Traditional and socio-ecological dimensions of seabed resource management and applicable legal frameworks in the Pacific Island States

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Abstract

Traditional knowledge, customary marine management approaches and integrated relationships between biodiversity, ecosystems and local communities promote conservation and ensure that marine benefits are reaped in a holistic, sustainable and equitable manner as fostered by contemporary ocean governance. However, the interaction between traditional knowledge, the present scientific approach to marine resource management and specific regulatory frameworks has often been challenging. To a certain extent, the value of community practices and customary rules, which has provided an incentive for regional cooperation and coordination, is acknowledged in several legal systems of the Pacific Island States and a number of regional and international instruments, but this important interconnectivity can certainly be perfected.

Based on recent multidisciplinary research (Tilot et al., 2021a; 2021b), this chapter presents a science-based overview of the marine habitats and activities that would be affected by deep seabed mining (DSM) in the Pacific region, along with an analysis of the traditional dimensions and their interconnectivity with the socio-ecological aspects of marine resource management. We then assess whether the applicable regulatory frameworks attach sufficient

importance to these traditional dimensions of seabed resource management and cultural representation in the Pacific region. On basis of this analysis, we identify best practices and formulate recommendations with regard to the current regulatory frameworks and seabed resource management approaches to reconcile competing values of the Pacific communities and to sustain the health of the Global Ocean.

Keywords: Pacific Island communities, ocean connectivity, sustainability, marine ecosystems, law of the sea, deep sea mining, global change, science-policy-society

1. Introduction

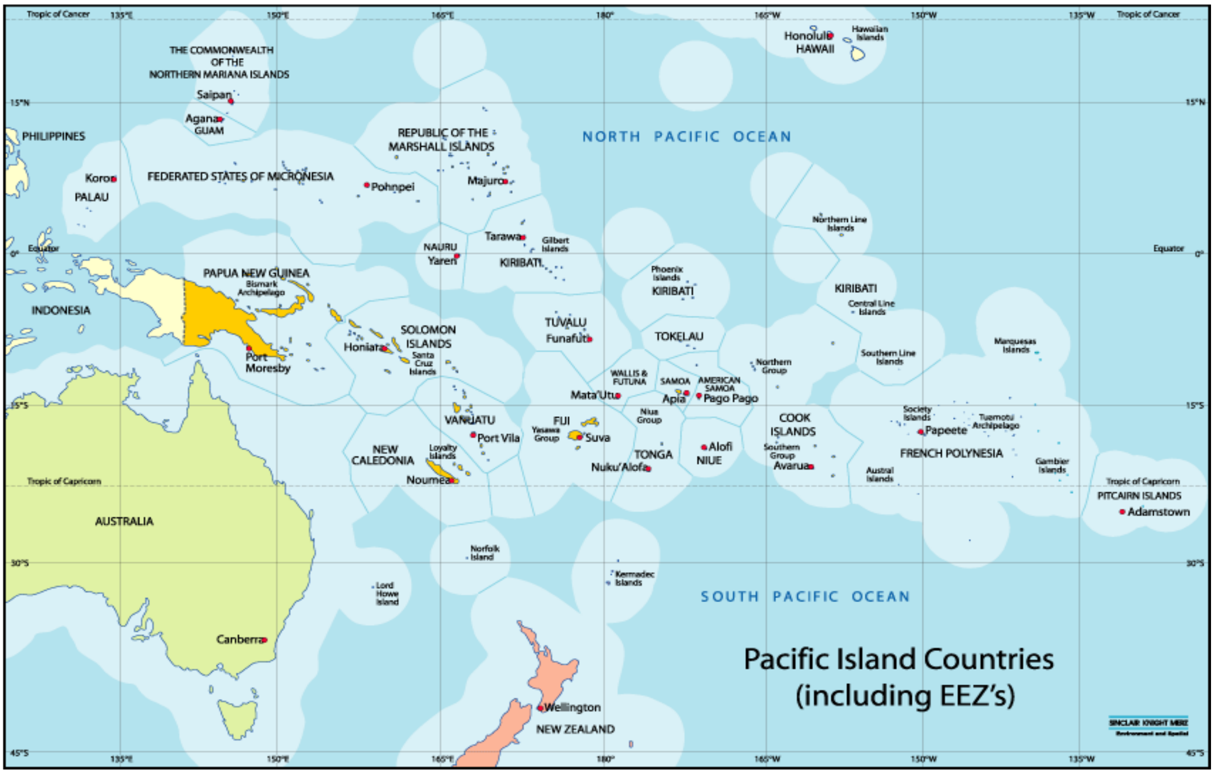

Figure 1. Map of the Pacific region including the Island States with the 200-mile Exclusive Economic Zones (EEZs) and the international waters within the region. Source: CartoGIS Services, College of Asia and the Pacific, The Australian National University.(https://asiapacific.anu.edu.au/mapsonline/base-maps/pacific-eez-zones-II).

The Pacific region (Figure 1) has conflicting ambitions of conservation and of exploitation as it is one of the largest oceans renowned as a hotspot in biodiversity also with marine resources of commercial importance (Dahl and Carew-Reid, 1985; D'Arcy, 2006; Petterson, 2008; Trichet and Leblic, 2008; Vieux et al., 2008; Kingsford et al., 2009; Cardno Limited, 2016; Tilot, 2006; Tilot et al., 2021b). The region has the richest deposits of minerals on its seabed (polymetallic nodules, rare earths, metal-rich muds, cobalt rich ferro-manganese crusts, and hydrosulfide deposits) (Ernst and Young, 2011; Kato et al., 2011; Hein and Koschinsky, 2014) which are targeted by the Deep Sea Mining (DSM) industry (Hein, 2013; Havice and Zalik, 2019). These deposits are located on the seabed both within the limits of national jurisdiction of several island states, as well as beyond.

Within national jurisdiction, on the (legal) continental shelf, deep sea mining activities are regulated by the national legislation of the coastal state (UNCLOS, Art. 77). Beyond the limits of national jurisdiction, however, the seabed and subsoil that comprise 'the Area' (UNCLOS, Art. 1(1)), are governed by a comprehensive international regime and managed by the International Seabed Authority (ISA) (UNCLOS, Art. 157(1)). The ISA has already awarded contracts to 31 states, - of which several Pacific Island states such as Tonga, Nauru, Kiribati and the Cook Islands have sponsored non-state actors or private enterprise – for exploration activities in the Area and many of these exploration efforts take place in the Clarion Clipperton Zone (CCZ), where polymetallic nodules and cobalt-rich crust deposits of commercial importance are heavily concentrated. Similar activities are also being conducted or anticipated on the continental shelves of certain coastal states, subject to domestic laws and without interference from the ISA.

The future exploitation of the mineral resources of the seabed presents unique opportunities for the Pacific Island States for economic growth via scientific and technological progress, as well as to the world to satisfy the increasing metal demand in the global shift toward sustainable energy (Hein et al., 2013; Zalik, 2018; Havice and Zalik, 2019). However, it also poses additional challenges to the preservation and sustainable management of the planet's richest ecosystems and marine genetic resources and to the ecosystem services they provide (Leary et al., 2010; Tilot, 2010; McCauley et al., 2015; Niner et al., 2018; Tilot, 2019). Therefore, potential harm to the marine environment and the interests of coastal communities, as well as to the rest of the planet, should be adequately assessed and prevented (Tilot et al., 2018; Tilot at al., 2021a).

Local and traditional communities of many of the Pacific Island States have long-held attachments to the sea, envisioned as a continuum with Nature and Peoples (Bambridge, 2016; Bambridge et al., 2021), in particular to species and specific marine areas, processes, habitats, islands and natural seabed formations (Lewis, 1972; Lohmann et al., 2008). In this region, the conservation and sustainable management of the marine environment and its resources, generally of economic importance, is promoted through traditional knowledge and customary practices, emphasizing the interconnectivity between species and ecosystems (Ruddle and Johannes 1989; Akimichi 1995; Bambridge, 2016; Tilot et al., 2021b).

Combined with centuries of acquaintance, these traditional and indigenous approaches constitute keystones to holistic forms of marine resource management, mainly linked to fisheries and protected areas and species (Pomeroy 1995; Veitayaki 2004; Gavin et al., 2015; Friedlander, 2018).These approaches occupy an important place in the culture, the society, the spirituality and the traditions of the Pacific Island communities (Bambridge, 2016; Bambridge et al., 2019) and represent opportunities for the region (Friedlander and Gaymer, 2020). Thus, if seabed mining activities do not take these interests and visions into account, the impact on the local and traditional communities with rich maritime cultures (Malinowski, 1935; Kent, 1980; Johannes, 1981; Hviding and Baines, 1992; Hau'ofa, 2008) might be significant and could seriously affect their Human Well-being and Sustainable Livelihoods

(HWSL)[1] (D'Arcy, 2013). Especially considering the fact that Pacific Island States are presently subject to multiple stress factors such as population growth, extreme weather events, unsustainable fisheries practices, alien species invasions, sea level rise, acidification and coral bleaching associated with global warming, in particular in the Marshall Islands, Guam, Northern Mariana Islands, the North-West Hawaiian Islands and Kiribati (Pacific Community, 2012; IPCC SROCC, 2019). As these newly recognized HWSL dimensions, in particular traditional knowledge of the Pacific Island communities, rely on the resources from the deep sea and open waters (D'Arcy, 2013), these would require an innovative regulatory framework for the management of the exploitation of deep sea mineral resources which would ensure the preservation of the seabed and the water column, considering the cumulative impacts of DSM and other human activities (Woodall et al., 2014) and of global change (Levin et al., 2020).

2. Socio-ecological interconnectivity with the ocean realm in the Pacific region: Main natural resources and activities that would be affected by DSM in the Pacific Region

It is important to outline that DSM activities, which occur in different geographic areas with varied mineralogy and associated value chains (Petterson and Tawake, 2018), take place in a tridimensional perspective from the seabed, through the water column to the surface and the air above (Miller et al., 2018). The extraction of ore might take place at the seabed through a process of cutting and disaggregation, but it is then pumped upwards through the water column as a slurry, concentrated with the release of diluted seawater, and then transported across the sea to a terrestrial processing centre (Miller et al., 2018).

Thus, DSM would affect the main natural resources and activities located within coastal waters (nearshore pelagic and deep-water bottom fish), as well as in the open oceans and the deep sea (Tilot, 2010; Dyment et al., 2014; Tilot et al., 2018). An overview of the zones and activities that would be affected by DSM is presented here:

The EEZs of the 22 Pacific Island States span across much of the tropical and subtropical Pacific Ocean, encompassing an area that exceeds 27 million km^2 or 8 % of the global ocean (Figure 1). While coastal fishing areas across the Pacific account for only 1.25 % of this ocean area (FAO, 2020), the marine environment plays a major role in the economic, social and cultural well-being of Pacific Islanders by sustaining a multitude of important activities that fuel local, national and international economies and provide livelihoods and food security for millions of people (Pauwels and Fache, 2016).

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[1] HWSL are commonly used in the Convention for Biological Diversity (CBD) and the international fora on sustainable development. HWSL are the social, spiritual, cultural and traditional characteristics and the capabilities, tangible assets and means of living that set the stage for sustainability, resilience and adaptability of people to change collectively (WCED, 1987; Holden et al., 2014).

Coastal fishing in the Pacific region encompasses artisanal fishing supplying domestic markets, subsistence fisheries, which support rural economies and the industrial-scale shrimp fisheries (Gillett, 2010). Almost all the coastal catch is taken by Pacific Island Countries (Solomon I, Cook, Fiji, Kiribati, Marshall, Federated States of Micronesia (FSM), Nauru, Vanuatu, Niue, PNG, Palau, Tonga, Tuvalu, Samoa) with very little access by foreign fishing vessels. However, there is concern about whether benefits and services currently derived from coastal ecosystems, in terms of food security, culture, employment and recreation can sustain livelihoods in the Pacific Island States as coastal fisheries are declining (Hilmi et al., 2016). This concern has accelerated efforts to enhance the socio-ecological resilience of coastal communities in the Pacific which depend heavily on healthy ecosystems and sustainable fisheries (David, 2016; Gillett and Tauati, 2018). Efforts have been made to reduce the pressure on coastal ecosystems by improving the management of coastal fisheries, establishing protected areas and developing nearshore pelagic fisheries and deep sea fisheries which target reef slopes, outside barrier reefs, and shallow and deeper seamounts at more than 500m depth (Godstien et al., 2016).

Deep-water bottom fishing has been known for many years in the Pacific region, and has been practised for generations in some of the remote island communities of the Pacific, particularly in Polynesia (SPC, 1999). The most active export-oriented deep-water bottom-fish fisheries in the Pacific Islands are presently in Fiji and Tonga (The Western and Central Pacific Fisheries Commission, 2019). As deep-sea fisheries typically concentrate on shallow seamounts which are assessed as highly vulnerable (Tilot, 2013; Williams et al., 2020), there may as well be competing uses with planned deep sea mining on seamounts where commercially interesting cobalt-rich crusts are located.

The target species of offshore fishing, undertaken mainly by large industrial-scale fishing vessels, are swordfish, skipjack tunas, yellowfin tunas, albacore, bigeye tuna, black marlin, blue marlin, Indo-Pacific sail-fish, shortbill spearfish, striped marlin, blue shark which are essentially open water species migrating over large routes across the Pacific region (Luschi, 2013). The Western and Central Pacific Ocean (WCPO) tuna fishery is the world’s largest and most valuable fishery with different seasons according to the targeted species. It accounts for nearly 60% of global tuna production and has a value of around US$4.5 billion annually (The Western and Central Pacific Fisheries Commission, 2019). Tuna taken within Pacific Island Countries waters account for about 45% of the WCPO catch by volume and provide around 25% of the world’s canned tuna supply (mainly for EU and US) (Havice et al., 2019; WCPFC, 2019). But only 20% of this catch is taken by Pacific Island fleets with not more than 10% processed locally, the main benefits for Pacific Island Countries deriving mostly from the fishing access fees **(**Pacific Islands Forum Fisheries Agency, 2019**).**

In open seas of the Pacific, numerous species use different depths in the water column as feeding grounds, e.g., bluefin tunas from the surface to 200m depth, yellowfin and bigeye tunas and swordfishes upto 1000m depth (FAO, 2000; Block et al., 2011; Schor et al., 2014). Whales can be found in open oceans at great depths (Ponganis, 2016), e.g., to 1,500m for Bottlenose whales, 2400m for sperm whales which are generally associated to seamounts

(Boucher et al., 2014), 3000m for Cuvier's beaked whale and possibly at 4258m for unidentified large vertebrates according to geomorphological evidence recorded on the seafloor in the CCZ (Marsh et al., 2018).

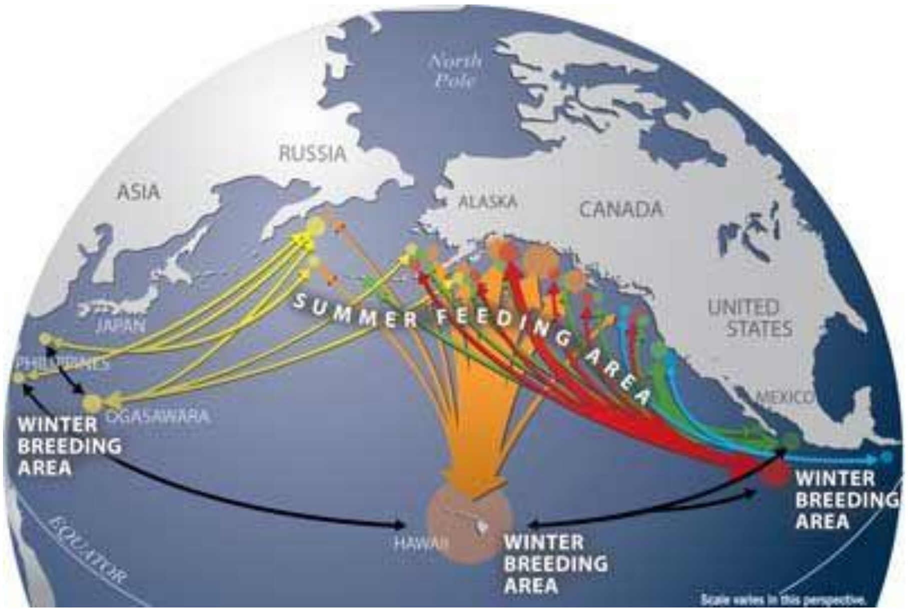

Figure 2. Map of humpback whale migration routes in the Pacific region (https://hawaiihumpbackwhale.noaa.gov). The dark arrows pass by the tropical Pacific Islands range.

Whales have long formed part of the stories and traditions of Pacific Island peoples (Cressy, 1998; Flood et al., 1999; Creason, 2004; Firestone and Lilley, 2007). The movements and migrations of whales (Figure 2) have many parallels with the voyaging of the Pacific Island people (Feinberg, 1995; Gladwin, 1970; Gooley, 2016; Finney, 1998; Lewis, 1972; New York Times Magazine, 2016). During the last century, the great whales of the South Pacific were hunted to the brink of extinction. However, this century has seen a strengthening of regional and national initiatives to conserve whales.

Open water ecosystems in the Pacific region provide important ecosystem services and societal benefits, not only for the people in the Pacific Islands but also for people around the world due to the migrating nature of many marine species (De Groot et al., 2012). Indigenous Peoples and Local Communities (IPLCs) have a role as custodians of significant ecosystems and of species generally travelling between coastal waters and high seas (Ey and Sherval, 2016; Eckstein and Schwarz, 2019). They are central to the debate addressing gaps in governance in Areas Beyond National Jurisdiction (ABNJ) and the lack of a comprehensive framework for biodiversity conservation and management (Vierros et al., 2020).

