing industry and environmental organizations as the primary initiators against the planned mining of phosphates. The September 2016 decision of the Namibian Minister of Environment to approve a project by Namibian Marine Phosphate (Pty) Ltd after the expiration of the moratorium, has since been deferred due in part to corruption charges and other protests. The principal shareholder of Solwara 1, the Ottoman MB Holding, also holds 85 percent of the shares of Namibian Marine Phosphate (Pty) Ltd through its subsidiary Mawarid Mining LLC. Due to the price for phosphate increasing by more than 900 percent in 2007 and 2008, quite a number of applications were made for mining phosphate in exclusive economic zones worldwide. In Mexico, this was also rejected, while in South Africa, three companies - Green Flash Trading 251 (Pty) Ltd, Green Flash 257 (Pty) Ltd and Diamond Fields International Ltd. - hold a combined 150,000 km² of licensed areas within the EEZ and are awaiting approval for exploration.[91]

In 2003, Canada was the first country to put a hydrothermal vent field completely under conservation, the Endeavour Hydrothermal Vents Marine Protected Area.[92] Portugal has since declared four hydrothermal fields to be under conservation (Rainbow, Lucky Strike, Menez Gwen, Dom Joao de Castro Bank).[93] Mexico established the Guaymas Basin and Eastern Pacific Rise Hydrothermal Vents Sanctuary. The protective zone encompasses the seabed as well as the water column of 500 m depth

87 The other one is Atlantis II in the Red Sea, a project licensed by Sudan and Saudi Arabia as part of their co-managed exclusive economic zones. In 2011, a consortium from Diamond Fields Ltd. (Canada) and Manafa (Saudi Arabia) obtained a research and extraction license for minerals similar to those found in Solwara 1 - mostly copper, gold and zinc. The German-based Preussag company had obtained an exploration license for Atlantis II in 1976 but the agreement was terminated in 1981 due to sinking prices of raw materials. See Hjalmar Thiel, Ludwig Karbe, Horst Weiher: Environmental Risks of Mining Metalliferous Muds in the Atlantis II Deep, Red Sea, in: Najeeb Rasul and Ian Stewart (ed.): The Red Sea, Berlin and Heidelberg 2015, pp. 251- 266

88 EPA: Trans-Tasman Resources Ltd Marine Consent Decision, June 2014 https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000004/Boards-Decision/EEZ000004-Trans-Tasman-Resources-decision-17June2014.pdf. "Iwi", literally meaning "bone", is the name for largest social units among the Maori.

89 EPA: Decision on Marine Consent Application by Chatham Rock Phosphates Limited to Mine Phosphorite Nodules on the Chatham Rise, February 2015, https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000004/Boards-Decision/EEZ000004-Trans-Tasman-Resources-decision-17June2014.pdf

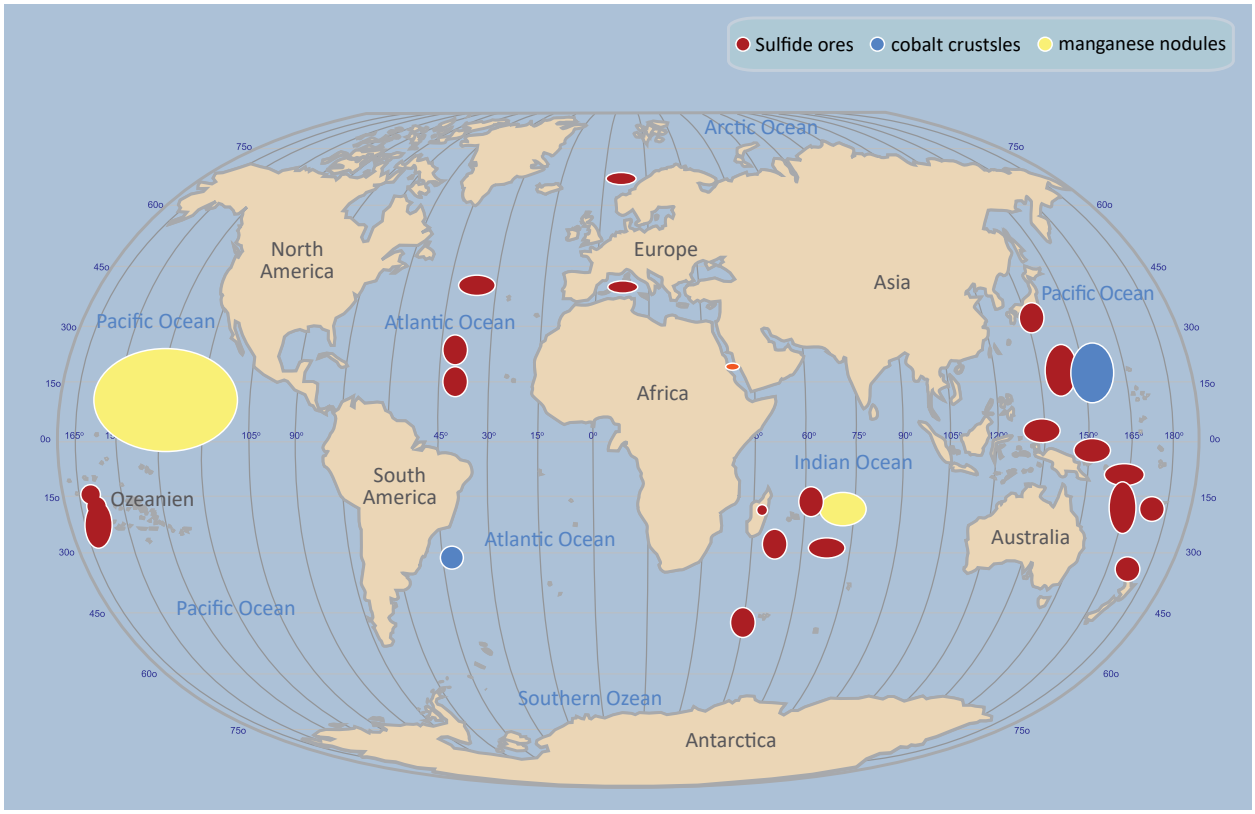
90 https://www.doc.govt.nz/about-us/statutory-and-advisory-bodies/conservation-boards/taranaki-whanganui/media-releases/seabed-mining-decision/

91 November 18, 2016, Phosphate Mining Firms Set Sights on Southern Africa's Sea Floor https://ramumine.wordpress.com/tag/namibia/

92 http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/endeavour-eng.html

93 http://mpas-portugal.org/project/hydrothermal-vents/

Chapter 6



Licence areas for deep sea mineral deposits

downward. Above, the area remains accessible for the fishery.[94]

Structural Conflicts of Interest, Lack of Government Capacity

Despite recent political commitments to sustainable development paths, Papua New Guinea is characterized by a historically grown culture of the extractive industries, in which both the state and local communities and landowners are tied to mining projects by financial and economic incentives. The first approaches to seabed mining were partly shaped by this tradition.

The state of PNG holds 15 percent of the Solwara 1 project. The investment is perceived by Eda Kopa, a 100 percent subsidiary of state-owned Petromin. Investment in Solwara 1 has cost PNG $ 120 million to date.

The PNG Mining Act states in section 17 that the state may participate in mining projects for a stake of up to 30 percent. Such a step was taken several times for mining projects on land. The goal was to generate additional government revenues beyond the income from the licenses. In the case of Solwara 1, the financial participation of the State explicitly served the purpose of helping Nautilus Minerals out of a financial crisis. „The project was being financed purely by equity partners up to the point that grant and fund raising was required to raise capital to build and integrate the technology. The development license and title to the tenement was necessary to secure debt financing."[95] When the state's participation did not take place initially and eventually became the subject of a lengthy argument, the Nautilus's stock fell from USD 3 (January 2011) to just 25 cents (January 2013).

94 http://www.deepseanews.com/2009/07/new-mpas-in-mexico-protect-vents-whale-sharks/

95 Department of Mineral Policy and Geohazards Management (DPMGM) of PNG: State's Equity Participation. SPC-EU EDF10 Deep Sea Minerals (DSM) Project, Pacific ACP States Regional Workshop on DSM Law and Contract Negotiations, 11th - 15th March 2013 Nuku'alofa, Tonga http://dsm.gsd.spc.int/public/files/meetings/STATE_S_EQUITY_PARTICIPATION.pdf

Chapter 6

There is currently no specific legal foundation for seabed mining in Papua New Guinea to define relevant approval procedures. The licensing of seabed mining is carried out under the provisions of the Mining Act of 1992 and the Environmental Act of 2000. According to the Environmental Act, Nautilus expressed interest in a mining license for Solwara 1 in October 2006. In February 2007, Nautilus submitted the Environmental Inception Report, which was accepted in May 2007, followed in October 2008 by Nautilus's submission of the Environmental Impact Statement (EIS). A public hearing took place in April of 2009. In December 2009, the Department of Environment and Conservation issued its approval. In January 2011, Nautilus received a temporary 20-year license for mineral extraction in Solwara 1.

The four authorities directly responsible for monitoring the Solwara project are the Conservation and Environment Protection Authority CEPA, which emerged from the Environment Ministry; the Mineral Resources Authority MRA; the Department of Mineral Policy and Geohazard Management DPMGM; and the National Fisheries Authority State Fisheries Department NFA. Three out of these four agencies (CEPA, MRA, NFA) self-finance directly from license fees and other charges from these mining projects. There is a fundamental conflict of interest, of being responsible for the authorization and control of these projects on the one hand and on the other hand depending on their continuance. In several interviews, it was emphasized that CEPA and MRA see their task in allowing as many extraction projects as possible, and as quickly as possible. In the case of Solwara 1, this is mirrored through the fact that the environmental approvals and the issuing of licenses took place without prior consultation with the provincial governments of East New Britain and New Ireland and without a specific legal regulatory framework for seabed mining.

After Nautilus had submitted the Environmental Impact Statement (EIS), the Environment Ministry commissioned the external consultant firm Cardno-Acil to conduct an independent review of the EIS. This report is, however, not publicly accessible.

The environmental monitoring during the planned mining is delegated by CEPA to Nautilus. The corresponding Environmental Management and Monitoring Plan (EMMP) was drawn up by Nautilus. The role of CEPA is limited to inspections onboard the production support vessel every six months. For civil protection, the National Maritime Safety Authority is responsible. Neither New Ireland nor East New Britain provinces have any state capacity for disaster protection. The NFA confirmed that PNG does not have any facilities in place that are technically able to test local foods such as fish and seafood for heavy metal contamination. Samples would have to be sent via Port Moresby to Singapore for analysis.

Due to a lack of technology, most states in the world rely on the data of the companies and the few scientific institutions that have the capacity to conduct research in the deep ocean. This dependence is a fundamental problem when it comes to state control of deep sea mining.

Limits of Acceptance

In the case of Solwara 1, both adjacent provinces, East New Britain and New Ireland, are included in the system of financial revenues from the mining project. Usually, in PNG, the so-called Memorandum of Agreement (MoA) manages closer agreements between the company, the state governments, and affected landowners. Such agreements usually clarify the allocation of funds for regional development activities, details of employment and training, the provision of supplies and services, financial disclosure requirements, environmental measures, measures following the closure of the mine and the distribution of fees and infrastructure. MoAs are a major source of revenue for provincial governments. In the case of Solwara 1, the provinces' share of royalties will be divided 60/40 between New Ireland and East New Britain. In addition, New Ireland Province is negotiating its own „Memorandum of Understanding" (MoU) with Nautilus, hoping to get additional financial benefits in exchange for the Province's approval of the project.

PNG has a parliamentary system with only one parliamentary chamber, based on a majority voting system. Provincial governments are elected simultaneously with national parliamentary elections. The 20 provinces, the Autonomous Region of Bougainville and the National Capital District each choose a governor who then is also a member of the National Parliament. Alongside those 22 seats, there are 89 additional seats, or „open seats", which are occupied by the winners of the 89 electoral

Chapter 6

districts. The Prime Minister is elected by Parliament and appoints the other members of his cabinet.

Since the pollical parties are rather weak in PNG and the voting system makes no provision for a run-off, there is no predominance of a few large parties (like in other majority voting systems) but rather a highly fragmented parliament and a necessity for multiparty coalitions. It is common for deputies to switch parties during a legislative period, as is the establishment of new parties and split-offs from already existing ones. As the 22 provinces have no regional parliaments, there is no parliamentary opposition at the provincial level. This secures the provincial governors a strong position of power in their respective provinces, which is further enhanced by their concurrent membership in the National Parliament. However, their position in relation to the central Government is weakened by the fact that they do not represent a regional parliament or its majority. The overall result is a political culture that is highly personalized. Corruption is a notorious problem, prevalent at all political levels.

Since neither Nautilus nor the national Government acknowledge the property rights of the coastal inhabitants in the sea area, the usual political extraction regime that promotes acceptance by the allocation of financial benefits is undermined in this aspect. Nautilus attempts to bridge this gap with its community projects. Until now, the program „Nautilus CARES“ (which stands for „Community Accountable, Responsible Environmentally and Safe“) has invested in water and sanitation supply for 29 schools in New Ireland, as well as in malaria protection, book donations for various schools, and health care. For its CSR program, Nautilus has budgeted annual costs of 491 US dollars per capita per year.

The effect in terms of acceptance, however, is low. „They take our minerals and give us latrines,“ said a villager from New Ireland in an interview. The fact that the project will generate practically no employment is deemed particularly negative. As a Kono resident explained in an interview: „With logging we were receiving royalties. We had money. Logging contributed to our church and kastom activities. With seabed mining we do not see the same. Nautilus Minerals told us two weeks ago there will be 200 jobs only. So there will be no jobs for our young people. Everything will be computerized and the minerals will be taken and sent to China, so there's really nothing there for us and our government."

Chapter 7

The Business Model of the Investors

Given all the operational costs and capital costs, it seems quite unlikely that shareholders will see any profit from Solwara 1. However, Solwara 1 is a steppingstone to a whole new industry. (…) The more projects they have after Solwara 1 the more profitable they will be. (…) If they fail with Solwara 1 for one reason or another, all bets are off.

Ultra Long, financial investment blogger, Finland[96]

The listed company Nautilus Minerals Inc. has never distributed any returns since its foundation. Revenues will be realized only in the case of successful production in Solwara 1. Deep sea mining is a highly speculative business.

In 2009, the Russian mining company Metalloinvest (21.0%) was the major shareholder, followed by two other mining companies: Anglo American (Great Britain, 11.1%) and Teck Resources (Canada, 6.8%). As of today, the company is dominated by the Omani-owned MB Holding Company LLC (30,4%) and Metalloinvest (19.2%).[97] Anglo American, having reduced its share step by step before, withdrew completely in May 2018.[98] De facto, Nautilus is run by two billionaires: Mohammed Al Barwani, founder and owner of MB Holding (assets estimated at 1 billion US dollars), and Alisher Usmanov, the principal owner of Metalloinvest, CEO of Gazprom Investment and owner of a publishing house (with assets of 14 billion US dollars).

The share price of the Nautilus‘ stock has been declining strongly over the years. This was partly due to the constant issuing of additional shares which ensured the constant increase of capital. On the other hand, the projected time horizon for the mining start has been extended continually and it is uncertain whether the funds necessary for the operation could be procured. Whereas the price per share lay at 5 US dollars in 2007, it was worth less than 1 US dollar by early 2009. The granting of a mining permit at the beginning of 2011 saw the share price climb to 3 US dollars once again. The share price plunged to as low as 25 cents after the attempt of the PNG government to opt out of Solwara 1 in July 2012. The subsequent agreement between the parties in 2014, leading to a state participation of 15%, fuelled Nautilus with a further 120 million US dollars and spurred the share price to 50 cents once again. Since then, the price per share has fallen to 15 US cents in 2016 and to 4 US cents as of February 2019.

In August 2016, Nautilus halted its procurement of necessary equipment due to an acute lack of funds, laid off employees and allowed the majority of its permits for other areas in the Pacific to expire. As other attempts of fundraising failed, the two principal investors secured a „bridge loan," which is supposed to provide Nautilus with a monthly supply of 2 million US dollars in the course of a year. Nautilus‘ license areas in the Bismarck Sea have drastically diminished, in favour of larger license areas around Tonga and the Solomon Sea. In PNG waters, Nautilus holds on to Solwara 1 but gave up most of its other licenses. Obviously, the chances to carry through with another mining project in PNG are deemed low by Nautilus. This can also be understood as a reaction to the adverse political climate around deep sea mining in PNG.

In July 2018 it became known that the construction of the support vessel had been stopped by Mawei Shipbuilding because MAC Goliath, the contractor engaged by Nautilus to procure the vessel, had failed to pay the contractually agreed instalments.[99] Negotiations over the vessel (Nautilus intends the vessel to be bought by a third party or a new joint venture company) have not been concluded.[100] In August 2018 the replacement of Michael Johnston as CEO was announced.[101] The schedule for the start of commercial mining at Solwara 1 will be delayed. As of February 2019, Nautilus has not announced an updated schedule. The only money Nautilus is able to obtain comes from its two main investors, Metalloinvest and MB Holding (Mawarid), who together founded Deep Sea Mining Finance Ltd with equal 50

96 http://thoughtsofaprivateinvestor.blogspot.de/2011/06/nautilus-minerals-revisited.html

97 Cf. Nautilus Minerals: Press Release 1/17/2019. MB Holding, through its subsidiary Mawarid, stepped in picking up a 10% share in September 2011.

98 https://finance.yahoo.com/news/anglo-american-end-investment-deep-164115045.html

99 https://www.mining-journal.com/capital-markets/news/1341843/nautilus%E2%80%99-vessel-contract-cancelled; Nautilus Minerals: Press Release 10/2/2018

100 Nautilus Minerals: Press Release 12/2/2018

101 https://www.marketwatch.com/press-release/nautilus-minerals-announces-departure-of-president-and-ceo-michael-johnston-2018-08-07

Chapter 7

percent ownership, providing additional funds for Nautilus. The loans are secured against the assets of Nautilus' subsidiaries and bear interest at 8 percent per annum.[102] This is likely to further diminish any chances that PNG, as shareholder of the Solwara 1 project, might be able to tap any profits arising from the Solwara 1 operation.

