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Sustainable DSM Technology Relevant to the Protection of the Environment

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How can sustainable DSM technologies and methodologies promote environmental protection?
Due to their location and geological and mineralogical characteristics, deep sea mineral deposits prima facie lend themselves to environmentally sustainable mining technologies and methodologies:

- Minimal overburden and stripping;
- Decreased extraction waste;
- Minimal production infrastructure;
- No drill blasting;
- No acid mine drainage at mine site;
- No deforestation; and
- Clean mineral processing solutions for nodules that can result in zero tailings.
When it comes to sustainability DSM is already ahead of the game
Sustainable DSM technology will play a key role in protecting and conserving the planet’s environment in three important ways:

(1) Providing a more sustainable and environmentally acceptable alternative means of meeting the world’s increasing demand for strategic metals;

(2) Providing a long term sustainable source of raw materials at affordable prices necessary to facilitate economic and social development leading to a reduction of poverty which is one of the greatest threats to the planet’s environment;

(3) Providing key strategic metals at affordable prices necessary to build the Green Economy.
Three Pillars of Sustainable Development

Global level
National level
Regional level

Social
Economic
Environment

Source: United Nations Conference on Sustainable Development
Three Pillars of Sustainable Development

As illustrated by the UN, the concept of Sustainable Development not only encapsulates local scale environmental impacts, it also recognises the environment on a GLOBAL LEVEL, as well as the importance of social and economic development.

It is necessary to consider the interlinkages of these three pillars and have an understanding of WHY an activity takes place in order to make an informed assessment regarding sustainability and where to draw the line of what is environmentally acceptable.
WHY DSM?

- Fundamentally there is a need to satisfy an escalating global demand for metal; a demand fuelled by population growth and an increasing number of emerging economies transitioning to industrialized and urbanized societies.

- To achieve economic growth and poverty reduction, developing States must have access to an affordable and reliable supply of resources such as nickel, copper and manganese, which are among the basic ingredients required for growth.
Basic infrastructure and services require vast quantities of metals: housing, schools, hospitals, transportation systems, telecommunication systems, water pipes and electrical cables etc.

Heightened demand for raw materials will likely continue for the foreseeable future with developing States such as China, India, Brazil and Indonesia (together representing over 40% of the world’s population) committed to improving their standards of living and promoting large scale economic and social development.
World copper consumption 1900 – 2008 (K TONNES)
World production –1900: 495 kt; 2008: over 15 Mt
Increasing Copper Demand

World consumption over the next 25 years will exceed all of copper metal ever mined to date.

Copper consumption over the last 25 years accounted for half of all copper metal ever mined in the world.

Sources: US Geological Survey (1900-83), Brook Hunt (1984 onwards)
Whilst metals are critical to sustainable development we are running out of mineral resources on land at a time when demand and human population are growing.

It is becoming harder to extract ore economically on land and in an environmentally and socially acceptable way.

Mining lower grade material on land is environmentally damaging as it requires:
- moving more rock per tonne of metal recovered
- greater surface area disturbance;
- higher fuel emissions per tonne of metal;
- larger waste rock dumps;
- larger tailings disposal.
The extra copper supply needed will likely not come from land where we are having to mine more and more tonnes at lower and lower grades.
Given:
(A) Developing States have a right to increase their standards of living; and
(B) The world needs to transition to a Green Economy; and
(C) Metals are critical to facilitating social and economic development and building the Green Economy...

...the critical question from an environmental perspective is not whether or not to mine, but rather, where and how such mining should take place...
What mining technologies and methodologies can be adopted to produce the metals society demands in the most environmentally sustainable manner?
The extraordinary advancements over the last few decades in offshore technology, engineering and equipment has taken mankind to a point at which DSM can now be considered as potentially viable from a technological perspective.