It is also important to outline that in the mesopelagic, bathyal (200-2000m) and abyssal realms (2000-6000m) and especially in the deeper hadal realm (more than 6000m), there is a significant lack of knowledge on species, biodiversity and on the relationships with the functioning of deep-sea ecosystems where trophic input is generally very low. Deep ocean environments represent the least explored areas on the planet and are assumed to be the largest reservoirs of mostly unknown species and ecosystems which might serve as a cradle of nonrenewable resources and contribute significantly to planetary biodiversity and global livelihoods. Specific adaptations, processes and communication such as bioluminescence, long-range acoustic communication occur in these most vulnerable and now coveted realms. Deep sea faunal communities are characterized by slow biological mechanisms, taxonomically high diversity and non-random sparse distribution over large areas (Tilot, 2006).

Deep midwater ecosystems (in the mesopelagic and bathypelagic depth zones) importantly represent more than 90% of the biosphere (Robison, 2009), connecting to shallow and deep-sea ecosystems and playing key roles in carbon export (Boyd et al., 2019), nutrient regeneration, and provisioning of harvestable fish stocks (Drazen and Sutton, 2017). The fish biomass of deep midwater ecosystems is assessed as 100 times greater than the global annual fish catch (Irigoien et al., 2014).

Recent global conservation and biodiversity issues, particularly the concern for potential and real threats to the high seas and deep-sea diversity, have provided an incentive to efforts aiming at exploring the structure and function of faunal communities in the water column and the bathyal and abyssal zones and developing marine spatial planning strategies and tools (Ardron et al., 2008). As connections between the different layers of the ocean are being studied, in particular to ocean circulation, it is becoming increasingly apparent that global changes and environmental impacts are affecting all marine organisms from phytoplankton to higher marine vertebrates and all oceanic processes (Tilot et al., 2018; Tilot, 2019; Drazen et al., 2020).

3. Characteristics of the main mineral resources targeted by DSM and vulnerability of associated ecosystems in the Pacific region

The characteristics and the vulnerability of the three main mineral ecosystems to be mined in the Pacific region (SPREP, 2020) are the following:

- *Ferro-manganese polymetallic nodules* are rock concretions, 4–14cm in diameter and variable in shape (Hein et al., 2015). They are generally found on the seafloor or buried in extensive fine sediment-covered abyssal plains and hills between 3500m and 6500m depth. Polymetallic nodules are composed primarily of concentric layers of iron and manganese oxides/hydroxides enriched with a variety of metals including Mn, Fe, Cu, Ni, Co, Pb and Zn (Mero, 1965). The growth of polymetallic nodules is relatively very slow. Nodules originate when precipitation occurs concentrically around a pre-existing nucleus (e.g. a shark's tooth/lithic fragment) and accretes at a rate of c. 1–10mm per million years (hydrogenetic nodules) or 1–300mm per year (diagenetic nodules). The most commercially important nodule deposit in the world oceans is located in international waters, in the Clarion Clipperton Fracture Zone (CCZ) within the North East tropical Pacific Ocean. This area has been assessed to contain more nickel, manganese and cobalt than all terrestrial resources combined (Halbach et al, 1988; Bernhard and Blissenbach, 1988; Hein et al, 2020). The CCZ includes the highest density of seabed mineral exploration licences on the planet. Other areas of potential interest are the Central Indian Ocean basin and the Economic Exclusive Zones (EEZs) of the Cook Islands, Kiribati and French Polynesia (Cronan and Hodkinson, 1989; Hein et al., 2013; SPC, 2013).

The biological parameters of polymetallic nodule associated ecosystems generally correspond to those characterizing abyssal benthic faunal communities, which are relatively slow with longer life spans and smaller biomasses. There is an adaptation to deep sea environment with true deep sea species with reproductive viability and durable radiations of species (Van Reusel et al., 2016). A series of preferential habitats for megafaunal assemblages have been identified in the CCZ ranked according to nodule coverage, slope degree, topography and currents as emphasized by a factor analysis of Reciprocal Averaging (Tilot, 2006). These results were confirmed by Vanreusel et al. (2016) with suspension feeders and detritus feeders prevalent in nodule areas. However, information is lacking on sensitivity to spatial-scale dependence of recolonization of benthic communities (Tilot, 2019).

Vulnerability of polymetallic nodule associated ecosystems to DSM

During the collection of polymetallic nodules on the seabed, impact would generate a sediment plume and noise close to the seabed in the abyssopelagic domain (5000-3000m), a plume and noise would then occur during the dewatering phase in the bathypelagic domain (3000-1000m), the mesopelagic (1000-200m), and epipelagic domains (200m-surface) where are marine mammal populations, deep sea fishers, commercial fishers (meso and bathypelagics). Diel vertical migration of marine species in general would also be affected as well as all biological, physiological and sensorial processes enabling communication (bioluminescence), feeding and reproduction (Miller et al., 2018). Deep sea communities associated with polymetallic nodules are predicted to be quite sensitive to environmental changes and in particular to hyper-sedimentation as expected by mining the seafloor. As detailed studies show that benthic habitats display heterogeneity at scales of 10 to 100m, terrain knowledge is necessary when engaging in nodule resource abundance assessment and predicting the scale of the impact of hyper-sedimentation during mining operations (Tilot, 2010; Peukert et al., 2018; Tilot et al., 2018). The spatial extent of direct mining impacts is estimated to be 300 to 600km^2 per year per contractor for manganese nodule mining (Oebius et al., 2001). Collector plume modelling to date suggests that the area of seafloor indirectly impacted would be many times larger (Aleynik et al., 2017; Jones et al., 2017; Gillard, 2019). The lack of data on spatial and temporal species distribution signifies that the full impact of mining on species is unknown (Miller et al., 2018; Tilot et al., 2018).

The recovery time of a reorganization of food webs would take longer in view of the slowness of biological mechanisms and the fact that the relatively high biodiversity of this ecosystem relies principally on the dependence of sessile fauna and epifauna to nodule deposits (Tilot, 2010). The associated ecosystem would probably be permanently altered by the fact that polymetallic nodules take such a long time to grow, if ever still possible. The impact of mining operations in the water column would be greater where water masses have been assessed as highly sensitive (Catala et al., 2015). In the CCZ, these are located in two bathymetric zones, from 500m to1500m with water masses characterized by a great molecular diversity and from 1800m to 3500m were the oldest water masses of the oceans have been identified (Tilot et al., 2018). At around 4000-6000m depth in the CCZ, bottom currents are variable, from 1-2cm/sec to 25cm/sec and more in the case of benthic storms and other events impinging on the sediment surface and associated faunal communities.

- *Cobalt-rich ferro-manganese crusts or Cobalt Rich Crusts (CRCs)* are located on seamounts, intra-plate volcanoes, volcanic chains and on volcanic or carbonate platforms from approximately 400m to 7000m depth. Cobalt-rich crusts are formed by layers of iron and manganese oxides enriched with metals such as Co, Fe, Mg, Ti, Ni, Pl and Rare Earth Elements (REE). CRCs originate by chemical precipitation and form very slowly from 1 to 6mm per million years. Most CRC's of economic interest are between 800m and 2500m depth (He et al., 2011; Hein et al., 2013, Hein and Petersen, 2014). There would be around 11 000 seamounts with CRCs in the Pacific Ocean (Yesson et al., 2011a; 2011b; Beaulieu, 2010). CRC's are particularly abundant close to the Federated States of Micronesia, Marshall Islands, Kiribati, Tuvalu, Cook Islands, and French Polynesia (Cronan and Hodkinson, 1989). The most prospective area for cobalt crusts is located in the Magellan Seamounts in the Pacific Ocean, east of Japan and the Mariana Islands (Cronan, 1984; von Stackelberg et al., 1984; Heinand Koschinsky, 2014).

Cobalt-rich associated biotopes are hot spots of marine biodiversity due to the fact that these are generally located on seamounts where topography, hydrodynamism and upwelling processes favour transport and trapping of nutrients. Isolated seamount hotspots would induce important speciation, endemism and higher abundance. Seamounts play a major role as stepping stones for population dynamics, biological connection and colonization. Moreover, seamounts attract a large trophic chain in particular bentho-pelagic communities often targeted by fisheries, a competing interest to DSM (Clark et al., 2016).

Vulnerability of CRC associated ecosystems to DSM

The vulnerability of crust ecosystems is high as sessile organisms are characterized by slow biological processes, long life spans, slow growth rates, genetic isolation and for most, a low dispersion rate of larvae, reasons for which seamounts have been considered globally as Vulnerable Marine Ecosystems (VMEs) to be managed accordingly (Watling and Auster, 2017). These characteristics imply that the impact of mining on relatively small areas could lead to the extinction of these biocenoses (Tilot, 2013; Levin et al., 2016; Watling and Auster, 2017). CRC mining may also cause benthic, mesopelagic (200–1,000 m) and bathypelagic (1,000–4,000 m) fish mortality (Gollner et al., 2017), based on studies on the impact of deep sea trawling on seamounts. The cumulative effects of natural impacts and other anthropic activities on the seabed and in the water column, such as fishing, are not well known but would be assessed as high. The spatial extent of direct mining impacts is estimated to be tens of km^2 for crust-mining (He et al., 2011). The area impacted indirectly would be many times larger (Gillard et al. 2019; Aleynik et al., 2017).

- *Seafloor massive sulphide (SMS) deposits* originate from hydrothermal activity in active tectonic settings such as volcanic arcs, back-arcs and Mid-Ocean Ridges (Dyment et al., 2014). The main metals are copper, iron and gold with small quantities of silver and zinc (Hannington et al., 2005, 2010, 2011). These polymetallic sulphides occur at depths of between 1000 and 4000m depth in average. SMS deposits require a long-lived hydrothermal system (several million to several hundred million years) (Boschen et al., 2013). They are distributed in small, discontinuous areas, (several $100m^2$) and strictly associated with emissions at hydrothermal vents emitting at high temperatures (350°C) that vary in time and space. Within the Pacific Islands region, SMS deposits are most abundant in the EEZs of Papua New Guinea, Solomon Islands, Vanuatu, Fiji, Tonga, and New Zealand, but not in the Cook Islands EEZ (SPC, 2013). The SMS chimio-synthetic microorganisms and bacteria (free or symbiotic) are the basis of the food chain. Associated faunal communities have narrow ecological niches within variations of physical parameters (T°C, pH, H_2S, CO_2, O_2) at hydrothermal vents (Martin et al., 2008; Tyler et al., 2003).

Globally, hydrothermal ecosystems are unstable (smokers, active sites, diffuse vents) with a life span of organisms relatively short and very fast growth and reproduction rates (approximately 6 months). Their biomass is very important and can reach several kg/m^2 (1000 to 10 000 times the biomass in proximate areas). Species richness is relatively poor, as most species are strictly restricted to hydrothermal habitats with 95% endemism (Wolff, 2005). Genetic flux is principally ensured by the propagation of large numbers of larvae, as most adults are characterized by small dispersal capacities. Complex bottom current patterns, local topography, such as discontinuity of transform faults along ocean ridges, and distances between sites are barriers to genetic flux and thus delineate biogeographical provinces (Van Dover et al., 2002).

Vulnerability of SMSs to DSM

Van Dover (2010) estimates that mining would alter the distribution of vents but the mineral component of chimneys could reform quite rapidly in an active zone (a growth of 40cm over 5 days has been recorded in the East pacific Rise (Hekinian et al., 1983)), however, it is unknown how long it would take for the recovery of the vent-associated ecosystem (Van Dover, 2010). Despite the fact that these species are adapted to rapid extinctions and recolonizations, the exploitation of a total hydrothermal area would interrupt the genetic flux and hinder any recolonization. As well, a highly repetitive exploitation of the mineral resources would not leave enough time for the species to complete their life cycle (Boschen et al., 2013; Van Dover, 2010; 2014). A hydrothermal vent operation could discharge $22\,000m^3$ to $38\,000m^3$ of material and sediment plume over the lifetime of one operation (Hoagland et al., 2010; Okamoto et al., 2019). These discharges could run continuously for up to 30 years, producing 500 000 000 m^3 of discharge over the lifetime of one minesite. The spatial extent of direct mining impacts is estimated to be tens of km^2 for sulfide mining (Van Dover et al., 2018).

In summary, DSM would probably have a considerable negative biological impact on a long term and at a regional scale, on the deep sea floor, overall the water column, the surface and the air over the ocean (Tilot, 2006; 2010; Miller et al., 2018). The changes to the seabed and overlying water-column that would be brought by mining activities would inevitably impact all faunal communities present including those in pelagic ecosystems, in particular targeted species and activities as stressed in the previous section (ASOM, 2011; Tilot, 2011; JPI, 2016; Tilot, 2016; Niner et al., 2018; Tilot et al., 2018; Tilot, 2019; Christiansen et al., 2019; Drazen et al., 2020). Mining-generated plumes may cause distress by their toxicity, reducing feeding, communication, causing buoyancy issues and by clogging respiratory and olfactory surfaces in particular for suspension feeders (Miller et al., 2018; Wilber and Clarke, 2001). At a population level, it could induce changes in community composition, emigration, decreased fitness and reproduction and at a certain level of discharge, it could cause mortality or irreversible changes to the community structure with the complete removal of the substrate (Miller et al., 2018). The discharge of metals and toxins into the mesopelagic zone could contaminate seafood, impact fisheries, carbon transport and biodiversity in general (Blum et al., 2013; Miller et al., 2018). Sediment plumes will also absorb light and change backscatter properties, reducing visual communication and bioluminescent signaling that are essential for prey-capture and reproduction in midwater animals (Haddock et al., 2010). The temperature of seawater would increase when return water would be pumped back into the sea (Miller et al., 2018). Noise from mining activities could cause physiological stress or interfere with larval settlement (Lin et al., 2019), foraging, and communication, such as by marine mammals (Gomez et al., 2016). Concerning water masses and ocean circulation, there would most probably be long lasting impacts of sediments plumes and noise leading to massive reductions in ecosystem services (Drazen et al., 2020; Rolinski et al., 2001) with multiple effects due to complexity, seasonal variations and global change. The low oxygen values of the thermohaline and intermediate waters would hinder the organic material decomposition, thus increase the sinking rates to the ocean floor.

On the seabed, due to limited nutrients sinking down from the surface, faunal communities are characterized as taxonomically highly diverse and distributed non-randomly over large areas. Recent research evidences rapid adaptation to variable trophic input and an opportunistic behaviour. Thus abyssal fauna is quite vulnerable to any change, presently it is affected by climate change with a reduction of Primary production and carbon export to the deep sea (Levin et al., 2018). The characteristics of an extreme environment may become harsher to fauna to survive with alternative states of the environment after impact (Tilot, 2016).

Furthermore, as technologies of extraction are not totally finalized, impacts cannot be correctly assessed on spatio-temporal scales. One must consider cumulative impacts, within the water column and the seabed, with both natural impacts (natural climate variation, El Niño events, earthquakes, tsunamis, underwater vulcanism, benthic storms..) and anthropogenic disturbances (pollution, fishing, seabed mining, oil and gas extraction, disposal of wastes...) generally resulting in degradation and homogenization of habitats across broad tridimensional areas (Glover and Smith, 2003; Smith et al., 2008; Thiel, 2003; Tilot, 2010; Woodall et al., 2014; Levin et al., 2016; Gollner et al., 2017; Van Dover et al., 2017; Miller et al., 2018). One would have to test the response of abyssal fauna to Deep Sea Mining activities and identify thresholds of impact for survivors and reorganization of food chains (Tilot et al., 2018; Tilot, 2019).

4. Traditional knowledge, visions and interests regarding marine resources and DSM in the Pacific Island Countries

Following the recognition by the UNCLOS of the special regimes of archipelagic waters (Part IV) and the EEZ (Part V), the Pacific transformed from islands in “a far sea” to a “sea of islands”. This last term is drawn from Epeli Hau’ofa, an islander who grew up in Papua New Guinea, Tonga and Fiji. Hau’ofa addressed the European framing of the islands as being about mentality as much as maps. The old map of tiny specks in a vast expanse of blue gives way to “a sea of islands” with all big nations in a connected “new Oceania” that the social networks call “the ocean in us” (Hau’ofa, 1992). The nexus of Islander’s identity in terms of belonging and connection according to Hau’ofa (1994) reminisces the traditional perspective of the first seafarers (Carson, 2018). These navigators would have conquered the Pacific in island-hopping voyages starting from Taiwan, a theory confirmed by extensive genomic analysis and the Austronesian language dispersal (Soares et al., 2016; Skoglund et al., 2016).

The Oceanian Peoples, the “people of the sea” (D’Arcy, 2006), are proficient navigators capable of reaching in giant outrigger canoes the different archipelagos, establishing colonies or maintaining trade with distant lands, relying on their intimate knowledge of marine species and processes (among other natural elements) to guide their voyages (Gooley, 2016; Kuhn, 2008; Lewis, 1972). Numerous Pacific Island Countries still practice the traditional art of navigating, using only one’s senses and knowledge passed by oral tradition from master to apprentice, by memorizing the motion of specific stars, reading the shape of clouds, the colors of the sea, recording wildlife species, the shape of waves, currents and water temperature, in summary, using a “sensory ecology of ocean navigation” (Lohmann et al., 2008). This would resemble the sensory navigation used by migrating species in open seas such as sea turtles, sharks and cetaceans (Lohmann et al., 2008). It is also a way to show the deep connection to Nature of the Oceanian Peoples. These navigation routes were represented by ancient polynesian stick charts and by star compasses displayed by shells on sand (Figures 3 and 4). These ancient navigation means appeared to be far more sophisticated in the Marshall Islands than present navigation with sextant, compass and maps (Romm, 2015).

