Paper Structure

- Context of Pacific Islands Development and DSM
- The EU-SPC-DSM Project
- Global & Pacific Perspectives for Mineral Demand: Economic, Social, Environmental
- Cook Island Manganese Nodules Case Study
- Synthesis/Analysis
National Jurisdictions of PICTs

Sea Area
- A total area of 27.8 million km² of EEZ

Land Area
- About 531,000 km² (a ratio of 52:1)

Extended Continental Shelf
- An additional 2.0 million km²
What are the biggest Pacific Development Issues?
Pacific Development Challenges

• **Persistent poverty** (93% of Fiji salary earners: < $8,000 US/ yr, >30-35% of Fijians classed as ‘below poverty line’; poverty differentials between rural and urban areas)

• **Lack of national resources over which governments have decision making powers**

• **Unemployment especially with the youth** (Pacific ‘official youth unemployment rate at 23% (62% in Marshalls) but under-employment probably >50%, maybe as high as >70%)

• **Limited health, education & welfare services** (large loss of life to NCD’s)

• **Limited modern infrastructure** (roads, ICT, safe navigational berths & wharves etc): discourages inward investment

• **Urbanisation** & remote island development: both opportunities as well as challenges

• **Adapting to environmental & social change**

• **Lack of capacity** in key areas

• **Migration of the brightest** and most skilled people: difficulties in public sector retention and loss of wealth-creation skills from private sector

• **Climate Change, Disaster & Risk, Rising Sea Levels**

• **Geographical Isolation, small markets, large transport distances**

• **Limited Livelihood Opportunities**

• **Limited Economic Development Options** (fishing, agriculture, tourism)
The EU-SPC-DSM Project
**Objectives:** to strengthen the system of governance and capacity of Pacific ACP States in the management of DSM through:

- development and implementation of sound and regionally integrated legal frameworks;
- improved human and technical capacity,
- effective environmental monitoring systems,
- Provision of scientific information & data
- Development of global communities of practice in science, environment, law & regulation
Deep Seabed Minerals Potential

Seafloor Massive Sulphides:
- PNG
- Tonga
- Solomon Islands
- Vanuatu
- Fiji

Manganese Nodules:
- Cook Islands
- Kiribati

Cobalt-rich Crusts:
- Republic of the Marshall Islands
- Federated States of Micronesia
- Kiribati
Cobalt Rich Crusts

Sulphides (Cu/Au + other metals)

Polymetallic (Manganese) Nodules

Clarion Clipperton Zone

Potential Mineral Occurrences and the Maritime Boundaries in the South-West Pacific Region

Legend
- Polymetallic Sulphides/Hydrothermal vents (active and confirmed)
- Potential Region of Polymetallic Nodules
- Potential Region of Cobalt-Rich Crusts
- Provisional Exclusive Economic Zones (EEZs) of the Pacific Island Countries (PICs)
- Potential areas of Extended Continental Shelf submitted by PICs
- Areas under Contract in the Clarion-Clipperton Fracture Zone
- Areas under Reserve in the Clarion-Clipperton Fracture Zone

19 Pacific ACP Member Countries with the marine minerals deposits in South-west Pacific region.
Source of map files:
- Nodules and Crusts regions: James R. Hein, US Geological Survey
- Hydrothermal vents: InterRidge database v.3.3
- International Seabed Authority

This map compiled by the Geoscience Division of SPC.
March 2016

The EEZ boundaries shown on this map are for illustrational purposes only.
Update on the Solwara 1 Project PNG

- Nautilus Minerals Oct 12 2017 Statement:
  - Submerged trials of Seafloor Production Tools, Motukea Island, Port Moresby. Auxilliary Cutter also trialled.
  - Mawei (China) Shipyard: vessel construction 90% complete. Cranes supplied from Korea.
  - Positive stakeholder and community engagement
  - Subject to financing, on track for developing the worlds first commercial Deep Sea Cu-Au mine by July 2019.
Okinawa, Japan: Ministry of Economy, Trade & Industry & Japan Oil, Gas & Metals National Corporation (JOGMEC), September 2017 announce the World’s first pilot test of Excavating & ore lifting for seafloor Polymetallic minerals @ 1600m depth
## DSM Policy and Legislation in PICs

<table>
<thead>
<tr>
<th>Country</th>
<th>DSM Policy</th>
<th>DSM Legislation</th>
<th>National Offshore Minerals Committee Established</th>
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<td>presented to Congress</td>
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</tbody>
</table>
Development of Regional DSM Frameworks