Importantly, it has become evident that DSM provides a viable solution from an environmental perspective as well.
DSM concepts generally involve the following basic processes:

- Extraction of minerals from the seafloor using seafloor mining equipment;
- Transport of the mined ore vertically via a riser and lift system from the seafloor to a vessel or platform on the sea surface;
- Dewatering of the ore onboard a vessel or platform and return of water;
- Transfer of the ore from the vessel or platform to a transport barge or bulk carrier; and
- Transport of the ore to land for processing.
Minimal Overburden, Stripping and Waste

Terrestrial mines often require the removal of overburden and waste rock to access the ore deposit. This can be up to 4 tonnes of waste for every tonne of ore. Moving large tonnages of waste rock results in significant carbon emissions and degradation of the environment. In contrast, deep sea mineral deposits generally occur directly on the seafloor and do not demand large pre-strips or overburden removal.
## Minimal Overburden, Stripping and Waste

<table>
<thead>
<tr>
<th></th>
<th>Nodule Mine</th>
<th>Copper Mine</th>
<th>Nickel Laterite</th>
<th>Manganese Mine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>1.3% Ni&lt;br&gt;1.1% Cu&lt;br&gt;29% Mn&lt;br&gt;0.2% Co</td>
<td>1.1% Cu&lt;br&gt;0.05% Mo</td>
<td>1.3% Ni&lt;br&gt;0.2% Co</td>
<td>35% Mn</td>
</tr>
<tr>
<td>Strip Ratio</td>
<td>N/A</td>
<td>2.3:1 (Antamina)</td>
<td>1:1 (Ambatovy)</td>
<td>1:1 (Eramet)</td>
</tr>
<tr>
<td>Ore Mined (Mtpa wet)</td>
<td>7.5 (30% water)</td>
<td>5.3</td>
<td>5.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Waste Rock (Mtpa)</td>
<td>NIL</td>
<td>12</td>
<td>5.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Tailings/Ore Ratio</td>
<td>15%</td>
<td>98%</td>
<td>+ 100%</td>
<td>45%</td>
</tr>
<tr>
<td>Tailings (Mtpa)</td>
<td>1.1&lt;br&gt;9% of Land Mine total</td>
<td>5.2</td>
<td>+ 5.3</td>
<td>2.0 shipped at a cost with ore</td>
</tr>
<tr>
<td>Tailings issue</td>
<td>Tailings are sold – no residue on site</td>
<td>Acid Mine Draining</td>
<td>Gypsum waste</td>
<td>Burden to furnace – decreases capacity</td>
</tr>
</tbody>
</table>

Total Land Mine tailings 12.5 Mtpa

Total Land waste 21.8 Mtpa
1 Nodule Mine vs 3 Land Mines

To produce same amount of metal

Copper Mine  
5.3 Mtpa ROM + 12.0 Mtpa waste = 17.3 Mtpa

Nickel Mine  
5.3 Mtpa ROM + 5.3 Mtpa waste = 10.6 Mtpa

Manganese Mine  
4.5 Mtpa ROM + 4.5 Mtpa waste = 9 Mtpa

TOTAL Land Mine Movement Ore + Waste = 36.9 Mtpa

Nodule Mine  
7.5 Mtpa ROM (wet) + Zero Waste = 7.5 Mtpa

Nodule Mine 1/5th of the material to be mined than 3 land mines
DSM = High Grade

Terrestrial mines @ 0.55% Cu and strip ratio of 2:1

Why dig up ~ 600 tonnes of Earth just to get 1 tonne of Copper?

Is this the wisest use of the planet’s environment?

SMS deposits 5% Cu with no strip ratio = 30 times less material needed to be mined to produce same quantity of metal.
No Acid Mine Drainage

One of the greatest sources of pollution caused by global mining is acid mine waters produced by exposing iron sulfides to the atmosphere.

“Water contamination from mining poses one of the top three ecological security threats in the world” (US EPA).

In contrast, acids cannot be produced in the ocean because seawater is alkaline.
Biodiversity

Nodule Mining - deep sea abyssal plains which are the most common environment on the planet.

The wide spread nature of nodule deposits, coupled with the designation of large MPA’s by the ISA, will ensure that the integrity of the nodule seafloor biodiversity is maintained.

Further protecting against bio-diversity loss is the fact that a significant proportion of any nodule licence area will not be mineable due to topographic constraints and because contractors will only mine in those areas that meet certain grade and abundance cut-offs. As such, vast tracks of representative areas will be protected. This cannot always be done with terrestrial mineral deposits.
Preservation Area in the CCZ amounts to **1% of the TOTAL EARTH LAND MASS** and would make this protected area the **20th largest country in the world!!!** The ISA should be commended for taking environmental precautions which are far more stringent than any land jurisdiction.
What other human endeavour has been subjected to a 40 year period of environmental studies and policy framing, had an international regulatory body established, and a preservation area the size of South Africa set aside, before commercialisation has even commenced?

