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The Importance of Ocean Science Diplomacy for Ocean Affairs, Global Sustainability, and the UN Decade of Ocean Science

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The ocean is highly impacted by human activities, and ambitious levels of science are urgently needed to support decision making in order to achieve sustainability. Due to the high cost and risk associated with ocean exploration and monitoring in time and space, vast areas of the oceanic social ecological system remain under-sampled or unknown. Governments have recognized that no single nation can on its own fill these scientific knowledge gaps, and this has led to a number of agreements to support international scientific collaboration and the exchange of information and capacity. This paper reviews current discussions on ocean science diplomacy, i.e., the intersection of science with international ocean affairs. Ocean science is intrinsically connected with diplomacy in supporting negotiations toward a more sustainable future. Diplomacy supports essential aspects of scientific work such as capacity building, technology and information/knowledge exchange, and access and sharing of research platforms. Ocean science diplomacy underlies the work of many intergovernmental organizations that provide scientific guidance, such as the Intergovernmental Oceanographic Commission (IOC), the Intergovernmental Panel on Climate Change (IPCC), and the International Council for the Exploration of the Sea (ICES), and United Nations Convention on the Law of the Sea (UNCLOS). To illustrate how critical science diplomacy is to global ocean affairs, this paper examines examples of the influence of ocean science diplomacy in UNCLOS. Furthermore, this paper discusses the utility of ocean science diplomacy in support of the UN 2030 agenda, and the UN Decade of Ocean Science.

Keywords: science diplomacy, United Nations (UN), sustainability, Decade of Ocean Science, 2030 Agenda and SDGs, Law of the Sea (UNCLOS), transdisciplinary science

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SCIENCE AND INTERNATIONAL RELATIONS

Science is a universal language that through empirical observation and evidence-based testing stands on grounds of replicability, transparency, and merit in search of the truth (Oreskes, 2019, p. 24). Science facilitates communication and cooperation as scientists seek ways to compare results across time and space to understand reality and socio-ecological phenomena (Wagner, 2002).

Science is generally perceived by society as apolitical and free of values, a search for evidence that enlightens our knowledge (Iñiguez et al., 2012). Despite the important debate in Academia on the political basis of science (Jasanoff, 1998; McCain, 2016), this public perception promotes science as a reliable source of knowledge that is widely used by policymakers and diplomats, from advising policy to reinforcing political values (Weiss, 2005; Pielke, 2007; Oliver and Cairney, 2019).

Modern diplomacy can be understood as a statecraft in building non-violent international relations advising, shaping, and implementing foreign policy (Barston, 2019; Boyd et al., 2019), whereby diplomats protect and promote national values and interests abroad (Kaltofen and Acuto, 2018a). In international relations, science can act as a country's soft power, as opposed to the traditional hard powers of force and coercion (Nye, 2017), reinforcing and spreading national views and values (e.g., House of Lords, 2014). Evidence-based negotiations bridge international relations and science (Kaltofen and Acuto, 2018b), posing a necessity to strengthen the participation of national science and technology communities in negotiation processes (Colglazier, 2016).

As the global community increasingly meets Anthropocene challenges, the integration of science and diplomacy is pivotal (Steffen et al., 2011; Kotzé, 2014). One current example involves climate science feeding diplomatic negotiations at the UN level. The Intergovernmental Panel on Climate Change (IPCC) reports have informed diplomatic discussions and resulted in progressive commitments from countries. From Kyoto to Paris, scientific advice has informed more assertive commitments to reduce greenhouse gas emissions (Ruffini, 2018). A new field of study has emerged to understand this interlinkage between science and international relations under *le chapeau* of science diplomacy (Fedoroff, 2009). Science diplomacy, though a new term, is being increasingly used by policymakers as a way of promoting international engagement around evidence-based decision making (e.g., Pandor, 2017; Moedas, 2019).

This paper aims to present current discussions on science diplomacy and its application in the context of ocean affairs. Here, I review different examples of what constitutes ocean science diplomacy by briefly analyzing the work of some key intergovernmental organizations, such as the International Council for the Exploration of the Sea (ICES) and the Intergovernmental Oceanographic Commission (IOC). A more in-depth analysis is presented for the United Nations Convention on the Law of the Sea (UNCLOS) (hereafter the Convention) and its implementing institutions as critical avenues for the application of ocean science diplomacy practices and power play among States in vital matters concerning ocean affairs. In addition, I explore the relationship between the UN 2030 Agenda for Sustainable Development and the upcoming UN Decade of Ocean Science for Sustainable Development (2021–2030), as both processes result from ocean science diplomacy practices and contribute to the implementation of the Convention. Finally, I discuss the current and future importance of ocean science diplomacy in global governance frameworks, in particular with a view to enhancing sustainability and regional ocean science and technology capabilities.

METHODS

The work presented here results from a literature review and a desktop analysis of the Convention and related implementing instruments. I analyzed the current theoretical discussions around science diplomacy and framed these into practical examples of the Convention's implementation. The evolution of the implementation of the provisions in the Convention can also be assessed by analyzing the annual UN General Assembly (UNGA)'s Omnibus resolutions for Oceans and the Law of the Sea, where States Parties agree on mutual issues of concern and calls for action with regard to ocean health, sustainability, and use. Therefore, I reviewed the last 10 years (2009–2019) of the omnibus resolution in search of the terms "science," "scientific," "research," and "knowledge." I extracted and compiled the full text of the agreed paragraphs that addressed ocean science at some level, to look for the main themes that States called for scientific expertise. By doing so, I present the recent updates on the role of science to international ocean affairs after the adoption of the Convention, as a means to illustrate the role of science diplomacy in progressing matters of common concern in the law of the sea and ocean affairs among States.

PROGRESSIVE EVOLUTION OF A NEW CONCEPT: SCIENCE DIPLOMACY

Science diplomacy practices date back to ancient times (e.g., Turekian et al., 2015). Reports from the negotiations of the Treaty of Kadesh, in a conflicted Egypt in 1300 B.C., show letters asking for doctors to be exchanged between the powers in dispute (Turekian, 2018). Contemporary examples of science diplomacy include the SESAME synchrotron light facility in the Middle East. SESAME has allowed researchers to cooperate in a politically tense region, arranging member countries to form a dialogue based on science (Rungius, 2020).