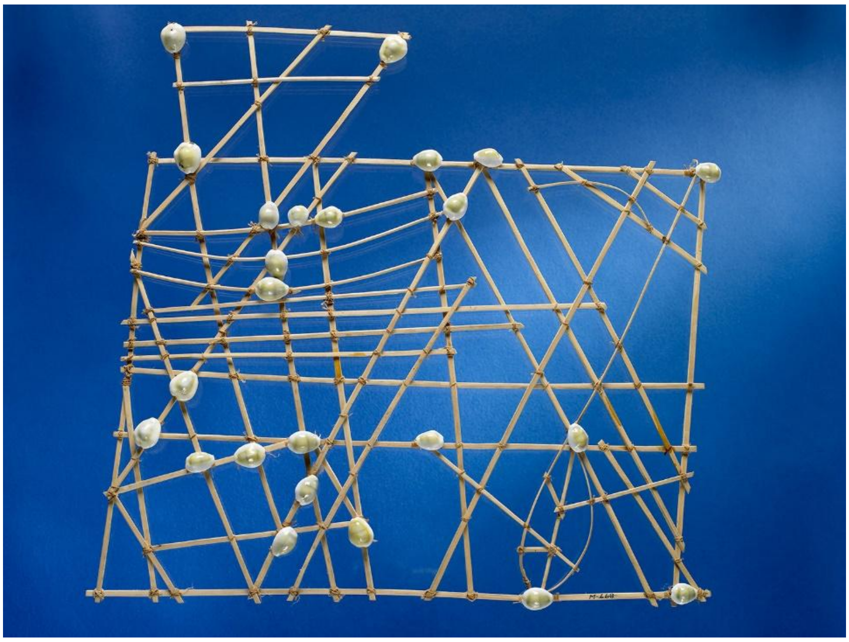

Figure 3. Ancient Polynesian stick chart using a sensory ecology of ocean navigation. The shells indicate islands or island groups. The sticks show ocean swells and their direction (with swell refraction patterns around an island). Photo E398227, Department of Anthropology, Smithsonian Institution, Photo by Donald E. Hurlbert.

Figure 4. Star compass of Mau Piailug, a famous micronesian navigator, taught in the Caroline Islands, with North at top. The "compass" that Mau Piailug carried was not magnetic but a mental model of where islands are located and the star points that one could use to navigate between them. This mental model would have taken years of study to build; dances, chants (rong) and stories help the navigator to recall complex relationships of geography and location. The stars give him highly reliable position information when visible, but navigators such as Mau Piailug managed to keep their position and tracks in mind even when blocked by clouds, using other references such as wind and swell as proxies (Thompson, 2007). The Photo represents a re-creation with shells on sand, with Satawalese (Trukic) text labels (Star Compasses from the Polynesian Voyaging Society).

Polynesians are said to have one of the richest, most diverse and complex collections of mythological tales and legends. There is also a spiritual connection, such as for the aboriginals of Australia on land and the Torres Straits Islander peoples, who have navigated their way across the lands and seas using paths called songlines or dreaming tracks. A songline is based around the creator beings and their formation of the lands and waters during the "Dreaming" (creation of earth) (James, 2016; Norris and Harney, 2014).

In Oceania, there is an ancestor veneration which has for role to cultivate kinship and continuity of family lineage. Depending on their lives, accomplishments, lineages and importance, deceased humans can become guardian spirits or family gods (aumakua in Hawaiian) for their clans. Many creatures can be guardian spirits (Figure 5), some are emblematic for certain island nations such as octopuses (*Na kika* in the Gilbert islands), turtles (*Tabakea* in Samoa), eels (*Riki* in Samoa), sharks *(Dakuwaqa* in Fidji), whales (*Tangaroa* for Maori) (Grimble, 2019; Loebel-Fried, 2002).

Figure 5. An etching called « Dokeran » produced in 2008 by Dennis Nona, a fisherman and a professional artist of Torres Strait. Dokeran is the story of a fisherman that has been transformed into a rock by a spirit that was in a turtle that he captured. This rock is now a sacred site on Badu island. Courtesy Dennis Nona/www.artsdaustralie.com.

The core expression of today's regionalism, the 'Blue Pacific', is built on Epeli's 'new Oceania' and the social networks he called 'the ocean in us', drawing on other indigenous thinkers (Wendt, 1976; Waddell, 2000). Shortly after the independence of most of Pacific

Island States, the Fijian Prime Minister Ratu Mara (1920-2004) advocated the concept of "Pacific Way", a cultural norm elevated to the political level during UNCLOS III negotiations (1973-1982) (Wallace et al., 1998). It promotes shared local values, including the respect for the *Vanua* encompassing the sea, and relies on a "unanimous" mode of decision-making, that stems from facilitative dialogue among the members of the community (Haas, 1992; Mara, 1997; see also the Talanoa dialogue within the framework of the 1992 United Nations Framework Convention on Climate Change). For generations, this "oceanian way of being" has helped islanders transmit their identity and unique relationship to each other and to their environment, taking a variety of forms, not always directly tied to nature (Bambridge, 2016). Myths, oral traditions and, cosmologies of the Samoan, Cook islander, Niuean, Tokelau, Kiribati, Fijian, Tongan, Maori (from Aotearoa- New Zealand), native Hawaiian, Kanak, M¯a'ohi (in French Polynesia), Ni-Vanuatu, Solomons and, Papuan peoples show that they conceived their world in holistic terms, dissolving classic western distinctions between human and non-human, nature and culture, as objects (Figures 5 and 6).

The Oceanian understandings of the world or "tidal thoughts" in most Pacific Islands emphasize relations regarding the land and surrounding waters as a continuum, a whole, including animals and peoples (Bambridge, 2016; Bambridge et al., 2021). The peoples of Oceania came to develop an understanding of the fragility of marine environments (Fache et al., 2016; Mawyer and Jacka, 2018; Bambridge et al., 2021). A sustainable practice in traditional Oceanic terms requires sufficient knowledge of the resource to understand how its exploitation will affect surrounding life cycles. In Papua New Guinea for example, it corresponds to a relational ontology that defines "beings", "spirits" and "nature" as co-shapers of the *graun* (the world or the cosmos) and not of separate realms (Childs, 2019).

Figure 6. An etching (216x513cm) called « Mutuk » produced in 2008 by Dennis Nona, a fisherman and a professional artist of Torres Strait. Mutuk is a traditional legend unique to the artist's island of Badu. It depicts the continuum between visible and invisible word, the close connection between living humans and deceased, marine animals and the spirits of the sea. Australian National Maritime Museum (ANMM).

5. The traditional perspective of marine resource management in the Pacific Island States

In many of the Pacific Islands, local communities have traditional, cultural and spiritual attachments to the sea, in particular to species and specific marine areas, processes, habitats, reefs, islands and natural formations. Centuries of acquaintance with the interconnectivity of terrestrial and marine ecosystems underlay traditional indigenous knowledge, and constitute keystones to holistic forms of marine resource management. These adaptive management techniques, practices and forms generally preserve or protect areas in an equitable manner and vastly precede their earliest formulations in Western models for marine conservation. Also traditional knowledge and customary management are not static but adapt according to ecological, societal and economic changes (Johannes, 1998, Govan et al, 2008, Veitayaki et al., 2011, Bambridge, 2016).

The most important marine conservation measure in Oceania was local marine tenure, where the right to fish in a location was controlled by a clan, chief or family (Johannes, 1978; Ruddle et al., 1992). Spatial closures within these tenure systems were employed throughout Oceania for various purposes, and these closures were often imposed to ensure large catches for special events or as a cache for when resources in the commonly accessed fishing grounds ran low (Johannes, 1978; Cinner et al., 2006). Temporal closures were widely used to reduce intensive harvest of spawning fishes or other predictable aggregations (e.g., migration routes) (Johannes, 1978; 1981). These customary practices include seasonal bans on harvesting, temporary closed (no-take) areas, and restrictions being placed on certain times, places, species or classes of persons. Closed areas include the “tabu” areas of Fiji, Vanuatu and Kiribati, the “ra’ui” in the Cook Islands, the “kapu” in Hawaii, the “tambu” in PNG, the “bul” in Palau, the “mo” in the Marshall Islands, the “tapu” in Tonga and the “rahui” in New Zealand (Mori). The “tabu” or “tapu” would design a permanent prohibition associated to an intrinsic sacralization and the “rāhui” or “ra’ui” concept would be a temporary ban on resources (or resource areas) expressing a political power rather than a control on these resources in an ecological perspective, e.g., from having free access either to food resources or to land and water (Bambridge et al., 2019).

In order to ensure the ongoing well-being of the people and their environment, these unwritten rules are often used to revive or build up stocks, in anticipation of upcoming celebrations or food shortages (Vieux et al., 2004). These concepts cover a complex system of communautary rules and prohibitions in many Pacific Island traditions and uses such as in Fiji, Samoa, Kiribati, Rapanui, Tahiti, Hawaii, Vanuatu and Tonga. Supernatural sanctions could rise if contravening to these traditional institutions (Grey, 2019; Juster, 2016; Mead, 2003; Love, 2021). Some traditional management systems are highly consistent with the ecosystem approach, presently recommended in science-based area mangement, such as the Hawaiian “ahupua’a” where extended elements of Hawaiian spirituality are integrated into the natural landscape. This same approach is observed as well with the Yap “tabinau”, the

Fijian “vanua”, the Marovo “puava” of the Solomon Islands and the “tapere” in the Cook Islands (Ruddle and Hickey, 2008).

The cultural and spiritual values associated with the natural environment and an important and respectful interaction with Nature has led to a Universal Declaration on the Rights of Nature, with a shared vision for collective action on global challenges. Community territory and property rights have extended to the sea in a habit of sustainable management of marine resources over generations (Pratt and Govan 2010). Maritime cultures often traverse territorial boundaries to form fluid and mobile networks with little adherence to demarcations drawn by administrators or conservationists (Acton et al. 2019).

Thus from Oceanian IPLCs perspective, DSM is not distanced from the island environment because the ocean is at the heart of one’s identity, and part of each individual’s future (Hau’ofa, 1994, 2008; Mawyer and Jacka, 2018). For example, *Lavongai* communities from New Hanover Island in Papua New Guinea, living several kilometers away from the Solwara 1 marine mineral deposit where *Nautilus Minerals Inc.* invested in a commercial seafloor massive sulfide mining, expressed their concern, when consulted on their perspective of future DSM activities, that they would not be able to join their ancestors after death anymore, as the place where spirits are supposed to pass over was located within the targeted area (Navarre and Lammens, 2017). These communities also claimed that DSM could alter the development of shark populations and thereby affect a traditional fishing practice, known as “shark calling”, an indigenous rite of passage from Papua New Guinea in which young men lure sharks from the deep using magic to catch and kill them bare-handed (Messner, 1990).

During the 1990s, in the context of an international funded project for assessing economic impact of natural resource conservation in the Pacific Island coastal waters, sites were identified with activities involving local communities for their management practices with objectives of sustainable use of marine resources with Marine Managed Areas (MMAs) (Jeudy de Grissac, 2003; Govan et al., 2009). In 2000, a network of 743 MMAs has been recorded among which 565 Locally Managed Marine Areas (LMMAs) (Jupiter et al., 2014). In this perspective, the denominated Polynesia Mana Node (Cook Islands, French Polynesia, Kiribati, Niue, Tokelau, Tonga, and Wallis and Futuna) includes a network of marine protected areas (MPAs) in the coral reef areas where local populations participate, reviving their culture and traditions as a basis for sustainable reef management (Tilot et al., 2021a). Today the network of LMMAs includes community members, land owning groups, traditional leaders, elected decision-makers, conservation staff, university scientists and researchers and donors who promote a diverse range of objectives, including biodiversity conservation, fisheries management, livelihood diversification, and climate change adaptation (Govan et al., 2008; 2009; Jeudy de Grissac, 2016; Weeks and Jupiter, 2013).

Furthermore, the first Large-Scale no-take MPAs (LSMPAs) and shark sanctuaries in the Pacific region have been initiated in the mid-2000s (Toonen et al., 2013; Wilhelm et al., 2014). These LSMPAs offer benefits that are not obtainable at smaller scales, primarily the ability to protect whole ecosystems and interdependent habitats so that biologically connected ecosystems can be included within the same management area (Toonen et al., 2013). Large no-take LSMPAs have been established in several areas (e.g., Hawai'i and US Pacific, Palau, Pitcairn, Kiribati), while a few jurisdictions have declared or promised to create their entire EEZs as multi-use LSMPAs (O'Leary et al., 2018). These actions have for objective to comply with their international commitments with regard to protecting marine ecosystems, to seek international recognition through environmental issues, or to increase control over their EEZ with regard to illegal fishing pressure (Leenhardt et al. 2013; Giron, 2016). The LSMPAs created after 2006 are mainly positioned on areas with high geostrategic stakes, notably in relation to the Asia-Pacific maritime pivot on tuna fisheries (Giron, 2016) or the presently denominated political Indo-Pacific pivot (Heiduk and Wacker, 2020).

The "Papahānaumokuākea Marine National Monument" (/whc.unesco.org/en/list/1326/) is a LSMPA in Hawaiian waters that protects sacred cultural sites on the islands of Nihoa and Mokumanamana, the latter having spiritual significance in Hawaiian cosmology (Kikiloi, 2010). Many Pacific Island countries have protected whales, often considered sacred, within their waters by creating whale sanctuaries which cover now more than 30 million km^2 of the South Pacific Ocean, encompassing the EEZs of 11 South Pacific countries, including Important Marine Mammal Areas (IMMA) (Figure 7). This largest whale sanctuary in the world represents a global blueprint for whale conservation and the management of shared resources[2]. Pacific Island Countries have demonstrated their commitment to whale conservation by joining a variety of international agreements promoting the conservation of whales, including the Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands[3]. Whale-watching, as an industry in the Pacific, is growing much faster than whale numbers are recovering and is proving to be by far the most lucrative use of whales (Hoyt, 1995), with the added attraction of doing them no harm, provided that the operations are well managed (Surma and Pitcher, 2015). As well, numerous shark sanctuaries are located in the Pacific Region, in New Caledonia, Tokelau, Samoa, Cook Islands, French Polynesia, Palau, Micronesia, Marshall Islands, Kiribati (Atlas of Marine Protection (mpatlas.org), Marine Conservation Institute). The first regional shark sanctuary in the world is in Micronesia (https://www.pewtrusts.org).

All these traditional management practices and tools could presently be considered as Other Effective area-based Conservation Measures (OECMs) as designated in the Aichi biodiversity target 11, concerning terrestrial and marine conservation, adopted in 2010 as part of the Strategic Plan for Biodiversity 2011-2020 by the Parties to the Convention on Biological Diversity (CBD) (Jeudy de Grissac, 2016). They are not an alternative but complementary to MPAs, in particular in countries where the central administration is far

[2] Available online at: https://www.wwfpacific.org/what_we_do/species/whales (accessed 30 April 2021)
[3] Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands, adopted in 2006 (https://www.cms.int/sites/default/files/document/Inf_03_PacificCetaceans_MoU%26AP_0.pdf, accessed April 20, 2021) (accessed 30 April 2021).

from local preoccupations, the national legislation is incomplete and where there is a lack of implementation on marine conservation aspects.

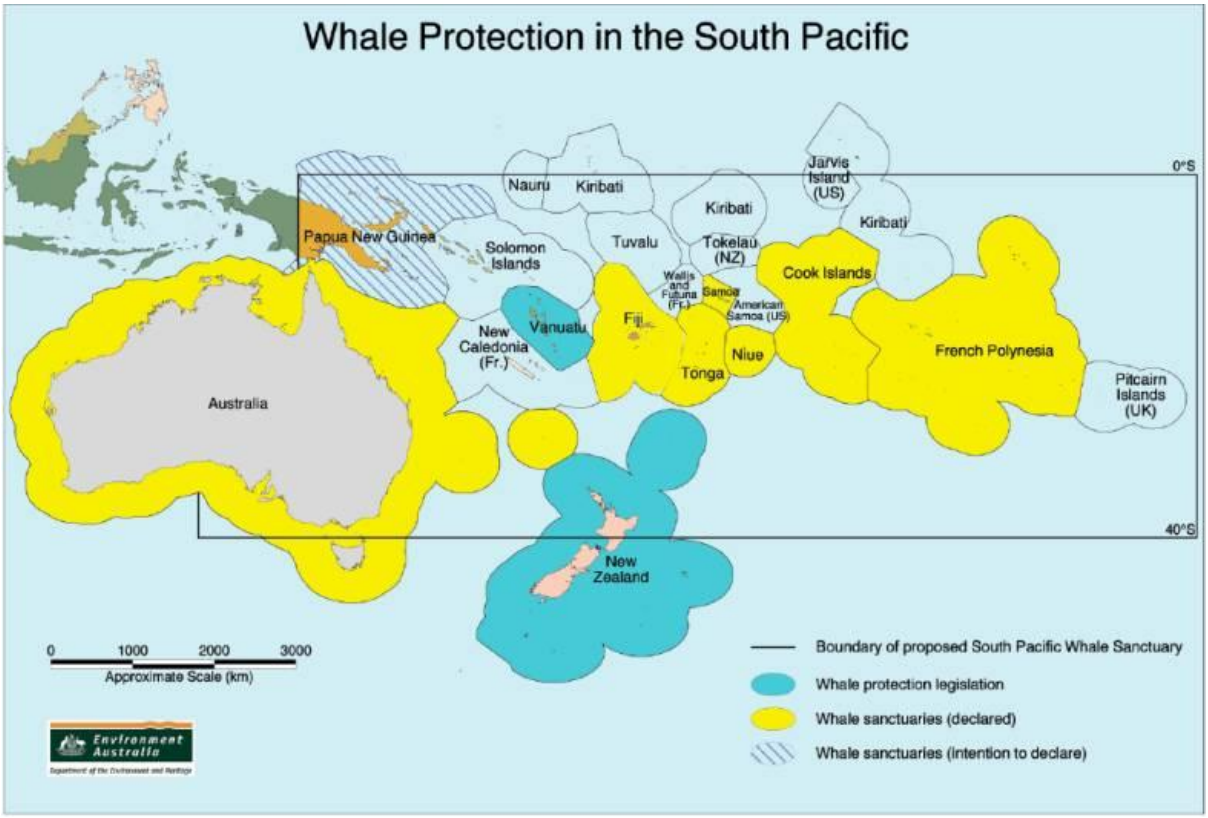

Figure 7. Map of Whale protection in the South Pacific including areas under whale protection legislation, declared whale sanctuaries and those that are in the process to be declared (source: Environment Australia).

