Nordic Council of Ministers

Strengthen the Global Science and Knowledge Base to Reduce Marine Plastic Pollution

Contents

Executive summary

Background and objectives

States are on the brink to start negotiations on a global agreement on plastic pollution. In this context, scientists, policymakers and stakeholders voiced requests for strengthening and improving the knowledge base on marine litter and microplastics. These requests often include demands for a scientific advisory mechanism or body that operates as two-way interface between science and policy and that informs policy- and decision-making in the global combat against plastic waste in the oceans. In this context, they also emphasise the need for a life cycle approach to marine plastic pollution that covers all stages in the plastics life cycle.

Against this background, the report makes the case for a global scientific mechanism on marine litter and microplastics and discusses the conditions to make it work effectively and to enable it to strengthen the global science and knowledge base on marine litter and microplastics.

The report's ultimate aim is to inform policymakers and stakeholders that seek to establish an effective global scientific mechanism on marine litter and microplastics. The report does not issue recommendations on any of the presented options but simply aims at informing decisions accordingly. It does so by

1. providing policymakers and stakeholders with arguments for the establishment of a global scientific mechanism on marine litter and microplastics; and
2. generating insights into key requirements, specific design features and institutional options of effective science-policy interfaces.

Structure

The report, first of all, substantiates the need for a global scientific mechanism on marine litter and microplastics (Chapter 2). To this end, it highlights the key benefits and identifies the key functions and outputs of effective science-policy interfaces in global environmental governance (Chapter 2). Against this background, it assesses the strengths and weaknesses in the existing landscape of scientific mechanisms and bodies on marine litter and microplastics at global and regional levels (Chapter 2). The report then derives the expected benefits as well as the desirable key functions and outputs of a global scientific mechanism on marine litter and microplastics (Chapter 2). Subsequently, it reviews key requirements, specific design features and related practices that make existing science-policy interfaces in global environmental governance work effectively (Chapter 3). Next, the insights from this review are applied to the possible design of a global scientific mechanism on marine litter and microplastics (Chapter 3). Before the report wraps up its main findings in the conclusions (Chapter 5), it discusses and compares core features of three options for the institutional setting of science-policy interfaces, their main advantages and disadvantages, and their implications in the context of marine plastic pollution (Chapter 4).

Key messages

Three key messages stand out:

1. The existing global science and knowledge base on marine litter and microplastics warrants political action across the entire plastics life cycle.
2. Yet, there is need for a global scientific mechanism on marine litter and microplastics in order to strengthen the global science and knowledge base and to improve scientific policy advice across the entire plastics life cycle.
3. In terms of effectiveness, decisions about the design of such a mechanism are overall more important than decisions on its institutional setting.

Key benefits and functions of science-policy interfaces

Key benefits: Science-policy interfaces contribute to global environmental governance in four ways. They

1. inform and guide national and international policymaking on a global environmental challenge by providing, synthesising and communicating scientific knowledge on that challenge and by translating scientific findings into policy-relevant knowledge, including policy recommendations;
2. guide scientific research in a way that its findings are relevant to political and other decision-making processes by involving relevant stakeholders and ensuring that scientific research responds to their needs;
3. create, maintain or raise awareness about an environmental challenge, influence agenda-setting and create pressure to act; and
4. lay the ground for effective political interventions by providing knowledge on the sources and causes of an environmental challenge and by assessing the effectiveness of policy interventions.

Key functions: To achieve their purpose, science-policy interfaces in global environmental governance typically perform five key functions. They

1. conduct timely and regular knowledge assessments;
2. catalyse and guide knowledge generation;
3. enable exchange between scientists, policymakers and stakeholders;
4. facilitate access to and exchange of knowledge, information and data; and
5. improve capacities to conduct knowledge assessments

Strengths and weaknesses in the existing landscape of scientific mechanisms and bodies on marine litter and microplastics

Strengths: The report finds that the existing global and regional assessments contributed to a consolidation of the scientific knowledge on the extent, sources, pathways and effects of marine plastic pollution. They consolidated what is known and identified what is not known or where knowledge needs to be further improved. Overall, the knowledge assessments agree that there is sufficient scientific knowledge to warrant political action and further research at all levels.

Weaknesses: Yet, the global and regional science and knowledge base on marine plastic pollution is in need for improvement. The current landscape of these bodies and mechanism is best described as a highly fragmented and insufficiently institutionalised patchwork. It features several weaknesses, shortcomings and gaps in the performance of the typical core functions that usually characterise science-policy interfaces in global environmental governance. Five stand out.

1. Gaps in global and regional assessment reports that review and synthesise existing knowledge (namely, too few regional assessments, lack of a comprehensive life cycle approach, neglect of knowledge on policy responses and inattention to sciences other than natural sciences).
2. Limited exchange between scientists, policymakers and stakeholders.
3. Limited access to knowledge, data and information.
4. Lack of regularity in global and regional knowledge assessments.
5. Lack of coordination of the various existing scientific mechanisms and bodies.

Overall, the status quo weakens the authoritativeness of global and regional scientific knowledge assessments on marine litter and microplastics and impairs the effectiveness of their scientific policy advice. Ultimately, it reduces their potential to realise the main benefits that science-policy interfaces typically offer in global environmental governance.

If well designed, a global scientific mechanism on marine litter and microplastics provides the best opportunity to overcome the existing weaknesses. It would help to strengthen the science and knowledge base in this area and to improve the scientific policy advice on this issue by increasing the authoritativeness of knowledge assessments.

Desirable key functions and outputs of a global scientific mechanism on marine litter and microplastics

Key functions: Any mandate of a global scientific mechanism on marine litter and microplastics should enable the mechanism to perform all five core functions of science-policy interfaces in global environmental governance. Then, the mechanism can best contribute to increasing the authoritativeness of the knowledge assessments and effectively improving the science and knowledge base on marine litter and microplastics that informs related policy- and decision making. Five key functions deserve however particular attention. The mandate needs to enable the global scientific mechanism to

1. promote the use of life cycle approaches to marine litter and microplastics in all its activities;
2. to consider the regional heterogeneity of the problem;
3. increase the coherence and consistency in the approaches to the knowledge assessments at global and regional levels;
4. improve the two-way exchange between scientists, policymakers and other stakeholders; and
5. provide easy access to scientific knowledge, data and information by establishing a clearing-house mechanism.

Key outputs: More specifically, the mandate needs to enable the global scientific mechanism to generate much needed outputs:

- Comprehensive and periodic global (and possibly also regional) knowledge assessments covering all stages in the life cycle of plastics
- Specific and periodic global (and possibly also regional) knowledge assessments on selected aspects of marine litter and microplastics, including separate assessments of knowledge on each individual stage in the life cycle of plastics and on the effectiveness of policy interventions
- Harmonisation and standardisation of methodologies to monitor and assess the extent, sources, pathways and effects of marine litter and microplastics at global and regional levels and across all stages in the life cycle of plastics
- Harmonisation of regional knowledge assessments or, at least, guidance to the greatest extent possible, thereby promoting comprehensive assessments of knowledge on all stages in the life cycle of plastics and separate assessments of knowledge on individual stages
- Identification and evaluation of effective mitigation strategies across all stages in the life cycle of plastics

Key requirements and desirable design elements of a global scientific mechanism on marine litter and microplastics

Key requirements: In general, the design of science-policy interfaces and thus also of a global scientific mechanism on marine litter and microplastics should meet four key requirements in order to fully exploit its potential: credibility, legitimacy, salience and relevance of outputs, and agility. In addition, it needs to find an appropriate balance between scientific independence of the mechanism and its responsiveness to the needs of policymakers and stakeholders.

Credibility: To gain credibility, the design needs to facilitate transparency, openness to potential critique or diverging views, and scientific independence. To this end, the design needs to ensure 1) an appropriate selection of relevant experts, 2) an independent peer review, 3) a separation of scientific and political processes and outputs, 4) an appropriate access to and use of knowledge data and information, and 4) transparent rules of procedure.

Legitimacy: To ensure legitimacy a broad range of scientists and multiple stakeholder groups need to be able to contribute to its work and to develop ownership towards the results. To this end, the design needs to ensure 1) inclusiveness as regards holders of scientific, indigenous and local knowledge, and 2) participation of knowledge holders, policymakers and stakeholders a) in the production of outputs and b) in decision-making processes.

Salience and relevance: To make the outputs salient and relevant, the design needs 1) to allow for a broad participation of relevant actors in the production of outputs, 2) tailor its outputs to the needs of target audiences, and 3) develop communication and outreach strategies.