There is much debate on what science diplomacy means. International relation scholarship has traditionally placed science exogenous to theoretical discussions (Mayer et al., 2014), a picture that is slowly changing due to the political power that science can exercise in international negotiations, in face of global environmental uncertainties. Consequently, science diplomacy has emerged as a new field to understand the interplay between science and international relations, in particular where there are global, transborder, and regional issues of common concern or interest (Berkman, 2019; Flink and Rüffin, 2019). Studies in this field include the influence of science in diplomatic relations, the dynamics of science acting as a source of power between nations, and the support that diplomacy can provide to research and innovation (Flink and Schreiterer, 2010; Leite et al., 2020). In this sense, science diplomacy can be framed as a discipline grounded on the fields of international relations, science–policy interface, and Science and Technology Studies (Fähnrich, 2017). Science diplomacy can also be described as a practice, and some have advocated that this is the dominant view in the literature, based on practitioners' perspectives and requiring further empirical basis (Ruffini, 2020). Science diplomacy as

a practice involves the collection, synthesis, and presentation of evidence to international decision-making processes, joint research projects acting as a dialog hub between nations, and scientific cooperation calling society to address humanitarian challenges (Rungius et al., 2018).

Discussions in science diplomacy generally frame the results into two distinct taxonomies due to the lack of a generally accepted definition of the concept. One of those taxonomies was provided by the Royal Society and the American Association for the Advancement of Science as a result of an event held in 2010 (The Royal Society, and AAAS, 2010). The concept is categorized as shown and exemplified in **Figure 1**.

Subsequently, Gluckman et al. (2018) proposed another set of categories that highlight the utility of the concept in transnational relations. According to those authors, science diplomacy practices would fall into three categories, namely:

i Actions designed to directly advance a country's national needs;
ii Actions designed to address cross-border interests; and
iii Actions primarily designed to meet global needs and challenges.

Both taxonomies, when confronted, show a progressing evolution of the concept. The Royal Society and AAAS taxonomy disregarded the role played by national interests in advancing science diplomacy, being brought to the discussion by Gluckman and colleagues in 2018. National interests are an essential part of diplomacy, and science is one of the many features considered in the decision-making process (Ruffini, 2020). In this case, science can both influence but also be influenced by diplomacy, grounded in national political agendas (Flink, 2020).

Globalization has provided many pathways for researchers to collaborate in global environmental agendas and engage with international decision makers, without undue regard to national political agendas (Leguey-Feilleux, 2017). Non-State organizations have been particularly active in engaging society and calling attention to environmental concerns grounded in scientific findings. These organizations, which include non-governmental and intergovernmental organizations, provide scientific evidence to international discussions by preparing policy briefs, community white papers, and side events in Convention of the Parties, for independent discussion based on science. This track 2 diplomacy, parallel to State-led diplomacy, has being identified as a more flexible and forthcoming form of international relations by which science can exercise its freedom and best address societal benefits and community interests (Jones, 2015; Gore et al., 2020). One example of such is the ongoing negotiation at the UN on a new legally binding instrument to regulate the access and benefit sharing of the marine biodiversity in areas beyond national jurisdiction (Harden-Davies, 2018). Science diplomacy facilitates how national political agendas can be brought into balance with community interests, with researchers centrally placed to provide evidence and inform future joint decisions (Legrand and Stone, 2018). As a pay-off, researchers are provided with access

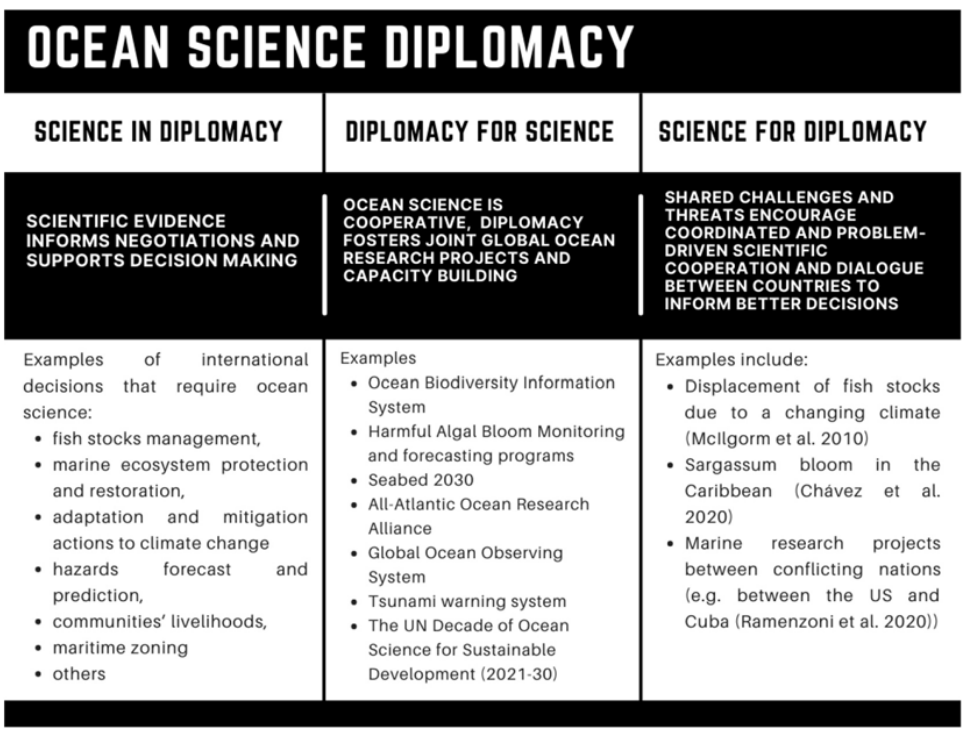

FIGURE 1 | Diagram showing the three categories of Science Diplomacy as informed by The Royal Society, and AAAS (2010), followed by examples of current matters in ocean affairs that illustrate this taxonomy.

to infrastructure and international funding (Berkman, 2019). Consequently, global environmental conundrums are excellent cases for science diplomacy.

THE OCEAN AS A RICH FIELD FOR SCIENCE DIPLOMACY

The ocean supports life on the planet by providing food (Food and Agriculture Organization of the United Nations, 2020), climate regulation (IPCC, 2019), and other essential ecosystem services (Lubchenco and Petes, 2010). Perceived as humankind's last frontier (Gibney, 1978), our relation to the ocean is not only economical (Fleming, 2010), but also social and spiritual (Costanza, 1999). At the same time, the ocean is highly impacted by human activities, including overfishing (Jackson et al., 2001), the loss of biodiversity and ecosystem services (Worm et al., 2006; Hughes et al., 2018), ocean warming (Poloczanska et al., 2013; Cheng et al., 2020), and sea level rise as a direct consequence of climate change (Small and Nicholls, 2003). Ocean ecosystem services are beneficial to humanity in its entirety. Land-locked and geographically disadvantaged States, with low or no proximity to coastal areas, still depend on marine transport systems, as well as food provision, climate regulation, and leisure services from the ocean (Nash et al., 2017).