Change in the Business Model

Over the years, Nautilus has fundamentally changed its business model for the Solwara 1 project. Initially, Nautilus thought the mining of the Solwara 1 resources would itself be profitable enough to refund the development costs and the construction costs for the mining tools. In the face of the actual costs, this aim became impossible. It is generally assumed that Solwara 1 alone cannot be profitable. "It is unlikely that the cost of exploring the resource and developing the new technology required to extract it will be covered by the revenues that it generates, so this operation will only prove to be successful if the same technology is then applied to other resources of the same type."[103]

The calculation is now to draw profits from the commercialization of the mining technology that is hoped to be used for many other seabed mining projects. Nautilus Minerals claims to hold 16 patents as intellectual property and hopes to commercialize them based on its "first-mover advantage".[104] This affirms the experimental character of the Solwara 1 project that was underlined by the local protests early on, likening the project to the region's abuse for nuclear testing. "The Solwara 1 project has come to be seen as an engineering experiment, an environmental experiment, an economic experiment, and a policy experiment."[105]

The viability of deep sea mining depends on whether the production costs of ore mining per extracted quantity of metal (operative costs plus allocated costs for the equipment construction) lie below those of the land mining projects[106]; or, alternatively, whether demand is so strong that sales can be achieved regardless of the higher prices. This would entail a situation similar to the oil market. Offshore oil is lucrative when prices are high; a sliding global price leads to the closing of platforms - a phenomenon that has seen widespread occurrence in recent years. Exclusive offshore companies are rare in the oil industry.

Nautilus presented a forecast of costs and resources to be expected from the Solwara 1 Project in June 2010.[107] The company based its forecast on the following assumptions: Solwara 1 has a deposit of approximately 1 million tons of ore, containing about 74,000 tons of copper and 166,000 ounces of gold; these deposits reflect a sales value of approximately 630 million USD in view of present market prices.[108] Prior to production starting, the accrued overheads will amount to 383 million USD (used for the construction of the underwater excavator, the production vessel, the pumping system, the drainage system, etc.). The operative costs beginning with the extraction are projected at 70 US dollars per ton of ore, meaning a total of approximately 70 million USD once the entire ore deposit is depleted. On paper, this implied a theoretical profit margin of 170-180 million USD. This margin would have been further diminished by other cost positions which weren't considered in the estimate, especially the costs for ore processing. It could turn out to be higher, however, should the ore deposits on Solwara 1 happen to be richer than expected.

The company has failed to provide an updated profitability calculation ever since. However, their annual report from 2015 stated: "The Company's existing mineral resources will not be sufficient to economically operate the Seafloor Production System. In order to demonstrate the economic viability of the Seafloor Production System, the Company will need to locate and classify significant

102 http://dsmobserver.com/2018/03/nautilus-receives-additional-bridge-loans/

103 Colin Filter and Jennifer Gabriel: How could Nautilus Minerals get a social license to operate the world's first deep sea mine? Marine Policy, January 2017, p. 3

104 Nautilus Minerals Inc.: Annual Information Form for the Fiscal Year concluded on December 31, 2015 and submitted on March 31, 2016, p. 25 and p. 32

105 Filter and Gabriel 2017, p. 3

106 At present, the production costs in land mining amounts to approximately 5,000 US dollars per ton of copper and 1,000 US dollars per ounce of gold, the latter differing considerably between the various mining areas.

107 SRK Consulting: Offshore Production System Definition and Cost Study, prepared for Nautilus Minerals, June 2010

108 The deposit's value would be 470 million USD for copper, at a price of 2.9 USD per pound, and 220 million USD for gold, at a price of 1,330 USD per once. At a recovery rate of 90 percent (which is a high estimate), this would result in a sales value of 630 million USD.

Chapter 7

new mineral resources or mineral reserves on its existing or new tenements."[109] The annual report repeatedly emphasizes that the data submitted in the Cost Study is not up-to-date and cannot be indicative of the project's financial prospects.

Apart from potential additional costs for the mining system and the extra costs for „Nautilus CARES", Nautilus was forced to give up part of the value added in the meantime, due to its troublesome financial situation. The contract with Tongling regarding the ore sale entails substantial discounts on the current market price: Tongling will pay 95 percent of the market price for the copper, 50 percent for the gold, 30 percent for silver, and nothing for any pyrite. In addition, Nautilus is obliged to finance the construction of a concentrator, a device that increases the metal content of the ore to be processed.[110]

The agreement with Tongling provided a forecast of the costs for the actual metal extraction of deep sea ore for the first time. The increase in cost compared to the original estimate is evidently so high, and triggers such a substantial raise in the production costs of the metal, that not only the deposit on Solwara 1 but also those in the neighbouring Nautilus' license areas would not suffice to outweigh the extraction costs (initially estimated at 383 million USD).[111] This has dampened the willingness of investors to inject even more funds into the project. The attempts from 2015 and 2016 to furnish capital by issuing additional shares were rather unsatisfactory.

The company reacted by dramatically reducing the running costs. Together with downsizing and bringing construction to a halt, the company saved primarily by cutting on license fees, reducing number and size of its underwater mining license areas. In 2009, Nautilus had stated: "A keystone of our corporate strategy is to consolidate our first mover advantage by adding title holdings over prospective ground in new countries."[112]

In 2011, the number and size of Nautilus' license areas peaked. In PNG waters alone, Nautilus held 205 tenements adding to 71,500 mi^2.[113] By the end of 2016, this stock had shrunk to 2 secured tenements of 170 mi^2. In 2017, a small increase occurred, to 4 PNG tenements of 1,100 mi^2, all in the Bismarck Sea. Nautilus completely abandoned all tenements in Fiji and Vanuatu. Apart from PNG, the company held only 25 tenements in Tonga and 1 tenement in the Clariton-Clipperton-Zone.[114]

Metalloinvest and Mawarid/MB Holding, the major shareholders, have tightened their control over Nautilus over the years. In October 2016, both companies secured Nautilus' cash position directly by a "bridge funding". In October 2017, financial control over Nautilus was outsourced to a new financing company, the "Deep Sea Mining Finance Ltd." (DSMF). Registered in Virgin Islands, the company is owned, as mentioned above, by Metalloinvest and MB Holding, each holding 50 percent. The DSMF assumed the acquisition of funds for Nautilus. In return, it has a veto right for all investment decisions and is remunerated by a set of different payments.

In February 2018, Nautilus presented a "Preliminary Economic Assessment (PEA)" for Solwara 1, prepared by AMC Consultant Pty Ltd. The report estimated the total capital costs for Nautilus' deep sea mining system at 530 million USD (instead of the 383 million USD estimated in the 2010 report) and the operating costs per ton of ore at 130 USD (instead of the 70 USD estimated 2010).[115] From the total capital costs of 530 million USD until production start, 315 million USD have already been paid while another 215 million USD have still to be invested, the report stated.[116] A positive cashflow for the operation is nevertheless projected because the estimation of the mineral deposit has increased and because "the analysis excludes capital sunk prior to 1 January

109 Nautilus Minerals Inc.: Annual Information Form for the Fiscal Year concluded on December 31, 2015 and submitted on March 31, 2016, p. 52

110 Nautilus Minerals: Annual Information 2015, p. 20

111 The Tongling agreement implies that from the initially estimated 630 million USD sales value of the Solwara 1 ore, Nautilus would keep max. 500 million USD. Considering that the operating costs have increased, especially the charter costs for the production vessel, this means that only mining Solwara 1 has become a losing deal.

112 Nautilus Minerals: Annual Report 2009, p. 11

113 Nautilus Minerals: Annual Report 2011, p. 14

114 Nautilus Minerals: Annual Report 2016, p. 33; Annual Information 2017, p. 42

115 AMC Consultants Pty Ltd: Preliminary Economic Assessment of the Solwara Project, Bismarck Sea, PNG, for Nautilus Minerals Niugini Ltd, 2/27/2018, p. 14, more detailed p. 224 ff. Of the estimated 530 Mio. USD total capital costs, about 300 Mio. USD are for the Seafloor Production Tools and the Lifter and Riser System. In 2010, the costs for SPTs and LARS was estimated at 185 Mio. USD.

116 According to Nautilus' "Status of Equipment", the SPTs are fully completed, as are most parts of the LARS.

Chapter 7

2018".[117] In other words: Mining Solwara 1 cannot pay for what Nautilus has invested so far.

This represents a substantial shift in the business model from mining profits to profits expected from patents. Nautilus' chances of success are now hinged entirely on the development of seabed mining into a general new industry. Solwara 1 can be characterized not only as an experimental deep sea mining project but also as an ice-breaker. Solwara 1 is supposed to demonstrate that deep sea mining can be profitable, to pave the way for the extractive industrialization of the seas and thereby transform Nautilus into a profitable company for its investors.

On February 22nd, 2019, Nautilus Minerals declared insolvency and filed for restructuring under the Companies' Creditors Arrangement Act.[118] This may not necessarily mean the end for Nautilus. It could as well result in a further shift of control and entitlements in favor of the two main investors.

Corporate Structure, Profit Shifting and Externalization of Costs

The shift in the business model was noticed by the state of PNG, too. After many years of negotiations with regard to PNG's participation in the Solwara Project – an operation that according to Nautilus' updated projections was not supposed to generate any profit in itself - the company finally conceded that the state of PNG would be entitledto a share in the outcome of certain intellectual property rights. Any hope of return of PNG's investment could only be based on these. The agreements themselves have not been released to the public.

Whether PNG ever sees any return of investment, however, is more than doubtful. According to the annual report, Nautilus has a complex group structure having no less than 56 wholly-owned subsidiaries - 8 direct subsidiaries at the first level, 30 indirect subsidiaries at the second level, which are held by the subsidiaries at the first tier, and 18 additional indirect subsidiaries at the third level. The companies are registered in a dozen different countries.[119] This kind of structure creates the ideal conditions for shifting costs and profits using internal invoicing between the individual businesses in such a way, as to generate maximum profits for Nautilus. The State of PNG has no influence on how Nautilus designs the business relationships between all its subsidiaries. If any share of profits for PNG from the patents were to occur, Nautilus could easily compensate for this by transferring more losses to the Solwara 1 project and claiming PNG's share in these losses, too. The 120 million US dollars paid by PNG exempt the state only from further financial claims prior to the commencement of the commercial mining, and not after.

Taking about business models, it should be noted that the economy of Solwara 1 (and of any further deep sea mining projects) is completely based on the total externalization of all environmental and social costs. The effects of pollution, the consequences of the destruction of habitats and the loss of revenues for the local population are not included in Nautilus' estimates of economic viability. While any potential profits will be appropriated privately, society has to bear the long-term costs to the environment and to the people. This is true as well for any catastrophic accidents. As with nuclear power and nuclear weapons testing in the Pacific, the operators are not obliged to insure the real risks of the operation. There is no cash in Nautilus' accounts, and the shareholders are not liable beyond their investments. The private billions of Barwani and Usmanov are safe.

117 Ibid., p. 230

118 Nautilus Minerals Inc: Press Release 2/22/2019. Restructuring under the Canadian CCAA is similar to Chapter 11 reorganization under U.S. bankruptcy law.

119 Annual Information 2015, p. 12

Chapter 8

Ecological Consequences of Solwara 1

As is the case for all mining, living systems will be disturbed and destroyed.

Environmental and Social Benchmarking Analysis of Nautilus Minerals Inc. Solwara 1 Project[120]

It doesn't matter where you are on this planet. Destruction here will affect you, too.

Michael Kasuk, Madang People's Forum

Seabed mining takes place within a medium that is ecologically more sensitive, where pollution spreads more easily and is harder to contain, whose ecological patterns and reaction to human impact are less understood, and that has not been industrialized, i.e. dominated by anthropogenic metabolism, in the same way as earth's landmass. Seabed mining marks a decisive step to the industrialization of the oceans. [121] It affects that part of the biosphere that could, as a buffer and reservoir, mitigate or compensate at least some of the consequences that resulted from the complete transformation of ecosystems on land.

Pollution, environmental destruction and irreversible change of ecosystems result inevitably from seabed mining. Even the proponents of seabed mining do not deny this. The question to be discussed is whether these results can be regarded as limited and bearable, or whether they have to be classified as critical and unacceptable. The Environmental Impact Statement (EIS) presented by Nautilus for the licensing process in 2008, prepared by the Australian consulting company Coffey Natural Systems, argues for a limited and tolerable impact of deep sea mining.[122] In 2016, Coffey merged with Tetra Tech, a worldwide operating U.S. consulting company whose major shareholder is the U.S. investment fund BlackRock.[123]

Underwater noise

Many sea creatures rely on acoustics for orientation and may be disoriented by noise pollution. Under water, noise carries over thousands of kilometers.[124] The sound of the Solwara 1 mining would be heard virtually all over the Bismarck-Solomon Sea which stretches over 754 to 359 miles and is known to be a comparatively quiet ocean. Nautilus concedes in its EIS that the Mining Support Vessel alone would be heard by whales over 600 km away.[125] The acoustic presence of a permanent construction site would inevitably have an impact on behavior and migration routes of fish and sea mammals, creating a constant level of stress. The searchlights of the Seabed Mining Tools may, in a more localized way, cause disorientation. "Illumination of the SMT will potentially attract fish or other mobile species in the area and place these at some risk of being sucked into the cutter head and the RALS, from which they would not survive."[126]

Saltwater absorbs sound waves much slower than air, so that the same level of sound constitutes a much higher noise pollution than on land. Communication by sound is important for sea mammals and fish, as is orientation by sound signatures. Each is impaired when there is increased background noise under water. Reef fish and fish larvae use vibration sounds from reefs for orientation.[127] These sounds are rather quiet in comparison and travel no further than 15 m. Nautilus' EIS makes no assessment of noise made by the Seafloor Mining Tools, like the Bulk Cutter. "Noise from the SMT cutter head has not been modelled (…) However, natural background noise from the erupting North Su volcano is likely to mask the sound of the SMT to a considerable extent and it is not considered further."[128] Throughout the operation, noise from the mining will constitute a significant strain to the marine environment, 24 hours a day.

120 David Batker and Rowan Schmidt: Environmental and Social Benchmarking Analysis of Nautilus Minerals Inc. Solwara 1 Project, Earth Economics, 2015, p. 98

121 Hance Smith: The Industrialisation of the World Ocean, in: Ocean & Coastal Management, No. 43, 2000, p. 11-28

122 Coffey Natural Systems: Environmental Impact Statement Solwara 1 Project, Brisbane 2008. Volume One: Main Report

123 https://www.coffey.com/en/about-us/our-history/; https://www.marketscreener.com/TETRA-TECH-INC-11172/company/

124 Coffey Natural Systems 2008, p. 7.47

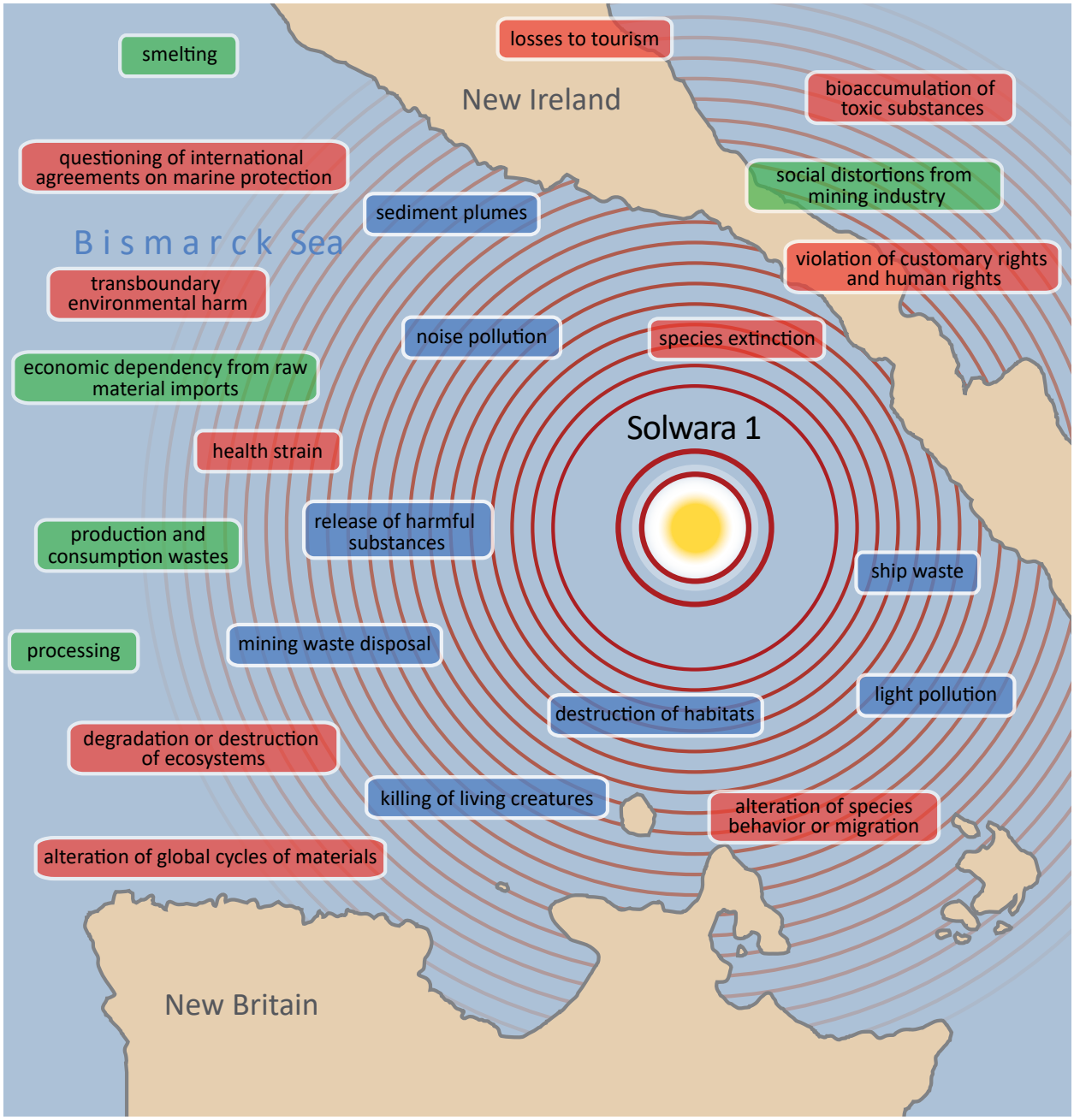
125 Coffey Natural Systems 2008 p. 9.28

126 Coffey Natural Systems 2008 p. 9.24

127 Doug Struck: Reef Fish Listen to Find Homes But Can't Hear Far, National Geographic, 2.9.2016, http://news.nationalgeographic.com/2016/09/reef-fish-use-sound-to-find-coral-homes

128 Coffey Natural Systems 2008 p. 9.20

Chapter 8



Immediate impacts from ore mining on hydrothermal vent fields
Expected consequences from ore mining on hydrothermal vent fields
Problem areas in raw material processing and economy

Chapter 8

Heavy metals and acids

Heavy metal contagion is one of metal ore mining's most serious environmental risks. The mined metals, if dissolved in water, are toxic. This is the case for e.g. copper, zinc, manganese, cobalt or nickel. If heavy metals are exposed, not only to water but also to atmospheric oxygen, they produce acid mine drainage (AMD). Metals are often mined as sulfide ores (e.g. pyrite), compounds of metals and sulfides that in water oxidize to hydrogen sulfide. Mine drainage water and mine tailings are therefore highly toxic.