In the recent years, the Pacific Island States have collectively established some of the world's most sophisticated and highly collaborative conservation and management tools. Through the establishment of cooperative capacity building institutions, these island states, characterized by minimal institutional capacity and large maritime domains, provide an important example of the benefits of regional and sub-regional cooperative approaches (Jeudy de Grissac, pers. comm.). Clearly, traditional knowledge and community-based marine managed areas have a central role to play in complementing science-based tools in the protection of the cultural and biological biodiversity and reaching national, regional and international targets related to conservation and the sustainable use of the biodiversity (Tuquiri, 2001; SPC, 2005; Jeudy de Grissac, 2016; Friedlander and Gaymer, 2020). In particular, the traditional knowledge role is explicitly recognized in the CBD work programme of island biodiversity[4], in the development of the Nagoya protocol on Access to Genetic resources and the Fair and Equitable Benefit-Sharing, in the designation of Ecologically or Biologically Significant Marine Areas (EBSAs) and in the development of an international legally binding instrument under the UNCLOS on the conservation and sustainable use of marine Biological diversity of areas Beyond National Jurisdiction (BBNJ) (Mulalap et al., 2020). As well, it is included in

[4]Available online at: https://www.cbd.int/island/ (accessed 16June 2021)

the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) assessments to strengthen the science-policy interface for biodiversity, long-term human well-being and sustainable development, in fisheries management (FAO, 2017) and in climate change action (Paris Agreement) (DOSI, 2021). Incorporating knowledge systems, biocultural approaches enables adaptive management and resilience in the face of environmental, social and economic change (Sterling et al., 2017) and increases the chances of long-term success of conservation interventions (Gavin et al.,2015; Jeudy de Grissac, 2015; 2016; DOSI, 2021).

6. Integration of traditional dimensions into regulatory frameworks on seabed mining in the Pacific

The wide array of activities which we refer to as DSM are not governed by one universal framework, but rather by an extensive set of legal instruments. The United Nations Convention on the Law of the Sea (UNCLOS, 1982)[5] sets out the overarching regime, but important distinctions must be made depending on the marine space (within and beyond the limits of national jurisdiction), the activities conducted (prospecting, exploration, exploitation) and the type of resources. As mentioned earlier, the seabed and subsoil beyond national jurisdiction are referred to as 'the Area' and are governed by a comprehensive international regime: the fundamental principles are contained in UNCLOS and the 1994 Implementation Agreement, while the more detailed rules are elaborated in the 'Mining Code', comprising the relevant regulations, standards, guidelines and procedures adopted by the ISA[6]. The ISA has currently issued regulations for the first phases of mining activities (prospecting and exploration), divided into separate sets for three distinct categories of resources, viz, polymetallic nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts (ISA, 2010, 2012, 2013), but has yet to adopt exploitation regulations (ISA, 2019a). Moreover, taking into account that non-state actors conducting deep sea mining operations in the Area must be sponsored by a state, national legislation, defining the conditions to obtain and maintain a certificate of sponsorship from the sponsoring state, would also play an important role (Willaert, 2020a).

When taking place on the continental shelf, which comprises the seabed and subsoil beyond the territorial sea up to a distance of 200 nautical miles from the baselines (and may be extended to the outer edge of the continental margin when this exceeds the stipulated 200 nautical miles) (UNCLOS, Art. 76), deep sea mining activities would fall under national jurisdiction and will be governed by the domestic law of the coastal state, which posesses exclusive sovereign rights over the natural resources that are located there[7].

[5] UNCLOS was signed on 10 December 1982 by 119 States and entered into force on 16 November 1994. It has 168 State parties as of May 2021: United Nations Treaty Series vol. 1833, p. 3.

[6] For more information, see https://www.isa.org.jm/mining-code.

[7] See infra, section 5

Zooming in on the integration of traditional dimensions in this extensive collection of regulatory frameworks, a number of encouraging examples can be identified. For instance, the 2017 Marae Moana Act of the Cook Islands created a multiple-use marine park “Marae Moana” (which can be translated as “ocean sanctuary”), encompassing their entire territorial sea and EEZ of almost 2 million km², that serves to protect and conserve the ecology, biodiversity and heritage values of the Cook Islands marine environment (IUCN, 2018; Willaert, 2021). Among others, it reinvigorates the local practice of “ra’ui” by designating marine protected areas around each of the fifteen islands, reserved for the local communities and closed to seabed mineral activities. The 2019 Seabed Minerals Act also takes the visions and interests of the Cook Islanders into account by prescribing that seabed mineral activities in the Area may not result in irreparable harm to any community, environment or cultural practice in the Cook Islands (McCormack, 2016).

Furthermore, the Federated States of Micronesia (FSM) Seabed Resources Act recognizes the duty to “employ best environmental practices in accordance with prevailing international standards in order to avoid, remedy, or mitigate the adverse effects of DSM on the Environment”[8], as well as to secure Free Prior Informed Consent (FPIC) (including through compensation) “if marine or coastal users likely to be directly adversely affected by DSM Activities” are identified by the relevant governing entity at any time, including through the environmental impact assessment process[9]. Tellingly, these provisions do not specify Indigeneous Peoples or similarly situated local communities, although an argument could be made that such Peoples and communities are included as “marine or coastal users”. Especially if the reference to “prevailing international standards” in connection to best environmental practices is interpreted to include FPIC and similar rights afforded to Indigenous Peoples by international law. Such users arguably include native inhabitants of the FSM who engage in instrument-free traditional navigation on the open Ocean, perpetuating a centuries-old practice in the FSM and other Pacific Island Countries, that relies on a keen understanding of marine life and processes (Feinberg, 1995; Gladwin, 1970; Gooley, 2016; Finney, 1998; Lewis, 1972; New York Times Magazine, 2016).

On the regional level, several initiatives have also been taken. For example, the 1986 Noumea Convention for the Protection of Natural Resources and the Environment of the South Pacific Region (in force on November 24, 1990) contains an indirect reference to the cultural value of areas and the exercise of traditional customary rights in its Protocol concerning Cooperation in Combating Pollution Emergencies in the South Pacific Region. Also the Pacific-ACP States Regional Legislative and Regulatory Framework (RLRF) for Deep Sea Minerals Exploration and Exploitation, which was supported by EU funding, serves as a roadmap to guide policy-makers and government agencies of Pacific Island States towards effective legislation, taking into account the long-term interests and visions of the island communities and future generations through several provisions (Tilot et al., 2021a). It clearly acknowledges the fact that Pacific Island communities rely for their livelihoods upon

[8] FSM Seabed Resources Act of 2014, §403(a)
[9] Ibid., Seabed Resources Act of 2014, §403(d)

the sustainable use of the ocean and its resources by stating that new activities should not unduly interfere with the various existing uses (including uses relating to highly migratory marine species and marine ecosystems adjacent to areas beyond national jurisdiction), therefore promoting integrated legislative or management regimes that take into account all sea uses and their mutual impact. Fishing of – and other activities relating to – highly migratory species (such as tuna, swordfish, marlin, sailfish, spearfish, sharks, turtles and whales) and other customary rights linked to the ocean (including cultural, social, political and spiritual rights) should be respected or adequately compensated. Significant importance is also attached to transparency and public participation, in order to enhance public knowledge and to ensure that all relevant information and visions are taken into account (Kakee, 2020). Although the areas, which will be directly affected by seabed mining activities, are to be largely outside customary fishing zones, it is deemed important for all Pacific Island States to identify all customary marine tenure in their EEZ and avoid any conflicts, for example by concluding agreements with traditional leaders or local councils.

In addition, the Pacific region – through its regional organizations and in collaboration with WIPO, UNESCO and other partners – has developed a regional framework for the protection of traditional knowledge and expressions of culture, guiding the Pacific Island States towards the development of appropriate national legislation on this vital topic in close consultation with indigenous peoples and local communities. Of specific relevance to seabed resource management, "traditional biological knowledge" is defined as "knowledge whether embodied in tangible form or not, belonging to a social group and gained from having lived in close contact with nature, regarding: (a) living things, their spiritual significance, their constituent parts, their life cycles, behaviour and functions, and their effects on and interactions with other living things, including humans, and with their physical environment; (b) the physical environment; (c) the obtaining and utilizing of living or non-living things for the purpose of maintaining, facilitating or improving human life." To the extent that DSM impacts such living things, their physical environments, and/or the ways in which holders of traditional knowledge utilize them for maintaining, facilitating, or improving human life (e.g., traditional knowledge and practices pertaining to highly migratory marine species of cultural significance, as well as to open ocean traditional navigation routes), the regional framework should play a key role in addressing such impacts (Tilot et al., 2021a).

Despite these encouraging examples of traditional knowledge, practices and interests of Pacific Island communities being considered by regulatory frameworks on marine resource management and seabed mining, it has to be noted, however, that these do not weigh up against the numerous instances in relevant legal instruments where no reference is made to these elements (for examples, see Tilot et al., 2021a, especially the detailed analysis, displayed in Table 2). Thus, if adequate integration or at least consideration of traditional and indigenous dimensions and visions, would be prioritized, there is still a long road ahead. For example, the international legal framework governing seabed mining activities in the Area, which - despite its remote location - is part of the sacred ocean and may affectgui numerous marine species of cultural significance that migrate between coastal areas and high seas, contains very few provisions related to traditional knowledge and interests. Although the overarching status of the deep seabed and its mineral resources as the Common Heritage of Mankind (CHM) (article 136) reflects the idea of collective ownership and preservation for future generations, the associated measures and mechanisms have yet to be adequately implemented by the ISA (Willaert, 2020b) and no explicit references to traditional dimensions have been integrated in the Mining Code (Jaeckel et al., 2017; Bourrel et al., 2018). Moreover, overall improvements to the international regime for the deep seabed in terms of transparency and public participation – which might serve as powerful catalysts to promote the integration and consideration of traditional knowledgein the relevant legal frameworks and decision-making – are certainly desirable (Willaert, 2020c).

Nevertheless, cautious steps towards increased integration of these aspects within the international seabed regime have been taken. Indeed, the current ISA Draft Exploitation Regulations attempts to implement article 149 UNCLOS by including rules regarding the preservation of human remains or objects and sites of an archaeological or historical nature that are found in the course of deep sea mining activities, which might serve as a recognition of the cultural values and traditional dimensions attached thereto (ISA, 2019a). Moreover, a proposal regarding a template with required minimum content for Regional Environmental Management Plans (REMPs) listed traditional knowledge of IPLCs as one of the guiding principles for the development of REMPs (ISA, 2020a). Attention is paid to cultural heritage and interests by taking into account the connectivity of migratory species which are of cultural significance to indigenous peoples, traditional marine management areas and measures, as well as routes and marine features used by local communities for traditional instrument-free navigation. The ISA Council decided that the Legal and Technical Commission should take this proposal into account when further developing the guidance on the development of REMPs and a relevant template (ISA, 2020b).

Suggestions were also made to promote participation of and particular regard to 'vulnerable communities' within the context of the Environmental Compensation Fund. These suggested amendments to the Draft Exploitation Regulations were welcomed during the first part of the 26th session of the ISA Council meetings (ISA, 2020c, 2020d), and one of the delegates suggested to refer specifically to indigenous people and local communities who reside in adjacent coastal states and are likely to be impacted (ISA, 2019b).

7. Conclusion

In the Pacific Island States, "community-based" and "participatory" approaches, through the integration of "traditional" knowledge and marine tenure, have become very popular means to reconcile the issues of marine conservation, fisheries management and the development of coastal communities (Ruddle and Johannes 1989; Akimichi 1995; Pomeroy 1995; Veitayaki 2004). The traditional holistic approach of marine resources management and sustainable use has been developed for a long time by local communities of islands of the Pacific and Southeast Asia. Where the interconnected nature of island ecosystems requires a holistic, integrated management approach, customary practices with their nature-people relations continuum perspective (Bambridge, 2016), have been effective in meeting community and ecosystem goals by preventing communities from exceeding their local carrying capacity.

In many countries of the world, these traditional practices have slowly disappeared, facing both development pressures and the disintegration of cultural and social ties at the local level. The absence of a formal inclusion of these traditional practices in regulatory texts has led to their disappearance as well as the disappearance of the knowledge of the natural environment that supported them (Jeudy de Grissac, 2015). That is why, the Pacific region is unique in view of the perpetration of its holistic approach and traditional management practices of marine areas and resources where nature, communities and open ocean are interconnected or even unified, in an ontological perspective. The Pacific Island States can pave the way to react to present global issues in marine conservation and ocean governance by completing, if not inspiring, science-based strategies and methodologies in the matter (Giron, 2016; Tilot et al, 2021a).

The integration of traditional dimensions in this extensive collection of regulatory frameworks concerning DSM has been achieved at different degrees. Pacific Island States generally recognize the precautionary principle/approach as well as the applicability of prevailing standards of international law, particularly with regard to averting, minimizing, or remedying harm to the marine environment. Several Pacific Island States explicitly recognize Indigenous rights or other relevant human rights, Free Prior Informed Consent (FPIC), including in connection with consultations with potentially affected "marine or coastal users". But few of those Pacific Island States also explicitly reference Indigeneous Peoples and attendant Indigenous Rights (with the exception of FPIC), which introduces a vagueness in the legislation that could be exploited to minimize or dismiss the full application of FPIC and similar rights and considerations to IPLCs in those States (Hunter et al, 2018; Aguon and Hunter, 2019; Mamo, 2020).

The Pacific Island states could benefit from combining their resources and expertise on traditional knowledge on ocean matters to include in a regional integrated strategy, such as in the Pacific Islands Regional Ocean Policy and Framework for Integrated Strategic Action (Tuquiri, 2001; SPC, 2005), for addressing the challenges of DSM, as fostered by Lily (2016), which would include innovations, cooperative planning and the involvement of all stakeholders which would encourage partnerships and collaboration locally and internationally. DSM mitigation responses and adaptations in the Pacific Islands have to be appropriate for each of these nations. Simulations and various scenarios can be applied to explore anticipated impacts (Bradley and Swaddling, 2018).

It will likely require some legal creativity to shoehorn considerations of traditional dimensions of seabed resource management in all these Pacific Island States solely based on their relevant national DSM legislation and policies, but the "hooks" are there, if interested stakeholders wish to utilize them. The integration of traditional knowledge generated by local communities into multi-actor and multi-scale decision-making processes and governance systems still depends on variable and complex socio-ecological systems. Those systems and circumstances influence and shape the development and implementation of norms, knowledge, innovations, practices and capacities highly relevant for managing interconnectivity and extensive human activities and ecosystems, such as deep seabed mining and ecosystems, and must therefore also be addressed in that regard.

A balance between all competing interests must be struck, and the environmental, social and cultural costs should not outweigh the potential benefits and the HWSL of the island communities. Admittedly, the potential conflicts arising out of seabed mining activities are numerous and significant, but there also seem to be ample opportunities for symbiosis, given the traditional approaches concerning marine resource management of the Pacific island communities. Therefore, if the interests and visions of the Pacific islanders are duly taken into account, this might lead to a balanced regime that reconciles the concerns and needs of all stakeholders.

The traditional knowledge is based on the Oceanian understanding or “tidal thoughts” of the world in most Pacific Island States regarding the land and the oceans as a continuum, a whole including animals and peoples (Bambridge et al., 2021). This concept is well in phase with the present science-based integrated approach of socio-ecological interconnectivity to marine environment management and governance and, therefore would be an added value to the present unifying vision of the Systems View of Life (Capra and Luisi, 2014).

Indeed, the holistic, integrated and trans-disciplinary approach is proven to better address global challenges such as global climate change, energy security, ecological degradation, environmental threats to human health and resource scarcity in a sustainable perspective, assessing the marine environment according to its environmental, economic and social values. The unifying vision was promoted in the mid-1980s by many international scientific organizations, in 1987 by the Brundtland Commission’s report “Our Common Future”, in the “Agenda 21” plan that emerged from the United Nations Conference on Environment and Development in 1992 and further developed at the World Summit on Sustainable Development held in Johannesburg in 2002. This new approach of sustainability science has for objective to understand the integrated “whole” of planetary and human systems by means of cooperation between scientific, social and economic disciplines, public and private sectors, academia and government to improve linkages between relevant research and innovation communities and relevant policy and management communities and foster shared prosperity and reduced poverty while protecting the environment.