The ISA is at the forefront when it comes to environmental protection.

Should DSM take place in the international seabed area it will take place under the world's best standards implemented by the ISA.
DSM = No Deforestation
A significant component of the world's future nickel supply is contained in nickel laterite deposits, which are predominantly located in the equatorial rainforest regions. Deep sea polymetallic nodule mining provides an opportunity to replace this nickel production and take the pressure off these unique rainforest environments, which are already feeling the strain of population growth, illegal logging, hydrocarbon production, oil palm plantations, transportation projects and farming.
Mineral Processing Technology

Because of their distinct mineralogy polymetallic nodules they lend themselves to mineral processing solutions that offer significant environmental benefits.

Disposal of tailings (large volumes and toxic) is generally recognised as the biggest environmental threat posed by mining.

Unlike a land mine, processing polymetallic nodules can leave zero waste or residue and there are no sulphides to later form acid discharges with rain.
Nodule Mine vs 3 Land Mines

To produce same amount of metal

TAILINGS:
Copper Mine 5.2 Mtpa tailings – acid mine drainage
Nickel Mine 5.3 Mtpa tailings – iron + gypsum
Manganese Mine 2.0 Mtpa “tailings” to be shipped with ore

Nodule Mine 1.1 Mtpa Tailings – inert, saleable – no residue on site

9% of land mines tailings!

PROCESSING:
Copper Mine 5.2 Mtpa Crush_grind_liberation
Nickel Mine 5.3 Mtpa Crush_grind_liberation_HPAL

Nodule Mine 7.5 Mtpa (30% wet) {5.3Mtpa dry}

30% less material to be processed!
A **Green Economy** is not possible without metals at affordable prices.
5MW Wind Turbine: 1500t steel, 5t Nickel, 15t Manganese, 5t Copper 5t Molybdenum

12x more Cu to create 1kw than conventional power generation
An electric vehicle has over TWICE the Copper content of the average car - 2km of copper wiring.

Manganese is needed for high strength steel sheet to replace heavier mild carbon thus making vehicles lighter and improving fuel efficiency and reducing vehicle emissions.

Nickel and Copper essential for batteries in Hybrid Cars.
Green Economy

- Alternative Energy systems depend heavily on copper to transmit the energy they generate with maximum efficiency and minimum environmental impact.

- Nickel plays an important role in air pollution abatement hardware.

- By supplying the minerals essential to building Green technologies (which are key to environmental quality in the future), DSM will make Green technologies more affordable and accessible to both developing and developed States.
Further Sustainable DSM Innovations

Whilst DSM prima facie lends itself to sustainable technologies, entities in the DSM industry will continue to devote resources aimed at pursuing environmentally responsible operations through:

- Innovations in technology and equipment;
- Improvements in energy use efficiencies; and
- Improvements in prevention, minimization and recycling of emissions and wastes.
DSM Technologies & Methodologies

- “Covered conveyors”
- “Catches”
- Plume reduction techniques;
- Positive displacement pumping
- “Diffusers”
- “Fully-Enclosed Systems”
- Sustainable Mine plans
Renewable energy sources may be considered for incorporation into a mining platform:

- Wind
- Wave
- Solar
- OTEC
Nauru Ocean Resources Inc. is studying an Ocean Thermal Energy Conversion system for its potential to generate electricity during mining. OTEC utilises the temperature differential from the water pumped up from the seafloor with the ore and the surface water temperature.
Application to Pacific Island States

Renewable energy research and development work will provide benefits to society generally as these renewable energy technologies will have applications far beyond DSM. For example, OTEC represents a valuable opportunity for Pacific Island States to generate much needed electricity and an opportunity for this renewable energy source to replace the current carbon polluting diesel and oil fired power generators of many Pacific Island States. Indeed, the Republic of Nauru previously set a world record for power output from an OTEC system where the power was sent to a real power grid.
Further DSM Tech Innovations

• Innovations to environmentally sustainable DSM technology will come from the service industry: those groups that design, manufacture and/or supply equipment and technology to the DSM industry.