Catastrophic incidents from tailings and mine drainage, released into rivers through leaching, dumping or dam failure, occur consistently in land mining. One of the worst environmental disasters caused by humans was the Ok Tedi environmental disaster in PNG. After the half-built tailing dam system collapsed in 1984 due to an earthquake, the operator, the Australian mining company BHP (Broken Hill Proprietary Company), continued the operation without the dam, with allowance by the PNG government. The mine tailings were disposed of directly into the Ok Tedi river. The river was contaminated along 620 miles between 1984 and 2013, as were large areas of adjacent forest and indigenous land. Other global examples of hazardous mine incidents were Marcopper (1996, Philippines, copper mine), Mount Polley (2014, Canada, copper mine), Buenavista del Cobre (2014, Mexico, copper mine), Gold King Mine (2015, USA, gold mine). The Mariana dam disaster or Bento Rodriguez/Samarco dam disaster (2015, Brazil, iron mine) resulted from an operation run by a joint venture to which BHP, operator of the Ok Tedi mine, was a party.

Everywhere on mainland Papua New Guinea and its islands, investors are looking for rich mineral resources

Water contaminated with heavy metals and acids kills fish and other water creatures and poisons rivers and soils for decades. Traces of heavy metal find their way into the food chain, accumulate in organisms and, finally, are found in human food.

Spilling or dumping of mine drainage or mine tailings into the sea is not permissible. This was settled by the London Convention in 1972, to which Papua New Guinea is a signatory, and by the London Protocol that followed in 1996.[129] The London Protocol explicitly obliges its signatories to take measures against waste dumping into the sea and accordingly implement mechanisms of control against it. "Priority shall be given to toxic, persistent and bio-accumulative substances from anthropogenic sources (e.g., cadmium, mercury, […] and, whenever relevant, arsenic, lead, copper, zinc, beryllium, chromium, nickel […]"

Dumping untreated tailings and drainage into open sea, is what Solwara 1 will do. The mined ore mixed with water (slurry) will be pumped through the riser pipe to the Mining Support Vessel where it is dewatered in the Dewatering Plant. The drainage, contaminated with heavy metals and acid, will be pumped down again through the riser pipe and dumped into the water. During the mining operation, Solwara 1 is set to pump 1,000 m^3/h of slurry from 1,600 m depth to the surface and, after extracting most of the profit-yielding minerals, pump it down again and release it into the deep sea.[130] This means that seabed mining at Solwara 1 would dump about 9 million cubic meters of toxic drainage per year into the Bismarck Sea during standard operation. For comparison: When the detention reservoir of the Samarco iron

129 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, in force since 1975, usually abbreviated "London Convention" or "LC '72"; Protocol to the London Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter, in force since 2006, usually abbreviated "London Protocol" or "LP".

130 In addition, 250 m^3/h of a similar mixture will be dumped directly onto the sea floor.

Chapter 8

mine in Bento Rodriguez broke, 62 million cubic meters of toxic drainage emptied into the Rio Doce. The toxic cocktail contaminated 650 km of the river's length, all the way down to the Atlantic.[131]

The standard operation of land mining spills considerable amounts of drainage into PNG's rivers and coastal waters even now. The consequences of this dumping have long since been scientifically monitored and considered critical. The OK Tedi, Porgera and Polukuma mines are dumping their drainages into the adjacent river systems to this day. The mines of Lihir and Simberi Island spill their tailings in 120 and 130 m depth directly into the sea. These mines were approved without conducting any risk analysis, or certain risks from "submarine tailings disposal" (STD) were not assessed. Recent scientific studies have demonstrated serious pollution loads and diversity loss in these regions.[132]

Nautilus' EIS considers dumping the tailings into the sea, which is illegal according to international standards, as harmless because it happens close to the seabed, at 25 to 50 m above ground. The organisms living or staying there would be used to heavy-metal-loaded or acidic waters. The particle cloud would rise no higher than 1,300 m depth, or some hundred meters higher if it moves over elevated ground. No spread or bioaccumulation in the food chain, especially regarding tuna (which preys on other fish, calamari and shrimp), would be expected.[133]

Recent empirical studies on bio-accumulation of heavy metals in deep sea fish, however, demonstrate serious health strain among deep sea predatory fish resulting from anthropogenic heavy metal discharges.[134] However the regular vertical migration of deep sea fish[135], resulting in a pass-on of accumulated heavy metals to predatory fish in higher waters is a proven concern. The systematic dumping of heavy-metal-loaded tailings at Solwara 1 therefore has to be considered a threat to the tuna industry in the Bismack Solomon Sea. The accumulation of mobilized toxic substances along the food chain up to human consumption constitutes a threat that would continue long after the end of the mining. In European waters, mobilized heavy metals have been one of the gravest problems of marine pollution for decades.

Habitat destruction

Habitat destruction by deep sea mining in unavoidable. If and to what extent the destruction of unique deep sea habitats is an acceptable consequence of deep sea mining, and whether the available scientific information to discuss and decide this issue is sufficient, has become a focus of growing importance in international debate.

Hydrothermal vent fields are areas where hot water spills through fissures in the seabed, usually near active underwater volcanoes or where tectonic plates collide. In some of these areas Black Smokers form from the precipitation of minerals that were dissolved in the hot saltwater pouring out into the surrounding cold water.[136] Vents were discovered in 1976, followed by the discovery of the Cold Seeps in 1984 (areas where seawater spills from the seabed without temperature difference to the environment). Today about 700 hydrothermal vent fields are

131 The Samarco incident is considered to be one of Brazil's biggest environmental disasters. 19 people were killed when the dam broke and when villages were flooded. Judicial disputes continue. So far, the operating company Samarco, a joint venture of Vale and BHP, has paid compensatory payments of 2.3 billion USD.

132 Hughes, Shimmield, Black, Howe: Ecological impacts of large-scale disposal of mining waste in the deep sea. Scientific Reports 5/2015; Elizabeth McKinnon: The environmental effects of mining waste disposal at Lihir Gold Mine, Papua New Guinea. Journal of Rural and Remote Health 1/2002, pp. 40-50

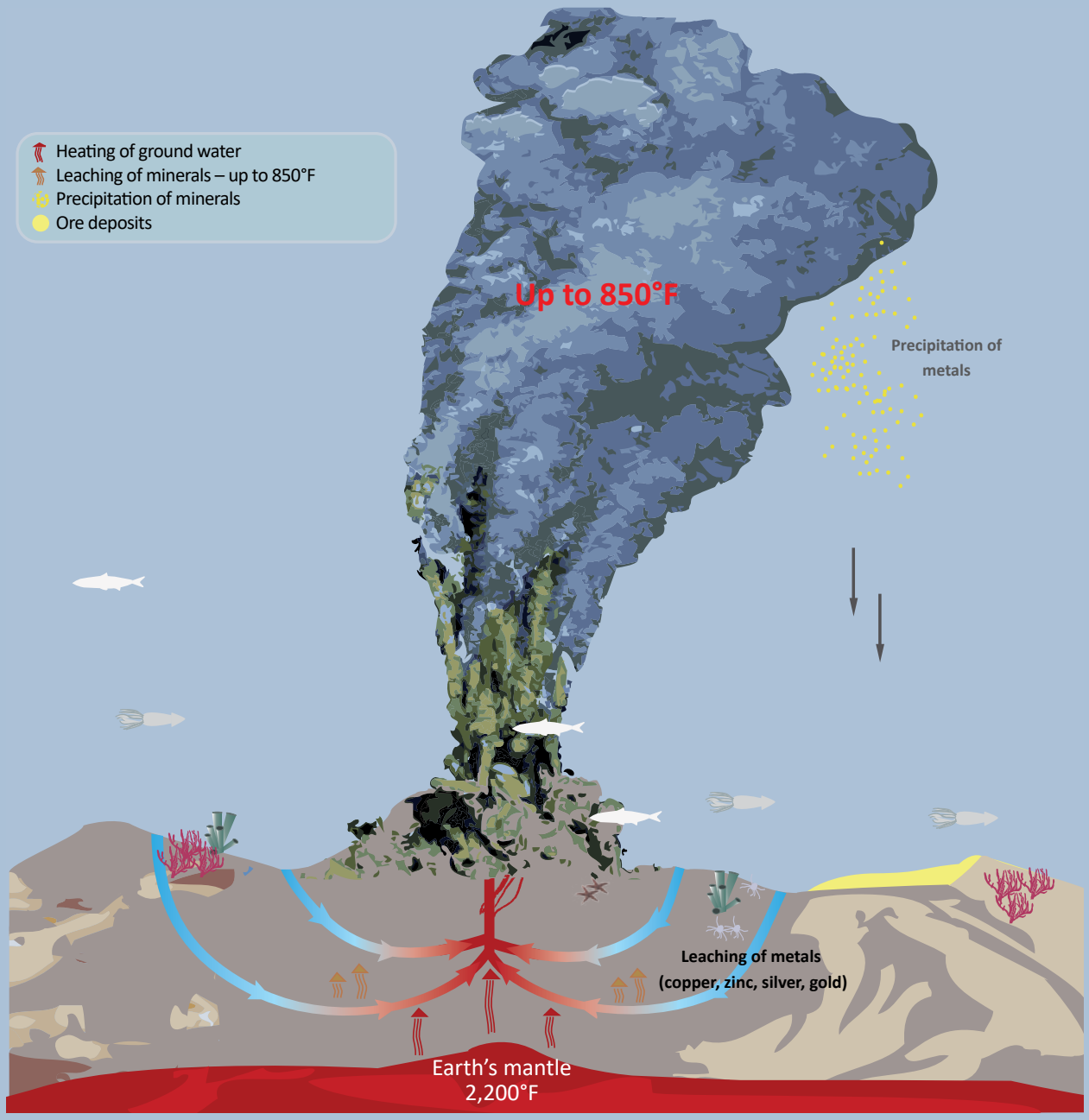
133 Coffey Natural Systems 2008 p. 9.16 f.

134 Stephen Feist et al.: Histopathological assessment of liver and gonad pathology in continental slope fish from the northeast Atlantic Ocean, Marine Environmental Research, No. 106, 2015, p. 42-50; Haruki Adachi et.al.: Bioaccumulation of Trace Elements in Marine Organisms from Deep-Waters of Off-Sanninn and Off-Hokuriku, Japan, in: Kawaguchi et al. (eds.): Interdisciplinary Studies on Environmental Chemistry – Environmental Pollution and Ecotoxicology, 2012, p. 169-176

135 Pedro Afonso et al.: Vertical Migrations of a Deep-Sea Fish and Its Prey, 2014, http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0097884

136 The precipitating minerals form the chimneys as well as the 'smoke', differing in color depending on the mineral composition and giving the chimneys their names as Black Smokers or White Smokers.

Chapter 8



Design of a Black Smoker

Water in the ground is heated by magma and minerals are dissolved in the hot water. The hot, mineral-rich water spills from the chimneys of the smokers in form of a steam plume, with temperatures up to 850°F.

Chapter 8

known.[137] It is estimated that there might exist between 1,000 and 5,000 vent fields in the world's oceans.[138] Current assumptions postulate that the total amount of ocean water is filtered once in 6-7 million years through hydrothermal vents.

At the hot wells of Black Smokers, unique ecosystems thrive. They build on microorganisms that derive their energy not from photosynthesis of sunlight but from chemosynthesis.[139] Feeding on these microorganisms, there are shrimp, snails, crabs, tube worms, anemones and deep sea fish. Hydrothermal vents are one of the most densely populated habitats in the deep sea, counting huge numbers of creatures in the smallest spaces and a high portion of species that exist only in this biotope. A 2005 survey counted 712 vent species of which 508 were endemic, existing nowhere else. A 2012 survey of 63 vent fields counted 591 species living there, belonging to 331 different genera.

All these species are adapted not only to the extreme conditions of deep sea life but to the no less extreme conditions of vents.[140] The vents from the Smokers lack uncombined oxygen, they are acidic and loaded with hydrogen sulfide, methane and metals like iron, zinc and copper that are usually toxic. The Black Smokers' biotopes are connected to the higher waters by vertical exchange. Organic material sinks to the ground, while deep sea organisms are part of the food chain of fish and sea mammals that move between different vertical layers.

Different vent fields show different biotopes and different species. Big tube worms prevail in the East Pacific region but are non-existent in vents in the Atlantic, the Indian or the South West Pacific. Vents on the Mid-Atlantic Ridge are swarming with deep sea shrimp whose bodies are populated by chemo-autotrophic bacteria providing them with nutrients. The Indian vents show deep sea shrimp, anemones and snails with symbiotic bacteria. Until now, science has made out 6 different types of vent fields. It is still unclear how big a portion of endemic species exists only in closely limited areas or even just on one single massive sulfide deposit, or how the vectors of population and gene pool take place between the Smokers or between the fields.

Diversity and number of organisms is higher on active Smokers than on inactive, but the latter continue to form active biotopes differing from the ones on active Smokers. Active and inactive Smokers are usually found in close proximity, on the same vent fields. There are some fields consisting only of inactive vents like the Atlantic "Lost City" field, and they are populated, too.

Seabed mining utterly destroys the ecosystems of the mined area. Inactive Smokers are collapsed and grinded, the upper sediment layer is removed completely in order to chop the underlying ore and suck it off. For reasons of feasibility, only inactive Smokers are to be mined. However, the sediment plume will spread onto active Smokers in the vicinity as well. Completely inactive fields are rare. Usually active and inactive Smokers are found in the same field. If these mixed fields are mined the habitats on inactive Smokers are destroyed directly while the habitats on active Smokers suffer from sediment clouds caused by the mining and by the disposal of mining waste.

When the mining has ended, the habitats stay destroyed. How low the possibilities of repopulation in deep sea are was highlighted by the German DISCOL project (Disturbance and Recolonization Experiment) that was conducted in 1989 in the Peruvian Basin. On the seafloor at 4,000 m depth, mining of manganese nodules was simulated. Until today, about 30 years later, these places are mostly dead. "Our observations show that removal or burial of nodules by the experimental ploughing or by the plume of resuspended material settling from the water column after ploughing has resulted in a near-total loss of such sessile fauna from directly ploughed areas of the seafloor, and a reduced abundance immediately next to plough tracks. (…) In places the initial plough tracks are still rather steep features of the seafloor (…) anthro-

137 Updated list on: http://vents-data.interridge.org/

138 Sven Petersen et al.: News from the seabed. Geological characteristics and resource potential of deep-sea mineral resources, Marine Policy No. 70, 2016, p. 175-187

139 The most common forms of chemosynthesis are based on oxidation of hydrogen sulfide in the hot environment. However, there have been discovered bacteria performing a sunlight-less form of photosynthesis, using the hot wells' infrared radiation.

140 Adaptation does not mean insensitivity. A current research project conducted by the German Federal Institute for Geosciences and Natural Resources (BGR) found that deep sea organism like shrimp show regular deformations resulting from this environment. These organisms would not be indifferent against an increase in heavy metals or acids due to the deep sea spilling of mining disposals.

Chapter 8

pogenic disturbance of the seafloor will also change the local hydrodynamic conditions."[141]

The repeatedly produced argument that the destruction of Black Smokers and their habitats would be a common natural process, e.g. by volcanic eruptions, is missing the point. Especially in fragile and dynamic local environments any additional strain from anthropogenic activities may be the tipping point to species extinction. Anthropogenic activity poses a threat to biodiversity not because otherwise there would be no species extinction but because it causes a species extinction that is exponentially accelerated and highly systematic, destroying a certain type of habitat simultaneously everywhere if its exploitation is economically attractive.

In June 2017, an international group of marine ecologists published a warning paper on deep sea mining. "Responsible mining increasingly strives to work with no net loss of biodiversity (…) We argue here that mining with no net loss of biodiversity using this mitigation hierarchy in the deep sea is an unattainable goal. (…) Most mining-induced loss of biodiversity in the deep sea is likely to last forever on human timescales, given the very slow natural rates of recovery in affected ecosystems. It is incumbent on the International Seabed Authority to communicate to the public the potentially serious implications of this loss of biodiversity and ask for a response."[142]

The destruction of hydrothermal vent fields by seabed mining contradicts international efforts for their conservation. PNG's 1993 Conservation Needs Assessment (CNA) report to the Convention on Biological Diversity (CBD) identified 30 marine areas with exceptionally high biological diversity. Due to their high ecological significance, the area around Solwara 1 has become part of the New Britain Trench Region, one of the Ecologically or Biologically Significant Marine Areas (EBSAs) addressed by the Convention. This marine area displays a high biological diversity and contains several sea mounts and hydrothermal vent fields. The marine areas around New Ireland, above all, have been identified as areas of exceptional ecological and biological significance. They are highly significant for the protection of marine species as tuna, sperm whale, sea turtle and seabirds, as well as for the diversity of deep sea creatures that are still only partially explored. The New Britain Trench Region is significant also for the mutual influence between the biological productivity of deep sea layers and higher layers. Subsequently, the area fulfills several of the scientific criteria that were laid down in 2008 to identify EBSAs and their ecological function.[143]

With its Resolution 59/25, the UN General Assembly in 2004 started a process to protect marine ecosystems from the negative impacts of deep sea fisheries. Like the CBD, the UNGA defines the habitats in the Bismarck-Solomon Sea that are now threatened by seabed mining as worthy of protection. In 2009, the FAO followed with its International Guidelines for the Management of Deep-sea Fisheries in the High Seas. The criteria for Vulnerable Marine Ecosystems that are worthy of protection, as defined by the Guidelines, resemble those for the definition of EBSAs.[144] Hydrothermal vents with their biotopes are listed as threatened marine habitats.