Agility: To ensure agility, the design should 1) establish a built-in review mechanism and 2) allow for flexibility in the scientific work to adapt to changing circumstances.

Balance between independence and responsiveness: To achieve this balance several options exist. At minimum, the design should separate scientific processes and outputs (e.g., knowledge assessments) from political processes and outputs (e.g. policy recommendations), and provide some informal avenues for scientists to influence (but not to decide on) the mechanism agenda and work programme. At maximum, the design could establish processes through which scientists, policymakers and stakeholders jointly decide on the work programme.

Key design elements: In the context of marine litter and microplastics, some of these design elements require specification.

1. Selected experts should include scientists from all relevant disciplines (and not only natural sciences) and holders of local and indigenous knowledge with a view to regional representativeness.
2. The mechanism should use and give equal consideration to knowledge from all relevant sciences (again beyond natural sciences) and relevant local and indigenous knowledge.
3. The mechanism's working and decision-making processes should be open to scientists from all relevant disciplines, other holders of relevant knowledge, policymakers and stakeholders (across all stages in the plastics life cycle) and allow for their broad participation.
4. The mechanism's built-in review process should enable scientists to identify, bring onto the agenda and quickly respond to newly emerging issue.

Options for the institutional setting of a global scientific mechanism on marine litter and microplastics

No institutional option as such is superior to the other options in terms of effectiveness, since the effectiveness of a science-policy interface hardly depends on its basic institutional setting but rather on the key elements and specific features of its design.

Likewise, there is no option that is overall more advantageous than all other options in terms of institutional requirements. Each option comes with trade-offs, features a range of advantages and disadvantages, and faces more or less severe constraints with regards to feasibility.

Despite deciding on an institutional setting, policy- and decision-makers will also have to decide on the scope of the global scientific mechanism. Whether the mechanism should incorporate or merely coordinate regional assessments will have implications for costs and the extent of consistency and coherence in the (regional) science and knowledge base.

Core features: Three options for the institutional setting are conceivable:

1. An intergovernmental panel, established through a separate and independent international agreement, with its own governing body that decides on the programme of work, budget and rules of procedure, and with its own secretariat.
2. A subsidiary scientific body under a multilateral agreement, where the governing body of the agreement decides on the programme of work, budget and rules of procedure, and the agreement's secretariat provides services
3. A scientific mechanism under an international organisation, where the governing body of the international organisation decides on the programme of work, budget and rules of procedure, and the organisation's secretariat provides services

Main advantages and disadvantages:

An intergovernmental panel has the highest independence from other institutions. In comparison, it incurs the highest administrative and organisational costs. Its establishment needs to overcome the widespread reluctance of states to create new institutions.

A subsidiary scientific body under a multilateral agreement has a high responsiveness to the needs of policymakers and stakeholders. It incurs lower administrative and organisational costs than an intergovernmental panel. Its establishment requires the prior adoption of multilateral agreement.

A scientific mechanism under an international organisation also has a high responsiveness to the needs of policymakers and stakeholders. It also incurs lower administrative and organisational costs than an intergovernmental panel. In comparison, its funding is less reliable, stable and continuous.

Implications: The decision about the institutional setting of a global scientific mechanism on marine litter and microplastics is less influential on whether the mechanism is able to perform the key functions of an effective science-policy interface and to meet its key requirements. This depends more on its mandate and specific design. The decision on the institutional setting is above all a question of political priorities and aims.

- An intergovernmental panel is the most promising option, if the aim is to establish a continuous and stable mechanism with secure funding.
- A mechanism under a multilateral agreement is the most promising option, if the aim is to limit additional costs and burdens.
- A mechanism under an international organisation is the most promising option, if the aim is to establish a mechanism in short time; to limit additional costs and burdens; and/or to make sure that a mechanism is established at all and all other aims are subordinated to this aim.

None of these options is necessarily exclusive of the others, since one could also imagine to initiate the interconnectivity between science and policy by establishing an integrated mechanism, which would then be either transferred to be governed by a new global agreement or spur negotiations for an intergovernmental panel.

List of Abbreviations

AHEG	Ad Hoc Open-ended Expert Group on Marine Litter and Microplastics
BRS	Basel, Rotterdam and Stockholm Convention
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CEP	Caribbean Environment Programme
COBSEA	Coordinating Body on the Seas of East Asia
COP	Conference of the Parties
CPPS	Permanent Commission for the South Pacific
CRC	Chemicals Review Committee
CST	Committee on Science and Technology
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GCO	Global Chemicals Outlook
GEO	Global Environment Outlook
GoF	Group of Friends
GPA	The Global Programme of Action for the Protection of the Marine environment from Land-based Activities
GPML	Global Partnership on Marine Litter
HELCOM	Baltic Marine Environment Protection Commission
HLPF	High-level Political Forum on Sustainable Development
IAASTD	Intergovernmental Assessment of Agricultural Science and Technology for Development
IAEA	International Atomic Energy Agency
ICCM	International Conference on Chemicals Management
ICES	International Council for the Exploration of the Sea
IGOs	Intergovernmental Organisations

IMO	International Maritime Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPCP	International Panel on Chemical Pollution
IRP	International Resource Panel
MAP	Mediterranean Action Plan
MARPOL	International Convention for the Prevention of Pollution from Ships
NGOs	Non-governmental organisations
NOWPAP	Northwest Pacific Action Plan
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAME	Protection of the Arctic Marine Environment – Arctic Council Working Group
PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
POPRC	Persistent Organic Pollutants Review Committee
ROPME	Regional Organization for the Protection of the Marine Environment
RSP	Regional Seas Programme
SACEP	South Asia Co-operative Environment Programme
SAP	Scientific Assessment Panel
SAICM	Strategic Approach to International Chemicals Management
SAPEA	Science Advice for Policy by European Academies
SBSTA	Subsidiary Body for Scientific and Technological Advice
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice
SDGs	Sustainable Development Goals
SPI	Science-policy interface
UNCCD-SPI	Unite Nations Convention to Combat Desertification Science Policy Interface
UNDP	United Nations Development Programme
UNEA	United Nations Environment Assembly

UNEP	United Nations Environment Programme
UNESCO-IOC	Intergovernmental Oceanographic Commission of United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNIDO	United Nations Industrial Development Organization
WIOMSA	Western Indian Ocean Marine Science Association

1 Introduction

1.1 Background

"The accumulation of plastic litter in the ocean is a common concern for humankind owing to its far-reaching environmental, social and economic impacts." (UNEP 2016, p. xii) Already in 2016, this was the conclusion of the United Nations Environment Programme (UNEP). The United Nations General Assembly (UNGA) describes "marine debris, and plastics in particular, [as] some of the greatest environmental concerns of our time, along with climate change, ocean acidification, and loss of biodiversity" (UNGA 2017, pp. 33–34). Others see marine litter and microplastics as "one of the greatest anthropogenic threats our planet faces" (EIA et al. 2020, p. 2; see also United Nations Conference on Trade and Development (UNCTAD) 7/27/2020) or a "planetary boundary threat" (UNEP 2019b, p. 31).

Responses to this threat require not only "systemic solutions covering policy, technology, management, financing, knowledge and research, awareness raising and behaviour change" (UNEP 2019b: 9). In the most recent related resolution of the United Nations Environment Assembly (UNEA), states also stress "the importance of more sustainable management of plastics throughout their *life cycle* in order to increase sustainable consumption and production patterns" (UNEP 2019g: 1). This life cycle approach includes upstream or pre-consumption solutions, e.g. innovative and sustainable product designs, as well as downstream or post-consumption solutions, e.g. better plastic waste management. In November 2020, at the Fourth Meeting of the Ad-hoc Open-ended Expert Group on Marine Litter and Microplastics, many states underscored the need for a life-cycle approach (ENB 2020). Assessments of marine litter and microplastics deem this approach necessary as plastic losses to the environment occur at every stage of the plastics life cycle, including production, use and disposal (UNEP 2019b: 43-56): Moreover, they "come from a variety of sources, including plastic products, textiles, fisheries, agriculture, industry and general waste" (SAPEA 2020). Consequentially, plastic litter and microplastics occurs everywhere in the environment: They are "already present across air, soil and sediment, freshwaters, seas and oceans, plants and animals, and in several components of the human diet" (SAPEA 2020). In other words, the accumulation of marine litter and microplastics in the oceans is often only the ultimate result of a long sequence of plastic losses to the environment. Marine plastic pollution starts with the production of plastics and – before it occurs – affects other environmental compartments, too.