• However, before these service industry and equipment manufacturers start designing environmental innovations to compliment DSM technology they need to firstly see that there is an industry into which they can sell their products.

• They need to see there are commercially viable exploitation regulations first so that they are confident a market for their products will exist.
Tech Development Reality

Regarding the actual technology that will be used in the International Seabed Area, Contractor’s will only know the actual specifics of such technology once the engineering design work has been carried out on a commercial scale. Such engineering work (at the level of detail necessary to commercialize deep sea mineral deposits) will only be carried out once there is in place Exploitation Regulations to provide Contractors with enough certainty to justify commencing the mining equipment spend, or until it is clear that the Regulations will take a form that is conducive to attracting this large capital expenditure.
EIA – Principals vs Prescriptions

- Not possible to prescribe all of the EIA techniques and studies at this stage given that Contractors will not know the precise technology that will be used, and its associated impact, as they will not invest capital for this level of detailed engineering until after the Exploitation Regulations have been adopted.

- EIA’s must pertain specifically to the actual mining technologies and methodologies adopted by the specific contractor carrying out activities, and each contractor will need to tailor their studies to take account of the particular impact their specific activities will have on the marine environment, which will differ from Contractor to Contractor.
Environmental Regulations

Consider the regulatory frameworks used in the offshore dredging, offshore trenching, and offshore oil and gas industries.

Why reinvent the wheel? Particularly in the Pacific Islands where limited financial resources may be better spent on capacity building to administer the legislation and regulations.
The environmental provisions of Chapter XII of UNCLOS apply to dredging, trenching and offshore oil and gas in the same way as DSM.

Part XII does not differentiate between “seabed activities”.

The obligations on the Coastal State under UNCLOS Part XII are the same irrespective of whether the activity being carried out in the “marine environment” is dredging, trenching, offshore oil, offshore gas, or mining.

PSIDS could learn from the experience of those States carrying out those activities. Look at the laws and regulations that are already in existence for those other seabed activities in other States.
Dredging industry moves 2 billion tpa off seafloor – an activity permitted by virtually every Coastal State Party to UNCLOS
Recommendations

ISA Contractors are recommended to:
(i) standardize environmental baseline data; and
(ii) submit all environmental data to the ISA, to further ensure the ISA is in the best position to effectively manage the Clarion Clipperton Zone.
Recommendations to ISA Contractors

- Standardize environmental data according to the latest and highest standards for the relevant discipline in order to facilitate analysis and comparisons, and make this data available to all stakeholders and for exchange, review and analysis in forums such as workshops;
- ISA Contractors should facilitate free exchange and easily accessible availability of environmental information and biological sample collections gathered during exploration for international scientific peer review and understanding and national and global heritage use;
Recommendations to ISA Contractors

Deposit environmental data securely in freely and easily accessible appropriate national and international archives for review, further scientific analysis and reporting; and

Deposit for review, further reporting, and scientific research representative collections of biological specimens in appropriate repositories with requisite long-term storage facilities, which may include national museums, government institutions, relevant specialized global repositories and universities.
Recommendations to ISA Contractors

ISA Contractors should facilitate communication of scientific information to the international community regarding environmentally related technical developments and scientific knowledge as needed to improve the international scientific communities understanding of the deep sea environment.
NORI’s Environmental Program

NORI has committed to sharing the results of its environmental studies with the ISA to advance Mankind’s scientific and environmental understanding of the deep sea environment in the CCZ.

NORI’s proposed baseline studies will establish the initial state of the marine environment in the licence area and will encompass: (a) physical oceanography; (b) chemical oceanography; (c) sediment properties; (d) biological communities; (e) bioturbation; (f) sedimentation; and (g) geological properties.
Advancing Environmental Science

NORI is further committed to:

- providing transparency in its environmental activities by regular reporting of environmental planning, monitoring, assessment and other actions relating to protecting and preserving the marine environment;
- liaising with stakeholders and facilitating partnerships with the global scientific community on environmental matters; and
- Reporting on environmental performance to the ISA and scientific researchers.
Advancing Environmental Science

NORI’s EIA will provide valuable data for:
- The ISA;
- The international scientific community; and
- Pacific Island States looking to make environmental decisions within their own EEZ’s.
Vinaka!