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Investigating challenges of a sustainable use of marine mineral resources

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Abstract

High-tech products as well as renewable energy systems require ever-increasing quantities and more different metals. The extraction of metals and industrial minerals for the production of consumer goods and machines take place almost exclusively on land now. However, the interest in marine mineral resources has been re-inflamed due to the problem of geopolitical availability, such as fragile or failed raw material states and oligopolistic structures among the producers. This article gives a brief outline of the political, social and economic context of this change in interest in marine mineral raw materials extraction.

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Keywords: seabed activities; marine mineral resources; sustainability; Post Paris Agenda; multi-stakeholder processes, technology

1. Introduction

Humanity has the ability to make development sustainable, to ensure that it "meets the needs of the present without compromising the ability of future generations to meet their own needs…" [1] Thus, the definition of sustainable development was introduced in the report of the 1987th Brundtland Commission. This was the first major milestone and a good starting point addressing sustainable issues. The definition of sustainable development can be traced further back, when in the 1972 Stockholm Conference on the Human Environment the conflicts between environment and development were first acknowledged. To promote sustainable development, the UN Conference

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on Environment and Development was set in Rio de Janeiro in 1992, which led to the Agenda 21, which essentially outlined the actions and international agreements on climate change and biodiversity.[2] In contrast to Agenda 21, the UN declared eight development targets to be achieved by 2015, with its Millennium Development Goals. A list of 21 targets in the fields of poverty, human rights, equality, democracy, environmental sustainability and peace was signed by the 189 member states in the year 2000. [3] Compared to former UN development policies, the objectives were developed in cooperation between governments, international organizations and companies. Moreover, the objectives were more comprehensive and concrete than previous attempts had been. On the basis of the results, as well as from national and international political efforts, further measures were adopted at an international level. For example, in September 2015, the UN General Assembly adopted a sustainable development agenda for the next 15 years. The agenda contains 17 key sustainable development objectives and 169 targets to be reached by 2030. The objectives represent a further development of the Millennium Development Goals from the year 2000. For the first time key objectives like Oceans, seas and marine resources (Goal 14), as well as Production and Global partnership (Goal 17) were explicitly addressed. [4]

Although 30 years after the achievement of sustainable was first defined, including supplements, which lead to further successful development, it still can be stated that there is an inherent ambiguity in the definition. It quickly becomes apparent that definitions can vary a great deal, depending upon perspective. For sustainable development, this means that the differences in the perspectives, with regard to non-renewable energies, can still be individually interpreted, in accordance with each stakeholder: e.g. industry, society and government. It may mean for the industry or business sustained profits. For the various sectors of society the definition is more complex. On the one hand, in the case of mining and other resource extraction, industries have the potential to cause negative effects on the environment, local human health and social well-being. On the other hand mining also generates income and vital raw materials for society. All the various interests of the stakeholder groups are further complicated because they are not independent, and commonly overlap. [5] Bearing this in mind, this paper deals with a new chapter in the commercial exploitation of marine resources, which will open in an area beyond national jurisdiction (ABNJ) – the deep sea. The excavation of massive sulfides and manganese nodules is expected to begin within the next few years. In addition to the two mentioned deposits, cobalt crusts are also of interest for marine mining. For high-tech products and new developments these three deposits, which contain different valuable metals are of great interest. Natural gas and oil have been extracted from the seas for decades, but the ores and mineral deposits on the sea floor in the ABNJ have attracted little interest so far. Main reasons for this behavior were the limited commercial interest on the side of investors because of stable economy reasons, in combination with the lack of new technologies capable of realizing such a difficult project. [6] Yet as resource prices rise and problems of political availability develop, such as fragile or failed raw material states and oligopolistic structures among the producers aggregate, the appeal of ocean mining and interest in mineral raw materials of the deep sea has been renewed.

The following chapters will give a brief introduction in the current situation of the distribution of the raw mineral resources. It describes the current state of art with regard to the regulations of the future planned mining of raw marine materials. After a description of the resources of interest from the ABNJ region, a comparison of the reserves on land and their use in high-tech products and technologies follows. The approach contains recommendations for action on the activities to achieve the objectives, with reference to the fields of technologies, environmental studies, ecological impacts and legal conventions.