In view of this problem, demands for a global agreement to reduce marine litter and microplastics have been rising for many years. Most prominently, the Nordic Ministers of Environment and Climate adopted a declaration in April 2019, calling for a global agreement (Nordic Council of Ministers for the Environment and Climate 2019). In 2020, two significant step were taken in this context. First, in June 2020, Norway, Antigua and Barbuda, and the Maldives initiated the Group of Friends (GoF) to Combat Marine Plastic Pollution. 54 countries, the European Union (EU) and several civil society organisations, including the World Wildlife Fund for Nature (WWF), joined this initiative. Amongst other objectives, the Group aims at supporting "the process to explore global response options, including a new global agreement" (Norwegian Government 2020a; see also Norwegian Government

2020b). In its declaration, the Group supports demands to adopt a life cycle approach. It calls for "a comprehensive response that considers the entire lifecycle of plastics at the local, national and global levels" (Norwegian Government 2020b). Second, in October 2020, the Nordic Council published a report on the possible design of a new global agreement to prevent plastic pollution (Raubenheimer and Urho 2020). This report again emphasises the need for a life cycle approach. It concludes that the shortcomings in the current governance of plastic pollution "necessitate a global response that extends beyond waste management to address the entire life cycle of plastic pollution" (Raubenheimer and Urho 2020b: 9). Plastic pollution should not be only addressed in the oceans but "requires a much-needed systemic change that enables better management of plastics on land too" (Raubenheimer and Urho 2020b:11). Ultimately, the reduction or even elimination of the discharge of plastics into the oceans "can only be achieved when global governance spans the entire plastics life cycle, addressing product design and the entire supply chain" (Raubenheimer and Urho 2020b:11). Similar declarations from a variety of actors preceded or followed up on these initiatives. Among these actors were regional international organisations, e.g. the African Ministerial Conference on the Environment (ACMEN) (ACMEN 2019), the Caribbean Community (CARICOM) (Caribbean Community (CARICOM) 7/6/2019), the Pacific Regional Environment Programme (SPREP) (SPREP 2018, p. 21), and the EU (EC 2020a, 2020c). Moreover, think tanks (EIA et al. 2020; Simon et al. 2018), foundations, e.g. the Allen MacArthur Foundation (The Ellen MacArthur Foundation 2020), and civil society, e.g. the WWF (WWF et al. 2020; WWF 2019) support the calls for a global agreement on plastic pollution. Likewise, multinational companies endorsed such an agreement (www.plasticpollutiontreaty.org). Last but not least, the relevant academic and policy literature welcomed the call for a global agreement (Rochette et al. 2020, p. 9).

Many of these calls to global action go hand in hand with requests for strengthening and improving the knowledge base on marine litter and microplastics. These requests often include demands for a scientific advisory mechanism or body that operates as interface between science and policy and informs policy- and decision-making in the global combat against plastic waste in the oceans. In the most recent UNEA resolution on marine litter and microplastics, states stressed "the urgent need to strengthen the science-policy interface at all levels and to do more to support science-based approaches" (UNEP 2019g, p. 1). The Chair's Summary of the Fourth Meeting of the Ad Hoc Open-ended Expert Group on Marine Litter and Microplastics also lists the establishment of an international advisory scientific panel as one of the response options to be forwarded to UNEA's Fifth Session for further consideration (UNEP 2020a). The GoF to Combat Marine Plastic Pollution aims at "advancing policy-relevant research and understanding of the plastic pollution problem to decision-makers" (Norwegian Government 2020b, p. 4). Likewise, in its 2019 Implementation Framework for Actions on Marine Plastic Litter, the G20 emphasises the importance to share scientific knowledge and information on this issue. It also intends to "encourage international coordination on scientific research [...] and the sharing of scientific knowledge" (G20 2019, p. 4). Moreover, the Nordic Council's report on the design of a new global agreement proposes to establish a global science policy interface (Raubenheimer and Urho 2020b: 93-95). Other actors advocate similar demands (EIA et al. 2020, p. 10; Simon et al. 2018, IV and 35; G7 2018, pp. 3–4; Raubenheimer et al. 2018, p. 220).

1.2 Objective and structure

This study introduces and discusses approaches to designing a global scientific mechanism or body that operates as science-policy interface on marine litter and microplastics in order to strengthen the global scientific knowledge base about the entire life cycle of plastics. Overall, the study serves to support decision-makers and stakeholders in the set-up of such a mechanism, body or interface that effectively informs policymaking at all levels. This also includes the support of a possible global agreement on plastic pollution.

To this end, the study makes a case to establish a global scientific mechanism on marine litter and microplastics and identifies key functions, minimum requirements and options for the institutional setting that enable the mechanism to work effectively. Chapter 2 substantiates the need for a global scientific mechanism on marine litter and microplastics and identifies desirable key functions and outputs of such a mechanism. Chapter 3 proposes minimum requirements in the design of such mechanism that ensure its successful operation. Chapter 4 finally works out three different options for the institutional setting of a global scientific mechanism on marine litter and microplastics.

2 The case for a global scientific mechanism and its key functions

The overall status quo of the existing landscape of global and regional scientific advisory bodies and mechanisms on marine litter and microplastics is in need for improvement. It features several weaknesses, shortcomings and gaps in the performance of the typical core functions that usually characterise science-policy interfaces in global environmental governance. This weakens the overall authoritativeness of scientific knowledge assessments on marine litter and microplastics and impairs the effectiveness of their scientific policy advice. Thus, the current state of affairs reduces the potential to realise the main benefits that science-policy interfaces typically offer in global environmental governance. If well designed, a global scientific mechanism on marine litter and microplastics helps to overcome the weaknesses in the status quo. As result, it helps to strengthen the knowledge base and to improve the scientific policy advice on this issue. This is the basic argument for its establishment.

The argument derives from three considerations:

1. An overview on main benefits and typical core functions of science-policy interfaces in global environmental governance in general.
2. A review of the existing landscape of global and regional bodies and mechanisms that operate as science-policy interfaces on marine litter and microplastics.
3. An appraisal of key achievements and shortcomings of this landscape in performing typical core functions of science-policy interfaces in global environmental governance.

Taken together, these considerations eventually permit proposals on the necessary and desirable key functions and outputs that deserve particular attention in the establishment and design of an effective global scientific mechanism on marine litter and microplastics.

2.1 Benefits and core functions of scientific mechanisms in global environmental governance

Global environmental scientific mechanisms or bodies operate as two-way interfaces between science and policy. As "essential elements towards more effective environmental governance" (Koetz et al. 2009, p. 1), they serve two goals. On the one hand, they inform and guide national and international policymaking on a global environmental challenge. To this end, they provide, synthesise and communicate scientific knowledge on the extent, sources, causes, effects and governance of that challenge. Equally important, they translate scientific findings into policy-relevant knowledge, including policy recommendations. On the other hand, they guide science. They feed knowledge needs of stakeholders, including policymakers, into scientific research. As result, they ensure that science produces insights relevant for stakeholders and their decisions. In other words, science-policy interfaces in global environmental governance are "social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making" (van den Hove 2007, p. 815).

If well-designed, global environmental scientific mechanisms or bodies benefit the governance of a global environmental challenge at international, regional or national levels in three ways. First, their assessments of the extent, effects and trends of an environmental challenge create, maintain or raise awareness about an environmental challenge. They influence agenda-setting and create pressure to act. Second, they lay the ground for effective political interventions. They do so by providing knowledge and understanding of the underlying sources and causes of the environmental challenge and by assessing the effectiveness of existing or planned policies. Third, they guide scientific research in a way that its findings are relevant to political and other decision-making processes. To this end, they involve the relevant stakeholders into the identification of research priorities and ensure that scientific research responds to these stakeholders' needs.

To achieve their purpose, science-policy interfaces in global environmental governance perform five key functions:

1. Conducting timely and regular knowledge assessments
2. Catalysing and guiding knowledge generation
3. Enabling exchange between scientists, policymakers and stakeholders
4. Facilitating access to and exchange of information and data
5. Improving capacities to conduct knowledge assessments

2.1.1 Conducting timely and periodic knowledge assessments

This is the core function and key activity of any science-policy interface in global environmental governance. The knowledge assessments regularly collect, accumulate, review and critically judge the existing, possibly fragmented scientific knowledge on an environmental challenge and its governance. More recently, global science-policy interfaces increasingly turn to also review indigenous, local and non-traditional knowledge in their assessments. The global and regional knowledge assessments of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) were the first such assessments that systematically review indigenous and local knowledge (McElwee et al. 2020). Likewise, UNEP's Global Environment Outlook (GEO) considers indigenous and local knowledge and includes authors from indigenous people (UNEP 2019d). In preparation of its Sixth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC), for example, strives to take into account indigenous knowledge and to include indigenous authors (SEI 2020).