4 Regional DSM Frameworks developed:

(1) Regional Legislative and Regulatory Framework;

(2) Regional Financial Framework;

(3) Regional Environmental Management Framework;

(4) Regional Scientific Research Guidelines.
Assistance provided by SPC

- National DSM Committees
- National Consultation
- National DSM Policy
- National DSM Law

- Awareness Raising Events
- Publications
- Regional Guidelines / Frameworks
- Regional Workshops

- Science & Data Management
- Cost Benefit Analysis
- Contracts and Negotiations
- DSM Documentaries / Information Brochures

- Technical Training
- Internships
- Attendance at International Events
- Regional DSM Treaty
Examples of Project Scientific
And Technical information for
Pacific Islands Countries
Global & Pacific Perspectives for Mineral Demand:
Economic, Social, Environment
Socio-Economic Drivers that will affect Mining and Deep Sea Mining

The Stone Age did not end because of lack of stone resources...the oil age will not end because of lack of oil

Deep Concerns over Planetary Management are impacting more than many Realise....

Ways of doing business are being Forced to change

e.g. Hydrocarbons = Evil

Even if most people are ‘hypocrites’

Environmental Responsibility Report
2017 Progress Report, Covering Fiscal Year 2016
Looking forwards:

- A more African-Asian world
- The challenge of Age: old vs young
- A relatively affluent world
- A densely populated world
- A world where environment will matter more
The great acceleration

Unprecedented species-planetary impact
In 4.55 Billion years of time:
Humans since 1950
The trajectory of the Anthropocene: The Great Acceleration
Will Steffen, Wendy Broadgate, Lisa Deutsch, Owen Goftney and Cornelia Ludwig
2015 Anthropocene Review
Based on Steffen et al. (2004) Global Change and the Earth System

More information
www.igbp.net
www.stockholmresilience.org
www.futureearth.info
www.globaia.org
www.anthropocene.info
Socially, Mining will increasingly struggle to justify itself as a ‘Good Corporate Citizen’ and a ‘Planetary Protector’

Question: How can Deep Sea Mining be justified when it will impact on the biology of untouched ecosystems?
Global Drivers for Mineral Demand
Example: Rare Earth Elements

King, Geology.com, 2017

Alonso et al., 2012
Copper is the 'metal of the future'

Past performance does not guarantee future results.

Source: Bloomberg, U.S. Global Investors
“It’s a really bright future for cobalt,” Vivienne Lloyd, analyst at Macquarie Research, told the *Financial Times*. “There doesn’t seem to be enough of it.”

Before now, there was very little mainstream interest in cobalt as an investment, but that’s changing as rapidly as world governments are joining the chorus to move away from fossil fuels. One sign of that change is the London Metal Exchange’s (LME) upcoming cobalt contracts, one for the physical metal and another for the chemical compound cobalt sulphate. This will allow investors to trade the underlying metal and participate in the electric vehicle “revolution,” as
Cook Islands Case Study:
Manganese Nodules
Average abundance of nodules
Kilograms per square metre

Clarion-Clipperton Zone: 15 kg/m²
Peru Basin: 10 kg/m²
Indian Ocean: 5 kg/m²
Cook Islands: 5 kg/m²

Source: James R. Hein, US Geological Survey
Figure 5. Location of nodule zones in Oceania.
Pacific Island Country DSM Development:
Example: Deep Sea Metallic Nodules of Cook Islands
**Cooks:** Low-Medium Lying/ relatively affluent / small population / land area 237km² / Large Ocean state: Ocean / Land Ratio of c. 8440:1 (Ocean area c. 2M km²)

**Economic Zone (Mkm²)**

**Population:** (+ PNG (8M))
Total c. 11M
Cooks prepare for possible future extraction of seabed minerals:

Policy & Regulation

1. Cook Island Seabed Policy 2014
2. Seabed Minerals Act 2009

Minerals Tender 2015
Marine Reserve Areas

Also: Tax Arrangements / Foreign Investment / Employment / Environment / Social & Community / Fiscal / Sovereign Wealth Fund
Seabed deal hauling in $1m

May 15th & Oct 31st 2017

Cook Islands have already earned more than $90,000 from one deep sea minerals agreement signed in 2016 with an American company to give them reserved rights in certain deep seabed areas within the country’s Exclusive Economic Zone.

In September last year, the Cook Islands led by Natural Resources Minister Pele Maara signed an agreement with Ocean Minerals (OML) to have the first rare earth elements (REE) in certain high-value deep sea minerals approved by Cabinet before it was signed.