2. Resources of interest for high-tech products and new technologies

2.1. Interest in resources of the deep sea

The current situation is that the International Seabed Authority (ISA) has approved a total of 28 contracts for exploration, which covers more than 1.3 million square kilometers of the seabed in the ABNJ. Explorative work is taking place simultaneously in the Pacific, Indian and Atlantic oceans. The map (Fig. 1) shows the Clarion - Clipperton Zone in the Central Pacific where 14 contractors are exploring for polymetallic nodules. [6]

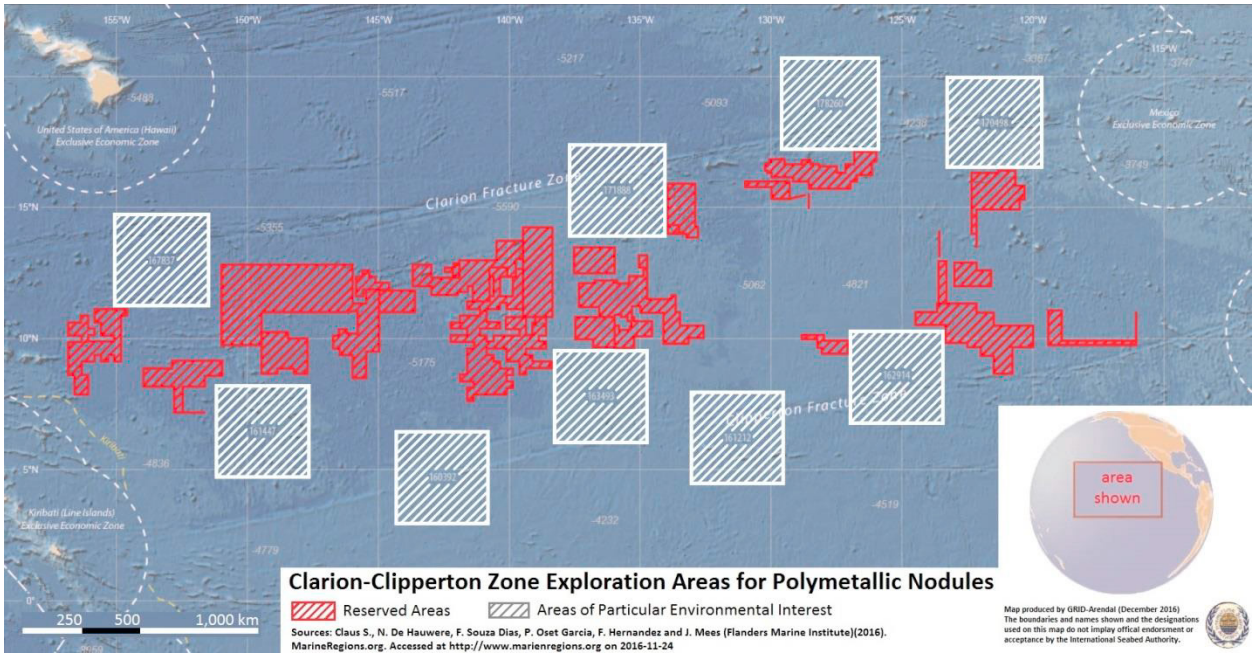

Fig. 1. Map of reserved Areas in the Clariton- Clipperton Zone [7]

The main reasons for this behavior were the minimal commercial interest of the investors due to a stable economy, combined with the fact that no technologies existed, which were capable of realizing such a project. [6] There are important differences, and no direct comparison between deep seabed mining and offshore oil and gas development projects, so that deep seabed mining is classified as a new activity. Nevertheless, as response to the series of economic crises, between 2007 and 2011, the interest in the marine mineral raw materials has been re-ignited. Accompanied it led to a dramatic increase in interest in deep-sea mining particular from the private sector between 2011 and 2015. In this four-year period 18 contracts were approved through the ISA. Funding and type of investors has been changed as well after 2011. Most investment before 2011 has come from state- funded research programs. Corresponding contracts were held by governments or government agencies. The investors in early days were “relatively small and speculative companies operating through developing countries”. Now there are “large-scale multinational operators such as Keppel in Singapore, Lockheed Martin in the UK and DEME Group in Belgium that have made significant investment”. [6] The creations of rules, for a fair allocation of marine resources as well as an estimation of the long-term effects for the environment, are currently in progress. [8]