The knowledge assessments may address the environmental challenge and its governance comprehensively, including its extent, sources, causes, effects and trends as well as related policy responses and options. Prominent examples of such assessments are the IPCC reports (see: IPCC 2020b) or the regional and global reports on ecosystem services of the IPBES (see: IPBES 2020a). In addition, knowledge assessments like UNEP's GEO (UNEP 2019d) also specifically monitor and evaluate progress in the implementation of policies and assess the effectiveness of existing or planned policy interventions.

The knowledge assessments may also focus on certain specific aspects of the environmental challenge and/or governance issues. In the aftermath of the adoption of the Paris Agreement on climate change, the IPCC, for example, published a special report on the impacts of global warming of 1.5°C (IPCC 2018a). Knowledge assessments may be global or regional. In addition to its global assessment reports, the IPBES, for example, regularly conducts and publishes knowledge assessments in different world regions, including Africa, the Americas, Asia and the Pacific and Europe and Central Asia (IPBES 2020b).

To provide these assessments, science-policy interfaces use existing knowledge that has already been published and make it accessible to broader audiences. They do not conduct independent scientific research. Instead, they operate as an authoritative review mechanism that reveals what is known (and what not) with what levels of confidence or certainty. Therefore, they bring together and summarise the insights from existing scientific studies. In doing so, they also draw on existing overviews or assessments of related research. On the basis of their assessments, global science-policy interfaces often prioritise areas for policy actions and recommend effective policy options. As result, science-policy interfaces help identifying and establishing a common, shared, reliable and consolidated knowledge base on both, the scientific and policy dimension of an environmental challenge – without denying inherent and persisting uncertainties and limitations of scientific knowledge.

Policymakers and stakeholders (can) refer to this knowledge base and draw on it when making decisions and choosing policy priorities at international, regional and national levels. For example, they regularly reference the findings of UNEP's Global Chemicals Outlook in submissions to the negotiation process on a follow-up instrument of the Strategic Approach to International Chemicals Management (SAICM) (e.g. see: UNEP and ICCA 2019). Likewise, the global and regional assessments of IPBES find their way in policymaking processes at national and regional levels, e.g. in the United Kingdom's (UK) Green Finance Strategy (UK government 2019) or the EU Pollinators Initiative (EP 2019).[1]

2.1.2 Catalysing and guiding knowledge generation

This function directly derives from the knowledge assessments. They usually also reveal and name knowledge needs for future research. UNEP's GEO, for example, devoted a separate chapter on future data and knowledge needs (UNEP 2019d). As result, science-policy interfaces might catalyse and guide the knowledge generation in at least four ways.

First, through their knowledge assessments, science-policy interfaces can indirectly catalyse research by operating as authoritative source for scientists. When identifying research needs, scientists can draw on the knowledge assessments, as they do for example in case of the IPCC (e.g., Vasileiadou et al. 2011) or IPBES (e.g., Pereira et al. 2019; Araújo et al. 2019). Likewise, research funding agencies and other

1. The IPBES maintains an Impact Tracking Database (TRACK) that records, documents and shares examples of its impact on science and policymaking (https://ipbes.net/impact-tracking-view).

research institutions might turn to such assessments when deciding about adaptations to their research programmes. The knowledge assessments might thus motivate and prompt research that fills the identified gaps.

Second, science-policy interfaces can also use the knowledge assessments to more directly influence and shape the knowledge generation. They might explicitly recommend the prioritisation of certain research needs that deserve more scientific attention. On this basis, they might persuade or directly request scientists, research funding agencies and other research institutions to adapt their research priorities and programmes accordingly.

Third, science-policy interfaces can guide research by providing conceptual and methodological approaches on how to conduct research. For example, IPBES published a guide on how to conduct knowledge assessments on biodiversity and ecosystem services (IPBES 2018). The Brazilian Biodiversity and Ecosystem Services Assessment (IISD 2018) and a similar assessment by the Nordic Council of Ministers (Belgrano 2018) used this guide. Or the science-policy interface might formulate guidelines for the use of research methods, like, for example, the IPCC (Knutti et al. 2010) and the Science-Policy Interface of the UN Convention to Combat Desertification (UNCCD-SPI) (Chotte et al. 2019) do.

Fourth, some science-policy interfaces in global environmental governance also include early warning or horizon scanning procedures. These serve to identify newly emerging issues and highlight new areas of knowledge and research. Such procedures are in place at the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)[2], the International Resource Panel (IRP), or the Scientific Assessment Panel (SAP), a subsidiary body to the Montreal Protocol.

2.1.3 Enabling exchange between scientists, policymakers and stakeholders

This function is indispensable to ensure that science-policy interfaces do actually operate as a two-way interface that allows communication in two directions, from policymakers and stakeholders to scientists and vice versa. On the one hand, the exchange serves to ensure that the knowledge assessments in particular and science more generally produce knowledge that is relevant, understandable and accessible for policymakers and stakeholders. On the other hand, the exchange serves to ensure that policymakers and stakeholders regularly review their political priorities, preferences and needs in light of scientific knowledge and evidence. Overall, the exchange serves to increase the likelihood that policymakers and stakeholders use the scientific knowledge in their considerations and decisions. The exchange facilitates these processes in several ways.

First, the exchange helps to make the knowledge assessments as responsive to the needs of policymakers and other stakeholders as possible. It provides policymakers and other stakeholders with the opportunity to shape the knowledge assessments along their needs. They might, for example, use this exchange to request knowledge

2. GESAMP is a global advisory body sponsored by the International Maritime Organization (IMO), the Food and Agricultural Organization (FAO), Intergovernmental Oceanographic Commission of UN Educational, Scientific and Cultural Organization (UNESCO-IOC), UN Industrial Development Organization (UNIDO), World Meteorological Organization (WMO), International Atomic Energy Agency (IAEA), UN, UNEP, UN Development Programme (UNDP).

assessments on a specific topic. A case in point is the IPCC's special report on the impacts of global warming of 1.5°C (IPCC 2018a). In 2015, the 21st Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) invited "the Intergovernmental Panel on Climate Change to provide a special report in 2018 on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways" (UNFCCC). Policymakers and other stakeholders might also use this exchange to induce and guide the generation of new knowledge and to influence future research priorities. Essentially, the exchange thus allows policymakers to ensure that they gain knowledge that they consider important and relevant for their political decisions.

Second, and in the reverse direction, the exchange helps to ensure that scientific findings reach policymakers and stakeholders. In the exchange scientists can direct the attention of policymakers and other stakeholders to aspects of an environmental challenge that in their view deserves particular political attention (even if this does not overlap with or even runs counter to political priorities and preferences). To this end, scientists can explain and highlight what existing research reveals (and what not). They can also elaborate on the consequences their insights might imply for policy- and decision-making. Or they use the exchange to raise the awareness of policymakers and stakeholders about newly emerging issues that require political interventions. Moreover, the exchange provides scientists with the opportunity to influence decisions on research programmes and funding and thus the generation of new knowledge. They might, for example, highlight what further research is needed to improve the understanding and the governance of an environmental challenge. Essentially, the exchange ensures that scientific knowledge enters and shapes policy- and decision-making processes.

Third, the exchange helps to facilitate mutual understanding between scientists, policymakers and stakeholders. On the one hand, the exchange brings scientists to reduce complexity and to communicate their findings in a way that policymakers and stakeholders can easily understand them. To make the results of their work and the knowledge assessments more accessible, many science-policy interfaces nowadays communicate these to policymakers and stakeholders through different outreach activities. For example, IPCC organises webinars (https://www.ipcc.ch/apps/outreach/index.php) and produces videos, interactive figures and infographics (https://www.ipcc.ch/outreach-material/). IPBES maintains an own video channel on YouTube (https://www.youtube.com/user/ipbeschannel/videos), regularly publishes podcasts on its homepage (https://ipbes.net/podcast) and also holds webinars on specific topics (https://ipbes.net/webinars). Taken together, this might improve the guidance that scientists provide to policymakers. Meanwhile, the exchange allows policymakers to explain their needs and requirements with regard to how scientists prepare, communicate and present their knowledge. They can also use the exchange to better understand the peculiarities, limitations and uncertainties of the scientific knowledge and process. Taken together, this might improve the guidance that policymakers and stakeholders provide to science. It might also improve the capacity of policymakers and stakeholders to interpret scientific findings.