The marine environment is considered as a global commons, and it is on humanity's best interest to preserve and sustainably use its resources and services (Vogler, 2012; Rudolph et al., 2020). Ocean management relies both on national policies and regulations and on international cooperation (Attard, 2018). Scientists are best placed to identify and comprehend hazardous anthropomorphic phenomena in the ocean, seeking answers to inform policy (Nursey-Bray et al., 2014; Tengö et al., 2014; Sudhakar, 2020). Therefore, ocean science is essential both to assess ocean environmental limits (Baähr, 2017; Nash et al., 2017) and to provide evidence to sustainably limit our efforts on crossing those ocean boundaries (Ingeman et al., 2019).

International non-governmental and intergovernmental organizations play an important role in the international ocean decision-making. For instance, ICES, a North Atlantic intergovernmental scientific body, has been advising policy since 1902, in particular with regard to fisheries management. ICES provides evidence to support regional and national decision making, but also assists countries on crafting their positions in international fora when requested to do so. Advice is delivered by a broad network of scientists who use their peer collaboration to reach out even further and conduct scenario-building, so information is policy-relevant (ICES, 2019). In fact, Robinson (2020a) advocates that ICES has developed subsequent ocean science diplomacy mechanisms, describing ICES critical role in shaping ocean science diplomacy. Historically, ICES is well respected and cooperates closely with other relevant international organizations, such as the IOC of UNESCO.

The IOC is broadly recognized as the international scientific body for ocean affairs at the UN level (Pavliha and Gutiérrez, 2010). It is an institution that has combined science and diplomacy since its inception in 1960. With 150 Member States, IOC has been central in organizing and pushing ocean science under the mandate of the UN General Assembly (UNGA). IOC relies upon at least two definitions of ocean science. First, ocean science includes all disciplines related to the ocean, i.e., the classical fields of oceanography: physical, biological, chemical, and geological, as well as hydrography, health and social sciences, engineering, the humanities, and multidisciplinary research on the relationship between humans and the ocean (IOC-UNESCO, 2017, p. 19). Second, and more recently in the context of the UN Decade of Ocean Science for Sustainable Development, this definition has been expanded to include the supporting infrastructure (observations, data systems, etc.); societal benefits, such as knowledge transfer and applications in regions that are lacking science capacity; science-policy/user interface; and local and indigenous knowledge (IOC-UNESCO, 2020b, p. 2). Although both definitions are debatable, the key message is that ocean science is transdisciplinary in essence and is now being used to fulfill other roles, such as producing goods for social benefit and fostering transfer of technology and capacity development.

THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

The Convention on the Law of the Sea sets the rights and obligations of State Parties in relation to the law of the sea and ocean affairs, thereby providing a global ocean governance framework that is almost universally accepted (Koh, 1982). The Convention is a living example of how national interests are balanced with global interests regarding the exploration and conservation of the ocean (Long, 2007). National interests included States claims to extended maritime spaces. Global interests were mainly the expanding threat of unregulated natural resources exploration (Brown and Fabian, 1974). Consequently, the United Nations General Assembly convened the Third United Nations Conference on the Law of the Sea—UNCLOS III in 1973 to discuss ocean matters in plenitude (Koh and Jayakumar, 1977). It was only after 9 years of long and intense negotiations at the UN that the Convention was finally adopted in 1982 and entered into force in 1994. Today, it is the globally recognized regime dealing with all matters relating to the law of the sea, being ratified by 167 States Parties and the EU (United Nations, 2019b).

Science was at the very core of negotiations at UNCLOS III (1973–1982) (Hayes, 2011). Diplomats needed to be supported by scientific information to negotiate Convention matters as well as to rebut evidence presented by other parties. This power of science was very influential to inform the agenda setting as well as the advancement of the negotiations (Brown and Fabian, 1974). For example, during the process of framing the draft provisions of the new treaty, it became evident that countries with better scientific capabilities could drive negotiations by presenting strong evidence that anchored discussions around that information, something called in negotiation theory as the anchoring effect (Furnham and Boo, 2011).

One example of this anchoring effect in ocean negotiations involves the discussions on deep sea mining, which were central

to the successful conclusion of UNCLOS III. Evidence on mineral richness and potential commercial value resulted in the creation of the International Seabed Authority (ISA) under the Convention. The ISA is an organization by which States Parties organize, administer, and control activities in the "Area," i.e., the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction [Convention's Art 1 (1)]. The Authority organizes and controls activities guided by the principle that sets the Area as a common heritage of (hu)mankind (Wedding et al., 2015) as adopted by the Convention and later reinforced in the Convention's 1994 Implementation Agreement (Lodge and Verlaan, 2018). Therefore, even States which are not part of the Convention are still bound to the Authority's role in regulating this common heritage as part of customary international law, overseeing equitable opportunities in the Area (Willaert, 2021). ISA's *raison d'être* is basically to apply scientific evidence to regulate both mining and environmental protection, making sure that any resulting benefits are shared among all. The ISA continually develops and enhances codes of conducts and technical guidelines, all based on evidence presented by States Parties. Considering that our knowledge of the deep sea is still inadequate, the lack of sufficient scientific evidence is a common ground, a situation in which the precautionary principle is generally applied (Ardron et al., 2018). However, most Member States to the Convention lack the capacity to produce or evaluate scientific evidence in relation to the deep ocean, leaving those States with higher capabilities to drive the regulatory framework for mining and environment impact assessments of this common heritage of humankind (Wolfrum, 1983).

Historically, disparities in science and technology capacities drove countries to adopt distinct positions in negotiating the Convention. Developing countries recognized their lack of scientific and technological capabilities as a threat, undermining their ability to properly address technical issues as well as progressing on the potential exploration of the marine natural resources and resulting incomes (Hayes, 2011). In addition, sociotechnical imaginaries[1], i.e., technologies that were not yet available or commercially viable, drove developing countries' concerns in relation to sovereignty rights, access, and potential benefit sharing of those explorations (Robinson, 2020b). Developed countries, in turn, were concerned whether the Convention would post obstacles on the conduct of marine research abroad, limiting their access to foreign waters and therefore any potential prospective research on marine resources (Shapley, 1973), in addition that it would require the mandatory exchange of ocean technologies to developing countries. Consequently, the Convention recognized the importance of ocean science in adopting Parts XIII and XIV, addressing Marine Scientific Research and the Development and Transfer of Marine Technology, respectively.