2.2. Regulations and responsibilities

The sea, that covers 71 per cent of our earth, is divided into several legal zones by the United Nations Convention on the Law of the Sea (UNCLOS). The UNCLOS represents the primary instrument governing the protection of sea and the most comprehensive international treaty ever concluded. It was adopted at the 1982 UN Conference on the Law of the Sea and came into force, after protracted negotiations, in 1994. According to Article 76 it defines, among other things, the continental shelf, the territorial sea, the Exclusive Economic Zone (EEZ) and the high seas (Fig. 2). The sovereignty of a state decreases with increasing distance from the coast. Extending from the baseline and up to 12 nautical miles the territorial sea is defined. Here the sovereignty of the coastal state is already restricted, because ships of all nationalities are allowed to cross these waters. In the EEZ extending 200 nautical miles off the coast, the coastal state has the sole right to explore and harvest living and non-living resources. For example, the coastal state may exploit oil, natural gas, mineral resources or even fish stock. In the area of the continental shelf, which is a natural extension of the continent and can go beyond the EEZ, the coastal state is allowed to explore and harvest

living and non-living resources on or under the seabed. [9] In article 156 the United Nations also establish the International Seabed Authority (ISA). The ISA is the only organization responsible for controlling the allocation and exploitation of resources in and on the seabed. The Authority's jurisdiction extends to all mineral resources of the seabed beyond national jurisdiction, which UNCLOS defines as the "common heritage of mankind" (Article 136).

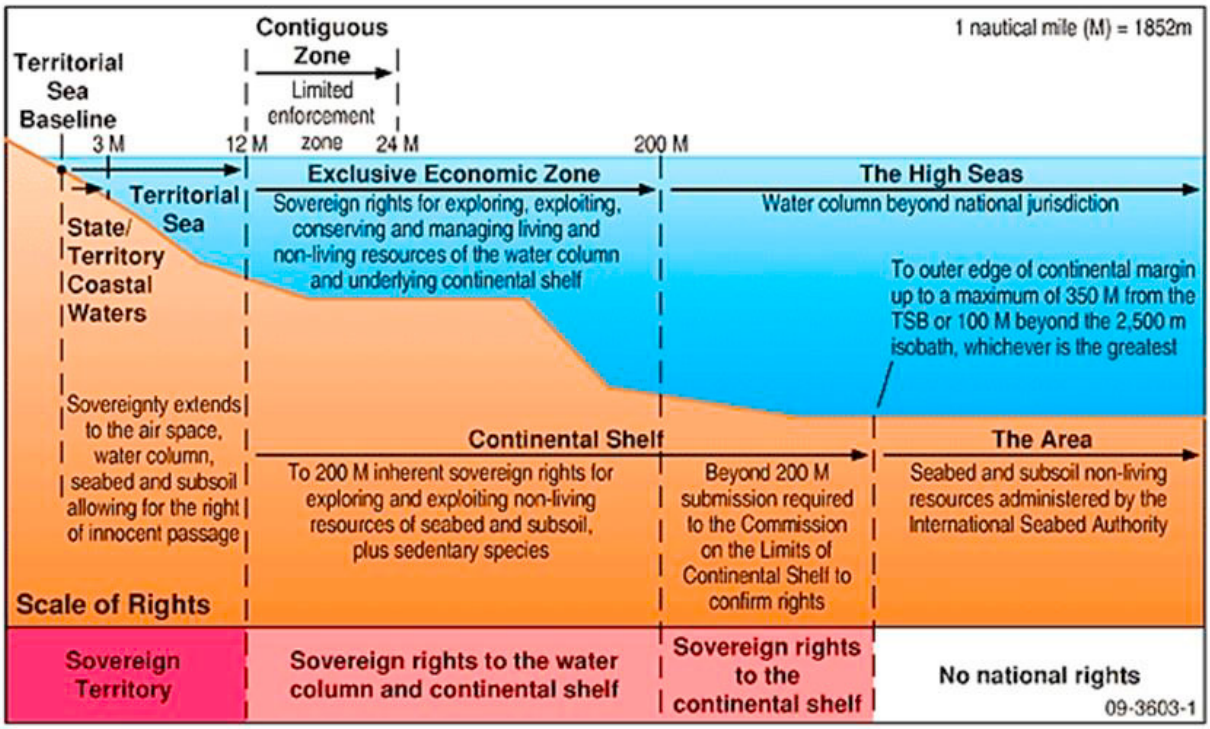

Fig. 2. Maritime zones and rights under the 1982 United Nations Convention on the Law of the Sea (UNCLOS) [10]

2.3. Main resources of interest in the ABNJ

The three main types of resources deposits which contain different valuable metals the interest in focused are Manganese nodules, Cobalt crusts and Massive sulphides.