In sum, the exchange thus serves to ensure the "co-evolution, and joint construction of knowledge with the aim of enriching decision-making" (van den Hove 2007, p. 815). This is one of the main objectives of science-policy interfaces in global environmental governance. In practice, such a co-evolution and joint construction of knowledge takes place on several occasions. It takes place in the determination of the work programme for the science-policy interface when scientists, policymakers and stakeholders discuss the priorities of future knowledge assessments and other activities. It also takes place in the wrap-up of the results of finalised knowledge assessments when scientists, policymakers and stakeholders negotiate and formulate summaries for policymakers. These summaries usually synthesise the key findings of the assessment reports and reduce their complexity in order to make them more accessible for policymakers (e.g., IPCC 2018b; IPBES 2019; UNEP 2019c). And it takes place in specific programmes set up to foster the mutual exchange between scientists, policymakers and stakeholders. An outstanding example in this regard is the IPBES and its rolling plan (IPBES 2017). This plan established several programmes that aim at improving the mutual understanding between scientists and policymakers, including, for example, the IPBES Fellowship Programme and the IPBES Training and Familiarization Programme.

2.1.4 Facilitating access to and exchange of information and data

This function serves to improve the use and generation of knowledge. To enhance the knowledge foundations and the possibility to use knowledge, science-policy interfaces often provide access to materials on which the knowledge assessments rest. These materials include scientific and policy knowledge, information and data as well as methodologies or indicators. Some science-policy interfaces, such as IPBES, also use and then provide access to data and information from citizen science projects or indigenous and local knowledge holders. To facilitate access to and exchange of information and data, many science-policy interfaces established clearinghouse mechanisms that facilitate information exchange, access to data and create transparency. The IPCC, for example, maintains a Data Distribution Centre that provides climate, environmental and socio-economic data for complex climate models. The joint clearinghouse mechanism of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (hereafter "the Basel Convention"), the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention) and the Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention) ensures exchange of information on scientific research, regulations, capacity-building and the implementation status of the conventions. The Convention on Biological Diversity has a similar mechanism in place.

2.1.5 Improving capacities to conduct knowledge assessments

Science-policy interfaces often engage in capacity-building in order to strengthen the knowledge foundations and to improve their knowledge assessments. The IPBES, for example, provides technical support to related scientific mechanisms at regional and national levels (IPBES 2017). Capacity-building may also include training on methodologies and tools. UNEP, for example, holds courses on the conduct of integrated environmental assessments that follow the GEO process (UNEP 2020b). Moreover, some science-policy interfaces support the development of skills among scientists to better understand and respond to the needs of policymakers or – vice versa – help policymakers improving their ability to understand scientific processes, their potential but also their limitations. An outstanding example is here again the IPBES and its rolling plan (IPBES 2017).

2.2 Review of existing global and regional scientific bodies and mechanisms on marine litter and microplastics

The appeals to establish a global scientific mechanism on marine litter and microplastics also point to the benefits that science-policy interfaces provide in global environmental governance. "The need for better scientific and technical knowledge and understanding is a key factor in any collaborative processes [...] and should be an objective of any new developments in this area" (UNEP 2018d, p. 101). The appeals emphasise that improvements in the knowledge base about marine plastic pollution facilitate the identification, implementation and monitoring of effective policy actions and technical options to address this challenge (UNEP 2019b, p. 31; Vince and Hardesty 2017, p. 4). Therefore, a science-policy interface "could strengthen confidence in the outcomes of policy interventions" (UNEP 2020e, p. 8). Finally, a "deeper base of scientific evidence can also [...] serve as the evidence-based policy platform for the generation of binding international conventions with broad legitimacy" (Mendenhall 2018, p. 296).

In fact, the establishment of a global scientific mechanism on marine litter and microplastics is the best option to achieve these goals and to fully realise the benefits of a science-policy interface. This is the case even though several global and regional scientific mechanisms and bodies exist that work on marine litter and microplastics. Yet, none of them performs all five core functions that typically characterise science-policy interfaces in global environmental governance. Nor exists a body or mechanism that focuses solely on marine plastic pollution. Instead, the existing bodies only deal with marine litter and microplastics as one out of several topics.

This is the main result of the review of existing global and regional scientific mechanisms and bodies on the problem of marine plastic pollution and their outputs (e.g., reports, databases, workshops, etc.).[3] The review answers two questions:

1. To what extent is the existing landscape of scientific mechanism and bodies on marine plastic pollution already suitable to realise the benefits of science-policy interfaces in global environmental governance?
2. To what extent do these mechanisms or bodies already perform the typical core functions of such interfaces?

3. At global level, relevant international organisations in the UN system were taken into account. At regional level, the 18 existing Regional Seas Programmes were taken into account (for an overview see https://clmeplus.org/un-environment-regional-seas-program/). The review took into account outputs that 1) synthesise the state of scientific knowledge on the extent, sources, pathways and effects of marine plastic pollution; 2) gather and analyse knowledge on policy options to combat marine plastic pollution; 3) translate scientific findings into policy recommendations; and/ or 4) identify and set priorities for future research.

2.2.1 Key functions

Conducting timely and periodic knowledge assessments

At global level, three reports exist that systematically and comprehensively assess the scientific knowledge on marine plastic pollution (see Table 1). These assessments by UNEP, GESAMP and the Science Advice for Policy by European Academies (SAPEA)[4] reviewed and critically judged the existing scientific knowledge on extent, sources, pathways and effects of marine litter and microplastics. Two reports are currently being prepared by UNEP and the Organisation for Economic Co-operation and Development (OECD) (see Table 1).[5] Moreover, the first UN World Ocean Assessment (UN 2017) devoted a separate chapter on the state of the scientific knowledge on impacts of plastic pollution in the oceans (Wang et al. 2017). Likewise, the chapter on oceans and coasts in UNEP's most recent GEO devoted several sections on the state of knowledge on marine litter and microplastics (UNEP 2019d).

Table 1: Overview on comprehensive global knowledge assessments

Body	Title	Year
UNEP	Assessment on sources, pathways and hazards of litter including plastic litter and microplastics pollution	In preparation
OECD	Global Plastics Outlook 2060	In preparation
SAPEA[a]	A scientific perspective on microplastics in nature and society	2019
GESAMP	Sources, fate and effects of microplastics in the marine environment (two volumes)	2016a and 2016b
UNEP	Marine plastic debris and microplastics. Global lessons and research to inspire action and guide policy change	2016

[a] Science Advice for Policy by European Academies

In addition, some UN specialised agencies and other international organisations conducted knowledge assessments that reviewed and critically judged the existing scientific knowledge on *specific aspects* of marine plastic pollution. Among the topics were, for example, the impacts of microplastics on marine biodiversity (CBD Secretariat 2016, 2012), microplastics in fisheries and aquaculture (FAO 2017), microplastics in drinking water (WHO 2019), the sources of microplastics in the

4. SAPEA provides independent scientific advice to the European Commission to support its decision-making in many issue areas.
5. To guide this assessment, UNEP established a temporary Scientific Advisory Committee on Marine Plastic Litter and Microplastics composed of nearly 70 experts (UNEP 2019i).

oceans (IUCN 2017), plastics and coral reefs (UNEP 2019e) and losses of plastics across value chains (UNEP 2018c). Finally, numerous reports look into international and national policies and legal frameworks that address marine plastic pollution (e.g., UNEP 2018b, 2019b, 2017). On the basis of member states' submissions, these reports map existing policies, legal frameworks or conceivable policy options. They do however not assess their effectiveness. Hence, they rather provide policy inventories than assessments of the scientific knowledge on these policies. This applies also to UNEP's reports on response options that its secretariat prepared as inputs to the Ad hoc Open-ended Expert Group on Marine Litter and Microplastics (e.g., UNEP 2018e, 2018f).