Part XIII calls for international scientific cooperation for peaceful purposes, seeking to diminish the gaps between Member States' technical capacities to implement the Convention. The same applies to Part XIV, in which countries are called to share and transfer marine technologies to less capable nations, so that they can manage their jurisdictional waters and gain the benefits of the resources therein, as well as avail of their rights and discharge their obligations under the Convention. Although essential to the implementation of the Convention, these provisions are among the least implemented (Salpin et al., 2018).

Science in the Convention goes beyond Parts XIII and XIV. For instance, Part XV sets a complex compulsory dispute settlement mechanism for resolving disputes concerning the interpretation and application of the law of the sea (Doelle, 2006). Disputes must be solved peacefully and by negotiation in the first instance, and thereafter by recourse to judicial settlement, such as international arbitration. Resolving disputes are often dependent on the evidence tendered by the parties. For example, if the dispute is about maritime delimitation, countries need to present data on baselines and geological features such as islands, rocks, and low-tide elevations. If it is on natural resources, such as fisheries, evidence on aspects such as fish population dynamics and ecosystems health is needed. In this context, research capacities become a matter of statecraft in international ocean negotiations. Countries with high technical capabilities are best placed to provide stronger arguments that can result in solving disputes in their benefit. Furthermore, scientific experts and their opinions can have a major bearing on the outcomes of judicial settlement (Boyle and Harrison, 2013). Scientific evidence is increasingly decisive in the resolution of international disputes concerning damage to biodiversity and degraded ecosystems (Long, 2019).

CURRENT EXAMPLES OF THE ROLE OF OCEAN SCIENCE IN THE LAW OF THE SEA

There are many examples of how ocean science is essential to implement the Convention, from direct provisions such as Parts XIII and XIV, to provisions indirectly impacted by ocean science, such as dispute settlements and maritime delimitation. We will address a few of these examples regarding how ocean science can be impactful in defining maritime boundaries, setting limits for the exploration of natural resources and regulating access to ocean areas out of national jurisdictions. This non-exhaustive list of examples aims to illustrate the importance of evidence provision to international decision making in ocean affairs.

Boundary Delineation and Delimitation

States Parties to the Convention have the right to define and claim the outer limit of their continental shelf where it exceeds 200 nautical miles. According to Article 76 of the Convention, this right only applies to the seabed and ocean floor and subsoil, not the water column and air space above. This can result in large oceanic areas under States Parties' rights to commercially explore living and non-living resources such as minerals, oil, and gas. As a rule, the establishment of maritime boundaries is within the sovereign powers of countries,

[1] Sociotechnical imaginaries are defined by Jasanoff and Kim (2009) as "collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects." Robinson (2020b) further explores how the ocean imaginaries caused uncertainty in the international community leading to the UNCLOS negotiations.

with the sole exception of establishing the outer limit of the continental shelf beyond 200 nautical miles, which is subject to an important international oversight process and procedural obligations regarding the tendering of scientific evidence to the Commission on the Limits of the Continental Shelf (CLCS). The latter is the body responsible for analyzing States Parties submissions and drawing recommendations on the outer limits of the continental shelf beyond 200 miles. Scientific evidence is all that matters to CLCS, made up of scientific and technical experts, and the outer limit established by the coastal State on the basis of the recommendations of the Commission are final and binding (as per paragraph 8 of article 76 of the Convention). These recommendations can impact demanding States Parties economically, geopolitically, and socially (Suarez, 2013). States Parties had 10 years after the entry into force of the Convention, or until 2004, to submit their claims (as per article 4 of the Annex II of the Convention). Countries with less capabilities to provide such evidence are disadvantaged in exploring their rights over any potential extension of their continental shelf or in meeting the required timeline for making a submission to the CLCS. This shows how technical capacities and scientific evidence are determinant to the Convention's implementation by coastal States. Noteworthy, some countries still proclaim extensions of the continental shelf unilaterally despite the requirements of the Convention (Morales, 2020).

Exploration and Regulation of Living Resources

Another good example of ocean science interaction with the law of the sea is the regulatory framework for the exploration of straddling and migratory fish stocks. This framework was the outcome of its own diplomatic negotiation after the adoption of the Convention and once again ocean science played a central role in its adoption. In 1995, an implementing agreement was adopted under the Convention, with a very long title, namely: the Agreement for the Implementation of the Provisions of the UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, or "Fish Stocks Agreement" (FSA) (United Nations, 1995). The FSA sets the general procedures to manage and conserve fish stocks and is given effect in regional fisheries management organizations (RFMOs), where intense diplomatic negotiations take place, regarding the allocation of fishing entitlements and the setting of conservation and management measures to prevent the collapse of the overall fish stocks. Scientific evidence in the form of stock assessment advice has a bearing on decisions, on the one hand, to close highly lucrative commercial fisheries or, on the other, to facilitate the over exploitation of fish populations. The Agreement provides a solid legal basis for the application of the best available scientific knowledge, the precautionary approach[2], and the ecosystem-based management. Thus, the Agreement is aimed at ensuring that scientific evidence is an intrinsic component of decision making in fisheries with potentially huge economic, social, and environmental consequences (Robinson, 2020a). Ocean science diplomacy has a major bearing on how this evidence is used by RFMOs to address these complex issues and, once again, scientific and technical capacities are of pivotal importance to statecraft and to redressing global conservation concerns (Worm and Branch, 2012).

Unknowns abound in vast parts of the ocean. Many questions remain unanswered by ocean science. Diplomacy walked hand in hand with science even in face of great uncertainties at UNCLOS III and subsequent negotiations on the seabed mining regime in 1994 and the straddling fish stock agreement in 1995. Both science and diplomacy inform all aspects of this engagement. As more evidence becomes available due to progressive availability application of new ocean technologies and research tools, the possibility arises that States and intergovernmental organizations can press ahead in addressing some of the issues left unresolved by UNCLOS III. A case in point relates to the regulation of the access and benefit sharing arising from the exploration of the biodiversity beyond national jurisdiction, or simply BBNJ (Long and Chaves, 2015). The BBNJ negotiating process is currently underway, based on a draft text for this new implementing agreement (United Nations, 2019a). Negotiations are centered in four main themes: marine genetic resources, including questions on the sharing of benefits; measures such as area-based management tools, including marine protected areas, environmental impact assessments and capacity-building, and the transfer of marine technology. The current draft posits the use of the best available scientific knowledge as a guiding principle. Ocean areas beyond national jurisdiction are among the least known by science, so this agreement, if successfully negotiated, can improve the scientific endeavor needed to unveil almost half of the Earth's surface (St. John et al., 2016). Scientific evidence will be determinant to identify the source of living resources and to advance in marine omics. Diplomacy will be essential to foster programs of capacity building and transfer of marine technology. In addition, the governance of international marine protected areas and the conduction of ecosystem impact assessments will rely intensively on the dynamics between science and diplomacy. Thus, BBNJ is a new interesting case of science diplomacy in action, as pointed out by Harden-Davies (2018).