In the agreement, the Houston-based company now has a five year period to explore for REE in the 11,000km2 in the Cook Islands EEZ to one day explore for the elements that are now known to be found in the sediments of our deep ocean floor. No actual seabed licence has been issued to OML at this stage.
CI Nodules: N-S and NNE-SW High Concentration Distribution Trend

Particularly enriched in Hi-Tech metals: Co, Ti, Te, Nb, REE, Y, Pt, Zn,
Value of One Ton of CI Nodules: $1111 – 1460 USD

CI Nodules have more Mn, Co, Zr & Te than terrestrial reserves

CI Nodules: 15-21% of terrestrial reserves for REE, Mo, Nb, W

CI Nodules: have 50% Ni, 32% V, 26% Ti of terrestrial reserves

CI Nodule Elemental Abundance / Clarion Clipperton Zone Nodule Elemental Abundance

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1 From Hein et al. (2013).
3 Dry metal tonnages calculated using element distribution maps (Figs. 5-7, SM), except tellurium which was determined using total nodule tonnage and average Te content in Table 4.
A CBA of Deep Sea Mining in the Pacific conducted in 2015.

Results indicate that DSM mining has the potential to make the people of PNG & CI better off.
Potential Environmental Impacts:

How can these be independently monitored?
Potential Impacts from DSM Mining

Vessels' noise and lights can attract/repel surface animals

Routine discharge from vessel

Increases in vessel activities

Particulates from returned water discharge/cutting plumes can smother animals

Animals and habitat directly removed by machines

Noise vibration from riser system

Cobalt-rich Ferromanganese crusts (CRC)

Active Seafloor Massive Sulphide (SMS)

Dormant Seafloor Massive Sulphide (SMS)

Manganese Nodules (MN)

Return water plume may be released higher in the water column

Noise lights, vibration from machines

800 - 2,500 metres

1,000 - 3,500 metres

4,000 - 6,500 metres

Naturally occurring plumes

8

Citation
Habitats and biodiversity in nodule regions. Source: GRID-Arendal.
Megafauna of the CCZ nodule province including (a) small-eyed omnivorous fish, (b) a predaceous cirrata octopus, (c) suspension-feeding sponge and brisingid asteroids, (d) a deposit-feeding starfish (Hyphalaster), (e) a 50-cm long, deposit-feeding sea cucumber (Psychropodes longicauda), (f) a suspension-feeding anemone attached to a nodule, and (g) another 60-cm long deposit-feeding sea cucumber (Psychropodes semperiana).

A pterasterid sea star and a sea anemone on a nodule field. Photo courtesy of Ifremer/Nautil, Nodinaut.

A macrourid rattail, Coryphaenoides serrulatus, photographed at 2 000 m on soft-sediment sea floor with many quill worm tubes, off the coast of New Zealand. Photo courtesy of M. Clark.

A penaeid shrimp and a sea urchin belonging to the genus Plesiodyiadema on a nodule field. Photo courtesy of Ifremer/Nautil, Nodinaut.
Figure 20. Example of a sea-floor manganese nodule mining system and related sources of potential environmental impacts. While mineral processing (concentrating) is part of the minerals life cycle, it is not specific to deep sea mining. We focus on issues related to deep sea mining extraction and associated processes only. It should also be noted that a vessel-based mineral processing facility is not currently considered viable.

Citation

In 1978, experimental dredging to recover nodules was carried out in the Clarion Clipperton Zone. The dredging removed the upper 4.5-cm layer of sediment and left behind a track approximately 1.5 m wide. In 2004, a team of researchers returned to the area, where the original disturbance is still clearly visible more than 20 years later. Photo courtesy of Ifremer, Nodinaut 2004, Nautilus.
Summary: Abyssal Plain Ecosystems are generally diverse, have high infaunal densities, low larger fauna abundance, highly sensitive to disturbance, Impacts may be long lasting, large areas may be impacted, ? Areas of ‘No-Mining’ vs ‘Areas of Mining’?

Citation
Conclusions

- Pacific Islands region has limited options for economic development
- Deep Sea Minerals present a possible development option
- Pacific Islands EEZ’s contain significant DSM wealth
- Island nations are preparing for DSM Mining but will need constant assistance
- Anthropocene planetary impacts affect attitudes and social licence for mining
- Cook Islands is an instructive case study for DSM
- Mn Nodule Deep Ocean Environments may be very sensitive, unique, and difficult to manage re mining impacts