If responsibility, openness and interconnection are indeed to be the watchwords of progress in the 21st century (Kacenelenbogen, 2010; 2017), then these concepts should be paramount in guiding the design of a pertinent – that is, inclusive and based on a recognition of the politics of mining as “embedded in a world of things, bodies, networks and socio-economic relations” (Bakker and Bridge, 2006) – regulatory framework establishing standards and guidelines for deep sea mining. An essential first step in that direction would be to consider the vast oceanic space as not only bursting with precious (and, for the most part, unknown) life, but also as a highly social and political locus, a “voluminous” (Bridge, 2013; Elden, 2013) or "ontological" space, that is, a political – even *moral* – actor in its own right (Steinberg and Peters, 2015, Lehman 2013).

RECOMMENDED ACTIONS

We have integrated here some of the recommendations on the topic from a recent publication (Tilot et al., 2021a) and from a policy brief on the topic that we coauthored (DOSI, 2021):

⇨ <u>For consideration of the UN system and international agreements:</u>

- To align the sectoral mandates and activities in ABNJ (e.g. between the ISA and the IMO (shipping), FAO and RFMOs (fisheries), ICPC (submarine cables) and the ongoing negotiating process for the conservation and sustainable use of marine Biodiversity of areas Beyond National Jurisdiction (BBNJ) (DOSI, 2021).

⇨ <u>For consideration of the ISA :</u>

- To mainstream the conservation and sustainable use of marine biodiversity and marine resources in deep seabed mining define deep seabed mining activities.
- To precise all deep seabed mining impacts (sea-bottom, water column, surface and air above) (small distance and long distance, duration of impacts, primary and secondary impacts, cumulative impacts, ...).
- To foster an adaptive context-based socio-ecological governance that relies on the active participation (with their Free, Prior and Informed Consent (FPIC), in accordance with the United Nations Declaration on the Rights of Indigenous Peoples) of local and traditional communities in decision-making as well as in the implementation of DSM projects because traditional knowledge and practices about resource management in the Pacific fundamentally rely on reciprocal relationships.
- To recognize the cultural and social values attached to traditional knowledge and traditional practices relative to deep-sea ecosystems through national legislations and ISA regulations.
- To encourage ISA Member States to undertake a strategic level of engagement with 'the public' on matters that are beyond the scope of individual Environmental Impact Assessments (EIAs) for each exploitation and Strategic Environmental Assessments (SEAs) for multiple exploitations in the same basin, region or ocean (DOSI, 2021).
- To develop a mechanism for compensation in case of damage/impacts to the quality of environment and future region (Environmental fund) considering all the potential impacts of DSM, on the seabed, in the water column and at the surface, and the spread of these impacts far from the exploitation area and inside waters under national jurisdiction, in addition to the creation of a fund for receiving and distributing the benefits of DSM exploitation, part of the fund could be allocated to riparian states for compensation of environmental damage and destruction.

⇨ <u>For integration / dissemination of traditional knowledge, traditional knowledge holders, IPLCs at the local and national levels</u>

- To collect traditional knowledge on marine ecosystems and resource management practices, to produce and circulate the information at all levels of stakeholders.

- To collect the perspectives that traditional knowledge holders have of DSM and of the DSM areas when agreed upon by local and traditional communities. Wider consultation is needed to fully understand the significance of deep seabed mining areas to traditional knowledge holders and communities with different cultural and historical values. A broader diversity of deep-sea perspectives including multi-cultural and spiritual significance warrant consideration in collective decision making (Worm et al., 2021).
- To integrate traditional knowledge related to environment into risk assessment measures through a precautionary approach (DOSI, 2021).
- To integrate traditional knowledge into marine spatial planning and governance processes in DSM projects (DOSI, 2021).
- To collect traditional knowledge at the local and national level and identify relations with traditional management and sustainable use of natural resources. Public awareness of traditional knowledge can be raised through: an online portal for and by Indigenous Peoples (Mamo, 2020), One Ocean Hub Code of Practice, The International Indigenous Youth Council, Elder councils, showcasing traditional knowledge in the most appropriate medium (DOSI, 2021). An important first step would be to have traditional knowledge data repositories that are consistent with the IOC Oceanographic Data Exchange Policy or the relevant UN subordinate body data policy. Such repositories must be formed with the FPIC of the relevant traditional knowledge holders through a culturally appropriate and rights-sensitive manner in accordance with the United Nations Declaration on the Rights of Indigenous Peoples (DOSI, 2021).
- To evaluate importance of natural resources, in particular mineral seabed resources and the Human Well-being and Sustainable Livelihoods (HWSL) of local communities (social and economic values).
- To develop the recognition of traditional knowledge and traditional practices at the national level, as a precautionary approach, and consider to transfer the informal practices of the local communities in formal legislation and/or regulations.

⇨ For consideration of scientists and experts:

- To collect scientific knowledge related to marine ecosystems and seabed resource functioning in an ecosystem-based approach integrating the socio-ecological aspects of marine uses in order to better appreciate the holistic approach of traditional knowledge related to marine ecosystems and seabed resource management for Island States of the Pacific Region.
- To analyse and monitor the variability of socio-ecological factors intervening in the functioning of marine ecosystems in order to adapt progressively the seabed resource management.
- To investigate on hybrid forms (traditional knowledge practices with science-based management/conservation practices) of marine resource management applicable to DSM and, in this context, their replicability in different oceans in the world.

References

Académie des Sciences d'Outre-mer (ASOM), (2011). Recommendations on the conservation and management of biodiversity of three deep-sea ecosystems targeted by mining (polymetallic nodules, cobalt rich ferro-manganese crusts and hydrothermal sulfurs). Panel of international experts meeting organized at UNESCO, Paris, France on 15 December 2010.

Acton, L., Campbell, L., Cleary, J. A., Gray, N., Halpin, P. N., (2019). What is the Sargasso Sea? The problem of fixing space in a fluid ocean. *Political Geography*, 68: 86-100. https://doi.org/10.1016/j.polgeo.2018.11.004.

Aguon, J., and Hunter, J., (2019). Second wave due diligence: the case for incorporating free, prior, and informed consent into the deep sea mining regulatory regime. *Stanford Environ. Law J.*, 38, 3–55.

Akimichi, T., (1995). Indigenous Resource Management and Sustainable Development: Case Studies from Papua New Guinea and Indonesia. *Anthropological Science*, 103 (4): 321-327. https://doi.org/10.1537/ase.103.321.

Aleynik, D., Inall, M.E., Dale, A., Vink, A., (2017). Impact of remotely generated eddies on plume dispersion at abyssal mining sites in the Pacific. *Sci. Rep.*, 7, 16959. https://doi.org/10.1038/s41598-017-16912-2.

Ardron J., K. Gjerde, S. Pullen, V. Tilot., (2008). Marine spatial planning in the high seas. *Marine policy, The international journal of Ocean Affairs*, 32, 5, 2008.https://doi.org/10.1016/j.marpol.2008.03.018.

Bakker, K., and Bridge, G., (2006). Material worlds? Resource geographies and the « Matter of Nature ». *Progress in Human Geography*, 30 (1) :5-27. https://doi.org/10.1191/0309132506ph588oa.

Bambridge, T., (2016). Rahui: Legal pluralism in Polynesian traditional management of resources and territories. *Pacific Series.* Australian National University Press. 269pp. ISBN 9781925022797.

Bambridge, T., Gaulme, F., Montet, C., Paulais, T., (2019). Communs et ocean. Le rahui en polynésie. *Ed. Au vent des îles*. 175pp. ISBN : 978-2-36734-200-9.

Bambridge, T., D'Arcy, P., Mawyer, A., (2021). Oceanian sovereignty: rethinking conservation in a sea of islands. *Pacific Conservation Biology*. *CSIRO Publishing*. https://doi.org/101071/PC20026.

Beaulieu, S. E., (2010). InterRidge Global Database of Active Submarine Hydrothermal Vent Fields: Prepared for InterRidge, Version 2.0. *World Wide Web Electronic Publication*.

Bernhard, H., and Blissenbach, E., (1988). Economic importance, in:"The Manganese Nodule Belt of the Pacific Ocean" , Halbach, P., Friedrich, G., and von Stackelberg, U. (Eds.), *Ferdinand Enke Verlag Stuttgart.*

Block, B. A., Jonsen, I. D., Jonsen, S. J., Winship, A. J., Schaefer, S. A., Bograd, S. J., (2011). Tracking apex marine predator movements in a dynamic ocean. *Nature*, 475, 86–90. https://doi.org/10.1038/nature10082.

Blum, D., Popp, B. N., Drazen, J. C., Choy, C.A., Johnson, M.W., (2013). Methylmercury production below the mixed layer in the North Pacific Ocean. *Nat. Geosci.* 6,879–884. https://doi.org/10.1038/ngeo1918.

Boschen, R.E., Rowden, A.A., Clark, M.R., Gardner, J.P.A., 2013. Mining of deep-seafloor massive sulfides: a review of the deposits, their benthic communities, impacts from mining, regulatory frameworks and management strategies. *Ocean and Coastal management*, 84, 54-67. https://doi.org/10.1016/j.ocecoaman.2013.07.005.

Bouchet, P. J., Meeuwig, J. J., Salgado Kent, C. P., Letessier, T. B., Jenner, C. K., (2014). Topographic determinants of mobile vertebrate predator hotspots: Current knowledge and future directions. *Biol. Rev.*, 90, 699–728 (2015). https://doi.org/10.1111/brv.12130.

Bourrel, M., Swaddling, A., Atalifo, V., Tawake, A., (2018). Building in-country capacity and expertise to ensure good governance of the deep sea minerals industry within the Pacific region. *Marine Policy*, 95, 372–379. https://doi.org/10.1016/j.marpol.2017.03.022.

Boyd, P.W., Claustre, H., Levy, M., Siegel, D.A., Weber, T., (2019). Multi-faceted particle pumps drive carbon sequestration in the ocean, *Nature*, 568 (7752), 327–335, https://doi.org/10.1038/s41586-019-1098-2.

Bradley M., and Swaddling, A., (2018). Addressing environmental impact assessment challenges in Pacific Island Countries for effective management of deep-sea minerals activities, *Marine Policy*, 95, 356–362. https://doi.org/10.1016/j.marpol.2016.06.017.

Bridge, G., (2013). The Hole World: scales and spaces of extraction. *New Geographies*, 2: 43-8. https://scenariojournal.com/article/the-hole-world. (accessed April 28, 2021).

Capra, F., and Luisi P.L., (2014). The systems view of life. A unifying vision. *Cambridge University Press*. 498pp. https://doi.org/10.1017/CBO9780511895555.

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

Carson, M., (2018). Archaeology of Pacific Oceania: inhabiting a Sea of Islands. *Routeledge World Archaelogy*. Abingdon, Oxon; New York, NY, USA. ISBN : 978-1-138-09713-1.

Catalá, T. S., Reche, I., Álvarez, M., Khatiwala, S., Guallart, E. F., Benítez-Barrios, V. M., et al., (2015). Water mass age and ageing driving chromophoric dissolved organic matter in the dark global ocean. *Global Biogeochem. Cycles*, 29, 1–18. https://doi.org/10.1002/2014GB005048.

Childs, J., (2019). Greening the blue? Corporate strategies for legitimising deep sea mining. *Political Geography*, 74, 102060. https://doi.org/10.1016/j.polgeo.2019.102060.

Christiansen, B., Denda, A., Christiansen, S., (2019). Potential effects of deep seabed mining on pelagic and benthopelagic biota. *Mar. Policy*, 114, 103442. https://doi.org/10.1016/j.marpol.2019.02.014.

Cinner, J., Marnane, M.J., McClanahan, T.R., Almany, G.R., (2006). Periodic closures as adaptive coral reef management in the Indo-Pacific. *Ecol. Soc.*, 11 (1). https://www.ecologyandsociety.org/vol11/iss1/art31. (Accessed April 23, 2021).

Clark, M., Althaus, F., Schlacher, T., Williams, A., Bowden, D., Rowden, A., (2016). The impacts of deep-sea fisheries on benthic communities: a review. *ICES Journal of Marine Science*, 73, *Issue suppl 1, January 2016*, 15-169. https://doi.org/ /10.1093/icesjms/fsv123.

Creason, A. M., (2004). Culture clash: the influence of indigenous cultures on the international whaling regime. *Calif. West. Int. Law*, 35, 83–126. ISSN 0886-3210.

Cressy, J., (1998). Making a Splash in the Pacific: Dolphin and Whale Myths and Legends of Oceania. *Rapa Nui Journal: Journal of the Easter Island Foundation*, 12, 3, 75-84. https://kahualike.manoa.hawaii.edu/rnj/vol12/iss3. (Accessed April 23, 2021).

Cronan, D. S., (1984). Criteria for the recognition of areas of potentially economic manganese nodules and encrustations in the CCOP/SOPAC region of the central and southwestern tropical Pacific, *South Pacific Marine Geological Notes*, *CCOP/SOPAC*, 3, 1, 1984.

Cronan, D. S., and Hodkinson, R. A., (1989). Manganese nodules and cobalt-rich crusts in the EEZ's of the Cook Islands, Kiribati and Tuvalu, Part III: nodules and crusts in the EEZ of western Kiribati (Phoenix and Gilbert Islands), *CCOP/SOPAC Technical Report 100*, Suva Fiji, 47pp.

Dahl, A. L., and Carew-Reid, J., (1985). Environment and Resources in the Pacific: A Regional Approach. *UNEP Regional Seas Reports and Studies, 69*. Geneva: United Nations Environment Programme. Dahl, Arthur L., and Jeremy Carew-Reid (eds.), 294pp.

D'Arcy, P., (2006). The People of the Sea: Environment, Identity and History in Oceania. Honolulu: *University of Hawai'i Press*. 292pp. ISBN-13: 9780824832971.

D'Arcy, P. (2013). Seabed mining and oceania: imminent resource bonanza or resource curse writ large? in "L'eau dans le Pacifique Sud: Entre mythe et Réalités". Ed. C. Berger and J.-L. Roques (*Paris: L'Harmattan*), 205–219.

David, G., (2016). The challenge of sustainability for Pacific island village fisheries, a historical perspective. in: "Fisheries in the Pacific". Simonne Pauwels, Elodie Fache. *Pacific-credo Publications*. 77-117. DOI : 10.4000/books.pacific.395.

De Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., et al., (2012). Global estimates of the value of ecosystems and their services in monetary units. *Ecosyst. Serv*., 1, 50–61. https://doi.org/10.1016/j.ecoser.2012.07.005.

Deep-Ocean Stewardship Initiative (DOSI), (2021). The Necessity of Traditional Knowledge for Management of Deep-Seabed Mining. Policy Brief prepared by the DOSI Minerals Working Group, in particular, Amon D., Escobar E., Guilloux B., Howell K., Jones D., Koyavakauta C., Levin L., Mulalap C., Sing P., Sink K., Tilot V., Turner P., Vencatesan A., Willaert K. https://www.dosi-project.org/topics/minerals-deep-sea-mining/(Accessed June 6, 2021).

Drazen, J., and Sutton, T., (2017). Dining in the Deep: the feeding ecology of deep-sea fishes. *Annual Review of Marine Science*, 9(1). https://doi.org/10.1146/annurev-marine-010816-060543.

Drazen, J., Smith, C., Gjerde, K., Haddock, S., Carter, G., Choy, A. et al., (2020). Opinion: Midwater ecosystems must be considered when evaluating environmental risks of deep-sea mining. *Proceedings of the National Academy of Sciences of the United States of America*. https://www.pnas.org/content/117/30/1745. (Accessed April 23, 2021)..

Dyment, J., Lallier, F., Le Bris, N., Rouxel, O., Sarradin, P.-M., Lamare, S., et al., (2014). Les impacts environnementaux de l'exploitation des ressources minérales marines profondes. Expertise scientifique collective. Brest: *ESCO CNRS-IFREMER*, 930pp.

Eckstein, L., and Schwarz, A., (2019). The making of Tupaia's map: a story of the extent and mastery of Polynesian navigation, competing systems of wayfinding on James Cook's endeavour, and the invention of an ingenious cartographic system. *J. Pacific History*, 54, 1–95. https://doi.org/10.1080/00223344.2018.1512369.

Elden, S., (2013). Secure the volume: Vertical geopolitics and the depth of power. *Political geography*, 34 :35-51. https://doi.org/10.1016/j.polgeo.2012.12.009.

Ernst, and Young, (2011). Technology Minerals: The Rare Earths Race Is on! https://institut-seltene-erden.org/wp-content/uploads/2012/03/Ernstyoung-REE1.pdf(Accessed June 6, 2021).

Ey, M., and Sherval, M., (2016). Exploring the minescape: engaging with the complexity of the extractive sector: exploring the minescape. *Area* 48, 176–182. https://doi.org/10.1111/area.12245.

Fache, E., Pauwels, S., Veitayaki, J., (2016). Introduction; Pacific Islanders, « custodians of the ocean » facing fisheries challenges. in : "Fisheries in the Pacific". Simonne Pauwels, Elodie Fache. *Pacific-credo Publications*. 77-117. https://doi.org/10.4000/books.pacific.395.

Feinberg, R. (1995). Seafaring in contemporary Pacific Islands: Studies in Continuity and Change. DeKalb, IL: *Northern Illinois University Press*, 237pp. https://doi.org/10.1525/ae.1997.24.1.262.