Both initiatives, CBO and UNGA 59/25, resulted from international debates on marine protection, and both are contrary to the perspective of seabed mining. In the Bismarck Sea, the endangerment of migratory species like whales, turtles or sharks is also contrary to the Convention on the Conservation of Migratory Species of Wild Animals (mostly abbreviated as Convention on Migratory Species, CMS).[145]

141 Autun Purser, Yann Marcon and Antje Boetius: Return to DISCOL. Megafauna distribution 26 years after simulated nodule mining, MIDAS newsletter No. 6, 2016

142 Van Dover et.al.: Biodiversity loss from deep-sea mining. Nature Geoscience, June 2017

143 1 Uniqueness or rarity, 2 Special importance for life history stages of species, 3 Importance for threatened, endangered or declining, species and/or habitats, 4 Vulnerability, fragility, sensitivity, or slow recovery, 5 Biological productivity, 6 Biological diversity, 7 Naturalness

144 1 Uniqueness or rarity, 2 Functional significance of the habitat, 3 Fragility, 4 Life-history traits of component species that make recovery difficult, 5 Structural complexity

145 PNG is not among the 127 signatories of the CMS, but Australia, New Zealand, Fiji and the Cook Islands are. However, the absence of many Pacific Island countries (Tonga, Kiribati, Solomon Islands, Vanuatu etc.) from the CMS is striking.

Chapter 9

The Coral Triangle, a Hotspot of Biodiversity

Vents sustain complete ecosystems. Each vent is different from the next. We don't know the connections between deep sea ecosystems and those higher in the water column. By the time we see the impacts it will be too late to rescue the ecosystems and fisheries.

Ralph Mana, University of PNG

The loss of biodiversity has many consequences that we understand, and many that we do not.

Joy Schochet, Rainforest Conservation Fund [146]

The Bismarck-Solomon Sea is part of the Coral Triangle, a triangular marine area in the Pacific. It encompasses the Philippines in the North, the Solomon Islands and the Northern Coastline of Papua New Guinea in the East; its Southern limits are Timor-Leste and Java and its Western limit is the East Coast of Borneo. Being 2.2 million mi^2 large, the Coral Triangle is among the world's most biologically diverse marine areas, sometimes called the "Amazon of the seas". It is the place where Indian Ocean and Pacific Ocean meet. During evolutionary history, this border zone between two Oceans has spawned an enormous variety of species due to the exchange of waters and creatures, and the environmental conditions are constantly shifting along with climate and sea level.

Coral reefs are the characteristic feature of the Triangle's underwater landscape. 29 percent of the world's coral reefs, 76 percent of coral species and 37 percent of reef fish species are clustered here, on just 1 percent of the Earth's surface.[147] The Coral Triangle is acknowledged as a high priority area for marine protection. About 1,900 zones covering 77,560 mi^2 are now marine protected areas.[148] 130 million people depend directly or indirectly on the Triangle's ecosystems for their existence.

85 percent of the Coral Triangle reefs are threatened, 45 percent are at high or very high stress levels.[149] The reefs are strained by climate change, land-based sources of stress like sediment and nutrient imports, and pollution from wastewater discharges.

PNG's reefs are among the most species-rich in the Triangle. Of all Coral Triangle Reefs, they have been the least threatened by local stress factors until now.[150] However, this doesn't protect them from overall thermal stress, nor PNG, from the consequences of climate change which can already be seen. The small islands in coastal waters are shrinking due to sea level rise. The sinking of six atolls in Manus Province, West of New Ireland Province, is attributed to this dynamic. Satellite data show a sea level rise of 7mm per year since 1993. Sea level rise in PNG is therefore considerably faster than the global average of 2.8-3.6 mm/y.[151] In addition, average temperature has risen 0.11°C per decade since 1950, confirming global trends, and ocean acidification has increased. Temperature rise and acidification endanger reefs and fish stocks because the latter respond to environmental changes in the medium term. Depending on various scenarios, a 0.3 to 1.2°C temperature rise is expected by 2030. Recent studies on climate change affirm that it is the interaction of all negative impacts that ultimately decides on the scale and the speed of coral reef decay.

Whether the reefs will survive the already inevitable consequences of climate change (higher water temperatures, lower oxygen content, higher concentration of CO^2, acidification) has immediate impact not only on food security and economic development of the whole region but on public safety, too. Coastal ecosystems like mangrove forests and coral reefs are natural protective barriers that can significantly mitigate the impact of extreme natural phenomena like storm tides. This correla-

146 Joy Schochet, Rainforest Conservation Fund

147 WWF Australia: The Coral Triangle and Climate Chance. Ecosystems, People and Societies at Risk, Sydney 2009

The Coral Triangle also contains the world's largest stretch of mangrove forests.

148 Alan T. White et.al.: Marine Protected Areas in the Coral Triangle. Progress, Issues, and Options, Coastal Management 42, February 2014, pp. 87-106

149 Burke, Reytar, Spalding, Perry: Reefs at Risk Revisited in the Coral Triangle, Washington D.C. 2012

150 Burke et.al. 2012 p. 34

151 SPREP (South Pacific Regional Environment Programme): Pacific Islands and Sea-Level Rise (factsheet); https://climate.nasa.gov/vital-signs/sea-level/

Chapter 9

A glimpse into one of the species-rich coral reefs in Papua New Guinea

tion has been underlined by the United Nations Office for Disaster Risk Reduction (UNISDR).[152]

625 million people globally, 83 percent of which are living in developing countries, live in "Low Elevation Coastal Zones" less than 10 m above sea level. Population density in low coastal areas is five times higher than the global average. 30 percent of people living in "Low Elevation Coastal Zones" settle in areas that are already threatened by extreme storm tide events. According to the "Sea Level Rise (SLR) Risk Index", PNG is among the 10 countries that face the highest risks from SLR. The most severe catastrophic events in the 21st century until now were the tsunamis off Sumatra in 2004 and off Sanriku coast (Japan) in 2011. Climate change has doubled the frequency of floods and storms since 1980 and tripled the number of people affected. Floods are the main global cause of deaths from natural disasters, accounting for 6.8 million deaths in the 20th century. Against this background, the preservation of natural coastal ecosystems is highly relevant especially for economically weaker countries like PNG.

The waters of the Coral Triangle are connected by several currents and by the routes of migratory fish, like the different species of tuna. Tuna represents one of the region's most important fisheries resources. During migration, tuna move in depths between 200 and 700 m, but may dive deeper as well.[153]

From an ecological perspective, the Coral Triangle is one of the most unfavorable and problematic zones imaginable for deep sea mining. Precisely this region, however, is the focus of interest at present.

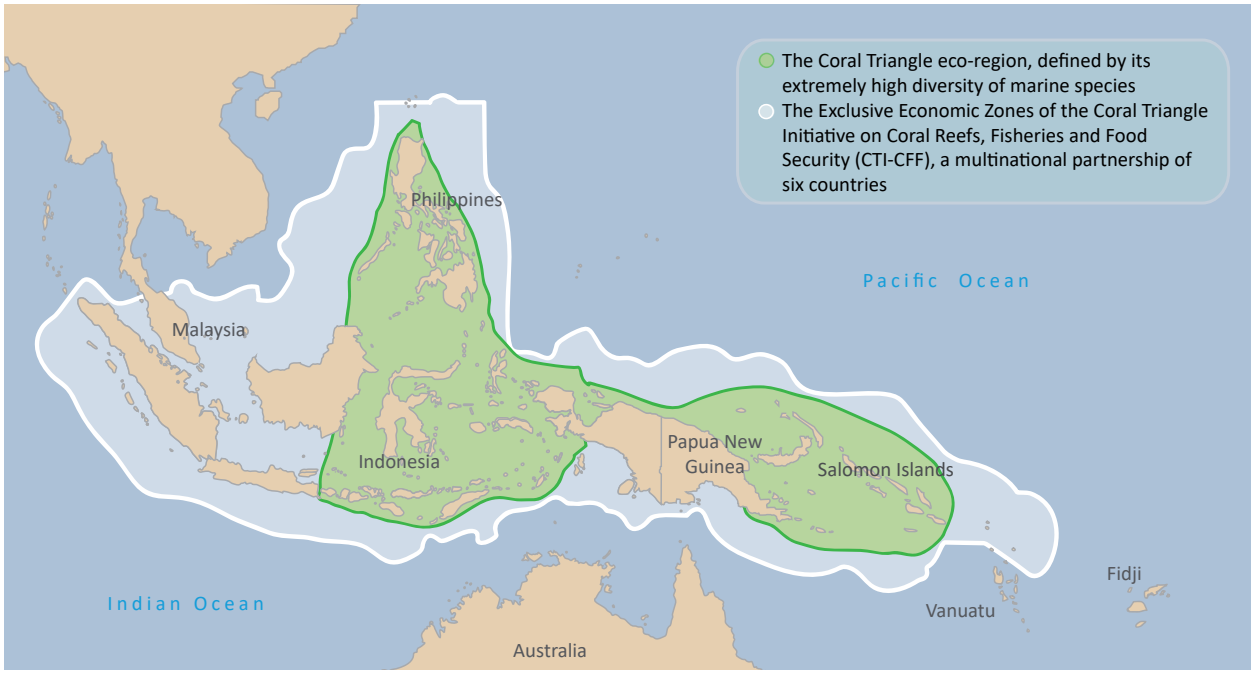
Sea Floor Industrialization

PNG's sea life is extraordinarily diverse and worth protection not only in the higher layers but also in the deep sea. How widespread, how unique and how manifold the species are that thrive under the special and very extreme conditions of vent habitats is barely known. The discovery of hydrothermal vents and cold seeps held far-reaching consequences not only for marine biology, our understanding of deep sea ecology and the predic-

152 Sunil Santha: Coastal Resources, Ecosystem Services and Disaster Risk Reduction. An Analysis of Social and Environmental Vulnerability along the Coast of India, Input Paper to the 2015 UNISDR report, January 2014

153 National Institute of Water and Atmospheric Research of New Zealand (NIWA): Tuna spawning grounds, https://www.niwa.co.nz/te-k%C5%ABwaha/tuna-information-resource/biology-and-ecology/spawning-grounds

Chapter 9



The Coral Triangle

The Coral Triangle, representing 1.5 percent of the world's oceans, is home to over 85 percent of all sea turtle species, 76 percent of all coral species and 37 percent off all reef fish species.

tions of marine diversity. It also inspired the theories about the genesis of life on Earth.

PNG's geology grants the country a wealth of mineral resources. It is situated in a geologically young and active region where the Indian-Australian and the Pacific Plate and several tectonic sub-plates converge. As a result, quakes and volcanic eruptions are frequent and mineral deposits have formed like those that Nautilus Minerals is planning to exploit by sea bed mining.

The Pacific enfolds the largest cluster of mineral ore deposits on the sea floor known today. This equally applies to massive sulfides (hydrothermal vents), ferromanganese crusts (seamounts) and manganese nodules. To the North-East, the Coral Triangle is adjoined by the Pacific Crust Zone (PCZ), the Clarion-Clipperton-Zone (CCZ) and the seamounts of Penrhym Basin. If extensive industrialization of the sea floor by mineral ore mining should become reality, the Coral Triangle's coasts and islands would be its starting point.

Stirring up the sediment and dumping heavy-metal-loaded ore-dust above the seafloor could have far-reaching consequences. Hydrothermal vents induce heavy metals into the ocean. 10 to 20 percent of the iron and copper that is dissolved in seawater comes from vents. The vents are connected to the circulation of these metals in the oceans. If ore that was solid and buried in the seafloor is dug out, chopped and partly applied again in dissolved form with wastewater and tailings, the natural mobilization of metals into seawater gets artificially accelerated and increased.

Extensive seabed mining would unleash a fast-forward effect comparable to the mobilization of CO^2 by burning fossil fuels. Sinks that were built over millions of years, in this case heavy metal sinks on the seafloor, would be liquidated in short time and partly released into the oceans. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ guidelines), e.g., set the threshold value for zinc in aquaculture water at 5 microgram per liter. 1 t of the ore in the Solwara 1 deposit, dissolved in water, would bring 1 million liters of seawater beyond that threshold value. Therefore, a vessel casualty (of the mining support vessel or the transport vessel) near the coastline or near the reefs is considered to be one of the most severe ecological disasters that could be caused by Solwara 1

Chapter 9

immediately.[154] The indirect consequences of insidiously increased heavy metal levels in seawater over years and decades, however, may represent an environmental damage on a much larger scale.

It is important to bear in mind that Solwara 1, finally, is about the establishment of a new technology and a thorough exploitation of a new kind of natural resource, not about a single, limited project. It constitutes a transgression, an invasive step into a part of the biosphere that so far has only been superficially and indirectly influenced by mankind. An environmental debate on Solwara 1 must not leave out the question what impact some hundred or thousand parallel seabed mining projects might have. Solwara 1 is only the beginning. It exposes Earth's largest eco-region, the deep sea with all its relationships to global cycles, to mining. Solwara 1 is a local threat of global environmental dimension.

Biodiversity

The extinction of species is often perceived primarily in its ethical and cultural-aesthetical dimensions. When extinct, a species is lost forever. The common heritage of mankind becomes poorer.

But there is more to it. Species loss and biodiversity loss present a fundamental threat to the survival of mankind. We usually do not recognize this dimension because we use only a small part of the existing biodiversity. From 10,000 eatable plant species, only c. 150 are cultivated by mankind. 30 of these species provide (directly or as livestock feed) 95 percent of all calories and proteins that are consumed by the world's human population. Only 4 of these species provide about 50 percent of world food: Rice, maize, wheat and potato. Animal proteins come mostly from 3 species: cattle, swine and chicken.[155] The range of fish species for human consumption is still relatively broad. In aquaculture, however, it is narrowed, too: About half of the amount of fish produced in aquaculture comes from 10 species.[156] We like diversity because we practice it so little.

But it is unlikely that precisely this set of species will feed the human population 100 years from now. No one knows which species will be the most apt under conditions of climate change and the necessary transformation to a less intensive agriculture. The global focus on just a handful of food plants and livestock species needs high inputs of energy and material that cannot be maintained in a more sustainable future. The global poor already rely to a significant part on local and regional food plant species for their diet.[157] Indigenous peoples use an even broader range of plant species. The loss of biodiversity endangers mankind's chances of adapting to changing environmental conditions.

Natural ecosystems need biodiversity to survive environmental changes. To cope with new conditions, some genetic abilities become important that haven't been relevant before. This is not only true for species diversity but also for the diversity of the species' gene pools. Biodiversity is nature's insurance system. In a diverse ecosystem, the dissemination of pathogens – like transferable diseases – is partly absorbed by host species that do not transfer it further, thereby slowing down the spread of the pathogen (an effect called "dilution"). Diminished diversity impairs this kind of natural, collective immune system and may increase the probability of human infections.[158]

Ecosystems are highly complex, and diversity is necessary for the way they work. Biodiversity is the resource and medium of an ecosystem's creativity, enabling it to fill ecological niches, create complex biological products, steer local and global cycles and create and sustain self-sustaining, sustainable biospheres. The exact functions of biodiversity for ecosystems, and the functions of ecosystem diversity for the planetary biosphere, are still only rudimentarily understood. But it is safe to say that biodiversity increases an ecosystem's ability to make productive use of most different environmental frameworks, as well as the resilience of ecosystems to stressors.

154 Richard Steiner: Independent Review of the Environmental Impact Statement for the proposed Nautilus Minerals Solwara 1 Seabed Mining Project. Conducted for the Bismarck-Solomon Seas Indigenous Peoples Council, Madang 2009;

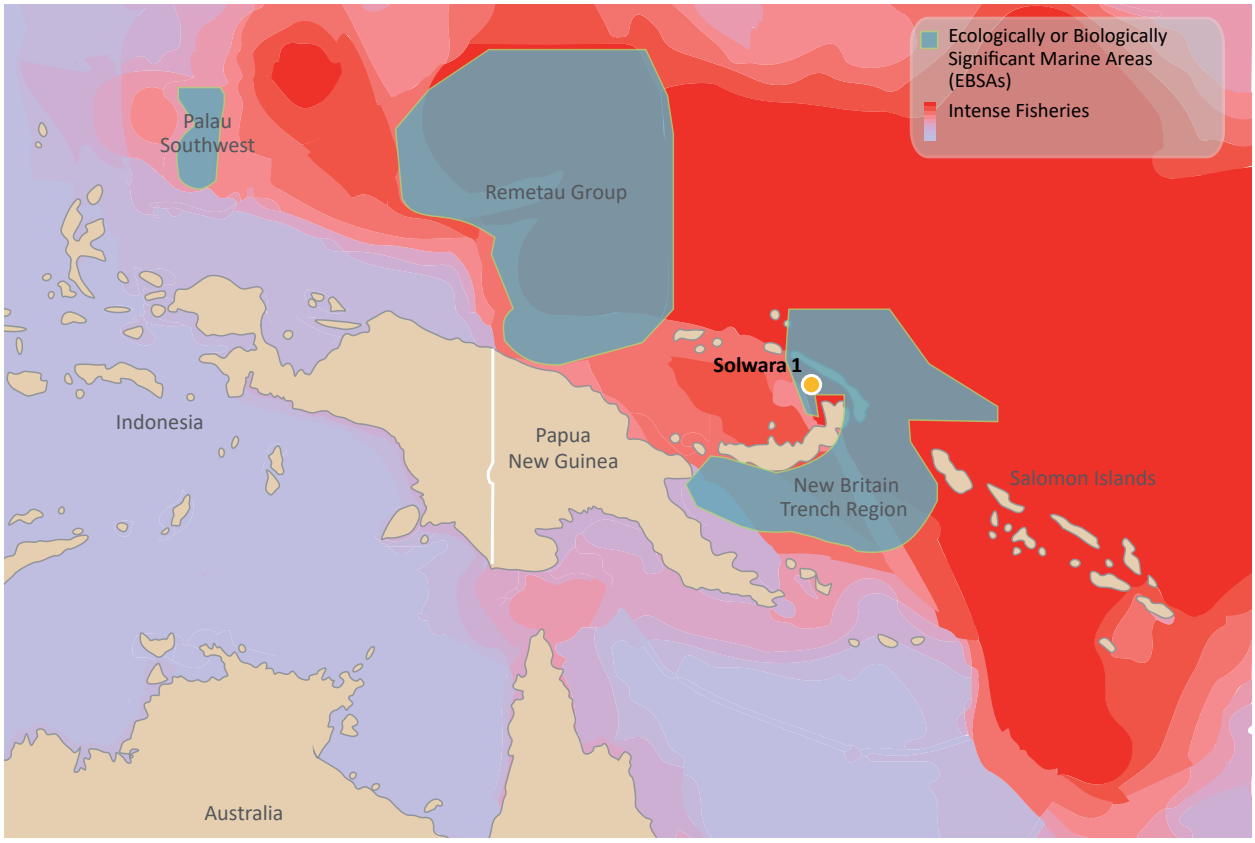
155 György Füleky: Cultivated Plants, Primarily as Food Sources, UNESCO/Encyclopedia of Life Support Systems (EOLSS), 2009, http://www.eolss.net/sample-chapters/c10/E5-02.pdf

156 FAO: Fishery and Aquaculture Statistics 2014, Rome 2016, p. 30

157 FAO: What is happening to agrodiversity? http://www.fao.org/docrep/007/y5609e/y5609e02.htm

158 Eric Chivian and Aaron Bernstein: How our health depends on biodiversity, CBO/UNEP, Boston 2015, p. 19

Chapter 9



Solwara 1 The location of Solwara 1 amidst a marine area of high value for ecology and fisheries

The New Britain Trench Region, the Remetau Group (South-west Caroline Islands and Northern New Guinea) and Palau Southwest are among the 26 Ecologically or Biologically Significant Marine Areas (EBSAs) in the Western South Pacific Region that have been described by the Convention on Biological Diversity. They belong to the global marine areas most valuable and worthy of protection.