At regional level, comprehensive and systematic assessments are scarce and often outdated. Since 2010, only four of the 18 Regional Seas Programmes (RSP) published such assessments (see Table 2). The majority of these however rather monitor and assess the occurrence of litter and microplastics in the oceans. They hardly provide a review of existing knowledge on sources, pathways and effects of marine plastic pollution. This also holds for the other reports that were published before 2010 (see Table 2). Like at the global level, the RSP also published a few assessments on specific aspects of marine plastic pollution, for example on floating marine litter (NOWPAP and MERRAC 2020) or on storm-water related litter (OSPAR Commission 2019). Moreover, some regional reports on the state of the marine environment devoted smaller sections in which they assess the scientific knowledge on marine litter and microplastics (e.g., HELCOM 2018; NOWPAP and POMRAC 2014; Diez et al. 2019). Likewise, some RSP's Action Plans on Marine Litter briefly summarise selected scientific knowledge on marine litter (e.g., SACEP 2019; UNEP-CAR/RCU 2014).

Table 2: Overview on comprehensive regional knowledge assessments

Body	Title	Year
Abidjan Convention/UNEP	West Africa Marine Litter Desktop study	In preparation
COBSEA[a]/UNEP	Status of Research, Legal and Policy Efforts on Marine Plastics in ASEAN+3	2020
Arctic Council/ PAME[b]	Desktop Study on Marine Litter, Including Microplastics, in the Arctic	2019
OSPAR[c] Commission	Assessment document of land-based inputs of microplastics in the marine environment	2017a
UNEP/MAP[d]	Marine litter assessment in the Mediterranean	2015
OSPAR Commission	Marine litter in the North-East Atlantic Region. Assessment and priorities for response	2009
UNEP	Marine litter in the Baltic Sea Region	2009
Black Sea Commission	Marine litter in the Black Sea Region	2007
PERSGA[e]/UNEP	Marine litter in the PERSGA Region	2008
COBSEA/UNEP	Marine litter in the East Asian Seas Region	2008
SACEP[f]	Marine Litter in the SAS Region	2007
WIOMSA[g]	A regional overview and assessment of marine litter related activities in the West India Ocean Region	2007
CPPS[h]/UNEP	Marine litter in the South-East Pacific Region. A review of the problem	2007

[a] Coordinating Body on the Seas of East Asia,
[b] Protection of the Arctic Marine Environment,
[c] Convention for the Protection of the Marine Environment of the North-East Atlantic,
[d] Mediterranean Action Plan,
[e] Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden,
[f] South Asia Co-operative Environment Programme,
[g] Western Indian Ocean Marine Science Association,
[h] Permanent Commission for the South Pacific

Catalysing and guiding knowledge generation

The existing global and regional knowledge assessments identify knowledge needs and formulate recommendations for future research. Hence, they might indirectly induce and guide the generation of new knowledge. In addition, several reports have been published that propose guidelines for the monitoring and assessment of marine litter and microplastics. If taken up, such guidelines also guide the knowledge generation, above all on the quantification of marine litter and microplastics. Most of these reports propose a harmonisation of monitoring and assessment at regional level (see Table 3). There are however also a few reports that propose such harmonisation at global level (UNEP 2020c; GESAMP 2019; Cheshire et al. 2009). Moreover, GESAMP also established a procedure to identify new and emerging issues related to the pollution of the marine environment ("scoping activities") (GESAMP 2020). In fact, these scoping activities put the topic of marine litter and microplastics on the agenda of GESAMP in the first place and also prompted its knowledge assessments (GESAMP 2016a, p. 11).

Table 3: Overview on regional guidelines for monitoring and assessment

Body	Title	Year
African Marine Waste Network	African Marine Litter Monitoring Manual	2020
UNEP/CEP[a]	Harmonizing marine litter monitoring in the wider Caribbean Region. A hybrid approach	2019
OSPAR Commission	Guidelines for monitoring marine litter washed ashore and/or deposited on coastlines (beach litter)	2017b
HELCOM[b]	HELCOM Guidelines for monitoring beach litter	2017
UNEP/MAP	Integrated Monitoring and Assessment Guidance	2016
European Commission	Guidance on monitoring of marine litter in European seas	2013
NOWPAP[c]	Guidelines for Monitoring Marine Litter on the Seabed in the Northwest Pacific Region	2010
OSPAR Commission	Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area	2010
NOWPAP	Guidelines for monitoring marine litter on the beaches and shorelines of the Northwest Pacific Region	2007

[a] Caribbean Environment Programme,
[b] Baltic Marine Environment Protection Commission,
[c] Northwest Pacific Action Plan

Enabling exchange between scientists, policymakers and stakeholders

There is also no continuous and established procedure for exchange between scientists, policymakers and stakeholders on that issue at global or regional levels. Nevertheless, such exchanges took place in the course of the preparation of some knowledge assessments. Yet, these exchanges went hardly beyond one off-exercises.

In case of GESAMP's comprehensive global knowledge assessment, scientists and policymakers (members of the sponsoring specialised UN agencies and of interested member states) exchanged views and discussed comments on drafts of the knowledge assessments during several meetings and workshops (GESAMP 2016a, p. 7). This is an established procedure at GESAMP. Likewise, in the preparation of UNEP's comprehensive global knowledge assessments an advisory group brought together experts that governments and major stakeholder groups had nominated. The advisory group reviewed and commented the knowledge assessments and developed policy recommendations in close exchange with the scientists that conducted the assessment (UNEP 2016, pp. 2–3). Following a well-defined and established procedure, the preparation and finalisation of SAPEA's global knowledge by SAPEA also involved several rounds of exchange between scientists, policymakers and stakeholders (EC 2020b).

At regional level, the exchanges between scientists, policymakers and stakeholders during the preparation of the most recent assessments rather followed an ad-hoc and informal procedure (if there was any exchange at all) (Lyons et al. 2020; PAME 2019; OSPAR Commission 2017a; UNEP/MAP 2015). However, very few RSP established expert groups on marine litter. In these groups experts and policymakers share and exchange knowledge and information on this issue more generally. These are the Group of Experts for Marine Litter and Microplastics in the framework of the Nairobi Convention, the Working Group on Marine Litter at COBSEA, the Expert Group on Marine Litter as part of PAME and the Intersessional Correspondence Group on Marine Litter at the OSPAR Commission. Only the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has a body that fulfils functions of a science policy interface, the Scientific Commission. While the Commission has several working groups, none of them deals specifically with marine litter and microplastics. In fact, only one meeting of the Working Groups featured this topic in the past five years.

Facilitating access to and exchange of information and data

Access to materials that were used in the existing knowledge assessments has hardly been provided by the organisations that conducted such knowledge assessments. The only exceptions are COBSEA and PAME. Their regional knowledge assessments provide an inventory of scientific research in the region[6]. Some RSP however do provide access to scientific and policy knowledge, data, information, methodologies and/or indicators related to marine plastic pollution. To this end, they established clearing-house mechanisms, mostly on data, information and indicators. These are the Data Centre of CCAMLR, the Integrated Information System of the Regional Organization for the Protection of the Marine Environment (ROPME), the Data & Information Management System as well as the Assessment Portal of the OSPAR Commission, the Map and Data Service of HELCOM, and the Regional

6. COBSEA's inventory is accessible at https://cutt.ly/kstW1Qy. PAME's collection is accessible at https://pame.is/document-library/desktop-study-on-marine-litter-library.

Activity Centres on Special Monitoring & Coastal Environmental Assessment and on Data & Information Network of NOWPAP. Finally, the International Council for the Exploration of the Sea (ICES) and its Data Portal on Marine Environment brings together data on marine pollution from the OSPAR Commission, HELCOM and the Arctic Monitoring and Assessment Programme (ICES 2020), including data on marine litter and microplastics, where available.

2.2.2 Appraisal: key achievements and shortcomings

Key achievements

The existing assessments contributed to a consolidation of the scientific knowledge on the extent, sources, pathways and effects of marine plastic pollution. They did so in two regards. On the one hand, they consolidated what is known. On the other hand, they identified what is not known or where knowledge needs to be further improved.

In sum, the results of these knowledge assessments largely converge on several key findings with regard to knowns, unknowns and research needs (Table 4). Overall, the knowledge assessments agree that there is already sufficient scientific knowledge to warrant action and further research (e.g., UNEP 2018d, p. 76; Government of Canada 2020, p. 10; SAPEA 2019, p. 60). The G20 (G20 2017, p. 1) and UN member states (UNGA 2017, p. 33) share this view. Moreover, many other key findings of the existing knowledge assessments also gained political acceptance among states. The description of marine plastic pollution as an environmental challenge in the four UNEA resolutions on this issue largely mirror the conclusions of the existing knowledge assessments on what science knows and what research needs remain (c.f. UNEP 2019h).