- Manganese nodules cover enormous areas of the seabed of the Pacific and Indian Oceans. They are located mainly in the deep sea levels of the oceans in large water depths between approx. 4,000 and 6,500 m water depth. The most economically interesting manganese region, outside the EEZs, is the CCZ in the eastern equatorial Pacific. This is the area with the most exploration licenses for manganese nodules, awarded by the ISA. In manganese nodules significant levels of different metal values are involved that determine the economic interest. The essential ingredients include manganese, iron, copper, nickel, cobalt and titanium among other substances such as molybdenum, zinc and lithium.
- Polymetallic/cobalt crusts: similar to the manganese nodules polymetallic crusts are almost everywhere in the oceans. Economically interesting deposits are, however, mainly concentrated on the deep-sea mountains of the western Pacific. In particular, they are found in water depths between 1,000 and 3,000 m. of particular economic interest are ingredients: manganese, iron, cobalt, nickel, platinum and rare earth elements.

- Massive sulphides are ore deposits and found in many places on the active and inactive volcanic sea floor. That is why they are not in the deep ocean basin but in the middle depths of a few hundred to a few thousand meters of water depth. Depending on the region, they contain widely different amounts of copper, zinc, lead, gold and silver, as well as numerous important trace metals such as Indium, Germanium, Tellurium or Selenium.[11]

2.4. Problem statement

Particularly in leading industrialized nations, it is feared that over the next few decades the supply of raw materials that are important for the industry could become more uncertain. How reliable the supply of raw materials is in the long term depends largely on the reliability of supplier countries. Important factors are political stability and investment security and transparency. [12]

At this point, one should be aware of the difference between resources and reserves. Reserves are proven occurrences of resources, whose extraction with the current technologies can be carried out economically feasible. If, on the other hand, an occurrence is not yet proven with respect to its metal content and volume, or the extraction and processing is not economically feasible, we speak of resources. [13] Reserves, as a description for the degree to which a material is necessary as a contributor to an energy pathway or uses in high tech products, are dynamic. Economics, new geological understanding and new technologies drive exploration and reserves figures. There are many examples of reserve growth. [14] High-tech products as well as renewable energy systems require ever-increasing quantities and more and more different metals. For the production of high performance magnets, which are needed for technology and high end products, rare earth, some of which are contained in manganese nodules, are vital. In contrast to the transport of electricity via lines (earth and land cables), non-ferrous metals, such as copper, are needed. Special steels and alloys, in turn, require elements such as cobalt and nickel.

These raw materials are currently being mined almost exclusively on land. However, certain risks are hidden in the land reserves. It is to be expected that the trend of a gradual shift towards new energy technologies including new energy systems, renewable energy sources in the coming decades continues. Of note are the rising world market prices, due to continuously rising demand, especially on the Asian markets. As a politically influenced restrictions example, consequences of such dynamics appeared from 2003 to 2013: The economic boom in China helped contribute to a long period of high prices in the metal markets, but also led to temporary supply shortages. [15] Another example is the huge price hike of copper and other resources after 2006, when China secured major quantities of resources. At those times there could be no question of scarcity, however.[14] A few years later China imposed an export restriction on rare earth around 2010/11. Some countries possess extraordinary percentages of reserves and production. The unequal geological distribution of materials is compounded by the ability or inclination for a country to explore for, produce and export them. [14] The fact is so-called critical raw materials usually come from very few countries. [15] For example, China produced 92.1 % of rare earth elements in 2013. Another example for a highly demanded element is Germanium, which is defined as a rare metal. Germanium is used for the radio technology in smart phones, in semi-conductor technology and in thin-film solar cells. [16] “However, few minerals contain appreciable amounts and no mining for germanium itself is carried out. The majority of commercial extraction comes from lead zinc ores…” [14]