The rate of species extinction is c. 100 times higher today than the natural background rate. If it continues along this path its effects will match those of the five known mass extinction events in Earth history.[159] Global species and biodiversity loss is considered to be one of those developments that tend to violate the so-called "planetary boundaries" or "guard rails" of sustainable development in a most drastic way.[160] "Certain Earth system conditions must be avoided at all costs (…) planetary guard rails [are] quantitatively definable damage thresholds, whose transgression either today or in future would have such intolerable consequences that even large-scale benefits in other areas could not compensate these (…) Once the guard rails have been transgressed, global environmental change becomes a socially intolerable risk for human civilization."[161]

The destruction of highly diverse habitats and the establishment of monocultures represent the most severe threat to global biodiversity. On behalf of sustainable development, those practices have to be stopped urgently. Deep sea biological hotspots, therefore, need resolute protection. This understanding led the EU in 2016 to adopt a complete ban on fishery below 800 m depth, at Vulnerable Marine Ecosystems (VME) below 400 m, to save seafloor habitats from the impacts of bottom

159 Vânia Proença and Henrique Miguel Pereira: Comparing Extinction Rates: Past, Present, and Future, Encyclopedia of Biodiversity, Vol. 2, 2013, http://www.isa.ulisboa.pt/inbio/theoeco/publications/Proenca_2013_EncyclopediaBiodiversity.pdf

160 Johan Rockström et al.: Planetary boundaries: exploring the safe operating space for humanity. Ecology and Society, vol. 14, no. 2, 2009, http://www.stockholmresilience.org/download/18.8615c78125078c8d3380002197/ES-2009-3180.pdf

161 German Advisory Council on Global Change (WBGU): World in Transition: A Social Contract for a Great Transformation, Berlin 2011, p. 32

Chapter 9

trawling.[162] The justification referred to other EU regulations, especially the sustainability goals of its reformed Common Fisheries Policy (CFP), and the need for coherence with those. There is no reason why seabed mining, a practice at least as destructive to those habitats as bottom trawling, should then be allowed.

Science and research

The knowledge of marine ecology is far from sufficient for the needs of precautionary, ecosystem-based environmental protection. The literature on deep sea ecology is a highly dynamic field, with lots of new insights gained in a short period of time. This indicates how unclear and unstable the scientific base for ecological impact assessments is at the moment. Long time accepted assumptions are revised or challenged by new knowledge, demonstrating that deep sea ecology is far more complex than it was supposed to be. Establishing seabed mining today would not just be hasty, it would be an irresponsible field trial. Crucial elements are still missing from truly scientific deep sea ecology as would be needed for the procedures that define precautionary environmental politics and a sound environmental impact assessment of sea bed mining. We have only very limited insight into the marine world. Just 0.0001 percent of the oceans are considered explored. 90 percent of all marine species are supposedly unknown. Exploring the specific adaptation strategies and ecological rules of the deep sea remains a challenge.

Responsible science must reveal these limits. Marine science has become an official part of political procedures. New industrial interventions into nature cannot be feasible or legal without accepted ecological impact analysis and analysis-based regulations. The necessarily fragmentary character of our understanding of marine ecological processes, especially regarding the deep sea and its interaction with the totality of ocean layers and regarding the cumulated effects of additive strains, makes such a procedure impossible for deep sea mining at present.

The introduction of modern eco-systematic analysis has triggered an epistemological debate on environmental impact assessments. The implications of this debate for deep sea mining are still not clear.[163] Insufficient data and poorly understood systematic interrelations render highly invasive, long-range interventions like seabed mining a trial-and-error-approach. From this perspective, seabed mining is a field trial, supposed to bring further insight into processes that ought to be known before starting. This is a repetition of well-known mistakes that were made by industrialization programs in the 20th century. The fact that the economic structures and actors of seabed mining are pretty much the same as those of land mining inspires little confidence in that regard.

A specific problem of deep sea exploration is that the scientific actors are extremely dependent on industrial actors and their commercial interests because the object of investigation is inaccessible by normal means. In the absence of large, publicly funded basic research projects, the connection with commercial ventures is usually the only way for scientists to explore the deep sea. As an urgent political consequence of this, public financing has to be increased in order to strengthen independent marine science, drawing neither its research questions, nor its research design, nor its rules of publicity from mining companies. This science has to be obliged primarily to the preservation of marine ecosystems and a better understanding of their function, not to the profit-making interests of third parties.

At the moment, there is little scope for independent deep sea science, and the number of scientists with access to first-hand data and material is very small. It is a highly exclusive insight. The standards of transparency, verification and social responsibility should therefore be very high for this field of science.

162 Regulation 2016/2336 of the European Parliament and of the Council of 14 December 2016

163 One implication is that mitigation strategies have to be ecosystem-specific, which is not possible if the ecosystem is only poorly understood. Cf. Van Dover et.al. 2017: "The relationship between any gain in biological diversity in an out-of-kind setting and loss of biological diversity in the deep sea is so ambiguous as to be scientifically meaningless."

Chapter 10

Deep Sea Mining and Global Need for Resources

Are We Going to Run Out of Copper? It is highly improbable.

World Copper Factbook 2014

The publication of the Earth Economics study[164] commissioned by Nautilus, in May 2015, marked a decisive shift in the argument for deep sea mining. The original assertion that the environmental and social impacts of deep sea mining are negligible and comprehensively easy to manage were discarded. The acknowledged negative impact on the local environment and population is instead compared to mining on land ("benchmarked") and presented as the less destructive alternative.[165] Solwara 1 is openly propagated as a gateway to the full exploitation of the oceans as a mining site. „Expanding metal mining to the deep seabed opens most of the earth's solid surface to mining for the first time."[166] This does not above all serve the interests of the mining industry and mining corporations, the study tells us, but the interests of global justice and the development of the Global South. „The need for an increased stock of copper in performing built capital such as residential houses, renewable power and electronics is growing, and must continue to grow if much of the world's population is to escape abject poverty."[167]

This new kind of argument does not only reflect the shift in Nautilus' business model described in chapter 7, from the perspective of an economically viable mining site at Solwara 1 to the perspective of patent profits due to a large-scale expansion of deep sea mining operations way beyond Nautilus' own capacity. The new argument is a reaction to the fact that the first generation of pro-seabed-mining arguments has already been exhausted and needs to be replaced with a new one.

Deep sea mining had been justified by impending global shortages of raw materials especially rare and difficult to mine, like Rare Earth elements, pointing out that digitization increases the demand for these. However, RareEarth materials play no role whatsoever in Solwara 1. What would be mined here, apart from gold, is copper – a metal that is abundant on global markets and has sufficient additional land deposits. The „World Copper Factbook," published by the multinational ICSG work group, has come to the unambiguous conclusion that, despite its unabated demand, no shortages on copper are to be expected.[168]

The detailed study conducted by the Federal Institute for Geosciences and Natural Resources (BGR), together with the Fraunhofer Institute for Systems and Innovation Research (ISI) and the Rhine-Westphalia Institute for Economic Research (RWI) concerning the „trends in supply and demand of mineral resources", also denies any impending shortages of mineral resources in the foreseeable future.[169] Absolute limits were not to be expected from the supply but from the sinks, the environmental capacity to absorb waste products of industrial production and resource extraction. BGR regards sea-extracted minerals not as necessary to satisfy global demand for raw materials, but merely as „an option for the diversification of raw material sources."[170]

Circular Economy

Copper is the ideal raw material for a circular economy. In a circular economy, raw materials are constantly recycled, making new material inputs to the system unnecessary. Copper is currently one of the most recycled metals. In 2012, thirty percent of the newly used copper worldwide came from recycled copper. „As secondary copper production does not lead to loss of quality of copper and involves a significantly lower energy consumption compared to primary copper production, the

164 Batker and Schmidt 2015

165 „Raw materials, biological control, climate stability, air quality, waste treatment, habitat and nursery, nutrient cycling, genetic resource values, and science and education values will be impacted by Solwara 1, but less so than for the terrestrial copper mines examined." Batker and Schmidt 2015, p. xi

166 Ibid, p. 102

167 Ibid, p. 134

168 ICSG: The World Copper Factbook 2014, p. 9. The ICSG (International Copper Study Group) represents the most prominent producer and consumer countries of copper. The 24 member states include, among others, Chile, China, Germany, the EU, Mexico, Peru, Russia and the United States.

169 Manuel Frondel et.al.: Trends in Supply of and Demand for Mineral Resources. Final report on research project no. 09/05 conducted by the Federal Ministry of Economics and Technology (BMWi). RWI Essen, Fraunhofer ISI and BGR, 2006

170 BGR: Marine Mineral Resources at the BGR. Marine Resources Newsletter 2016, p.8

Chapter 10

global end-verification and social responsibility should therefore be very high for this field of science.

of-life recycling rate (EOL-RR) for copper has already exceeded 50 percent according to UNEP."[171] Recycled copper is indistinguishable from newly extracted copper; it does not lose any of its properties. Copper compounds can easily be solved. „Unlike other commodities such as energy or food, copper is not 'consumed'."[172] The easy recyclability of copper makes copper scrap a valuable commodity and is the reason why processed copper is the non-ferrous metal most favoured by thieves.

The increase in global copper consumption as of 2003 is mainly due to China's catching-up industrialization. Two-thirds of global copper consumption are attributed to the Asia region, with 38 percent to China alone. However, the rise in demand in China is expected to flatline. „China's influence on the demand will increase no further since the country's economic growth has already been curbed and the material intensity of copper in China has presumably peaked already."[173]

Technological innovation implies not only a current need for copper but also new potentials for saving. The use of renewable energy currently utilizes significantly more copper than the use of non-renewable energies. Transition to electromobility is increasing the demand for copper as well. On the other hand, the implementation of wireless control and smart technologies eliminates the need for control via cable lines. Both trends have had little impact on the consumption of copper until now, however. In 2013, not even one percent of the entire copper production was invested in future technologies for electric traction motors for hybrid, electric and fuel-cell vehicles, or for radio-frequency identification (RFID) chips. The share for the use of copper on behalf of these future technologies is expected to rise to 25 percent by 2035, with regard to the copper extracted in the year 2013.

„Urban mining", the recycling of metal components from already existing goods and devices, is a viable perspective. Only rare earth elements, frequently built in electronic equipment, are a challenge. They are used in very tiny quantities per device, and their recycling often requires complex processes and considerable energy input.[174] Recycling techniques for rare earth metals have been underdeveloped because commodities prices are too low to make recycling economically feasible and because the quantities in circulation are too small. This is currently changing. The rise in the price of lithium carbonate from 5,000 to 14,000 US dollars per ton in 2016 had its roots in the expected accelerated entry of electromobility. This development immediately increased the research in rare earth metal recycling.

As is the case for many non-metal raw materials (e.g., plastics), the transition to a substantial circular economy requires a "design for environment" (DFE) approach, or "cradle to cradle" (C2C) approach. Goods have to be designed and built in a way that allows for easy recycling.[175]

Opening up new sources of raw materials in the deep sea, if successful, will not decrease land mining. On the contrary, it will direct investment capital away from innovations in recycling and circular economy, encouraging a wrong path of unsustainable use of natural resources.

Lack of Consistency

The guiding principle of sustainable development as part of the United Nations process is the green economy (Green Economy). „A green economy can be thought of as one which is low carbon, resource efficient and socially inclusive."[176] A low-carbon economy (an economy based on low carbon dioxide emissions recycling economy), circular economy and an integrated consideration of the environmental and social impacts of possible developmental paths constitute the three crucial pillars for global transition to a sustainable economy and lifestyle.

171 German Agency for Raw Materials (DERA): Information on Raw Material 16: Risk Assessment for Copper. Short report, Berlin 2013, p. 15

172 ICSG 2014 p. 9

173 DERA, leg.cit., p. 16

174 Doris Schüler et.al.: Study on Rare Earths and Their Recycling, Freiburg Institute for Applied Ecology, Darmstadt 2011, p. 109

175 Ellen MacArthur Foundation: Towards the Circular Economy. Accelerating the scale-up across global supply chains. Report to the World Economic Forum, January 2014

176 UNEP: Towards a Green Economy Pathways to Sustainable Development and Poverty Eradication, UNEP Report 2011

Chapter 10

Produktionsanlage der chinesischen Firma Ramu Nico für den Abau von Nickel und Kobalt in der Provinz Madang (Papua-Neuguinea)

The commencement of deep sea metal ore extraction is inconsistent with this strategic orientation inspired by the Green Economy. An expansion of the supply of raw materials with a consequent price reduction for metal resources is bound to thwart the transition to a circular economy. Investments in metal recycling, in the development of appropriate processes, and in the design and manufacture of reusable industrial and consumer goods, will no longer be considered rewarding. Private investment would be focused on the exploitation of new seabed resources, instead of being directed towards the conservation and recycling of metals. The transition to a green economy is a crucial decision for our economic development. Seabed mining is counterproductive to this choice. High prices on raw materials result in their saving and recycling. Low prices on raw materials, on the other hand, block this path of development.

As far as development policy is concerned, a potential drop in prices for metallic raw materials means bad news as well. Many countries of the Global South are producers of mineral raw materials. Dwindling prices of raw materials will have a direct negative impact on the income as well as the employment opportunities of these countries. Intensifying price competition would exert pressure on current mining projects, which in turn would squeeze working conditions, wages, safety standards and environmental measures. Chile, Zambia, Mexico and Peru will be particularly affected by falling copper prices. Declining gold prices would impact Peru, South Africa, Mexico, Ghana and Papua New Guinea.

The EU has at least developed strategic guidelines for the first two pillars of the Green Economy.[177] The stipulated orientation focuses on the saving of resources and recycling economy. It is inconsistent with the Union's positive assessment of sea-bed mining in the framework of its Blue Growth Strategy, as well as its commitment to promoting seabed mining in the Pacific region, in particular, the „Deep Sea Minerals Project" in collaboration with the South Pacific Community (SPC).[178] Even

177 Roadmap to a Resource Efficient Europe, COM (2011) 571 from September 20, 2011; Towards a Circular Economy A Zero Waste Programme for Europe, COM (2014) 398 from September 25, 2014

178 http://dsm.gsd.spc.int/. For a brief overview of the project see: http://dsm.gsd.spc.int/public/files/countries/Overview_of_the_SPC-EU_Deep_Sea_Minerals_Project_DSM_Workshop.pdf

Chapter 10

though it is reasonable and necessary to foster a specific legislative process for marine resources in the Pacific, the SPC-EU Deep Sea Minerals Project aims specifically at facilitating sea-bed mining by creating an institutional framework for it.[179] The proposed legal framework provides neither the consistent implementation of free, prior and informed consent (FPIC) by the indigenous landowners, nor the systematic exclusion of dumping waste from the shelf into the sea.

Which Resources?

Interestingly enough, even the proponents of sea-bed mining are displaying an increasingly critical attitude towards Solwara 1, as well as towards rapidly advancing deep sea mining pilot projects in general. One of many examples is the most recent study presented by the World Bank on the topic of seabed mining in the Pacific.[180] The World Bank explicitly calls for a more cautious and slower approach. The study states that all three types of mineral deposits on the ocean floor will provoke widespread and irreversible destruction of habitats and that environmental disasters have to be considered as possible worst-case scenarios. "A sound precautionary approach, which does not preclude the option of 'no development' is needed."[181] The apparent concern is that the obviously inadequate approach of projects such as Solwara 1 will discredit deep sea mining in general. „Solwara 1's successes and failures have and will continue to shape the wider global DSM industry."[182]

The World Bank has encountered coherence problems as well. In 2005, its famous report „The sunken billions" presented a calculation of financial losses caused by overfishing in the oceans. It underlined the point that aggressively exploited fish stocks breed significantly less fish (i.e., less product) than stocks that are sustainably managed. The World Bank has recently published a follow-up report.[183] It is the oceans' fish resources, however, that are endangered by the introduction and expansion of deep sea mining.

A resource-oriented perspective on deep sea mining, therefore, has to take into account two completely different resources caught in an irreconcilable conflict but of a different kind of value. The fish stocks in the oceans are essential for the survival of the world population, the food security of the Global South in particular, as well as the prospects of sustainable development for all countries. Minerals mined from the ocean floor, on the other hand, are not.

179 For a more detailed critique of the SPC-EU edf10 program and its „model legislation", see Blue Oceans Law and Pang, loc.cit.