OCEAN SCIENCE IN THE UN GENERAL ASSEMBLY RESOLUTIONS

In the previous section, we presented examples of major aspects of the law of the sea which require science to inform State practice as well as diplomatic processes under the Convention. Since the Convention does not hold regular Conference of the Parties as other UN conventions do (e.g., Climate Change Convention), the evolution of themes that concern States about ocean health can be assessed in the annual omnibus resolution on the ocean and law of the sea adopted by the UNGA. These UNGA resolutions reflect the progress that is being made and the challenges that arise in implementing the Convention, along with emerging issues of States Parties' concern.

[2]Art. 6 (2)—States shall be more cautious when information is uncertain, unreliable, or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.

Table 1 presents the full extract of the adopted paragraphs in a 10-year timeline (2009–2019), with the corresponding numbering of each paragraph for further reference.

Over the past 10 years, ocean science issues of concern have increased, resulting in UNGA's omnibus resolutions to expand each year in term of the number of paragraphs as well as in terms of themes covered. Three issues have been present for the past 10 years. First, the UNGA has adopted a *chapeau* paragraph stating how important ocean science is to advance knowledge, provide well-being, and contribute to decision making. Second, ocean science was acknowledged as essential to improve risk management tools in conserving and managing vulnerable marine ecosystems. Lastly, ocean science is essential to the establishment of marine protected areas. Another recurring theme since 2010 is the use of ocean science to identify and protect ecologically or biologically significant areas. In brief, science was identified as relevant for social, economic, and cultural benefit as well as more generally to promote marine conservation. More recently, there has been a distinct focus on the issue of pollution in the UNGA's resolution, with marine litter and underwater noise being addressed since 2016 and 2018, respectively. Looking at this 10-year sample, we can identify that once a subject is incorporated into the UNGA resolution, it remains there. Such a feature opens to the possibility of two hypotheses: (i) there is an inefficiency of the adopted measures to solve those issues or (ii) there is a lack of sufficient scientific evidence to support effective conservation measures. These two hypotheses open a series of questions on the efficiency of UN actions toward ocean conservation. Efficiency in this case is of course dependent on States' national policies and regulations, which are very diverse on the use of the available scientific information. Further research on how UNGA's annual resolutions are impacting national policies shall be necessary and the Sustainable Development Goals (SDGs), as we will discuss later, can present a good case. Science diplomacy can be challenged in this sense on how effectively it is producing better policies and public goods. For now, provisions on the importance of ocean science are thus recurring items of the UNGA's resolution. Accordingly, it can be expected that the progressive implementation of the UN Decade of Ocean Science for Sustainable Development (2021–2030) shall be continuously updated in years to come.

THE UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT

The Decade of Ocean Science shall be an important opportunity for science diplomacy to target global community interests in spite of national interests in the ocean.

The Decade targets seven societal goals, with ambitions to achieve a clean, resilient, productive, safe, well-observed, documented, and predicted ocean (Ryabinin et al., 2019). It also envisages engaging with society and delivering results for an evidence-based decision making, based on sustainability and peace. Ocean scientists are being urged to break the silos and work closely with international affairs and purveyors of traditional knowledge.

Scientists are answering this call and are expecting much from the implementation of this UN Decade (Claudet et al., 2019). The Decade presents itself as "an important opportunity to address gaps in ocean science, increase knowledge, improve synergies, and support the sustainable conservation and management of marine resources" (A/RES/74/19, para. 301, **Table 1**). The Decade's roadmap (IOC-UNESCO, 2018) highlights how critical it is to coordinate and cooperate in ocean sciences to progress sustainable development. Four distinctive aspects of the role of ocean science diplomacy are highlighted below around the thematic areas of inclusivity, sustainability, inequality, and community interests.

Enhancing Inclusivity

Perhaps, a major oversight to date is that official documents from this Decade primarily highlight natural science's evidence, with far limited participation from social sciences. The seven societal goals themselves very much reflect the gaps identified by traditional natural science, such as oceanography and hydrology. These gaps have been already identified in several documents (e.g. Inniss et al., 2017; IOC-UNESCO, 2017, 2019; Miloslavich et al., 2018) which, up to this point, have been largely unsuccessful in producing the desired change through decision maker's actions.

In times when Governments are failing to implement effective solutions to global problems and trust in science is diminished, public engagement becomes essential (Colglazier, 2020). Social sciences can provide evidence in support of actions to improve public engagement and science uptake in decision-making processes (Bennett et al., 2019). Thus, this UN Decade of Ocean Science should be a turning point for a more equitable participation of knowledge producers and users (along with the difficulties in identifying them). In this context, it needs to be transdisciplinary. Transdisciplinary actions in the Decade of Ocean Science need to start by building up research questions and hypotheses among different disciplines and stakeholders (as in Rudd, 2014). As Jahn and colleagues propose:

> *Transdisciplinarity is a critical and self-reflexive research approach that relates societal with scientific problems; it produces new knowledge by integrating different scientific and extra-scientific insights; its aim is to contribute to both societal and scientific progress; integration is the cognitive operation of establishing a novel, hitherto non-existent connection between the distinct epistemic, social–organizational, and communicative entities that make up the given problem context.* (Jahn et al., 2012, p. 8)

Therefore, the UN Decade of Ocean Science for Sustainable Development is an opportunity to change how scientists organize themselves around a common goal, as well as interact with policymakers and society in general (Wisz et al., 2020). In turn, it can represent an avenue for society to better acknowledge science and engage in science making through citizen science (Schrögel and Kolleck, 2019) and be empowered through Ocean Literacy (for further readings on the later, please refer to Santoro et al., 2017; Squarcina and Pecorelli, 2017; Marrero et al., 2019).

TABLE 1 | Exact extracts from the United Nations General Assembly resolutions on oceans and the law of the sea in which references to marine science or scientific are made. Ten years of exerts (2009–19)[a].