Finney, B., (1998). Voyage to Polynesia's land's end. *Antiquity*, 75, 172–181. https://doi.org/ 10.1017/S0003598X0005287X.

Firestone, J., and Lilley, J., (2007). Aboriginal Subsistence Whaling and the Right to Practice and revitalize cultural traditions and customs. *J. Int. Wildlife Law Policy*. 8, 177–219. https://doi.org/10.1080/13880290590965339.

Flood, B., Strong, B., Flood, W., (1999). Pacific Island Legends. *Tales from Micronesia, Melanesia, Polynesia and Australia.* 266pp. Bess Press.

Food and Agriculture Organization of the United Nations (FAO), (2000). Biological Characteristics of Tuna. Michel Goujon and Jacek Majkowski. https://www.fao.org/fishery/topic/16082/en(Accessed June 6, 2021).

Food and Agriculture Organization of the United Nations (FAO), (2017). Traditional knowledge use for the sustainable management of marine and fishing resources. CoopeSoliDar. ED. International Collective in Support of Fishworkers (ICSF). https://www.icsf.net/images/monographs/pdf/english/issue_162/162_SM_ES_COSTA_RICA%20traditiona%20Knowledge.pdf(accessed May 27, 2021) (accessed May 27, 2021).

Food and Agriculture Organization of the United Nations (FAO), (2020). Building resilience of small-scale fisheries to ensure food security and nutrition in the Pacific. *35th Session FAO Regional conference for Asia and the Pacific*. FAO APRC/20/4. Thimphu, Bhutan, 17-20 February 2020. https://https://www.fao.org/3/nb839en/nb839en.pdf (accessed May 27, 2021).

Friedlander, A., (2018). Marine conservation in Oceania: Past, present and future. *Mar. Pollut. Bull.*, 135: 139-149. https://doi.org/ 10.1016/j.marpolbul.2018.05.064.

Friedlander, A., and Gaymer, C., (2020). Progress, opportunities and challenges for marine conservation in the Pacific Ilsands. *Marine and Freshwater Ecosystems*. *Special issue: Advances in science for ecology and sustainable management of oceanic islands.* 221-231. https://doi.org/10.1002/aqc.3464.

Gavin, M., McCarter, J., Mead, A., Berkes, F., Richard, J., Stepp, J. et al., (2015). Defining biocultural approaches to conservation. *Trends in Ecology and Evolution*. 30, 3, 140-145. https://doi.org/10.1016/j.tree.2014.12.005.

Gillard, B., (2019). Physical and hydrodynamic properties of deep sea mining-generated, abyssal sediment plumes in the ClarionClipperton Fracture Zone (eastern-central Pacific). *Elementa* 7, 5. https://doi.org/10.1525/elementa.343.

Gillett, R. (2010). Marine fishery resources of the Pacific Islands. *FAO technical paper 537*. 58pp. http://www.fao.org/3/i1452e/i1452e00.pdf? (Accessed April 23, 2021).

Gillett, R., and Tauati, M.I., (2018). Fisheries in the Pacific. Regional and national information. *FAO Fisheries and Aquaculture Technical Paper No 625*. Apia, FAO. 412pp.ISBN 978-92-5-130515-7.

Giron, Y., (2016). The other side of large-scale, no-take, marine protected areas in the Pacific Ocean in: *Fisheries in the Pacific*. Simonne Pauwels, Elodie Fache. *Pacific-credo Publications*. 77-117. https://doi.org/10.4000/books.pacific.395.

Gladwin, T. (1970). East is a Big Bird: Navigation and Logic on Puluwat atoll. *Cambridge, MA: Harvard University Press*, 260pp. ISBN 9780674224261.

Glover, A., and Smith, C., (2003). The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. *Environ. Conserv*., 30, 219–241. https://doi.org/10.1017/S0376892903000225.

Gollner, S., Kaiser, S., Menzel, L., Jones, D. O. B., Brown, A., Mestre, N. C., et al. (2017). Resilience of benthic deep-sea fauna to mining activities. *Mar. Environ. Res*. 129, 76–101. https://doi.org/10.1016/j.marenvres.2017.04.010.

Gomez, C., Lawson, J. W., Wright, A. J., Buren, A. D., Tollit, D., and Lesage, V. (2016). A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. *Can. J. Zool*. 94, 801–819. https://doi.org/10.1139/cjz-2016-0098.

Gooley, T., (2016). How to read water. Clues and Patterns from puddles to the sea. *Sceptre Press, Hodder and Stoughton Ltd*. 400pp. ISBN 13 : 9781473615229.

Govan, H., Aalsberg, W., Tawake, A., Parks, J., (2008). Locally-Managed Marine Areas: A Guide to Supporting Community-based Adaptive Management. *Locally-Managed Marine Area Network*, Suva, Fiji. 70pp. https://www.sprep.org/att/IRC/eCOPIES/Pacific_Region/210.pdf (accessed May 27, 2021).

Govan, H., Tawake, A., Tabunakawai, K., Jenkins, A., Lasgorceix A, Schwarz et al., (2009). Status and potential of locally-managed marine areas in the South Pacific: meeting nature conservation and sustainable livelihood targets through wide-spread implementation of LMMAs. Suva, Fiji: *SPREP/WWF/WorldFish-Reefbase/CRISP*. *RePEc.*134pp. ISBN: 978-982-04-0402-1 (print) 978-982-04-0403-8 (online).

Grey, G., (2019). Polynesian mythology. The myths, legends, songs and ancient traditional history of the new zealanders and pacific islanders. *Pantianos classics*. 152 pp. ISBN-10 : 1789871654.

Grimble, A., (2019). Tungaru traditions: writings on the Atom Culture of the Gibert Islands. *Center for Pacific Islands Studies. Number 7 of Pacific Islands monograph series. School of Hawaiian, Asian and Pacific Studies*, University of Hawaii Press, Honoulu. 382 pp. ISBN 0824812174, 9780824812171.

Haas, P.M., (1992). Introduction: epistemic communities and international policy coordination international organization. *Knowl. Power Int. Policy Coord.*, 46, 1–35. https://doi.org/10.1017/s0020818300001442.

Haddock, S.H., Moline, M. A., Case, J.F., (2010). Bioluminescence in the sea. *Annu. Rev. Mar. Sci.*, 2, 443–493. https://doi.org/10.1146/annurev-marine-120308-081028.

Halbach, P., Friedrich, G., von Stackelberg, U., (1988). The manganese nodule belt of the Pacific Ocean: Geological environment, nodule formation and mining aspects, *Enke, Stuttgart, Germany*. 403pp. ISBN 3 432 96381 5.

Hannington, M. D., Ronde, C.E.J., Petersen, S., (2005). Sea-floor tectonics and submarine hydrothermal systems. In: *Economic Geology 100th Anniversary Volume*. *Society of Economic Geologists, Inc*. Editors: J. W. Hedenquist, J.F.H. Thompson, R.J. Goldfarb, J.P. Richards. 111-141. https://doi.org/10.5382/AV100.06.

Hannington, M. D., Jamieson, J., Monecke, Y., Peterson, S., (2010). Modern sea floor massive sulphides and base metal resources: toward an estimate of global sea-floor massive sulphide potential. *Soc. Econ. Geol*. *Special Publication.* 15, 317–338.ISBN 978-82-7701-119-6.

Hannington, M. D., Jamieson, J., Monecke, Y., Peterson, S., Beaulieu, S., (2011). The abundance of seafloor massive sulphide deposits. *Geology*, 39, 1115–1158. https://doi.org/10.1130/G32468.1.

Hau'ofa, E., (1992). SO201: Society, culture and change in the Pacific : Reader-Volume 1.

Hau'ofa, E., (1994). Our Sea of Islands. *The Contemporary Pacific: A Journal of Island Affairs* 6 (1), 148-161. First published in “A New Oceania: Rediscovering Our Sea of Islands”, edited by Vijay Naidu, Eric Waddell and Epeli Hau'ofa. Suva: School of Social and Economic Development, The University of the South Pacific, 1993. https://www.jstor.org/stable/23706895(Accessed April 23, 2021).

Hau'ofa, E. (2008). We Are the Ocean: Selected Works. *Honolulu: University of Hawaii Press*, 188pp. ISBN-13: 9780824831738.

Havice, E., and Zalik, A. (2019). Ocean frontiers: epistemologies, jurisdictions, commodifications. *Int. Soc. Sci. J*. 68, 219–235. https://doi.org/10.1111/issj.12198.

Havice, E., McCoy, M.A., Lewis, A., (2019). Market and industry dynamics: Western and Central Pacific Ocean distant water tuna purse seine fishery. Honiara, Solomon Islands; *Forum Fisheries Agency*. 105pp. FFA_PurseSeineStudy2019_FinalReport-1.pdf (Accessed June 13, 2021).

He, G., Ma, W., Song, C., Yang, S., Zhu, B., (2011). Distribution characteristics of seamount cobalt-rich ferromanganese crusts and the determination of the size of areas for exploration and exploitation. *Acta Oceanol. Sin.*, 30,63–75. https://doi.org/10.1007/s13131-011-0120-9.

Heiduk, F., and Wacker, G., 2020. From Asia-Pacific to Indo-Pacific. Significance, implementation and challenges. SWP Research Paper 9. *Stiftung Wissenschaft und Politik, German Institute for International and Security Affairs. July 2020. Berlin.* https://www.swp-berlin.org/publications/products/research_papers/2020RP09_IndoPacific.pdf (accessed June 17, 2021).

Hein, J. R., and Koschinsky, A., (2014). Deep-ocean ferromanganese crusts and nodules, in *Treatise on Geochemistry*, 11, 273–291. *Ed. S. Scott* (Amsterdam: Elsevier), https://doi.org/10.1016/b978-0-08-095975-7.01111-6.

Hein, J. R., and Petersen, S., (2014). The geology of cobalt-rich ferromanganese crusts. In: “Deep Sea Minerals: Cobalt-rich Ferromanganese Crusts; A physical, biological, environmental, and technical review", 1c. 14pp. *Secretariat of the Pacific Community (SPC).* Editors: Elaine Baker, Yannick Beaudoin.

Hein, J. R., Mizell, K., Koschinsky, A., Conrad, T., (2013). Deep-ocean mineral deposits as a source of critical metals for high-and green-technology applications: comparison with land-based resources. *Ore Geol. Rev*., 51, 1–14. https://doi.org/10.1016/j.oregeorev.2012.12.001.

Hein, J. R., Spinardi, F. S., Okamoto, N., Mizell, K., Thorburn, D., Tawake, A., (2015). Critical metals in manganese nodules from the Cook Islands EEZ, abundances and distributions. *Ore Geol. Rev*., 68, 97–116. https://doi.org/10.1016/j.oregeorev.2014.12.011.

Hein, J., Koschinsky, A., Kuhn T., (2020). Deep-ocean polymetallic nodules as a resource for critical materials. *Nat. Rev. Earth Environ,* 1(3).158–169, https://doi.org/10.1038/s43017-020-0027-0.

Hekinian, R., Francheteau, J., Renard, V., Ballard, R., Choukroune, P., Cheminee, J., et al. (1983). Intense hydrothermal activity at the axis of the East Pacific Rise near 13°N: submersible witnesses the growth of sulphide chimney. *Mar. Geophys. Res.,*6, 1–14. doi: 10.1007/BF00300395.

Hilmi, N., Bambridge, T., Safa A. et al., (2016). Socioeconomic significance of fisheries in the Small Island Developing States: natural heritage or commodity? in : "Fisheries in the Pacific". Simonne Pauwels, Elodie Fache Ed. *Pacific-credo Publications*. 77-117. DOI: 10.4000/books.pacific.395.

Hoagland, P., Beaulieu, S., Tivey, M., Eggert, R., German, C., Glowka, L., et al. (2010). Deep-sea mining of seafloor massive sulphides. *Mar. Pol*. 34, 728–732. https://doi.org/10.1016/j.marpol.2009.12.001.

Holden E., Linnerud, K., Banister D., (2014). Sustainable development: Our Common Future revisited. *Global Environment Change*, 26, 130-139. https://doi.org/10.1016/j.gloenvcha.2014.04.006.

Hoyt, E., (1995). The Worldwide Value and Extent of Whale Watching. *Whale and Dolphin Conservation Society*, 1–36. Bath, UK. ISBN-13 : 978-0951907887.

Hunter, J., Singh, P, Aguon, J., (2018). Broadening Common Heritage: Addressing Gaps in the Deep-Sea Mining Regulatory Regime, *Harvard Environmental Law Review*. https://harvardelr.com/2018/04/16/broadening-common-heritage/(accessed May 2, 2021).

Hviding, E., and Baines, G.B.K., (1992). Fisheries Management in the Pacific: Tradition and the Challenges of Development in Marovo, Solomon Islands. *United Nations Research Institute for Social Development* (*UNRISD) Discussion Paper,* (32). Geneva: United Nations Research Institute for Social Development. March 1992. 19pp. https://www.unrisd.org/80256B3C005BCCF9(accessed May 6, 2021).

(The) Intergovernmental Panel on Climate Change (IPCC) Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) (2019). https://www.ipcc.ch/site/assets/uploads/sites/3/2019/12/SROCC_FullReport_FINAL.pdf (accessed March 11, 2021).

International Seabed Authority (ISA), (2010). Regulations on Prospecting and Exploration for Polymetallic Sulphides in the Area (15 November 2010), *International Seabed Authority.* ISA Doc. ISBA/16/A/12/Rev.1 (2010).

International Seabed Authority (ISA), (2012). Regulations on Prospecting and Exploration for Cobalt-rich Ferromanganese Crusts in the Area. Kingston: *International Seabed Authority*. 2012 ISBA/18/A/11(accessed March 1, 2021).

International Seabed Authority (ISA), (2013). Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area. Kingston: *International Seabed Authority*. 2013 ISBA/19/C/17(accessed March 1, 2021).

International Seabed Authority (ISA), (2019a). Draft Regulations on Exploitation of Mineral Resources in the Area. Kingston: *International Seabed Authority*. ISBA/25/C/WP.1(accessed March 1, 2021).

International Seabed Authority (ISA), (2019b). Draft regulations on Exploitation of Mineral Resources in the AREA - Collation of Specific Drafting Suggestions by Members of the Council. Kingston: *International Seabed Authority*. ISBA/26/C/CRP.1(accessed March 1, 2021).

International Seabed Authority (ISA), (2020a). Proposal for a Template with Minimum Requirements for Regional Environmental Management Plans: A Proposal for a Standardized Approach. Kingston: *International Seabed Authority*. ISBA/26/C/7(accessed March 1, 2021).

International Seabed Authority (ISA), (2020b). Decision of the Council Concerning a Standardized Approach for the Development, Approval and Review of Regional Environmental Management Plans in the Area. Kingston: *International Seabed Authority*. ISBA/26/C/10 (accessed March 1, 2021).

International Seabed Authority (ISA), (2020c). 26th session of the ISA Council meetings (First Part). *Earth Negot. Bull*., 25, 17–21. https://www.isa.org.jm/node/19448(accessed June 6, 2021).

International Seabed Authority (ISA), (2020d). Draft regulations on exploitation of mineral resources in the Area. Prepared by the Legal and Technical Commission. ISBA/25/C/WP.1 26th annual session of the International Seabed Authority (First Part). https://www.isa.org.jm/files/files/documents/Stakeholderconsultations_final-3.pdf (accessed June 16, 2021).

International Union for Conservation of Nature (IUCN), (2018). The Journey of Cook Islands: Marae Moana. https://www.iucn.org/news/oceania/201806/journey-cook-islands-marae-moana (accessed March 11, 2021).

Irigoien, X., Klevjer, T.A., Rostad, A., Martinez, U., Boyra, G., et al., (2014). Large mesopelagic fish biomass and trophic efficiency in the open ocean. *Nat. Commun.* 5, 3271. https://doi.org/10.1038/ncomms4271(accessed March 11, 2021).

Jaeckel, A., Gjerde, K. M., Ardron, J. A. (2017). Conserving the common heritage of humankind – Options for the deep-seabed mining regime. *Mar. Pol*. 78, 150–157. https://doi.org/10.1016/j.marpol.2017.01.019 (accessed March 11, 2021).

James, B., (2016). Songlines: the art of navigating the indigenous world. https://www.sea.museum/2016/05/31/songlines-the-art-of-navigating-the-indigenous-world(Accessed April 23, 2021).

Jeudy de Grissac, A. (2003). Protection de la Nature. Aires protégées. *Encyclopædia Universalis*,13pp. https://www.universalis.fr/encyclopedie/protection-de-la-nature-aires-protegees/#i_0. (accessed April 30, 2021).

Jeudy de Grissac (2015). Reviewing existing Mediterranean models of governance of MPAs with artisanal fisheries in « Fishing Governance in MPAs : potentialities for blue economy » (FISHMPABLUE).54pp.https://www.iucn.org/sites/dev/files/content/documents/fishmpablue_governance_models_review_existing_final_oct.pdf (accessed April 20, 2021).

Jeudy de Grissac, A. (2016). Les enjeux de la conservation de la biodiversité marine dans un contexte de développement durable : de l'exploration à la planification spatiale marine et à la gouvernance. *Publications de l'Académie des Sciences, Colloques, conférences, débats*. Colloque sur : « Les Océans: de l'origine de la vie à l'utilisation des bio-resources marines ». Académie des Sciences, Paris, 12 Avril 2016. https://www.academie-sciences.fr/pdf/conf/colloque_120416.pdf.(Accessed April 23, 2021).