180 World Bank: Precautionary Management of Deep Sea Mining Potential in Pacific Island Communities, Draft for Discussion, 2016 http://pubdocs.worldbank.org/en/125321460949939983/Pacific-Possible-Deep-Sea-Mining.pdf - See also message to: http://www.worldbank.org/en/news/press-release/2016/04/28/world-bank-report-urges-caution-in-deep-sea-mining-in-the-pacific

181 World Bank 2016 p. 11

182 World Bank 2016 p. 44. On p. 48 Solwara 1 is characterized as "a learning experience".

183 World Bank: The Sunken Billions. The Economic Justification of Fisheries Reform, Washington D.C. 2005; World Bank: The Sunken Billions Revisited Progress and Challenges in Global Fisheries, Washington D.C. 2017

Chapter 11

The Most Important Parking Lot in the World

Our message to Europeans is that: The interest to maintain your economic development, it has costs. It has costs to people living far away from you. Don't push that to the back of your mind. Think about it.[184]

Maureen Penjueli, Pacific Network on Globalization (PANG)

"The physical extent of the proposed Solwara 1 mine is 14 ha, the same area as a typical Walmart parking lot."[185] The consequences of Solwara 1, however, will reach much further. To the inhabitants of New Ireland, East New Britain and Madang provinces, to the prospective development of Papua New Guinea and the future of the oceans, Solwara 1 may be the most important parking lot in the world.

Solwara 1 is an experiment and a door-opener for seabed mining, the industrial seizure of one of the last unexploited natural resource deposits. It is supposed to be a place for seabed mining on trial, to get information about technical feasibility and ecological and social consequences in the field – to the detriment of the people in neighboring coastal areas and their sea rights, leaving to chance the consequences and risks that are foreseeable but no way near assessable, at least to their full extent.

Seabed mining is no careful sampling of the seafloor. It is mining in its full meaning, a massive environmental interference. The upper sediment layer of the seafloor is mechanically removed, the ore cracked and chopped. The "parking lot" is actually a high-performance construction site. It is situated, however, in a medium where physical, chemical and biological contamination is much more difficult to contain than on land. Dumping highly toxic tailings and wastewaters, contaminated with heavy metals and acids, back again into the open sea is an integral part of the technical and economic calculation. This is a violation of all effective international conventions that ban waste disposal at sea.

Solwara 1 does not comply with the effective and internationally acknowledged principles of free, prior and informed consent (FPIC) by the owners of indigenous land and sea rights. That the PNG government denies any indigenous sea rights off the coast, although the area of Solwara 1 is used for small-scale fisheries and cultural-spiritual traditions like Shark Calling, is purely arbitrary and illegitimate. There is no free, prior and informed consent by the owners of customary rights in New Ireland, East New Britain and Madang provinces to the Solwara 1 project. The consultations conducted by Nautilus at its own discretion are no substitute for this consent. On the contrary, indigenous communities and local campaigns call for a stop to Solwara 1.

A sound scientific assessment of ecological and social consequences does not exist. The lack of data and basic research makes it impossible to really assess the expectable environmental impacts with sufficient precision and to conceive of countermeasures. Experimental seabed mining at Solwara 1 will take place in an institutional context determined by a lack of regional structures of disaster management, a lack of public capacities for monitoring e.g. heavy metal concentration in sea food, a lack of governmental supervisory bodies that would guarantee a close and permanent control of the activities.

From an ecological and social point of view, it is hard to imagine a place that would be less suitable for seabed mining than the Bismarck Sea. It is a hotspot of biological diversity, an ecologically highly sensitive area closely connected to the Coral Triangle and its reef and mangrove landscapes, a region with high biodiversity and high sensitivity itself. Hardly a country could be more defined by marine subsistence economy, indigenous communities and low urbanization – and therefore be more dependent on the intact ecological state of its sea – as Papua New Guinea.

Solwara 1 aims for the start of seabed mining on a large scale. Therefore, the consequences of such dimensions have to be considered, too. They extend the risk of local disasters and affect the whole region and the state of its seas. Seabed mining will increase the heavy metal concentration in the food chain and in the world's oceans. Like the consumption of fossil fuels, it is environmental strain by quick motion. Heavy metal sinks that have been built over millions of years are opened in the shortest of time and released into the marine environment, at least partly. This will have far-reaching consequences, will endanger food security and fisheries industries in the whole region, and finally the ecosystems of the

184 Interview 4/22/2016

185 Batker and Schmidt 2015 p. 98

Chapter 11

world's oceans. Like with CO^2, it will be an insidious process, limiting future generations' options.

The costs of such consequences are externalized and imposed on society. The profits, on the other hand, are privatized. That PNG acts as co-owner and co-investor of the Solwara 1 project makes it harder to mount the state against this unfair calculation. In international law, the burden on future generations and on other countries is addressed by the precautionary principle and the principle of avoidance of transboundary harm. There is growing awareness that both principles are irreconcilable with experimental seabed mining. The precautionary principle "could involve the outright prohibition of mining around hydrothermal vents, because stirring up the seabed spreads toxic sulfides and disturbs the highly specialized ecosystems that flourish in the hot, mineral-laden water."[186]

Biological diversity is the living world's natural immune system, insurance system and method of creativity. The current speed of species extinction and biodiversity loss is one of the most critical and unsustainable exceedances of vital threshold values. The destruction of deep sea habitats at hydrothermal vents will lead to the extinction of various species that are not even known at present and whose contribution to the survival of other species and connected ecosystems is not known either. In a very short time, species will be extinct without any possibility to understand their importance for global ecology. To the present day it is impossible to tell which functions for the marine biosphere the deep sea ecosystems fulfill and which future use to mankind they may contain. It is safe to say, however, that the elimination of deep sea habitats and species will affect the oceans' resilience against climate change, reduce genetic resources and be of critical influence to food chains that lead all the way up to human food security.

Contrary to a common argumentation by its advocates, there is no need for seabed mining to satisfy future metal demands. No shortage of copper is to be expected, the metal that Solwara 1 will mine in the first place. Opening a new dimension of ore deposits to mining would, if successful, thwart the incentives for reduced resource consumption and increased metal recycling. In addition, sinking metal prices would deteriorate the national income of several countries in the global South, PNG among them. Investment would be directed to the extension of the resource basis and detracted from the responsible use of resources and the transformation to a circular economy. Seabed mining is a wrong path decision.

This holds true for Papua New Guinea, too. PNG's economic strategic plans stress, rightly, the need to switch from extractive industries to sustainable and potentially sustainable sectors: Small-scale fisheries, export-oriented fisheries, tourism. All these sectors are directly threatened by seabed mining in the Bismarck-Solomon Sea.

Instead of exposing their marine mineral deposits to exploitation, Papua New Guinea and the Pacific Island States should declare them and the ecosystems living on them protected. For the open sea outside national jurisdiction, the International Seabed Authority should do the same. Dumping tailings and wastewaters from mining into the open sea has to be prohibited and prevented with all certainty. Environmental compatibility, open and unbiased procedures, participation and transparency must be taken seriously in its entirety. There is an urgent need to establish and expand broad, independent marine and deep sea sciences.

Seabed mining is irreconcilable with the strategic orientation towards sustainable development, Green Economy, circular economy and social inclusion. The mining industry is by global standards one of the largest sources of waste, is responsible for severe environmental damage, social injustice and exploitation. These grievances have to be remedied on land instead of delivering further resources and industrial opportunities at sea to the mining industry and its actors. That the UN, in its Sustainable Development Goal (SDG) no. 14, states a perspective for maritime politics that does not contain any ore mining in the seas, has to be adhered to and affirmed.

It is of decisive importance to open up a political process to discuss by what goals the advancement of marine governance should be guided. Marine governance and the UNCLOS system are in need of embedding social and human rights standards as they have already been embedded in many other international processes. The coastal populations must be protected from the negative impacts of Ocean Grabbing, and civil society in its-

186 Michael Byers: International Law and the Arctic, Cambridge 2013, p. 192 f.

Chapter 11

entirety must be given legally entitled means of negotiating their concerns.

The Madang workshop in April 2016, bringing together representatives of local communities, NGOs, churches and academics, came after several days of discussion to the definite conclusion: Stop Solwara 1 – stop seabed mining completely. That is the position put forward by grassroots organizations in the Pacific, growing ever louder in Pacific civil society.

Arguments alone will not be enough to stop Solwara 1. It is the campaigns of the inhabitants of New Ireland, East New Britain and Madang provinces, of civil society organizations in Papua New Guinea and in the Pacific that will decide whether Solwara 1 and an accelerated beginning of seabed mining will be stopped. To help them to succeed, international support is needed, especially from those countries who deliver the capital and the technologies for Solwara 1 and who are responsible for the excessive resource consumption without which Solwara 1 would not happen. International civil society and the people in highly industrialized countries are called upon to support the local campaigns, thereby adjusting the balance of power against a very powerful industry and its multinational corporations. It is not only a question of solidarity. It means acting for one's own interest.

Bibliography and source list

A

Adachi, H. et al(2012):
Bioaccumulation of Trace Elements in Marine Organisms from Deep-Waters of Off-Sanninn and Off-Hokuriku, Japan, in: Kawaguchi et al (eds): Interdisciplinary Studies on Environmental Chemistry - Environmental Pollution and Ecotoxicology, 169-176.

Afonso, P. et al (2014):
Vertical Migrations of a Deep-Sea Fish and Its Prey, http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0097884.

Alcorn, Janis B. (1993):
Papua New Guinea Conservation Needs Assessment, Washington D.C.

Asian Development Bank (2015a):
Asian Development Outlook: Papua New Guinea.

Asian Development Bank (2015b):
Country Partnership Strategy - Papua New Guinea 2016–2020.

Asian Development Bank (2014):
State of the Coral Triangle: Papua New Guinea, 9-20.

Asian Development Bank (2012):
Country Diagnostics Study: Papua New Guinea - Critical-Development Constraints, Mandaluyong. https://www.adb.org/sites/default/files/publication/29776/png-critical-development-constraints.pdf.

Asian Development Bank (n.Y.):
Country Partnership Strategy Papua New Guinea 2016-2020. Executive Summary. https://www.adb.org/sites/default/files/linked-documents/cps-png-2016-2020-ea.pdf.

Australian Institute of Marine Science (2000):
Status of coral reefs of the world., Edited by Clive Wilkinson.

Avery, C. (2011):
Seafloor Massive Sulphides: Assessment of Sustainable Mining Potential through an Iterative Decision-making Framework.

B

Baker, E. et al (2013):
Deep Sea Minerals: Sea-Floor Massive Sulphides, a physical, biological, environmental, and technical review; Secretariat of the Pacific Community.

Banks, G.A. (2001):
Papua New Guinea Baseline Study.

Barbesgaard, M. (2016):
Privatization and Corporate Capture of Global Fisheries Policy; in: Right to Food and Nutrition Watch, 34-37.

Barbesgaard, M. (2016):
Blue growth saviour or ocean grabbing, The Hague.

Basu, S. et al (2013):
The Macroeconomic Effects of Natural Resource Extraction: Applications to Papua New Guinea, International Monetary Fund.

Batker, D. et al (2015):
Environmental and Social Benchmarking Analysis of the Nautilus Minerals Inc. Solwara 1 Project, Earth Economics.

Baunsgaard, T. et al (2012):
Fiscal Frameworks for Resource Rich Developing Countries, International Monetary Fund.

Beckage, B. et al. (2011):
The limits to prediction in ecological systems, in: Ecosphere, 2/11.

Bechhaus-Gerst, M. et al. (eds.) (2009):
Frauen in den deutschen Kolonien, Berlin.

Benton, D. (2017):
Mining on the Moon and Back.

Bianchi, D. et al. (2013):
Diel vertical migration: Ecological controls and impacts on the biological pump in a one-dimensional ocean model, in: Global Biogeochemical Cycles, 27/2013.

Birney, K. et al. (2006):
Potential Deep-Sea Mining of Seafloor Massive Sulfides: A Case Study in Papua New Guinea.
http://www.bren.ucsb.edu/research/documents/ventsthesis.pdf; last visit on Thu Mar 23 2017 13:39:46 GMT+0100.

Blue Ocean Law et al (2016):
Resource Roulette. How deep Sea Mining and Inadequate Regulatory Frameworks Imperil the Pacific and its People, Hagåtña und Suva.

Blue Ocean Law et al (2015):
An Assessment of the Secretariat of the Pacific Community Regional Legislative and Regulatory Framework for Deep Sea Minerals Exploration and Exploitation.

Boschen, R.E. et al (2016):
Seafloor massive sulfide deposits support unique megafaunal assemblages: Implications for seabed mining and conservation, in: Marine Environmental Research, 115/2016.

Bräuninger, M. et al (2013):
Ursachen von Preispeaks, -einbrüchen und -trends bei mineralischen Rohstoffen. Studie des HWWI im Auftrag der Bundesanstalt für Geowissenschaften und Rohstoffe, DERA Rohstoffinformation 17, Berlin.

Brewer, D.T. et al (2012):
Impacts of gold mine waste disposal on a tropical pelagic ecosystem, in: Marine Pollution Bulletin 64 (2012), 2790-2806

Bromley, D.W. (2008):
The Crisis in Ocean Governance: Conceptual Confusion, Economic Nonsense, Political Incoherence, in: Maritime Studies, 2008/6.

Brouwer, E. et al (1998):
Gender Analysis in Papua New Guinea, World Bank, Washington D.C.

Brüll, M. (1995):
Die deutschen Kolonien in der Südsee, in: Eva Gerhards und Edgar Dürrenberger (eds.): Als Freiburg die Welt entdeckte. 100 Jahre Museum für Völkerkunde, Freiburg 1995. http://www.freiburg-postkolonial. de/Seiten/Adelhauser-Bruell1.pdf

Budnik, V. et al (2016):
Future Development of the World Ocean Mining for the Industry, in: Procedia Engineering, 150/2016.

Bundesanstalt für Geowissenschaften und Rohstoffe (2017):
BGR Metallpreisindex.

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) (2016a):
Marine Mineralische Rohstoffe an der BGR. Newsletter.

Bundesanstalt für Geowissenschaften und Rohstoffe (2016b):
Deutschland - Rohstoffsituation 2015.

Bundesministerium für Wirtschaft und Energie (2017):
Fünfter Bericht der Bundesregierung über die Entwicklung und Zukunftsperspektiven der maritimen Wirtschaft in Deutschland.

Bundesministerium für Bildung und Forschung (2012):
Wirtschaftsstrategische Rohstoffe für den Hightech-Standort Deutschland. Forschungs- und Entwicklungsprogramm des BMBF für neue Rohstofftechnologien.

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2006):
Integriertes Küstenzonenmanagement in Deutschland - Nationale Strategie für ein integriertes Küstenzonenmanagement.

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2008):
Die Dritte Industrielle Revolution – Aufbruch in ein ökologisches Jahrhundert - Dimensionen und Herausforderungen des industriellen und gesellschaftlichen Wandels.

Bundesministerium für Wirtschaft und Technologie (2010):
Rohstoffstrategie der Bundesregierung - Sicherung einer nachhaltigen Rohstoffversorgung Deutschlands mit nicht-energetischen mineralischen Rohstoffen.

Bundesministerium für Wirtschaft und Technologie (2011):
Maritime Technologien der nächsten Generation – Das Forschungsprogramm für Schiffbau, Schifffahrt und Meerestechnik 2011-2015

Bundesministerium für Wirtschaft und Technologie (2011):
Nationaler Masterplan Maritime Technologien (NMMT) - Deutschland, Hochtechnologie-Standort für maritime Technologien zur nachhaltigen Nutzung der Meere.

Bundesverband der Deutschen Industrie e.V. (2014):
Positionspapier - Die Chancen des Tiefseebergbaus für Deutschlands Rolle im Wettbewerb um Rohstoffe.

Bundeszentrale für politische Bildung (2012):
Dossier innerstaatliche Konflikte, Bonn

Byers, M.: (2013):
International Law and the Arctic, Cambridge

C

Caldwell, M. u.a. (2009):
Pacific Ocean Synthesis: Scientific Literature Review of Coastal and Ocean Threats, Impacts, and Solutions, Center for Ocean Solutions.

Campbell, L. M. et al (2016):
Global Oceans Governance: New and Emerging Issues, in: Annual Review of Environment and Resources, 2016/41.

Cardno (2016):
An Assessment of the Costs and Benefits of Mining Deepsea Minerals in the Pacific Island Region - Deep-sea Mining Cost-Benefit Analysis, Pacific Community.

Cashmore, M. (2004):
The role of science in environmental impact assessment: process and procedure versus purpose in the development of theory, in: Environmental Impact Assessment Review, 24/2004.

Cathles, L.M. (2013):
Distribution of SMS deposits - Presentation to the International Workshop for Students "Seafloor Mineral Resources: scientific, environmental, and societal issues", Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR).

Chatzinikolaou, E. (2012):
Use and limitations of ecological models, in: Transitional Waters Bulletin, 6/2012.

Chin, A. et al (2011):
Status of Coral Reefs of the Pacific and Outlook: 2011; Global Coral Reef Monitoring Network, 56-67.

Chivian, E. et al (2015):
How our health depends on biodiversity, CBO/UNEP, Boston.

Coffey Natural Systems (2008):
Environmental Impact Statement Solwara 1 Project, Brisbane.

Constitution of the independent state of Papua New Guinea,
http://www.unesco.org/education/edurights/media/docs/600e78096209b63b86f0135f52694b257b4b0c0e.pdf,
Schedule 1.2: Meaning of certain expressions.

D

Danovaro, R. et al (2014):
Challenging the paradigms of deep-sea ecology, in: Trends in Ecology & Evolution, 29/8.

Deloitte Touche Tohmatsu (2015):
Papua New Guinea (PNG) - Extractive Industries Transparency Initiative (EITI) – Scoping Study for First EITI Report.

Department of Mineral Policy and Geohazards Management (DPMGM) of PNG (2013):
State's Equity Participation. SPC-EU EDF10 Deep Sea Minerals (DSM) Project, Pacific ACP States Regional Workshop on DSM Law and Contract Negotiations, 11th – 15th March 2013 Nuku'alofa, Tonga,
http://dsm.gsd.spc.int/public/files/meetings/STATE_S_EQUITY_PARTICIPATION.pdf.

Department of National Planning and Monitoring (2014):
National Strategy for Responsible Sustainable Development for Papua New Guinea, Port Moresby.

Deutsche Rohstoffagentur (2013):
Rohstoffinformationen 16: Risikobewertung Kupfer, Kurzbericht, Berlin.