Original text in the resolution	Year and corresponding paragraph in the original text										
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Recalling that marine science is important for eradicating poverty, contributing to food security, conserving the world's marine environment and resources, helping to understand, predict, and respond to natural events, and promoting the sustainable development of the oceans and seas, by improving knowledge, through sustained research efforts and the evaluation of monitoring results, and applying such knowledge to management and decision-making	Preamble	Preamble	Preamble	Preamble	Preamble	Preamble	Preamble	Preamble	Preamble	Preamble	Preamble
Reaffirms the need for States, individually or through competent international organizations, to urgently consider ways to integrate and improve, based on the best available scientific information and the precautionary approach and in accordance with the Convention and related agreements and instruments, the management of risks to the marine biodiversity of seamounts, cold water corals, hydrothermal vents, and certain other underwater features	132	150	173	190	206	221	227	249	252	254	260
Reaffirms the need for States to continue and intensify their efforts, directly and through competent international organizations, to develop and facilitate the use of diverse approaches and tools for conserving and managing vulnerable marine ecosystems, including the possible establishment of marine protected areas, consistent with international law, as reflected in the Convention, and based on the best scientific information available	134	153	176	195	211	226	232	254	259	261	267
Encourages States, in this regard, to further progress toward the establishment of marine protected areas, including representative networks, and calls upon States to further consider options to identify and protect ecologically or biologically significant areas, consistent with international law and on the basis of the best available scientific information	*	156	178	194	210	225	231	252	257	259	265
Recognizes the need for better understanding of the sources, amounts, pathways, distribution, trends, nature, and impacts of marine debris, especially plastics and microplastics, and to examine possible measures and best available techniques and environmental practices to prevent its accumulation and minimize its levels in the marine environment, and welcomes in this regard the work conducted under the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, led by the Intergovernmental Oceanographic Commission, and its report entitled "Sources, fate and effects of microplastics in the marine environment—a global assessment," and the report of the Executive Director of the United Nations Environment Program on marine plastic debris and microplastics, which reviews best-available knowledge and experiences in this regard and gives recommendations for further steps to reduce plastic litter and microplastic in the oceans	*	*	*	*	*	*	*	205	209	210	218
Calls upon States to consider appropriate cost-effective measures and approaches to assess and address the potential socioeconomic and environmental impacts of anthropogenic underwater noise, taking into account the precautionary approach and ecosystem approaches and the best available scientific information, as appropriate	*	*	*	*	*	*	*	*	*	275	281

(Continued)

TABLE 1 | Continued

Original text in the resolution	Year and corresponding paragraph in the original text										
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Notes the discussions at the twentieth meeting of the Informal Consultative Process, from 10 to 14 June 2019, on the theme of ocean science and the United Nations Decade of Ocean Science for Sustainable Development, during which delegations, inter alia, stressed the importance of marine scientific research, international cooperation and coordination, as well as of a stronger science–policy interface in understanding and effectively addressing the unprecedented pressures on the ocean, provided input to assist in preparing for the Decade and considered that the Decade will be an important opportunity to address gaps in ocean science, increase knowledge, improve synergies, and support the sustainable conservation and management of marine resources, and during which several delegations underlined the important complementary role of traditional knowledge held by indigenous peoples and local communities	*	*	*	*	*	*	*	*	*	*	301

"" means the absence of a paragraph in that year's UNGA resolution.*
[a]Documents included were A/RES/64/71; A/RES/65/37A; A/RES/66/231; A/RES/67/78; A/RES/68/70; A/RES/69/245; A/RES/70/235; A/RES/71/257; A/RES/72/73; and A/RES/73/124; A/RES/74/19. Accessed in June, 2020 at https://www.un.org/Depts/los/general_assembly/general_assembly_resolutions.htm.

Surprisingly, neither the UNGA resolutions nor the Decade's official documents express the importance of science diplomacy as a concept that bring about transformative change in relation to the ocean. All the elements associated with science diplomacy are, however, evident expressly or implicitly in the UNGA resolutions (as discussed above) and the Decade's official documents: science advising policy making, diplomacy relying on evidence, and promoting further research in answer to global challenges, countries overcoming political tensions to address global concerns, and building a science-based dialog. The Decade of Ocean Science is an opportunity to recognize and highlight the importance of science diplomacy in achieving the objectives of the Decade. On this basis, there is a compelling case that ocean science diplomacy should be one of the pillars of this UN Decade for it highlights how multi-stakeholder partnerships are built to deal with global ocean matters, as was done during UNCLOS III negotiations and other international multilateral mechanisms.

Promoting Sustainability

The Decade should be recognized as a science diplomacy process intended to feed into another UN process based on science diplomacy: the 2030 Agenda on the Sustainable Development Goals (SDGs). The Decade's motto "The science we need for the future we want" is a clear reference to the UN document "the Future we Want" that constitutes the basis for the 2030 Agenda (United Nations, 2012), making one effort directed to achieve the other.

The SDGs were established by the UNGA in 2015 as agreed goals negotiated by UN Member States to achieve a more sustainable world. It brings society, economy, environment, policy, and international relations together around 17 goals (Nilsson et al., 2016). The goals deal with social challenges such as poverty, education, equality, as well as environmental concerns related to the ocean, land and atmosphere. They are a result of diplomatic negotiations underpinned by information and knowledge, most of which is scientific, in particular to Earth's capacities to sustain life as we know (Sachs et al., 2019).

Science is particularly important to achieve ocean sustainability, which is addressed by Goal 14—life under water (hereafter, SDG 14) (Visbeck, 2018). SDG 14 has been identified as the most transversal of the 17 (Singh et al., 2018; Nash et al., 2020), although not considered as a priority in almost all political settings in different regions (Custer et al., 2018). When it comes to investment and development, leaders typically choose other priorities which are not environment themed, like education (Goal 4), peace and justice (Goal 16), and decent work (Goal 08) (McDonnell, 2018). Goal 14, however, is the only one that has an explicit call for more investment in science and technology[3], which complements the aims of the UN Decade of Ocean Science.

[3]Objective 14.A—Increase scientific knowledge, develop research capacity, and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.

The existence of SDG 14 was made possible through an intense science diplomacy process at the UN. Small Islands Developing States (SIDS, but also known as Large Ocean States), pushed for an ocean related SDG that would bring their concerns forward and were skillful in presenting sufficient evidence on how their livelihoods are affected by a healthy ocean system (Quirk and Hanich, 2016). This diplomatic effort exemplifies how democratic ocean science diplomacy can be. SIDS countries usually have limited research capacities and international cooperation is a useful tool to access foreign research infrastructure. By building these partnerships, SIDS have the potential to access foreign funding and infrastructure and drive research projects to their own needs, generating evidence to feed their domestic policies. As a result, the civil understanding of the importance of a healthy ocean has influenced these countries' external policies in search for more just international relations.