Many examples can be cited to illustrate that there is no issue of raw resource material scarcity. Experts estimate that the currently known reserves of rare earth metals worldwide, will last for 285 at current production levels, while resources are calculated to last almost 3,400 years. [17] Some resources are by-products of the extraction of other metals. For instance, both germanium and indium – which is vital for the manufacture of LCD displays – are by-products of lead and zinc mining. They occur in only small quantities in the lead and zinc deposits. In order to extract more germanium and indium, lead and zinc production would have to increase substantially. This would be uneconomic, however, because the demand for lead and zinc is not high enough. [16]

So the question is what is the real driver for the focus on marine mineral resources? Resources and reserves were all in place, long before political boundaries were established or humanity even considered their use. The fact that the reserves of the materials are declared as scarce, as exemplarily presented, depends entirely on the conditions of the economic and political situation and just shows that this is based on a multi- stakeholder problem. That is currently one of the most important reasons, why marine mineral raw materials have increasingly become the focus of national and international interests, even though it is clear that seabed deposits will never be able to replace the land deposits. They will merely contribute, to secure supply against the background of problems of political restriction and / or increasing price.

3. Research questions

Global targets for resource handling is already addressed, e.g. with the SDGs which are not legally binding. In this case, global indicators are provided to regulate the target achievement. Nevertheless, due to the abundance and different interpretations of the goals and the indicators, it is difficult to measure them in detail. In order to achieve common sustainability goals, it has been shown that the sole pressure caused by public attention and the lack of transparency has meant that sustainability impacts cannot be attempted by multinational agreements, e.g. which was shown by the Kyoto Protocol on Climate Change. It becomes necessary to find new approaches for sustainable resource use including marine resources which are currently in focus for future extraction. These approaches need to be internationally applicable and binding for all stakeholders. In this context, the following questions have to be investigated:

- What are appropriate mechanisms to ensure the sustainable and responsible use of resources and oceans?
- What are the necessary transformation processes to achieve common responsibilities?
- What is the role of multi-stakeholder processes within the necessary transformation processes?
- Which instruments can strengthen multi-stakeholder processes?

4. Approach

The global distribution and handling of resources needs to be rethought. At present, national-oriented thinking with corresponding economic self-interest prevails. Therefore, it is challenging to sustainably distribute and use resources in the sense of the SDG or other principles of Sustainable Development. For example, individual companies cannot be given the full responsibility for sustainability impacts because sustainability takes place at the multinational level. It is a multi-stakeholder issue. In this sense, multinational binding agreements need to be established in order to reach the common goal of preserving the earth and securing prosperity for future generations. Furthermore, there have already been approaches (e.g. "Enterprise" as the commercial arm of the ISA) to extract resources from an international independent company and distribute them globally. The establishment of this type of enterprise was prevented by a veto of the leading industrial nations. They assumed that they could not further expand their status and prosperity [WOR3].

Responsibility, transparency and legislation must be redefined and redeveloped. It concerns the following:

- Responsibility: At the international level, it was recognized that states and their resident companies must assume sustainability responsibility. Corresponding international committees and boards as well as NGOs were formed. They developed and published proposals at this level. It is the responsibility of those involved countries to transfer this responsibility to their resident companies.
- Transparency: At the international level, and sometimes at state level, instruments have been developed that allow for transparency in trade and handling of resources. These are, however, not partly lived because they relate to individual companies. Multi-stakeholder transparency is not given and is currently not demanded although it is needed for a sustainable distribution and handling.
- Legislation: At the international level there is no legislation for handling and using resources. Committees and boards develop proposals which can be implemented in national law. In turn, each country acts differently and the implementation is not compulsory.

The establishment of a superior institution which supervises the implementation and abidance of laws is actually necessary. On the one hand, the required international transparency can be created. On the other hand, sustainability responsibility can also be directly transferred to companies. At the same level, responsibility can be transferred to multi-stakeholders as well. The mentioned aspects are a long-term transformation process. The processes for responsibility, transparency and legislation interact with each other and they are overlapping. Against this background, the research questions of chapter 3 can be argued as following.

The first question deals with appropriate mechanisms to ensure the sustainable and responsible use of resources and oceans. There are already well-known principles established such as:

- Less consumption affords fewer products and thus fewer resources,
- Durable design of products and recycling possibilities lower the resource consumption,
- Use of low-emission technologies for the reduction and processing of resources and the
- Avoidance of environmentally harmful substances in the extraction and processing of resources.