Table 4: Key findings of existing knowledge assessments

Dimension	What is known	Where is more research needed
Extent/ occurrence	• Litter and microplastics occur everywhere in the oceans, at the surface, in the water column, in seabed sediments, at coasts and in biota. • They occur in and across many organisms, habitats and trophic levels and consequently in seafood.	• (More) exact quantification of the amount of litter and microplastics in the marine environment, including their spatial and temporal distribution • Assessment of occurrence in air, soil and freshwater compartments • Standardisation and harmonisation of assessment and monitoring methodologies
Sources	• All steps in the life cycle of plastic products from producers to waste management contribute to the occurrence of litter and microplastics in the oceans.	• (More) exact quantification of the contribution of the different sources to the pollution of the marine environment with litter and microplastics, including the share of different sources • Standardisation and harmonisation of assessment and monitoring methodologies
Pathways	• Most entry pathways of litter and microplastics into the oceans are well known.	• Knowledge on how and to what extent the various pathways transport litter and microplastics into the oceans • Standardisation and harmonisation of assessment and monitoring methodologies
Effects on marine environment	• Widespread occurrence of litter and microplastics in the oceans has adverse effects on marine environment. • Marine litter and microplastics threaten both individual marine species and entire habitats, ultimately resulting in a threat to marine biodiversity.	• Knowledge on how marine litter and microplastics affect the marine environment • Foundations and conduct of risk assessments • Analysis of effects on higher level of organisms or entire ecosystems
Impacts on humans	• Marine litter and microplastics have significant negative social and economic impacts, including costs of environmental damage and remediation. • Widespread occurrence of litter and microplastics in marine species is a growing threat to human health.	• Knowledge on how marine litter and microplastics affect human health and socio-economic systems. • Foundations and conduct of risk assessments for human health
Policy approach	• Addressing marine pollution from litter and microplastics requires a life-cycle approach.	• Effectiveness of political interventions

Own compilation. Sources: GESAMP 2016a, 2016b; UNEP 2016, 2018c, 2018d; SAPEA 2019

Key shortcomings

Several shortcomings characterise the landscape of existing global and regional scientific bodies and mechanisms, though two shortcomings stand out. The landscape is rather fragmented and it lacks a sufficient institutionalisation. Taken together, both shortcomings result in other, more specific shortcomings. Overall, they impair the effectiveness of the existing global and regional scientific mechanisms and bodies in performing the core functions that make science-policy interfaces beneficial to environmental governance.

Patchwork of global and regional knowledge assessments: The individual global and regional knowledge assessments spread across many different bodies, lack interlinkages, and often do not refer to each other. This might prevent the effective provision of scientific knowledge and advice on the extent, causes, sources, pathways, effects and trends of marine litter and microplastics. It might even result in competing or, even worse, contradictory knowledge claims and policy recommendations. These shortcomings are likely to negatively impact the establishment of a common, shared, reliable and consolidated knowledge base. Overall, this may eventually undermine the authoritativeness of each knowledge assessment and complicate unambiguous policy guidance. Policymakers and other stakeholders might therefore be unsure to whom to turn at global and regional levels when seeking for scientific advice and what advice to trust and rely on. The patchwork also complicates the unambiguous inducement and guidance of the knowledge generation when recommendations for future research and research priorities vary across knowledge assessments.

Gaps in knowledge assessments: Five main gaps characterise the existing knowledge assessments.

First of all, there are too few regional knowledge assessments. Many are outdated and were one-time efforts. Such regional assessments are however important, since "the sources, distribution and impacts of marine plastic debris and microplastics show great regional heterogeneity" (UNEP 2016, p. 23; see also GESAMP 2016a, p. 66, 2016b, 20 and 33-34).

Second, the majority of the regional assessments focus on the occurrence of litter and microplastics in the oceans but neglect sources, pathways and effects of marine plastic pollution. The effective prevention of the discharge of litter and microplastics into the oceans and the avoidance of its harmful effects in the marine environment and on human health, however, require knowledge assessments on sources, pathways and effects.

Third, hardly any global or regional assessment reviews knowledge on litter and microplastics across all life cycle stages of plastics. In particular, they mostly ignore knowledge on problems occurring at the pre-consumption stage that result from extraction, refinement and processing of raw materials, plastic processors, manufactures, distributors and retailers (upstream). However, effective and efficient responses to marine litter and microplastics require knowledge across all stages of the plastic life cycle. In fact, addressing the problem at the pre-consumption stage already would reduce the plastic pollution from the outset. It might, therefore, also reduce the need for comprehensive and possibly more costly political interventions at later stages in the plastic life cycle. The existing global knowledge assessments (e.g., UNEP 2019b, p. 31; SAPEA 2019, p. 27) as well as the UNEA resolutions on marine litter and microplastics (e.g., UNEP 2019h, p. 4) also emphasise the need for a life cycle approach to plastic pollution.

Fourth, there is an obvious lack in the assessment of scientific knowledge on adequate and effective policy responses and solutions in both, global and regional knowledge assessments. Such assessments would however provide insights into which responses work and which do not. Hence, they could improve the overall effectiveness of political interventions by identifying successful practices and highlighting lessons learnt.

Fifth, most knowledge assessments focus on natural sciences but neglect social sciences. The knowledge assessment by SAPEA provides a notable exception in this regard, though it concludes that social science research on marine litter and microplastics is still in its infancy (2019: 62).

Limited exchange between scientists, policymakers and stakeholders: The exchange between scientists, policymakers and other stakeholders is severely limited. It is barely institutionalised and, if so, mostly on an ad hoc basis and as one-off exercise. This increases the likelihood that the benefits that this exchange typically provides remain unrealised. The facilitation of mutual learning and understanding between scientists, policymakers and stakeholders requires a reliable framework for long-term exchange. Eventually, this might negatively impact the effectiveness of the scientific advice so that it cannot enrich decision-making or contribute to evidence-based policymaking.

Limited access to knowledge, data and information: Access to scientific knowledge, data and information on the problem that litter and microplastics pose to the marine environment, other environmental compartments, human health, or on promising policy responses, is severely limited. This renders the exchange and sharing of knowledge and best practices difficult. It also slows progress in understanding the problem and designing effective policy interventions.

Lack of regularity: The ad hoc nature global and regional knowledge assessments, including the related insecurity of their funding, prevents continuity. In the long-run, this may hinder the systematic accumulation of knowledge and further reduce the authoritativeness of the knowledge assessments.

Lack of coordination: A coordination and alignment of the various scientific mechanisms is absent, both at global and regional level as well as across these levels. Therefore, the overall fragmentation is likely to result in duplication of work and thus a waste of already scarce resources.

2.2.3 Summary and proposals: benefits, desirable key functions and outputs of a global scientific mechanism on marine litter and microplastics

The preceding analysis revealed that the existing landscape of global and regional scientific mechanisms and bodies on marine litter and microplastics is overall unsatisfactory. This is not to say that the existing scientific mechanisms and bodies have not significantly advanced the knowledge and understanding of the extent, sources, pathways, effects and governance of marine plastic pollution. Certainly, and very importantly, they contributed to the widespread recognition by science, policymakers and stakeholder that marine litter and microplastics pose a serious environmental threat that warrants action.

Yet, the existing scientific mechanisms and bodies are at best partially suitable to provide further authoritative and effective scientific advice to related policy- and decision-making processes at global and regional levels. This is above all due to their fragmentation and insufficient institutionalisation. Moreover, they feature some major constraints in performing typical core functions that make science-policy interfaces in global environmental governance and their knowledge assessments effective and beneficial. As result, the existing landscape of global and regional scientific mechanisms and bodies is hardly suitable to fully realise the benefits that such science-policy interfaces usually provide for the governance of environmental challenges. A single and overarching global scientific mechanism on marine litter and microplastics can overcome this status quo.

Against this background, the establishment of a well-designed single global scientific mechanism on marine litter and microplastics promises to yield three key benefits. First, such a mechanism is likely to increase the authoritativeness of knowledge assessments on marine litter and microplastics. Second, it provides the best opportunity to better ensure the effective performance of the typical core functions of such interfaces than the current landscape of scientific bodies and mechanisms. Third, it offers the best option to generate much needed outputs that strengthen the fight against marine plastic pollution.