Most developing countries and SIDS need to pool resources to access ocean research infrastructure and undertake projects that will enable them to implement SDG 14. Thus, international cooperation is also an important tool to deliver capacity for the 2030 Agenda. Ocean science diplomacy can present the necessary mechanisms for countries to advance their scientific capacities in exchange of granting foreign access to their waters, in a win–win situation. It is therefore necessary to identify where developing countries and SIDS strengths and weakness lie so as to negotiate directly or through competent international organizations in demanding the "fair and reasonable terms and conditions" in agreements, as predicated by the Convention [Article 266 (1)].

Addressing Global Inequalities

As seen previously, the disparities in ocean science and technology capacities between countries are determinant of their success in implementing the Convention and related instruments. Implementing Goal 14 and the UN Decade of Ocean Science will be particularly challenging for developing countries. Not many countries in the world have access to the necessary technology and human capacity to deliver ocean science, especially due to the high costs associated with marine research infrastructure and the challenges to develop and maintain scientific capacities domestically. UNESCO's Global Ocean Science Report (IOC-UNESCO, 2017) highlights the global disparities in science indicators, particularly the production of ocean science publications and citations (**Figure 2**). These disparities result, *inter alia*, in large sampling and knowledge gaps for immense ocean spaces, in particular the Southern parts of the

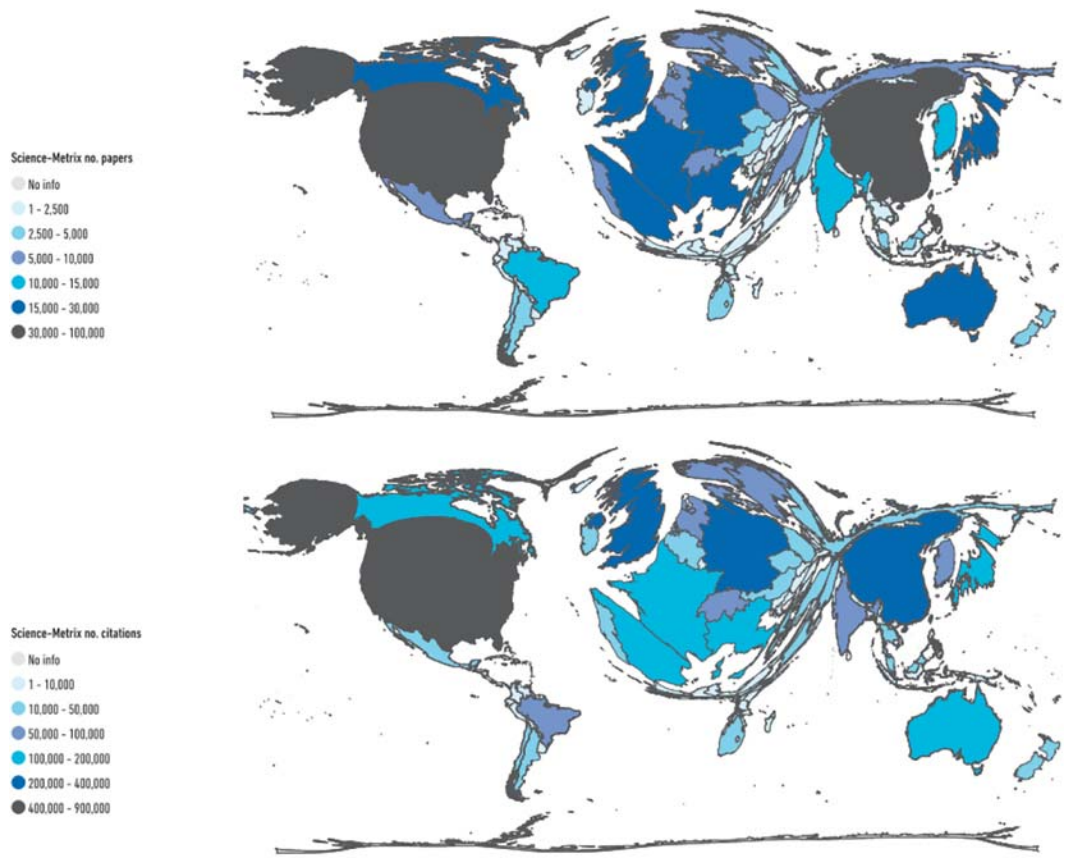

FIGURE 2 | Reproduced from the Global Ocean Science Report (IOC-UNESCO, 2017, p. 28). Original caption: "Publication and citation map of the world. The area of each country is scaled and resized according to the number of ocean science publications (top) or citations received (bottom). Different colors indicate a different number of publications (top) or citations (bottom)."

Atlantic and the Pacific (on the need for a more comprehensive assessment, see Inniss et al., 2017).

While most developing countries depend on foreign research capacities to explore their waters and offshore resources, developed countries gain benefits from accessing other coastal States' waters and exploiting the natural resources therein. Developing countries need to take their geopolitical needs into consideration when negotiating access to infrastructure and scientific capacities with more capable nations. By working together through science diplomacy schemes, they can then enhance their scientific capacities and gain the necessary knowledge to promote better ocean management and sustainability nationally and internationally. In this context, ocean science diplomacy can be a game-changer in finding common grounds of understanding and promoting research capacities worldwide by providing access to research infrastructure and human capacities (Harden-Davies and Snelgrove, 2020). The central issue to be resolved is to understand and apply science diplomacy as an aid to reorganize relevant stakeholders internationally to solve wicked humanitarian puzzles.

Advancing Community Interests

Governments frequently fail to apply the best available scientific knowledge for making decisions, and the ocean science diplomacy framework proposed in this paper shall aid authorities to recognize the benefits in further applying evidence to international policymaking. A force in this regard pertains to organizations that are not under the scrutiny of governments. Non-governmental organizations can have a leading role in presenting updated research evidence and call States to promote change. Non-State actors and international organizations have proven to be effective in promoting the linkage of science and international affairs on urgent ocean matters (Kaltofen and Acuto, 2018a). Experience in international and national decision-making processes over the past three decades demonstrates that NGOs in particular are very effective in gathering experts on certain topics and promoting public concern and engagement around what can be understood as a community interest (Cohen, 2011), communities here being defined as a group of individuals who share common values and concerns (Besson, 2018). Thus, NGOs and other non-State stakeholders promote evidence provision and community interests in international negotiations by organizing the technical debate and assisting delegations with experts and the organization of events. In this regard, these actions should also be considered as science diplomacy practices and a form of Track 2 diplomacy, i.e., diplomacy that happens beyond the formal State channels (Jones, 2015). This para-State form of international relations gives voice to societal concerns and foster community interests that are not necessarily aligned with any country's political view.