While these principles may sound trivial in their naming, they are difficult to implement from a global perspective. Single examples do exist but the findings are locally documented and the according data and information is either no longer traceable or not for everyone accessible. This includes impact assessments and the documentation of the results as well. Additionally, import and export policies are asymmetrically regulated under the GATT/WTO. [18] While tariffs are multilaterally negotiated and strictly disciplined, export duties are generally not. That way, international responsibility cannot be taken. In the future, the transparency of the comparability and consistency of the procedures must be made possible by a central administration or at least by a central access to the information. In order to move away from the inefficient non-cooperative equilibrium toward a cooperative solution, countries should exchange commitments on export taxes against lower binding tariffs in downstream sectors. These commitments would be the basis for future international legislation. The legislation, in turn, guides the trade of natural resources within previously agreed conditions towards more sustainable actions.

Since the first question reveals appropriate mechanisms, the second question deals with the necessary transformation processes in order to achieve common responsibilities. Especially the mining of deep-sea mineral resources can be seen as the conversion of natural capital, which has no owner except the earth itself, into financial capital, which is owned by single companies. Therefore, a fiscal mechanism is arguably the most direct approach for sharing the benefits of this conversion. That way, e.g. the ISA is specifically required to “provide for the equitable sharing of financial and other economic benefits derived from activities in the area […]” [19] and to develop rules, regulations, and procedures to this end through its Finance Committee. This would be an opportunity for a transformation into higher transparency with regard to handling resources as well. The major difference of deep-sea resources compared to resources from land is that continuous sea areas extend beyond national borders or are even – like the high seas – international areas. Sustainable handling of resources can only be achieved if numerous nations pull together in terms of legislation. A common legislation for all stakeholders needs to be established. Taking up responsibility is a global task for multi-stakeholders which require global legislation in turn.

The third question covers the role of multi-stakeholder processes along the transformation process. If states are considered as stakeholders, the asymmetry between import and export policies needs to be regulated in order to achieve a higher transparency. Joint reductions in trade restrictions would neutralize the beggar-thy-neighbor effect of the policy, while allowing trade to grow. These considerations may have implications in the context of the Doha negotiations. On the import side, countries have moved towards the possible application of a Swiss formula to cut tariffs, which implies a reduction of tariff escalation. On the export side, taxes are not under negotiation. To the extent that a trade agreement is motivated by the need to eliminate beggar-thy-neighbor effects of trade policies, this asymmetry between import and export policy is incoherent from the perspective of economic analysis and may limit the ability of countries to achieve meaningful gains in the trade of natural resources. Multi-stakeholders on a company level need to work closer together and share knowledge about sustainability impacts, e.g. sharing knowledge about ecological impacts of a certain technology in deep-sea mining. Furthermore, a common technology and know-how transfer from a global perspective seems to be necessary.

Transformation processes need to be initiated and handled with according instruments. The fourth question examines the instruments that strengthen multi-stakeholder processes. Especially the responsibility of (multi-) stakeholders must be strengthened, alone and together. Therefore, instruments to increase national commitments on a global level must be created in order to support the necessary transformation process. Different levels (local, regional, global) represent the basis for the interplay of binding and non-binding instruments. Regarding responsibility, transparency and legislation, a superior legislation, an enterprise and a control panel are necessary. An institution that establishes a common legislation for global trading and handling of resources is needed. Furthermore, the superior institution arranges that superior legislation is transferred into national legislation. In addition, instruments for the superior institution need to be defined, e.g. licensing and import / export control, and, eventually, a control panel needs to be established which proves whether laws are respected. Since comparability,

e.g. due to geographic reasons, is not given, the approach is in the direction of individual packages which are individually available and serve the overall purpose of sustainable development. Measurability through appropriate indicators must be provided.

5. Outlook

It is a call for collective action at all levels that implements a communications and advocacy plan which has to be anchored in key activities to achieve plan objectives and reach target audiences with tailored messages through identified channels. Activities have to be action oriented and easy to measure. In terms of the handling and use of our available resources of the earth there is still a long way to go, achieving a level of knowledge and public awareness, especially concerning marine resources which are currently in focus for future extraction. It is crucial to launch a debate about the use of marine resources, for without our natural collective interest in these diverse problems, we cannot exert the pressure that is needed to ensure that marine resources are extracted and utilized in a sustainable manner.

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