Johannes, R.E., (1978). Traditional marine conservation methods in Oceania and their demise. *Annu. Rev. Ecol. Syst.*, 9 (1), 349–364. https://doi.org/10.1146/annurev.es.09.110178.002025.

Johannes, R.E., (1981). Words of the Lagoon: Fishing and Marine Lore in the Palau District of Micronesia. *Univ of California Press*. 245pp. ISBN 0-520-03929-7.

Johannes, R. E., (1998). The Case for Data-less Marine Resources Management: Examples from Tropical Nearshore Fisheries. *Trends in Ecology and Evolution*, 13(6), 243-6. https://doi.org/10.1016/S0169-5347(98)01384-6.

Jones, D. O. B., Kaiser, S., Sweetman, A. K., Smith, C. R., Menot, L., Vink, A., et al. (2017). Biological responses to disturbance from simulated deep-sea polymetallic nodule mining. *PLoS ONE* 12: e0171750. https://doi.org/10.1371/journal.pone.0171750.

JPI (2016). JPI Oceans: The Ecological Impact of Deep-Sea-Mining. https://jpio-miningimpact.geomar.de/home(Accessed June 6, 2021).

Jupiter, S.D., Cohen, P.J., Weeks, R., Tawake, A., Govan, H., (2014). Locally-managed marine areas: multiple objectives and diverse strategies. *Pac. Conserv. Biol.*, 20 (2), 165–179. https://www.worldfishcenter.org/content/locally-managed-marine-areas-multiple-objectives-and-diverse-strategies(Accessed April 23, 2021).

Juster, A., (2016). Histoire et Culture d'Océanie : le rahui, une notion structurante de la société, en intime relation avec le pouvoir politique et le sacré. *Outremers 360°*. https://outremers360.com/culture/histoire-culture-doceanie-le-rahui-une-notion-structurante-de-la-societe-en-intime-relation-avec-le-pouvoir-politique-et-le-sacre-par-alexandre-juster(Accessed April 23, 2021).

Kacenelenbogen, E., (2010). Le nouvel idéal politique. Enquête sur la teneur et la cohérence de la théorie républicaine contemporaine. *Raisons politiques*, 2010/4 (n°40), 43-73. ISBN 9782724631999.

Kacenelenbogen, E., (2017). Liberalism confronts the Twentieth Century. Reading F.A. Hayek. In "Liberal Moments. Reading liberal texts". Bloomsbury Academic. ISBN 9781474251075.

Kakee, T., (2020). Deep-sea mining legislation in Pacific Island countries: from the perspective of public participation in approval procedures. *Mar. Policy*, 117:103881. https://doi.org/10.1016/j.marpol.2020.103881.

Kato, Y., Fujinaga, K., Nakamura, K., Takaya, Y., Kitamura, K. Ohta, J., et al., (2011). Deep-sea mud in the Pacific Ocean as a potential resource for rare-earth elements. *Nature geoscience*, 4, 535-539. https://doi.org/10.1038/ngeo1185.

Kent, G., (1980). The Politics of Pacific Islands Fisheries. Boulder, Colorado: Westview Press. 219pp. ISBN : 0891586830.

Kikiloi, K., (2010). Rebirth of an archipelago: sustaining a Hawaiian cultural identity for people and homeland. In: *Hūlili: Multidisplinary Research on Hawaiian Well-Being*, 7 (1): 73-115.

https://coe.hawaii.edu/edea/research/hulili-multidisciplinary-research-on-hawaiian-well-being/ (Accessed May 7, 2021).

Kingsford, R. T., Watson, J. E. M., Lundquist, C. J., Venter, O., Hughes, L., Johnston, E. L., et al., (2009). Major Conservation Policy Issues for Biodiversity in Oceania. *Conservation Biology*, 23(4): 834-840. https://doi.org/10.1111/j.1523-1739.2009.01287.

Kuhn, O., (2008). Science Break: Polynesian navigation. *Recorder (official publication of the Canadian Society of exploration Geophysicists*), 33, 7. https://csegrecorder.com/columns/view/science-break-200809. (Accessed April 23, 2021).

Leary, D., Vierros, M., Hamon, G., Arico, S., and Monagle, C. (2010). Marine genetic resources: a review of scientific and commercial interest. *Mar. Pol.* 33, 183–194. https://doi.org/10.1016/j.marpol.2008.05.010.

Leenhardt, P., Cazalet, B., Salvat, B., Claudet, J., Feral, F., (2013). The rise of large-scale marine protected areas: Conservation or geopolitics? *Ocean & Coastal Management*, 85: 112-118. https://doi.org/10.1016/j.ocecoaman.2013.08.013.

Lehman, J., (2013). Relating to the sea : Enliving the ocean as an actor in Eastern Sri Lanka . *SAGE Journals. Environment and Planning D : Society and space*, 31, 485-501. https://doi.org/10.1068/d24010.

Levin, L., Mengerink, K., Gjerde, K., Rowden, A., Van Dover, C. L., Clark, M. R., et al., (2016). Defining « serious harm » to the marine environment in the context of deep-seabed mining. *Mar. policy*, 74, 245–259. https://doi.org/10.1016/j.marpol.2016.09.032.

Levin, L., Baker, M., Thompson, A., (2018). Deep-Ocean Climate Change Impacts on Habitat, Fish and Fisheries. Rome: *FAO publications*, 166pp. ISBN: 978-92-5-131126-4.

Levin, L., Wei, C.L., Dunn, D., Amon, D., Ashford, O., Cheung, W., et al., (2020). Climate change considerations are fundamental to management of deep-sea resource extraction. *Glob Change Biol*. 26:4664-4678. https://doi.org/10.1111/gcb. 15223.

Lewis, D., (1972). We the Navigators. 360pp. *A.H. and A.W.Reed LTD., Wellington, NZ.* https://doi.org/10.2307/2800787.

Lily, H., (2016). A regional deep-sea minerals treaty for the Pacific Islands? *Marine Policy*, 220–226. https://doi.org/10.1016/j.marpol.2016.04.005

Lin, T.H., Chen C., Watanabe, H.K., Kawagucci, S., Yamamoto, H., Akamatsu, T., (2019). Using soundscapes to assess deep-sea benthic ecosystems. *Trends Ecol. Evol.*, (Amst.) 34, 1066–1069. https://doi.org/10.1016/j.tree.2019.09.006.

Loebel-Fried, C., (2002). Hawaiian legends of the guardian spirits. *A Latitude 20 Book, Hawaii. University of Hawai'i Press Honolulu*, 128pp. ISBN-13: 9780824825379.

Lohmann, K., Lohmann, C., Endres, C., (2008). The sensory ecology of ocean navigation. *J Exp Biol* (2008) 211 (11): 1719–1728. https://doi.org/10.1242/jeb.015792.

Love, M. (2021). Tabu, MPA and community: nomenclature and the political ecology of marine conservation in Vanuatu. *Journal of Political ecology*. 28, 91-110. https://doi.org/10.2458/jpe.2301.

Luschi, P., (2013). Long-distance animal migrations in the oceanic environment: orientation and navigation correlates. *Hindawi Publishing Corporation. ISRN Zoology*. Volume 2013, Article ID 631839, 23pp. http://dx.doi.org/10.1155/2013/631839.

McCauley, D. J., Pinsky, M. L., Palumbi, S. R., Estes, J. A., Joyce, F. H., and Warner, R. R. (2015). Marine defaunation: animal loss in the global ocean. *Science* 347:1255641. https://doi.org/10.1126/science.1255641.

Malinowski, B., (1935). *Coral Gardens and their Magic*. Volume I. Soil-tilling and agricultural rites in the trobriand islands. Ed. George Allen and Unwin. Ruskin House. London. 610pp. https://www.berose.fr/IMG/pdf/malinowski_1935-coral_gardens-vol_1.pdf (accessed April 4, 2021).

Mamo, D., (2020). The Indigenous Navigator: self-determined development. *The Indigenous world 2020*. Part 2. pp 685-693. 34th Edition. DANIDA funded. ISBN: 978-87-92786-98—2.

Mara, R. K., (1997). The Pacific Way: A Memoir. Honolulu, HI: University of Hawaii Press, 298pp.ISBN-13: 9780824818937

Marsh, L., Huvenne, V., Jones, D., (2018). Geomorphological evidence of large vertebrates interacting with the seafloor at abyssal depths in a region designated for deep-sea mining. *Royal Society open science*. https://doi.org/10.1098/rsos.180286.

Martin, W., Baross, J., Kelley, D., Russell, M. J. (2008). Hydrothermal vents and the origin of life. *Nat. Rev. Microbiol*. 6, 805–814. https://doi.org/10.1038/nrmicro1991.

McCormack, G., (2016). Cook Islands seabed minerals. A precautionary approach to mining. *Cook Islands Natural Heritage Trust, Rarotonga, Cook Islands*, 33pp. 978-982- 98133-1-2.

Mawyer, A., and Jacka, J. K., (2018). Sovereignty, conservation and island ecological futures. *Environ. Conserv*., 45, 238–251. https://doi.org/10.1017/S037689291800019X.

Mead, H., (2003). Tikanga Maori. Living by Maori Values. Hirini Moko Mead Copyright. 382 pp. *Huia Publishers*, Wellington, NZ.ISBN: 9781775502227.

Mero, J.L., (1965). The mineral resources of the Sea. XIII. 312pp. *Elsevier : Amsterdam, Netherlands*. https://doi.org/10.1017/S0016756800000339.

Messner, G.F., (1990). The Shark-Calling Ceremony in Paruai, New Ireland, Papua New Guinea. *The World of Music*, 32(1):49–83.https://www.jstor.org/stable/43561243 (Accessed April 24 2021).

Miller, K., Thompson, K., Johnston, P., Santillo, D., (2018). An overview of seabed mining including the current state of development, environmental impacts, and knowledge gaps. *Front. Mar. Sci.*, 4:418. https://doi.org/10.3389/fmars.2017. 00418.

Mulalap, C.Y., Frere, T., Huffer, E., Hviding, E., Paul, K., Smith, A., Vierros, M., (2020). Traditional knowledge and the BBNJ instrument. *Marine policy*, 122, 104103. https://doi.org/10.1016/j.marpol.2020.104103.

Nautilus Minerals, (2018). Nautilus Minerals Solwara 1 project. http://www.nautilusminerals.com/irm/content/png.aspx?RID=258 (Accessed April 22, 2021).

Navarre, M., and Lammens, H., (2017). Opportunities of deep-sea mining and ESG risks. *Amundi Discussion Papers Series*. DP-24-2017. 48 pp. https://research-center.amundi.com/page/Publications/Discussion-Paper/2017/Opportunities-of-deep-sea-mining-and-ESG-risks(Accessed April 28, 2021).

New York Times Magazine, (2016). The Secrets of the Wave Pilots. https://www.nytimes.com/2016/03/20/magazine/thesecretsof- the-wave-pilots.html (accessed March 10, 2021).

Niner, H., Ardron, J., Escobar, E.G., Gianni, M., Jaeckel, A., Jones, D., et al., (2018). Deep-Sea Mining with no net Loss of Biodiversity—An Impossible Aim. *Front. Mar. Sci*. 5:53. https://doi.org/10.3389/fmars.2018.00053.

Norris, R., and Harney, B., (2014). Songlines and Navigation in Wardaman and other Australian Aboriginal Cultures. *Journal of Astronomical history and heritage*, 1, 2. 1-14. https://arxiv.org/ftp/arxiv/papers/1404/1404.2361.pdf(accessed April 22, 2021).

Oebius, H.U., Becker, H.J., Rolinski, S., Jankowski, J.A., (2001). Parametrization and evaluation of marine environmental impacts produced by deep-sea manganese nodule mining. *Deep Sea Res. Part II Top. Stud. Oceanogr*. 48, 3469-3485. https://doi.org/10.1016/S0967-0645(01)00052-2.

Okamoto, N., Shiokawa, S., Kawano, S., Yamaji, N., Sakurai, H., Kurihara, M., (2019). World's first lifting test for seafloor massive sulphides in the Okinawa Trough in the EEZ of Japan. *In:Proceedings of the Twenty-ninth International Ocean and Polar Engineering Conference (2019*), 1–7.http://www.isope.org. (accessed March 10, 2021).

O'Leary, B.C., Ban, N. C. Fernandez, M., Friedlander, A.M., García-Borboroglu, P., Golbuu, Y., et al., (2018). Addressing criticisms of large-scale marine protected areas. *Bioscience*, 68 (5), 359–370. https://doi.org/10.1093/biosci/biy021.

Pacific Community (2012). Coastal Fisheries and Climate Change: Policy Brief 16. *Noumea, NC: Pacific Community*. https://spccfpstore1.blob.core.windows.net/digitallibrary-docs/files/8c/8cc2c1e6655d44d2aa11dfaa9279db79.pdf?sv=2015-12-11&sr=b&sig=TDxtU4LuV4JWYttjF7QCnVFKCrQtL97Ekb9teSDkO4E%3D&se=2021-12-14T00%3A30%3A59Z&sp=r&rscc=public%2C%20max-age%3D864000%2C%20max-stale%3D86400&rsct=application%2Fpdf&rscd=inline%3B%20filename%3D%22Anon_12_PolicyBrief16_ClimateCoastal.pdf%22(accessed June 7 2021).

Pacific Islands Forum Fisheries Agency (PIFFA), (2019). FFA Tuna Economic Indicators 2019. https://www.ffa.int/node/2465 (accessed April 28 2021).

Pauwels, S., and Fache, E., (2016). Fisheries in the Pacific. Simonne Pauwels, Elodie Fache. *Pacific-credo Publications*. 77-117. DOI : 10.4000/books.pacific.395.

Petterson, M.G., (2008). Minerals sustainability, emerging economies, the developing world, and the 'truth' behind the rhetoric. *Est. J. Earth Sci.*, 56 (3), 57–74. https://doi.org/10.3176/earth.2008.2.01.

Petterson M.G., Tawake, A., (2018). The Cook Islands (South Pacific) experience in governance of seabed manganese nodule mining. *Ocean and Coastal Management*, 167, 271-287. https://doi.org/10.1016/j.ocecoaman.2018.09.010.

Peukert, A., Schoening, T., Alevizos, E., Köser, K., Kwasnitschka, T., Greinert, J., (2018). Understanding Mn-nodule distribution and evaluation of related deep-sea mining impacts using AUV-based hydroacoustic and optical data. *Biogeosciences*. 15, 2525-2549. https://doi.org/10.5194/bg-15-2525-2018.

Pomeroy, R. S., (1995). Community-Based and Co-Management Institutions for Sustainable Coastal Fisheries Management in Southeast Asia. *Ocean & Coastal Management*, 27 (3): 143-162. https://doi.org/10.1016/0964-5691(95)00042-9.

Ponganis, P., (2016). Diving physiology of marine mammals and seabirds. Cambridge University Press. 346pp. ISBN-10 : 0521765552.

Pratt, C., Govan, H., (2010). Our Sea of Islands, Our Livelihoods, Our Oceania. *Framework for a Pacific Oceanscape: A Catalyst for Implementation of Ocean Policy*. Apia, Samoa: Secretariat of the Pacific Regional Environment Programme. 95pp. https://www.forumsec.org/wp-content/uploads/2018/03/Framework-for-a-Pacific-Oceanscape-2010.pdf (accessed May 3, 2021).

Robison, B.H., (2009). Conservation of deep pelagic biodiversity. *Conserv. Biol*., 23, 847-858. https://doi.org/10.1111/j.1523-1739.2009.01219.

Rolinski, S., Segschneider, J., Sundermann, J., (2001). Long-term propagation of tailings from deep-sea mining under variable conditions by means of numerical simulations. *Deep Sea Res. Part II Top. Stud. Oceanogr.*,48, 3469–3485 (2001). https://doi.org/10.1016/S0967-0645(01)00053-4.

Romm, C., (2015). How sticks and shell charts became a sophisticated system for navigation. *The Smithsonian magazine*. Protecting our environment : the innovative spirit. https://www.smithsonianmag.com/smithsonian-institution/how-sticks-and-shell-charts-became-sophisticated-system-navigation-180954018/(accessed April 23, 2021).

Ruddle, K., and Johannes, R.E., (1989). Traditional Marine Resource Management in the Pacific Basin: An Anthology. *Contending with global change, Study N° 2. Jakarta, Indonesia: Unesco/ROSTSEA.* 410pp.https://library.sprep.org/content/traditional-marine-resource-management-pacific-basin-anthology-study-2(accessed June 12, 2021).

Ruddle, K., and Hickey, F. R., (2008). Accounting for the Mismanagement of Tropical Nearshore Fisheries. *Environment, Development and Sustainability*, 10(5), 565-89. http://hdl.handle.net/10.1007/s10668-008-9152-5. (accessed April 23, 2021).

Ruddle, K., Hviding, E., Johannes, R.E., (1992). Marine resources management in the context of customary tenure. *Mar. Resour. Econ.*, 7 (4), 249–273.https://core.ac.uk/download/pdf/6253679.pdf(accessed June 12, 2021).

Schor, G. S., Falcone, E. A., Moretti, D. J., Andrews, R. D., (2014). First long term behavioral Records from Cuvier's beaked whales *Ziphius cavirostris* reveal record-breaking dives. *PLoS One 9:e92633*. https://doi.org/10.1371/journal.pone.0092633.

Skoglund, P., Posth C., Reich, D., (2016). Genomic insights into the peopling of the Southwest Pacific. *Nature*, 538, 510-513 (2016). https://doi.org/10.1038/nature19844.