As official UN documents call for a stronger participation of knowledge producers and users in both the science and policy making, it will be critical to promote inclusiveness and transparency. Ocean science diplomacy practices in the past and present have broken silos and promoted better communication. It thus represents a tool to assess and foster community interests, by promoting citizenry engagement in both research and decision making. In this regard, the role of indigenous and traditional knowledge has been gaining much attention in ocean affairs and that specific community shares important interests that both scientists and diplomats must consider (Kaiser et al., 2019).

CONCLUSION

Science diplomacy research can promote better coordination and transdisciplinary science in global ocean affairs. Ocean science diplomacy can also ensure the conduct of more effective equitable negotiations and the attainment of fair agreements between States and other entities, including international organizations, by balancing national interests with regional and global shared goals, as prescribed by the Convention. Understanding past negotiations in ocean affairs can help us shape future scenarios where science and international relations leverage expertise and scientific capacity to inform transnational decision making, as exemplified by the success of UNCLOS III and subsequent law of the sea negotiations. Clearly, there is a historical gap in scientific capacities between developed and developing countries (IOC-UNESCO, 2020a). This gap shaped different positions at the UNCLOS III negotiations. However, diplomacy, supported by scientific evidence, was successful in advancing on the adoption of the Convention and establishing mechanisms to address these differences. The necessary diplomacy to overcome those differences involved clustering (e.g., G77 + China, Landlocked, etc.) and trade-offs among States in achieving the compromises and the package of issues codified by the Convention. Capacity building and access to research infrastructure were some of those elements being traded over negotiations, in particular by countries with less capabilities (Nordquist et al., 1990). However, as shown by the Global Ocean Science Report (**Figure 2**), the mechanisms in place to boost research capacity and technology transfer have not yet been effective (Salpin et al., 2018; IOC-UNESCO, 2020a).

With the upcoming UN Decade of Ocean Science for Sustainable Development, there is a chance to look back and to learn from previous lessons in successful law of the sea negotiations. Ocean science diplomacy will be essential in advancing coordination of the necessary elements needed to overcome historical difficulties. The Decade should be an opportunity to understand how ocean science happens in the global south and what is needed to balance these inequalities to deliver the expected results, for instance, in the 2030 Agenda. The Decade not only represents an opportunity to continue long identified but necessary science initiatives, like mapping the entire seafloor (about this ambition, please refer to the Seabed 2030 Project in Mayer et al., 2018) and improving ocean forecast, but also to capture these certainly important actions in a broader framework. This framework will be cognizant of enabling developing countries to thrive in their national ocean scientific capacities in order to contribute over time with the necessary evidence for future decision making. The ocean community needs to leave the assistance provider view and adopt a co-ownership and co-development perspective in relation to

transnational processes, so finally "no one is left behind" becomes an imperative for a sustainable future (United Nations, 2016).

Fairness and justice would entail properly addressing intellectual property rights of ocean technologies, discussing benefit sharing mechanisms, investing in local communities, and establishing researchers in key areas so innovation and development would follow. The Decade is a global movement that needs to be dealt with through diplomacy, informed by cross disciplinary ocean science. The invisibility of local researchers that do not have access to ships and equipment, nor are able to calibrate and maintain oceanic instruments, needs to be properly addressed by diplomacy. Business as usual will not solve the problems. The Decade, however, can if it genuinely and successfully encourages partnerships through which change can be made.

Indeed, the effective management of current ocean issues demands broader participation and better communication between sectors, not just scientists and policymakers, but also society, private sector, coastal communities, educators, NGOs, and so on. Since there is still much to be revealed about the functioning of the ocean and science is being called upon to have a stronger societal role, investments need to be made in research infrastructure and human capacities, so our collective will be able to produce the necessary knowledge to feed into public policies and international negotiations.

Our dependency in the ocean is clear: as our life-supporting system or as the basis for many economies, life cannot thrive without healthy oceans. On the other hand, food provision in face of exponential population growth calls for a wise change in the use of marine resources. Science can certainly provide information, but not in the necessary pace. Thus, stakes are high, so are uncertainties, a scenario that fits well within the post-normal science theory (Funtowicz et al., 1991; Funtowicz and Ravetz, 1993). Post-normal science states that if science is to keep producing knowledge in the normal mode, established under the Kuhnian scientific method, it will not be effective enough to address community interests as fast as necessary. Academia needs to break the silos and allow a broader peer review community, encompassing the views from non-Academics into the scientific process (Kønig et al., 2017). By doing so, reorientations can be promoted in accordance with user's needs and results can be combined with traditional and indigenous knowledge, for example (Nursey-Bray et al., 2014). This approach facilitates better communication and mutual understanding would be triggered around a shared goal, exactly as the UN Decade for Ocean Science and the SDG's 2030 Agenda are requesting. Further research will be needed to understand the connecting dots on how post-normal science theory can boost science diplomacy mechanisms since both call for a break of silos and stronger interaction.

Society's participation in science and policymaking should not be undermined (Kahan et al., 2011; Stilgoe et al., 2014; Porter and Dessai, 2017; Squarcina and Pecorelli, 2017). Therefore, further studies on public engagement, public perception of science, and ocean literacy will certainly be key to inform the implementation process of the Decade of Ocean Science. In this context, ocean science diplomacy is one of the possible ways of promoting this post-normal science, allowing inclusive participation of non-experts, and bridging communities. Further research on this aspect should also be promoted.

From a national perspective, countries need to build internal mechanisms to align researchers with policymakers and society to identify gaps and strengths in its science and technology domestic frameworks. This will help enable States to negotiate internationally on fairer grounds. Science diplomacy research can provide good examples of practices that have progressed in this sense, such as the designation of science attachés to Embassies to act together with diplomats in both identifying opportunities for collaboration as well as promoting national's endeavors abroad (AAAS, 2017). Domestically, appointing science advisors to high Government hierarchies has proven to be an effective way to advance in the science–policy interface that desirably should connect to the country's external policy in negotiating possible solutions to national challenges (Gluckman, 2014).

Ocean science diplomacy can significantly contribute to global agendas on sustainable uses of the ocean that rely on national policies and international frameworks. It can be a change in balancing ocean research capabilities, allowing a broader participation of scientists and communities in the international decision-making process, and finding some hope for a more sustainable ocean in the future.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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