Division for Ocean Affairs and the Law of the Sea (1998):
The United Nations Convention on the Law of the Sea – A historical perspective.

Dold, B. (2014):
Submarine Tailings Disposal (STD) - A Review, in: Minerals, 2014/4.

Drew, J.A. et al (2015):
Quantifying the Human Impacts on Papua New Guinea Reef Fish Communities across Space and Time, in: PLoS One, 2015/10.

E

ECORYS (2014):
Study to investigate state of knowledge of Deep Sea Mining; European Commission - DG Maritime Affairs and Fisheries.

ECOSOC (2010):
Indigenous People. Development with culture and identity. Articles 3 and 32 of the United Nations Declaration on the Rights of Indigenous Peoples, Report of the international expert group meeting.

ECOSOC (2006):
Report of the Special Rapporteur on the situation of human rights and fundamental freedoms of indigenous people, Rodolfo Stavenhagen, 13.3.2006.

Ellen MacArthur Foundation report to the World Economic Forum (2014):
Towards the Circular Economy. Accelerating the scale-up across global supply chains, January 2014.

Ellis, E.C. et al. (2013):
Used planet: A global history, in: Proceedings of the National Academy of Sciences, 110/20.

Environmental Protection Authority (2015):
Decision on Marine Consent Application by Chatham Rock Phosphate Limited to Mine Phosphorite Nodules on the Chatham Rise, February 2015,
http://www.epa.govt.nz/eez/EEZ000006/EEZ000006_CRP%20Final%20Version%20of%20Decision.pdf.

Environmental Protection Authority (2014):
Trans-Tasman Resources Ltd Marine Consent Decision, Juni 2014,
http://www.epa.govt.nz/EEZ/EEZ000004/Trans_Tasman_Resources_decision_17June2014.pdf.

European Union (2012a):
Blue Growth - Opportunities for marine and maritime sustainable growth.

European Union (2012b):
Blue Growth Opportunities for marine and maritime sustainable growth Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

European Union (2007):
Eine integrierte Meerespolitik für die Europäische Union.

F

Fallon, E.K. et al(2017):
Oxidative dissolution of hydrothermal mixed-sulphide ore: An assessment of current knowledge in relation to seafloor massive sulphide mining, in: Ore Geology Reviews, 86/2017.

Feist, S. et al (2015):
Histopathological assessment of liver and gonad pathology in continental slope fish from the northeast Atlantic Ocean, Marine Environmental Research, 106, 42-50.

Filer, C. (2017):
How could Nautilus Minerals get a social licence to operate the world‘s first deep sea mine?, in: Marine Policy, January

Fleming, L.E. et al (2006):
Oceans and human health: Emerging public health risks in the marine environment; in: Marine Pollution Bulletin, 2006/53.

Food and Agriculture Organization of the United Nations (2016a):
Indigenous peoples central to efforts to combat climate change, 21.7.2016, http://www.fao.org/news/story/en/item/426406/icode/, Rom

Food and Agriculture Organization of the United Nations (2016b):
Fishery and Aquaculture Statistics 2014, Rom.

Food and Agriculture Organization of the United Nations (2015a):
Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication, Rom.

Food and Agriculture Organization of the United Nations (2015b):
Achieving Blue Growth through implementation of the Code of Conduct for Responsible Fisheries, Rom.

Food and Agriculture Organization of the United Nations (2014a):
Global Blue growth initiative and Small Island Developing States, Rom.

Food and Agriculture Organization of the United Nations (2014b):
The State of World Fisheries and Aquaculture – Opportunities and challenges, Rom, 76-77; 175-180

Food and Agriculture Organization of the United Nations (2012):
Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security, Rom.

Food and Agriculture Organization of the United Nations (2010a):
Policy on Indigenous and Tribal Peoples, Rom.

Food and Agriculture Organization of the United Nations (2010b):
National Fishery Overview – Papua New Guinea (PNG), Rom.

Food and Agriculture Organization of the United Nations (n.y.):
What is happening to agrodiversity?
http://www.fao.org/docrep/007/y5609e/y5609e02.htm.

Frondes, M. et al (2006):
Trends der Angebots- und Nachfragesituation bei mineralischen Rohstoffen. Endbericht Forschungsprojekt Nr. 09/05 des Bundesministeriums für Wirtschaft und Technologie (BMWi). RWI Essen, Fraunhofer-ISI und BGR.

Füleky, G. (2009):
Cultivated Plants, Primarily as Food Sources, UNESCO/ Encyclopedia of Life Support Systems (EOLSS).
http://www.eolss.net/sample-chapters/c10/E5-02.pdf.

G

Galkin, S.V. et al (2017):
Endemism and Biodiversity of Hydrothermal Vent Fauna.

Gandenberger, C. (2014):
Explorative Analyse der Zielbeziehungen zwischen Ressourceneffizienz und Versorgungssicherheit; Fraunhofer ISI.

Gena, K. (2013):
Deep Sea Mining of Submarine Hydrothermal Deposits and Its Possible Environmental Impact in Manus Basin, Papua New Guinea, in: Procedia Earth and Planetary Science, 6/2013.

GESAMP (2016):
Proceedings of the GESAMP International Workshop on the Impacts of Mine Tailings in the Marine Environment.

Gilberthorpe et al (2012):
Development on whose terms? CSR discourse and social realities in Papua New Guinea's extractive industries sector.

Gillett, R. (2016):
Fisheries in the Economies of Pacific Island Countries and Territories, Papua Neuguinea, Pacific Community, Nouema, Kapitel 14, 184-214.

Gjøsæter. H. et al (2017):
Evidence of Diel Vertical Migration of Mesopelagic Sound-Scattering Organisms in the Arctic. Front. Mar. Sci. 4:332. doi: 10.3389/fmars.2017.00332

Glasby, G.P. (2000):
Economic Geology: Lessons Learned from Deep-Sea Mining, in: Science 289, 551-553.

Government of Papua New Guinea (2014):
Papua New Guinea – Policy on Protected Areas.

Government of Papua New Guinea (2010):
Papua New Guinea's Fourth National Report to the United Nations Convention on Biological Diversity (CBD).

Government of Papua New Guinea (2009):
Report on the Status of Women in Papua New Guinea and the Autonomous Region of Bougainville, Waigani 2008, as cited in: Papua New Guinea Country Gender Assessment 2011-2012.

Griffin, A. (2015):
Asteroid mining made legal after Barack Obama gives US citizens the right to own parts of celestial bodies, on: www.independent.co.uk.

Günther, H. (1928):
Die Eroberung der Tiefe, Stuttgart.

H

Halfar, et al (2002):
Precautionary Management of Deep Sea Mining; in Marine Policy, 26/2.

Hauton, C. et al (2017):
Identifying Toxic Impacts of Metals Potentially Released during Deep-Sea Mining—A Synthesis of the Challenges to Quantifying Risk.Front. Mar. Sci. 4:368. doi: 10.3389/fmars.2017.00368.

Howe, A. (2008):
Deep-Sea Hydrothermal Vent Fauna: Evolution, Dispersal, Succession and Biogeography, in: Macalester Reviews in Biogeography, 1/6.

Hamlyn, G. (2013):
A New Voyage: Pacific People Explore the Future They Want - The second consultation of Bread for the World partners in the Pacific, November 2011, Berlin, Brot für die Welt Dialoge 11, Berlin.

Hauʻofa, E. (1993):
Our Sea of Islands, from A New Oceania: Rediscovering our Sea of Islands.

Hein, J. et al (2014):
Deep-Ocean Ferromanganese Crusts and Nodules, in: Steven Scott (ed.): Geochemistry of Mineral Deposits, Treatise on Geochemistry, 13/2014.

Herring, P. (2011):
The Biology of the Deep Ocean.

Hoagland, P. et al. (2010):
Deep-sea mining of seafloor massive sulfides, in: Marine Policy 34/2010.

Höhler, S. (2014):
Exterritoriale Ressourcen: Die Diskussion um die Tiefsee, die Pole und das Weltall um 1970, in: Global Commons im 20. Jahrhundert: Entwürfe für eine globale Welt, Oldenbourg.

Howe, A. (2008):
Deep-Sea Hydrothermal Vent Fauna: Evolution, Dispersal, Succession and Biogeography, in: Macalester Reviews in Biogeograhy, 1/6.

Hughes, D. et al (2015):
Ecological impacts of large-scale disposal of mining waste in the deep sea, PMC scientific report 5/2015. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4419517/

Hunter, T. et al (2013):
Deep Sea Bed Mining in the South Pacific - A background paper, Centre for International Minerals and Energy Law.

I

Inniss, L. et al (2016):
The First Global Integrated Marine Assessment World - Ocean Assessment I, United Nations.

Institut für internationales Recht an der Universität Kiel (ed.) (1970):
Die Nutzung des Meeresgrundes außerhalb des Festlandsockels (Tiefsee). Vorträge und Diskussionen eines Symposiums vom März 1969, Veröffentlichungen des Instituts für internationales Recht an der Universität Kiel, Band 64.

International Copper Study Group (ICSG) (2014):
The World Copper Factbook 2014.

Intergovernmental Oceanographic Commission et al. (2011):
A Blueprint for Ocean and Coastal Sustainability.

International Monetary Fund (2012):
Macroeconomic Policy Frameworks for Resource-Rich Developing Countries – Background Paper 1.

International Seabed Authority:
Cobalt Rich Crusts: https://www.isa.org.jm/files/documents/EN/Brochures/ENG9.pdf.

J

Jaeger, N. (2015):
Alles für uns!? Der globale Einfluss der europäischen Handels- und Investitionspolitik auf Rohstoffausbeutung, PowerShift – Verein für eine ökologisch-solidarische Energie-& Weltwirtschaft.

Jakimska, A. et al (2011):
Bioaccumulation of Metals in Tissues of Marine Animals, Part I: the Role and Impact´of Heavy Metals on Organisms, Pol. J. Environ. Stud. 20/5 (2011), 1117-1125.

Jakimska, A. et al (2011):
Bioaccumulation of Metals in Tissues of Marine Animals, Part II: Metal Concentrations in Animal Tissues, Pol. J. Environ. Stud. 20/5 (2011), 1127-1146.

James, P. et al (2012):
Sustainable Communities, Sustainable Development. Other Paths for Papua New Guinea, Honolulu.

Jarowinsky, M. (2015):
Stand der Aktivitäten im Tiefseebergbau in Deutschland unter besonderer Berücksichtigung von Umweltaspekten.

Jay, S. et al (2007):
Environmental impact assessment: Retrospect and prospect, in: Environmental Impact Assessment Review, 27/2007.

Jenisch, U. (2010):
Renaissance des Meeresbodens – mineralische Rohstoffe und Seerecht – Teil 1 und 2, in: NordÖR – Zeitschrift füröffentliches Recht in Norddeutschland, 10/2010, 11/2010.

Jenisch, U. (2014):
Tiefseebergbau und Umweltschutz – die Gesetzgebung der Internationalen Meeresbodenbehörde IMB, in: NordÖR - Zeitschrift für Öffentliches Recht in Norddeutschland, 10/2014.

Jessen, H. (2012):
Staatenverantwortlichkeit und seevölkerrechtliche Haftungsgrundsätze für Umweltschäden durch Tiefseebodenbergbau, in: Zeitschrift für Umweltrecht 2/2012.

Jessep, O. (1998):
The Elusive Role of Custom in the Underlying Law of Papua New Guinea, in: Melanesian Law Journal, 26.

Joint Declaration of Intent between the Minister for the Economy, Industry and Digital Affairs of the French Republic and the Federal Minister for Economic Affairs and Energy of the Federal Republic of Germany concerning Cooperation in the Field of deep Seabed Mining.

de Jong, S. et al (2016):
The circular Economy and Developing Countries a Data Analysis of the Impact of a Circular Economy on Resource-Dependent Developing Nations, Centre of Expertise on Resources.

Judd, S. (2016):
Deep sea Mining – PNG's sensitive marine ecosystems, in: Mining Monitor, 6/2016.

K

Kalafatic, C. (n.y):
Indigenous peoples' sustainable livelihoods, FAO thematic brief.

Kaschinski, K. (2013):
Die Ozeane und vor allem ihre Tiefsee sind keine auszubeutende Schatzkammer – Meer ist mehr als strategische Rohstoffreserve, in: Waterkant 2/2013.

Kaschinski, K. (2015):
Die Werbetrommel für die Jagd nach mineralischen Ressourcen der Tiefsee wird gerührt – Meeresbergbau – unnötig, teuer und riskant, in: Waterkant; 1/2015.

Kaschinski, K. et al (2016):
Die geplante Ausbeutung von Meeresbodenschätzen birgt globale Risiken – Nein zum Tiefseebergbau (nicht nur) im Südpazifik, in: Waterkant 2/2016.

Koshy, K. et al (2008):
Sustainable Development – A Pacific Islands Perspective, UNESCO.

Koslow, T. (2007):
The Silent Deep: The Discovery, Ecology and Conservation of the Deep Sea.

Kreysler, P. (2012):
Gold, Gas und Gier – Eine Spurensuche im Rohstoffkasino Papua-Neuguinea, Heinrich-Böll-Stiftung.

L

Lalli, C. et al (1997):
Biological Oceanography. An Introduction.

Latif, M. (2014):
Das Ende der Ozeane. Warum wir ohne die Meere nicht überleben werden.

Loreau, M. et al (2013):
Biodiversity and ecosystem stability: a synthesis of underlying mechanisms, in: Ecology Letters, 2013/16.

Lowe, J.J. (2012):
Mineral Resource Estimate - Solwara Project, Bismarck Sea, PNG - Technical Report compiled under NI43-101 -
Submitted to: Nautilus Minerals Nuigini Limited, Golder Associates.

Luick, J. (2012):
Physical Oceanographic - Assessment of the Nautilus – EIS for the Solwara 1 Project; for Deep Sea Mining Campaign.

M

Maconachie, R. et al (2013):
Editorial introduction: the extractive industries, community development and livelihood change in developing countries.

Mahnke, P. (2016):
Publishers Schiff & Hafen 2016/1: Meerestechnik in der Maritimen Agenda 2025.

Mann-Borgese, E. (1985):
Die Zukunft der Weltmeere. Ein Bericht an den Club of Rome.

Mansfield, B. (2004):
Neoliberalism in the oceans: „rationalization," property rights, and the commons question, in: Geoforum, 35/2004.

Marí, F. (2016):
Nein zum Tiefseebergbau im Südpazifik,
http://info.brot-fuer-die-welt.de.

maribus (2014):
world ocean review - Mit den Meeren leben, 2014 - 3 -Rohstoffe aus dem Meer – Chancen und Risiken.

Marina, TI. et al (2018):
Architecture of bmarine food webs: To be or not be a `small-world'.PLoS ONE 13(5): e0198217.
https://doi.org/10.1371/journal.pone.0198217

Marscheider-Weidemann, F. et al (2016):
Publishers Deutsche Rohstoffagentur: Rohstoffe für Zukunftstechnologien 2016.

Marshall, W. (1888):
Die Tiefsee und ihr Leben, Leipzig.

Matsumoto, W.M. (1984):
Potential Impact of Deep Seabed Mining on the Larvae of Tunas and Billfishes - NOAA Technical Memorandum NMFS, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center.

McClain et al (2010):
The dynamics of biogeographic ranges in the deep sea, in: Proceedings of the Royal Society B, 2010/277.

McKenna, K. (2016):
Land of the Unexpected - Natural Resource Conflict and Peace Building in Papua New Guinea.

McKinnon, E. (2002):
The environmental effects of mining waste deposal at Lihir Gold Mine, Papua New Guinea, in: Journal of Rural and Remote Health 1/2002.

McKenna, K. (2016):
Land of the Unexpected - Natural Resource Conflict and Peace Building in Papua New Guinea.

McLennan, B. (2006):
The History of Oceans Governance; Commonwealth of Australia - Department of Defence Canberra.

Memorandum of Understanding between the French Maritime Cluster (CMF) And The Deep Sea Mining Alliance (DSMA) On Industrial, Technological and Scientific Cooperation.

Memorandum of Understanding between the International Seabed Authority and the Pacific Community,
ISBA /21/C/11.

Mero, J. (1965):
The mineral resources of the sea.

MIDAS (2017):
Managing Impacts of Deep Sea Resource Exploitation - Research Highlights.

Miller, K.A. et al (2018):
An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps.Front. Mar. Sci. 4:418. doi: 10.3389/fmars.2017.00418.

Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur und Verbraucherschutz des Landes Nordrhein-Westfalen (2016):
Umweltbericht Nordrhein-Westfalen 2016.

Miranda, M. et al. (2003):
Mining and critical Ecosystems: Mapping the Risks, World Resources Institute (pub.).

Mitchell, S. et al. (2008):
Ruling the Sea: Institutionalization and Privatization of the Global Ocean Commons.

Morello, E.B. et al (2016):
The Ecological Impacts of Submarine Tailings Placement, in: Oceanography and Marine Biology: An Annual Review, 54/2016, 315-366.

Mrotzek-Blöß, A. et al (2016):
Endbericht Kurzstudie – Recyclingpotenzial von Technologiemetallen und anderen kritischen Rohstoffen als wichtige Säule der Rohstoffversorgung, Fraunhofer-Institut für Umwelt-, Sicherheits- und Energietechnik – Umsicht.

Mudd, G.M. et al (2014):
Mining in Morobe, Papua New Guinea – Impacts, Assurance and Self-determination.

Mullineaux, L.S. (2014):
Deep-Sea Hydrothermal Vent Communities, in: Marine Community Ecology and Conservation, by Bertness, M.D. et al.

N

National CTI Coordinating Committee of Papua New Guinea (2012):
State of the Coral Reefs of Papua New Guinea, Coral Triangle Marine Resources: their Status, Economies, and Management, 26-32.

National Institute of Water and Atmosheric Research of Nea Zealand (NIWA) (n.y.):
Tuna spawning grounds, https://www.niwa.co.nz/te-k%C5%ABwaha/tuna-information-resource/biology-and-ecology/spawning-grounds.

National Strategic Plan Taskforce (2009):
Papua New GuineaVision 2050, Port Moresby.

Nautilus Minerals Inc. (2018): Pressemitteilung vom 29.03.2018,
http://www.nautilusminerals.com/irm/PDF/1989_0/NautilusMineralsSeafloorProductionVesselLaunched.