Smith, C. R., Levin, L. A., Koslow, A., Tyler, P. A., (2008). The near future of the deep seafloor ecosystems. In "Aquatic Ecosystems: Trends and Global Prospects", Ed. N. Polunin, *Cambridge: Cambridge University Press*, 334–349. https://doi.org/10.1017/cbo9780511751790.030.

Soares, P., Trejaut, J., Rito, T., Cavadas, B., Hill, C., Eng, K. et al., (2016). Resolving the ancestry of Austronesian-speaking populations. *Hum. Genet*., 135:309-326. https://doi.org/10.1007/s00439-015-1620-z.

(The) Secretariat of the Pacific Community (SPC), (1999). Deep-bottom fishing techniques for the Pacific Islands. A manual for fishermen. Preston, G., Mead, P., Chapman, L., Taumaia, P., Australian

Agency for International Development (AUSAID) and Coastal Fisheries Programme Capture Sections, SPC. ISBN 982-203-681-7.

(The) Secretariat of the Pacific Community (SPC), (2005). Pacific Islands Regional Ocean Policy and Framework for Integrated Strategic Action, prepared for « the Council of Regional Organisations of the Pacific-Marine Sector Working Group ». 23pp. *Secretariat of the Pacific Community (SPC).* Available online at : http://macbio-pacific.info/wp-content/uploads/2017/08/Pacific-Ocean-Policy.pdf(accessed April 18, 2021).

(The) Secretariat of the Pacific Community (SPC), (2013). Deep sea minerals: manganese nodules," in « A Physical, Biological, Environmental and Technical Review », Vol. 1B, Eds. E. Baker and Y. Beaudouin, 70pp. *Secretariat of the Pacific Community (SPC),*978-982-00-0557-0.(accessed April 18, 2021).

(The) Secretariat of the Pacific Regional Environment Programme (SPREP), (2020). *SPC-EU Pacific Environmental Portal*. https://pacific-data.sprep.org/dataset/spc-eu-edf10-deep-sea-minerals-dsm-project-information-brochure-3-marine-minerals, (accessed April 18, 2021).

Steinberg, P., and Peters, K., (2015). Wet ontologies, fluid spaces: giving depth to volume through oceanic thinking. *SAGE Journals. Environment and Planning D: Society and space*. https://doi.org/10.1068/d14148p.

Sterling, E., Filardi, C., Toomey, A., Sigouin, A., Betley, E., Gazit, N., et al., (2017). Biocultural approaches to well-being and sustainability indicators across scales. *Nature Ecology and Evolution*, 1(12). https://doi.org/10.1038/s41559-017-0349-6.

Surma, S., and Pitcher, T., (2015). Predicting the effects of whale population recovery on Northeast Pacific food webs and fisheries: an ecosystem modelling approach. *Fisheries Oceanography*, 24: 291–305. https://doi.org/10.1111/fog.1210.

Thiel, H., (2003). Anthropogenic impacts on the deep sea. In: "Ecosystems of the World, Ecosystems of the Deep Ocean". 28, 427–472. *Ed. P. A. Tyler (Amsterdam: Elsevier).* ISBN 0 444 82619 X.

Thompson, N. (2007). Kū Holo Mau: 2007 Voyage for Mau. *Polynesian Voyaging Society*. (Archived from the original on 2011 5 18). http://archive.hokulea.com/holokai/2007/mau_1_intro.html) (accessed May 28, 5, 2021).

Tilot, V., (2006). Biodiversity and distribution of the megafauna **Vol 1** The polymetallic nodule ecosystem of the Eastern Equatorial Pacific Ocean. *Intergovernmental Oceanographic Commission. Technical Series 69*, Project UNESCO COI/Min Vlaanderen, Belgium. http://unesdoc.unesco.org/images/0014/001495/149556f.pdf.(accessed April 28, 2021).

Tilot, V., (2010). Biodiversity and distribution of faunal assemblages **Vol 3** Options for the management and conservation of the nodule ecosystem in the Clarion Clipperton Fracture Zone. *Intergovernmental Oceanographic Commission. Technical Series 69*,Project UNESCO COI/Min Vlanderen, Belgium. http://unesdoc.unesco.org/images/0014/001495/149556e.pdf#223.(accessed April 28, 2021).

Tilot, V., (2011). Protection des écosystèmes océaniques profonds dans le cadre de l'exploitation des ressources minières. Recommandations intégrées dans les résolutions du 10ème session du Congrès français de la nature-17 juin 2011.*IUCNdoc*..

Tilot, V., (2013). Applying an ecosystem-based approach to fisheries management: focus on seamounts in the southern Indian Ocean. Terminal Evaluation of the UNDP/ GEF project GEF 3138/PIMS 3657. May 2013. *GEF publications*, 168 pp.https://www.thegef.org/publications(accessed April 28, 2021).

Tilot, V., (2016). Les enjeux de la conservation de la biodiversité marine dans un contexte de développement durable : de l'exploration à la planification spatiale marine et à la gouvernance. Publications de l'Académie des Sciences, Colloques, conférences, débats. Colloque sur : « Les Océans: de l'origine de la vie à l'utilisation des bio-resources marines ». Académie des Sciences, Paris, 12 Avril 2016. https://www.academie-sciences.fr/pdf/conf/colloque_120416.pdf.(accessed April 28, 2021).

Tilot, V., (2019). Assessment of Deep-Sea Faunal Communities-Indicators of Environmental Impact. Chapter 4, 147-189. *In "Environmental Issues of Deep-Sea Mining. Impacts, Consequences and Policy perspectives*." https://www.springer.com/us/book/9783030126957. (accessed April 28, 2021).

Tilot, V., Ormond, R., Moreno-Navas, J., Catala, T., (2018). The benthic megafaunal assemblages of the CCZ (Eastern Pacific) and an approach to their management in the face of threatened anthropogenic impacts. *Front. Mar. Sci*., 5:7. https://doi.org/10.3389/fmars.2018.00007.

Tilot, V., Willaert, K., Guilloux, B., Chen, W., Mulalap, C.Y., Gaulme, F., Bambridge, T., Peters, K., Dahl, A., (2021a). Traditional dimensions of seabed resource management in the context of Deep Sea Mining in the Pacific: Learning from the socio-ecological interconnectivity between island communities and the ocean realm. *Front. Mar. Sci, special issue: Integrated Marine Biosphere Research: Ocean Sustainability, Under Global Change, for the Benefit of Society*, 8: 637938.| https://doi.org/ 10.3389/fmars.2021.637938.

Tilot V., Guilloux B., Willaert K., Mulalap C.Y., Kacenelenbogen E., Bambridge T., Gaulme F., Peters K., Moreno Navas, J., Dahl A., (2021b). Perspectives of tidal thinking around the concept of Oceanian Sovereignty in the context of Deep sea mining in the Pacific. *Front. Mar. Sci, special issue: Integrated Marine Biosphere Research: Ocean Sustainability, Under Global Change, for the Benefit of Society*, (in preparation).

Toonen, R.J., Wilhelm, T.A., Maxwell, S.M., Wagner, D., Bowen, B.W., Sheppard, C.R., et al., (2013). One size does not fit all: the emerging frontier in large-scale marine conservation. *Mar. Pollut. Bull*., 77(1–2),7–10.https://doi.org/10.1016/j.marpolbul.2013.10.039.

Trichet, J., and Leblic, I., (2008). Environnement dans le Pacifique Sud. *Journal de la Société des Océanistes*, *special issue*. 126-127. Trichet, Jean and Isabelle Leblic (eds.) Paris: *Société des Océanistes*. https://jso.revues.org/1804. (accessed April 28, 2021).

Tuqiri, S., (2001). Overview of an Ocean Policy for the Pacific Islands., *prepared by the Council of Regional Organisations of the Pacific-Marine Sector Working Group*, 77pp. Suva: SPC/PIROP.http://coastfish.spc.int/Asides/Other_orgs/SPOCCMSG/PIROP_overview_seremaia.pdf(accessed June 16, 2021).

Tyler, P. A., German, C. R., Ramirez-Llodra, E., and Van Dover, C. L. (2003). Understanding the biogeography of chemosynthetic ecosystems. *Oceanol. Acta* 25, 227–241. https://doi.org/10.1016/S0399-1784(02)01202-1.

(The) United Nations Convention on the Law of the Sea (UNCLOS), (1982). www.un.org/Depts/los/convention_agreements/texts/unclos/part1.htm(accessed March 11, 2021).

Van Dover, C., German, C., Speer, K.G., (2002). Evolution and biogeography of deep-sea vent and seep invertebrates. Science 295(5558):1253-7. https://doi.org/ 10.1126/science.1067361.

Van Dover, C. L. (2010). Mining seafloor massive sulphides and biodiversity: what is at risk? *ICES J. Mar. Sci*. 68, 341–348. https://doi.org/ 10.1093/icesjms/fsq086.

Van Dover, C. L. (2014). Impacts of anthropogenic disturbances at deep-sea hydrothermal vent ecosystems: a review. *Mar. Environ. Res*. 102, 59–72. https://doi.org/ 10.1016/j.marenvres.2014.03.008.

Van Dover, C. L., Ardron, J. A., Escobar, E., Gianni, M., Gjerde, K. M., Jaeckel, A., et al. (2017). Biodiversity loss from deep-sea mining. *Nat. Geosci*. 10, 464–465. https://doi.org/ 10.1038/ngeo2983.

Van Dover, C., Arnaud-Haond S., Gianni, M., Helmreich, S., Huber, J.A., (2018). Scientific rationale and international obligations for protection of active hydrothermal vent ecosystems from deep-sea mining. *Mar. Policy*, 90,20–28. https://doi.org/ 10.1016/j.marpol.2018.01.020.

Vanreusel, A., Hilario, A., Ribeiro, P. A., Menot, L., Arbizo, P. M. (2016). Threatened by mining, polymetallic nodules are required to preserve abyssal epifauna. *Sci. Rep.* 6:26808. doi: 10.1038/srep26808.

Veitayaki, J., (2004). "Building Bridges: The Contribution of Traditional Knowledge to Ecosystem Management and Practices in Fiji". *Reporting of the Millennium Ecosystem Assessment Conference "Bridging Scales and Epistemologies: Linking Local Knowledge and Global Science in Multi-Scale Assessments",* Alexandria, Egypt.

Veitayaki, J., Nakoro, D.A.R., Sigarua, T., Bulai, N., (2011). On cultural factors and marine managed areas in Fiji in Pacific Island heritage: archaelogy, identity and community. *Terra australis* 35: 37-50. https://doi.org/ 10.22459/TA35.11.2011.05.

Verlaan, P., (2011). The International Marine Minerlas Society's Code for Environmental Management of Marine Mining. *OCEANS'11 MTS/IEEE KONA*, *Conférence 19-22 September 2011. Hawaii, USA*. https://doi.org/ 10.23919/OCEANS.2011.6106970

von Stackelberg, U., Kunzendorf, H., Marchig, V., and Gwozdz, R., (1984). Growth history of a large ferro-manganese crust from the equatorial north Pacific nodule belt, *Geologisches Jahrbuch*, A 7 5, 213.ISSN 0341-6399.

Vierros, M., Harrison, A. L., Sloat, M., Ortuno Crespo, G., Moore, J., Dunn, D., et al., (2020). Considering indigenous peoples and local communities in governance of the global ocean commons. *Mar. Policy*, 119:104039. https://doi.org/10.1016/j.marpol. 2020.104039.

Vieux, C., Salvat B., Chancerelle, Y., Kirata, T., Rongo, T., Cameron, E., (2004). Status of coral reefs in Polynesia Mana node countries: Cook Islands, French Polynesia, Niue, Kiribati, Tonga, Tokelau and Wallis, and Futuna, IFRECOR, 189-198, in: Global Coral Reef Monitoring Network (GCRMN), (2004). Status of coral reefs of the World. Edited by Clive Wilkinson. Australian Institute of Marine Science.557pp.

Vieux, C., Chancerelle, Y., Aubanel, A., Salvat, B., (2008). Les modifications de la ligne de rivage dans les îles de la Société (Polynésie française) : un indicateur des pressions anthropiques en zone côtière. *J. Soc. Océan. 59–66.* https://doi.org/ 10.4000/ jso.3162.

Waddell, E., (2000). The emerging intellectual architecture of the Pacific. *The New Pacific Review. Pacific Ident.,* 1, 86–103. In: "Noumea Symposium Proceedings, 15-16 July, 1999". *The Australian National University, Canberra, Australia*. ISSN 1445-4947. 438pp. https://openresearch-repository.anu.edu.au/bitstream/1885/14749/1/New_Pacific_Review_01_01_.pdf. (accessed june 17, 2021).

Wallace, C., Weeber, B., Buchanan, S., (1998). Seaviews. Marine ecosystem management : obligations and opportunities. *Proceedings of the conference held in Wellington, 11-14th of February 1998*. Environment and Conservation Organisations of New Zealand, 1998. 278p. ISBN 0-9597786-1-6.http://www.eco.org.nz/uploads/Seaviews/Seaviews%20Proceedings.pdf(accessed June 17, 2021).

Watling, L., and Auster, P. J. (2017). Seamounts on the high seas should be managed as vulnerable marine ecosystems. *Front. Mar. Sci*. 4:14. https://doi.org/ 10.3389/fmars.2017.00014.

Weeks, R., and Jupiter, S.D., (2013). Adaptive comanagement of a marine protected area network in Fiji. *Conserv. Biol.*, 27 (6), 1234–1244. https://doi.org/10.1111/cobi.12153.

Wendt, A., (1976). Towards a new oceania. *Mana Rev*. 1, 49–60.https://ethnc3990.files.wordpress.com/2014/12/wendt-toward-a-new-oceania.pdf(accessed June 17, 2021).

(The) Western and Central Pacific Fisheries Commission (WCPFC), (2019). The Western and Central Pacific Tuna Fishery: 2018. Overview and status of Stocks. https://www.wcpfc.int/statistical-bulletins (accessed March 11, 2021).

Wilber, D.H., and Clarke, D. G., (2001). Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. *N. Am. J. Fish. Manage*. 21, 855–875. https://doi.org/.1577/1548-8675.

Wilhelm, T.A., Sheppard, C.R.C., Sheppard, A.L., Gaymer, C.F., Parks, J., Wagner, D., Lewis, N., (2014). Large marine protected areas – advantages and challenges of going big. *Aquatic Conserv: Mar. Freshw. Ecosyst.* 24 (Suppl. 2): 24-30. https://doi.org/10.1002/aqc.2499.

Willaert, K., (2020a). Crafting the perfect deep sea mining legislation: a patchwork of national laws. *Mar. Policy* 119:104055. https://doi.org/10.1016/j.marpol.2020.10 4055.

Willaert, K., (2020b). Effective protection of the marine environment and equitable benefit-sharing in the Area: empty promises or feasible goals? *Ocean Dev. Int. Law,* 51(2):175-192. https://doi.org/10.1080/00908320.2020.1737444.

Willaert, K., (2020c). Public participation in the context of deep sea mining: luxury or legal obligation? *Ocean and Coastal Management, 198, (2020) 105368.* https://doi.org/10.1016/j.ocecoaman.2020.105368.

Willaert, K., (2021). Seabed mining within national jurisdiction: an assessment of the relevant legislation of the Cook Islands. *Coastal Management*. https://doi.org/10.1080/08920753.2021.1928459.

Williams, A., Althaus, F., Maguire, K. Green, M., Untiedt, C., Alderslade, P. et al., (2020). The fate of deep-sea coral reefs on seamounts in a fishery-seascape: what are the impacts, what remains, and what is protected? *Front. Mar. Sci.*https://doi.org/10.3389/fmars.2020.567002.

Wolff, T., (2005). Composition and endemism of the deep-sea hydrothermal vent fauna. *Cahiers de Biologie Marine,* 46(2):97-104. https://doi.org/10.1007/978-3-319-45340-8.

Woodall, L., Sanchez-Vidal, A., Canals, M., Paterson, G., Coppock, R., et al., (2014). The deep sea is a major sink for microplastic debris. *The Royal Society Open Science*. https://doi.org/10.1098/rsos.140317.

(The) World Commission on Environment and Development (WCED) (1987). Report of the World Commission on Environment and Development: "Our Common Future" or (the Brundtland

Commission report) transmitted to the General Assembly as an Annex to document A/42/427. UN Documents: Gathering a Body of Global Agreements. http://www.un-documents.net/wced-ocf.htm 1 of 4 20/4/08 23:12(accessed April 26, 2021).

Worm, B, Eliff, C., Graça Fonseca, J., Gell, F., Serra-Gonçalves, C., Helder, N. et al., (2021). Making ocean literacy inclusive and accessible. *Ethics in Science and Environmental Politics*. 21 :1-9. https://doi.org/10.3354/esep00196.

Yesson, C., Clark, M.R., Taylor, M., Rogers, A.D., (2011a). The global distribution of seamounts based on 30 arc seconds bathymetry data. *Deep Sea Research Part I: Oceanographic Research Papers*, 58, 4, 442-453. https://doi.org/10.1016/j.dsr.2011.02.004.

Yesson, C., Clark, M.R., Taylor, M., Rogers, A.D., (2011b). Lists of seamounts and knolls in different formats. *PANGEA*, 58(4), 442-453.https://doi.org/10.1016/j.dsr.2011.02.004.

Zalik, A. (2018). Mining the seabed, enclosing the Area: ocean grabbing, proprietary knowledge and the geopolitics of the extractive frontier beyond national jurisdiction. *Int. Soc. Sci. J. 68*, 229–230. https://doi.org/10.1111/issj.12159.

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