Nautilus Minerals Inc. (2017):
Pressemitteilungen, Stand 23.03.2017
http://www.nautilusminerals.com/irm/ShowListItems.aspx?CategoryID=311&-Masterpage=&RID=311.

Nautilus Minerals Inc. (2016):
Annual Information Form for the Fiscal Year ended December 31, 2015, vorgelegt März 2016.

Nautilus Minerals Inc. (2015a):
Annual Information 2015.

Nautilus Minerals Inc. (2015b):
Annual Information Form 2015.

Nautilus Minerals Inc. (2014a):
Project Overview, Seafloor Production Equipment Status, Annual Report 2014.

Nautilus Minerals Inc. (2014b):
Press release 9.5.2014
http://www.mining.com/first-seabed-mine-to-go-ahead-as-nautilus-solves-disputewith-png-87314/.

Nautilus Minerals Inc. (2011a):
MDA 2010, submitted 3/23/2011,
http://www.nautilusminerals.com/irm/PDF/1395_0/MDampAforthefullyearendedDecember312010

Nautilus Minerals Inc (2011b):
Annual Report.

Nautilus Minerals Inc. (2009):
Annual Report.

Nautilus Minerals Inc. (n.y.):
Nautilus: Seefloor Production Tools, http://www.nautilusminerals.com/irm/content/seafloor-production-tools.aspx?RID=333.

Neumann, B. et al (2015):
Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding - A Global Assessment, in: PLoS ONE, 10/3.

Niner, H.J. et al (2018):
Deep-Sea Mining With No Net Loss of Biodiversity - An Impossible Aim. Front. Mar. Sci. 5:53.m doi: 10.3389/fmars.2018.00053.

O

Ochsenbauer, L. (2013):
Tiefsee: Reise zu einem unerforschten Planeten, Stuttgart.

Office of the Pacific Ocean Commissioner (2016):
Framework for a Pacific Oceanscape Results Framework – Background Report.
https://www.cbd.int/doc/meetings/mar/soiws-2016-03/other/soiws-2016-03-fpo-rf-en.pdf.

Olson, J. (2011):
Understanding and contextualizing social impacts from the privatization of fisheries: An overview; in: Ocean & Coastal Management, 54/2011.

Organisation for Economic Co-operation and Development (2016):
The Ocean Economy in 2030.

Ormaza, M. (2012):
Re-thinking the Role of Indigenous Peoples in International Law. New Developments in International Environmental Law and Development Cooperation, in: Goettingen Journal of International Law, 4/2012, 263-290.

P

Pacific Climate Change Science Program partners (2011):
Current and future climate of Papua New Guinea.

Pacific Islands Forum Secretariat (2014):
Palau Declaration on 'The Ocean: Life and Future' – Charting a course to sustainability.

Pante, E. et al (2012):
Exploration of the deep-sea fauna of Papua New Guinea, in: Oceanography, 25/3.

Pedersen, C. et al (2014):
The Global Ocean Grab - A Primer; TNI Agrarian Justice Programme, Masifundise and Afrika Kontakt.

Pennington, S.M. (2009):
Deep-Sea Mining in Papua New Guinea: Policy Frontier - Physical Oceanographic Assessment of the Nautilus EIS for the Solwara 1 Project.

Petersen, S. et al (2016):
News from the seabed - Geological characteristics and resource potential of deep-sea mineral resources, in: Marine Policy, 70, 175-187.

Pettersson, H. (1948):
Rätsel der Tiefsee, Bern.

Planque, B. (2016):
Projecting the future state of marine ecosystems, "la grande illusion"?, in: ICES Journal of Marine Science, 73/2.

Post, A. (1981):
Der Meeresbergbau aus der Sicht der internationalen Politik. Errichtung eines institutionellen Rahmens zur Beteiligung der UNO am Abbau von Manganknollen in der Tiefsee, Bern.

Pratt, C. et al (2010):
Our Sea of Islands - Our Livelihoods - Our Oceania – Framework for a Pacific Oceanscape: a catalyst for implementation of ocean policy.

Proença, V. et al (2013):
Comparing Extinction Rates: Past, Present, and Future, Encyclopedia of Biodiversity, Vol. 2
http://www.isa.ulisboa.pt/inbio/theoeco/publications/Proenca_2013_EncyclopediaBiodiversity.pdf.

Purser, A. u. a. (2016):
Return to DISCOL. Megafauna distribution 26 years after simulated nodule mining, MIDAS newsletter 6.

R

Rademaekers, K. et al (2015):
Technology options for deep-seabed exploitation – Tackling economic, environmental and societal challenges, European Union.

Rahmstorf, S. et al (2007):
Wie bedroht sind die Ozeane? Biologische und physikalische Aspekte. Frankfurt a.M.

Ramboll IMS Ingenieurgesellschaft mbH et al (2016):
Analysis of the Economic Benefits of Developing Commercial Deep Sea Mining Operations in Regions where Germany has Exploration Licences of the International Seabed Authority, as well as Compilation and Evaluation of Implementation Options with a Focus on the Performance of a Pilot Mining Test, Federal Ministry for Economic Affairs and Energy Division I C 4 Project No. 59/15

Rauchfuss, H. (2012):
Chemische Evolution und der Ursprung des Lebens, Heidelberg.

Ramirez-Llodra, E. et al (2010):
Deep, diverse and definitely different: unique attributes of the world's largest ecosystem, in: Biogeosciences, 7/2010.

Ramirez-Llodra, E. et al (2011):
Man and the Last Great Wilderness: Human Impact on the Deep Sea, in: PLoS ONE, 6/7.

Rat für Nachhaltige Entwicklung (2011):
Wie Deutschland zum Rohstoffland wird – Empfehlungen des Rates für Nachhaltige Entwicklung an die Bundesregierung.

Redmond, W. (2015):
President Obama Signs Bill Recognizing Asteroid Resource Property Rights into Law; www.planetaryresources.com.

Reichelt-Brushett, A.J. (2012):
Risk assessment and ecotoxicology: Limitations and recommendations for ocean disposal of mine waste in the Coral Triangle, in: Marine Pollution Bulletin 14(3):81–84.

Revenue Watch Institute (2013):
The 2013 Resource Governance Index.

Riegl, B. et al (2009):
Coral Reefs - Threats and Conservation in an Era of Global Change, in: The Year in Ecology and Conservation Biology.

Ritter, J. (2008):
Das unverdorbene Eiland, Spiegel online 11.06.2008,
http://www.spiegel.de/einestages/deutsche-kolonialgeschichte-a-946982.html.

Rockström, J. et al (2009):
Planetary boundaries: exploring the safe operating space for humanity, in: Ecology and Society, 14/2.
http://www.stockholmresilience.org/download/18.8615c-78125078c8d3380002197/ES-2009-3180.pdf.

Rosenbaum, H. et al (2015):
Accountability Zero - A Critique of the Nautilus Minerals Environmental and Social Benchmarking Analysis of the Solwara 1 Project; Deep Sea Mining Campaign.

Rosenbaum, H. (2011):
Out of our Depth: Mining the Ocean Floor in Papua New Guinea; Deep Sea Mining Campaign.

S

Saiki, A. (2017):
Measuring Regional Progress for a Blue Economy.
http://dpa.bellschool.anu.edu.au/sites/default/files/publications/attachments/2017-02/ib-2017-02-saiki.pdf.

Samadi, S. (2015):
Patchiness of deep-sea communities in Papua New Guinea and potential susceptibility to anthropogenic disturbances illustrated by seep organisms, in: Marine Ecology 36/2015.

Schertow, J. (2008):
Indigenous Communities Oppose Deep Sea Mining, 10.7.2008.
https://intercontinentalcry.org/indigenous-communities-oppose-deep-sea-mining.

Schuh, H. (2005):
Von der Südsee-Idylle zur Mondlandschaft, in: Die Zeit, 2.6.2005, http://www.zeit.de/2005/23/Nauru.

Schrieberg, D. (2017):
Asteroid Mining: The Next Grand Venture Of Tiny Luxembourg.
https://www.forbes.com/sites/davidschrieberg1/2017/01/24/asteroid-mining-the-next-grand-venture-of-tiny-luxembourg/#345c4553375a.

Schüler, D.: u. a. (2011):
Study on Rare Earths and Their Recycling, Ökoinstitut Freiburg, Darmstadt.

Schwoerbel, W. (1965):
Geheimnisvolle Tiefsee. Bilder aus dem dunklen Reich ozeanischer Tiefen, aus der Schatzkammer der Zoologen, aus einer Welt des Abenteurers und der Forschung.

Seabed Disputes Chamber of the International Tribunal for the Law of the Sea (2011):
Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area - Advisory Opinion.

Secretariat of the Pacific Community (2014):
SPC Factsheet Tuna.

Secretariat of the Pacific Community (2005):
Pacific Islands Regional Ocean Policy and Framework for Integrated Strategic Action.

Secretariat of the Pacific Community (2004):
Pacific Islands Regional Ocean Policy.

SERI et al (2009):
Overconsumption? Our use of the world ´s natural resources. Lösungsansätze; Wuppertal Institut für Klima, Umwelt, Energie.

Skibba, R. (2016):
Mining in Space Could Lead to Conflicts on Earth.
http://nautil.us/blog.

Smith, H.D. (2000):
Millennium essay - The industrialisation of the world ocean, in: Ocean & Coastal Management, 43/2000, 11-28.

Smith, J.E. et al (2016):
Re-evaluating the health of coral reef communities: baselines and evidence for human impacts across the central Pacific.

SRK Consulting (2010):
Offshore Production System Definition and Cost Study, prepared for Nautilus Minerals, Juni 2010.

Steffen, W. et al (2007):
The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?, in: Royal Swedish Academy of Sciences, 36/8.

Steiner, R. (2015):
Deep Sea Mining as an Ocean Threat, Huffington Post Blog, 20.10.2015.

Steiner, R.: (2009):
Independent Review of the Environmental Impact Statement for the proposed Nautilus Minerals Solwara 1 Seabed Mining Project. Conducted for the Bismarck-Solomon Seas Indigenous Peoples Council, Madang.

Strauss, B.H. et al (2015):
Mapping Choices: Carbon, Climate, and Rising Seas, Our Global Legacy. Climate Central Research Report, 1-38.

Struck, D. (2016):
Reef Fish Listen to Find Homes But Can't Hear Far, in: National Geographic, 2.9.2016. http://news.nationalgeographic.com/2016/09/reef-fish-use-sound-to-find-coral-homes.

T

van Tatenhove, J. (2011):
Integrated marine governance: Questions of Legitimacy, in: Maritime Studies, 10/1.

Thal, J. (2014):
High-Resolution Geologic Mapping of Seafloor Structures and Identification of Structural Systematics.
https://d-nb.info/1072225921/34.

The, L.S.L. et al. (2013):
A Global Estimate of the Number of Coral Reef Fishers, in : PLoS ONE 8/6.

The Economist (2015):
The blue economy - Growth, opportunity and a sustainable ocean economy.

Thibaut, L.M. et al. (2013):
Understanding diversity–stability relationships: towards a unified model of portfolio effects; in Ecology Letters, 2013/16.

Thiel, H. et al (2015):
Environmental Risks of Mining Metalliferous Muds in the Atlantis II Deep, Red Sea, in: Najeeb Rasul und Ian Stewart (eds..): The Red Sea, Berlin und Heidelberg, 251-266.

Thurber, A.R. (2014):
Ecosystem function and services provided by the deep sea, in: Biogeosciences, 11/2014.

TNI Agrarian Justice Programme et al. (2014):
The Global Ocean Grab - A Primer.
https://www.tni.org/files/download/the_global_ocean_grab.pdf.

U

Umweltbundesamt (2010):
Rohstoffeffizienz – Wirtschaft entlasten, Umwelt schonen.
https://www.umweltbundesamt.de/publikationen/rohstoffeffizienz

United Nations Development Programme (2016):
Human Development Report 2015 - Work for Human Development.

United Nations Development Programme (2009):
Indigenising Development. Poverty in Focus Nr. 17, Mai 2009.

United Nations- Economic Commission for Africa (2014):
Unlocking full potentials of the Blue Economy: Are African SIDS ready to embrace the opportunities?

United Nations - Economic and Social Commission for Asia and the Pacific - Pacific Office (2012):
Green Economy in a Blue World - Pacific Perspectives 2012.

United Nations Educational, Scientific and Cultural Organization (2009):
Global Open Oceans and Deep Seabed (GOODS) – Biogeographic Classification.

United Nations Environment Programme (2015):
Blue Economy: Sharing Success Stories to Inspire Change.

United Nations Environment Programme et al (2012):
Green Economy in a Blue World.

United Nations Environment Programme (2011):
Towards a Green Economy. Pathways to Sustainable Development and Poverty Eradication, UNEP Report.

United Nations Environment Programme (2007):
Deep-sea biodiversity and ecosystems - A scoping report on their socio-economy, management and governance, UNEP World.

University of the South Pacific (2012):
East Melanesian Islands Biodiversity Hotspot, Critical Ecosystem Partnership Fund

V

Van Dover, C.L. et al (2018):
Scientific rationale and international obligations for protection of active hydrothermal vent ecosystems from deep-sea mining, in: Marine Policy 90/2018, 20-28.

Van Dover, C.L. et al (2017):
Biodiversity loss from deep-sea mining, Nature Geoscience, Juni 2017.

Van Dover, C.L. (2014):
Impacts of anthropogenic disturbances at deep-sea hydrothermal vent ecosystems: A review, in: Marine Environmental Research, Nr. 102/2014.

Van Dover, C.L. (2011):
Mining seafloor massive sulphides and biodiversity: what is.at risk?, in: ICES Journal of Marine Science, Nr. 68/2.

Van Dover, C.L. (2000):
The Ecology of Deep-Sea Hydrothermal Vents. New Jersey

Vanreusel, A. et al (2016):
Threatened by mining, polymetallic nodules are required.to preserve abyssal epifauna, in: Scientific Reports, 6:26808/2016.

Venables, A.J. (2016):
Using Natural Resources for Development: Why Has It Proven So Difficult?, in: Journal of Economic Perspectives, 30/1, 161-184

Verne, J. (2013):
20.000 Meilen unter dem Meer. (Mit den Illustrationen der Originalausgabe).

W

Watling, L. et al. (2013):
A proposed biogeography of the deep ocean floor, in: Progress in Oceanography, 111/2013.

Weathers, K.C. et al. (2016):
Frontiers in Ecosystem Ecology from a Community Perspective: The Future is Boundless and Bright, in: Ecosystems, 2016/19.

Wendland, W. (1939):
Im Wunderland der Papuas. Ein deutscher Kolonialarzt erlebt die Südsee, Berlin, as cited in; Margarete Brüll: Die deutschen Kolonien in der Südsee, in: Eva Gerhards und Edgar Dürrenberger (eds.): Als Freiburg die Welt entdeckte. 100 Jahre Museum für Völkerkunde, Freiburg 1995, see: online unter http://www.freiburg-postkolonial.de/Seiten/Adelhauser-Bruell1.pdf

Whitty, J. (2010):
Deep Blue Home: An Intimate Ecology of Our Wild Ocean.

Wiedicke, M. et al (2015):
Publishers Mining Report 151/4: Deep-sea Mining - a Future Source of Raw Materials?

Wiedicke-Hombach, M. et al (2012):
Technologische und rohstoffpolitische Potenziale für die deutsche Wirtschaft, in: Schiff & Hafen, 2012/6.

Wilts, H. et al. (2014):
Recycling in Deutschland – Status quo, Potenziale, Hemmnisse und Lösungsansätze.

Wiese, J. (1906):
Das Meer. Geographische, naturgeschichtliche und volkswirtschaftliche Darstellung des Meeres und seiner Bedeutung in der Gegenwart.

Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (WBGU) (2011):
Welt im Wandel. Gesellschaftsvertrag für eine Große Transformation, Berlin.

Wolff, M. (1925):
Die Tiefsee und ihre Bewohner.

World Bank (2017):
The Sunken Billions Revisited. Progress and Challenges in Global Fisheries, Washington D.C.

World Bank (2016a):
Pacific Possible – Tourism.

World Bank (2016b):
Environmental and Social Framework, 4.8.2016.

World Bank: (2016c):
Precautionary Management of Deep Sea Mining Potential in Pacific Island Countries. Draft for Discussion.
http://pubdocs.worldbank.org/en/125321460949939983/Pacific-Possible-Deep-Sea-Mining.pdf and see:
http://www.worldbank.org/en/news/press-release/2016/04/28/world-bank-report-urges-cautionin-deep-sea-mining-in-the-pacific.

World Bank (2005):
The Sunken Billions. The Economic Justification of Fisheries Reform, Washington D.C.

World Forum of Fisher Peoples (2015):
Blue Carbon: Ocean grabbing in disguise? A public meeting organised by the World Forum of Fisher Peoples and the World Forum of Fish Harvesters and Fish Workers during the COP21 climate negotiations in Paris.

World Forum of Fisher Peoples, World Forum of Fish Harvesters and Fish Workers (2013):
A Call for Governments to Stop Supporting the Global Partnership for Oceans (GPO) and Rights-Based Fishing (RBF) Reforms.

World Resources Institute (2012):
Reefs at Risk Revisited in the Coral Triangle, 32-35.

WWF Australia (2009):
The Coral Triangle and Climate Change: Ecosystems, People and Societies at Risk.

X

Xanthaki, A. (2009):
Indigenous Rights in International Law over the Last 10 Years and Future Developments, in: Melbourne Journal of International Law, Vol. 10

Y

Yasuhara, M. et al. (2016):
Biodiversity–ecosystem functioning relationships in longterm time series and palaeoecological records: deep sea as a test bed, in: Philosophical Transactions Royal Society B 371/2016.

Z

Zeppilli, D. et al (2016):
Seafloor heterogeneity influences the biodiversity–ecosystem functioning relationships in the deep sea, in: Scientific Reports 6:26352/2016.

Zierul, S. (2010):
Der Kampf um die Tiefsee. Wettlauf um die Rohstoffe der Erde, Hamburg.

Zorn, J. (1995):
Women, Custom and State Law in Papua New Guinea,
Third World Legal Studies, Vol. 13, Art. 7.

Zorn, J. (1991):
Making Law in Papua New Guinea: The Influence of Customary, Law on Custom Law, Pacific Studies, Vol. 14, Nr. 4.