Increasing the authoritativeness of knowledge assessments

The major expected benefit of a single global scientific mechanism lies in its potential to increase the authoritativeness of knowledge assessments on marine litter and microplastics. When a single mechanism has the mandate and resources to conduct timely and periodic knowledge assessments, science is in a better position to speak with one voice than it is in the current landscape of scientific mechanisms and bodies. This reduces not only the disadvantages of the observed fragmentation and the existing patchwork of assessments. It also reduces the risk of competing or contradictory knowledge claims and policy recommendations. The scientific mechanism is then better able to establish a common, shared, reliable and consolidated knowledge base. Such knowledge base facilitates the provision of unambiguous policy guidance. Policymakers and stakeholders would have a more obvious choice to whom to turn when seeking scientific advice. This renders it more likely that they refer to and to use the advice when developing policies and taking decisions. Moreover, a single global scientific mechanisms improves the prospect that science provides a more coherent and consistent guidance to future research. Overall, this might significantly improve the effectiveness of the scientific input to related policy- and decision-making processes.

Improving the performance of core functions

Establishing a global scientific mechanism on marine litter and microplastics provides an excellent opportunity to pool and institutionalise all core functions that make science-policy interfaces work effectively. This reduces not only the observed limitations in the institutionalisation of many core functions and its disadvantages.

It also can help to reduce the weaknesses in the performance of these core functions that characterise the existing landscape of scientific mechanisms and bodies. Whether a global scientific mechanism actually overcomes these shortcomings depends however on the key functions covered by its mandate, work programme and resources. While all core functions are important for its effective operation, three functions deserve particular attention and require particular efforts against the background of the limitations in the existing scientific mechanisms and bodies. Namely, the mandate, work programme and resources need to make possible that the new mechanism

- ensures continuity and regularity in the provision of knowledge assessments;
- improves the two-way exchange between scientists, policymakers and other stakeholders by perpetuating it; and
- provides easy access to scientific knowledge, data and information on the environmental problem and existing governance options by establishing a clearing-house mechanism.

The new scientific mechanism could perform these and the other core functions at both, global *and* regional levels. As a "catch-all" or "one-stop" science-policy interface, it would then also take over all relevant core functions that until today the existing regional mechanisms and bodies perform (more or less). This not only further reduces the disadvantages of the observed fragmentation, the insufficient institutionalisation and the patchwork of knowledge assessments at global and regional levels. It might generally increase the coherence and consistency in the performance of all core functions across global and regional levels, for example in the conduct of global and regional knowledge assessments or in the exchange between scientists, policymakers and other stakeholders.

Alternatively the new scientific mechanism could perform the core functions only at global level. Then, as a "pure" global science-policy interface, it would not take over any core functions from the existing regional bodies and mechanisms. It might nevertheless provide tailored guidance and support to the existing regional bodies and mechanisms. This might improve their performance of those functions where they feature shortcomings and strengthen them with a view on their needs. Moreover, it could take over some overarching key functions for the regional mechanisms and bodies that it can perform better. These might include the

- coordination and alignment of the existing regional and, if possible, national knowledge assessments, e.g. by developing a common framework for regional (and national) assessments based on its approach to global assessments;
- strengthening of the cooperation among existing bodies and mechanisms, for example by establishing and maintaining a peer learning mechanism; and
- realisation of synergies and avoidance of duplication of work.

Generating necessary outputs

Last but not least, the establishment of a global scientific mechanism provides an excellent opportunity to ensure the generation of much needed outputs. Namely, the mechanism could produce outputs that

- conduct and publish timely and periodic global (and possibly also regional) comprehensive knowledge assessments covering all stages in the life cycle of plastics;

- conduct and publish timely and periodic global (and possibly also regional) knowledge assessments on specific aspects of marine litter and microplastics, including separate assessments of knowledge on each individual stage in the life cycle of plastics;
- increase the coherence and consistency in the approaches to the knowledge assessments at global and regional levels and, if possible, at national levels;
- develop harmonised and standardised methodologies to monitor and assess the extent, sources, pathways and effects of marine litter and microplastics at global and regional levels and, if possible, at national levels and across all stages in the life cycle of plastics;
- harmonise regional knowledge assessments or, at least, guide them to the greatest extent possible, thereby promoting comprehensive assessments of knowledge on all stages in the life cycle of plastics and separate assessments of knowledge on individual stages; and
- assess existing knowledge on the effectiveness of policy interventions and facilitate the design and implementation of effective mitigation strategies across all stages in the life cycle of plastics.

3 Key requirements, design elements and practices of an effective global scientific mechanism

The mere establishment of a new global scientific mechanism on marine litter and microplastics itself does not guarantee improvements in the realisation of the benefits such science-policy interfaces provide in global environmental governance. Nor does the mere assignment of the core functions and key outputs guarantee that it effectively strengthens the knowledge base on marine litter and microplastics or improves the governance of marine plastic pollution through the provision of well-informed scientific policy advice. In addition, to fully exploit the potential of science-policy interfaces, the design of the new global scientific mechanism must meet four key requirements that make such interfaces effectively perform these core functions: credibility, legitimacy, salience and relevance, and agility. Whether it is able to meet these requirements depends again on a number of more specific design elements and practices that are conducive to the effective operation of science-policy interfaces.

This is the main result of a review of the design of selected science-policy interfaces that already exist in other areas of global environmental governance, like climate change, biodiversity loss, natural resource use, chemicals pollution, ozone depletion, etc.[7] This review provides three insights that are important for and should feed into the more specific design of a new global scientific mechanism on marine litter and microplastics. More precisely, it provides insights into

1. elements in the design of existing science-policy interfaces in global environmental governance that are conducive to their effective operation;
2. successful practices and lessons learned in the actual operation of these science-policy interfaces; and against this background
3. specific, indispensable and innovative design elements that deserve particular attention in the design of an effective global scientific mechanism on marine litter and microplastics.

Taken together, these considerations eventually permit proposals on how the design of a scientific mechanism on marine plastic pollution and microplastics could meet these requirements.

7. The review included those science-policy interfaces in global environmental governance that were subject in studies analysing their effectiveness, namely IPCC, IPBES, IRP, GEO, GESAMP, SAP, UNCCD-SPI, and the Intergovernmental Assessment of Agricultural Science and Technology for Development (IAASTD).

3.1 Review of success conditions and practices at existing science-policy interfaces

Unfortunately, there is no one-size-fits-all solution for the design of a science-policy interface to be successful. Instead its design, mandate and goals needs to fit the circumstances that underlie an issue (Sarkki et al. 2019: 2). Hence, it requires careful consideration of the issue that it addresses (IPCP 2019, p. 79).

Studies emphasise, however, four essential key requirements that the design and practices of science-policy interfaces need to ensure for them to operate successfully. If the design meets these requirements, it increases an interface's effectiveness. The key requirements are "credibility, legitimacy, salience and agility" (IPCP 2019, p. 79). They already formed the basis of the design of some existing science-policy interfaces such as GESAMP and IRP (see GESAMP 2005 and UNEP 2019f). While all key requirements are equally important, it seems advisable to start the design of a new science-policy interface with considerations about how to best ensure credibility and legitimacy. A combination of different, sometimes overlapping, design elements of science-policy interfaces and related practices helps to meet these two key requirements. At the same time, they also contribute to achieve salience (and relevance) of a science-policy interface.

3.1.1 Credibility

In general, the credibility of science-policy interfaces increases with transparency, openness to potential critique or diverging views, and scientific independence. A variety of elements in their design and related practices help them to ensure this. Several stand out, while most of them aim at the credibility of the scientific work of a science-policy interface.

First, an appropriate selection of experts contributes to the scientific credibility of science-policy interfaces. To this end, the selection needs not only to follow specific, transparent and publicly available criteria (IPCP 2019, p. 79). To the best extent possible, these criteria need to move the merits of experts to the foreground, foster inclusiveness and maximise their independence. Otherwise, the selection is prone to criticism of arbitrariness, bias and/or political influence and the science-policy interface runs risk of being politicised. Most of the reviewed science-policy interfaces therefore apply criteria that require international recognition and qualification of the experts, disciplinary and geographical representativeness, and gender balance, all with a view on the specific needs of the science-policy interface (e.g.IPCC 2013). Moreover, science-policy interfaces typically have policies in place that address and prevent conflicts of interests (IPCC 2011) At IPBES, even a specific expert body, the Multidisciplinary Expert Panel, is responsible for selecting experts and defining the criteria (IPBES 2020c).

Second, peer review contributes to scientific credibility as this is the "gold standard" of any scientific process and output and ensures independence (Beck 2012, p. 156). The IRP, for example, "bases its assessments and advice on the latest and most reliable peer-reviewed science available internationally, from trusted institutions" (UNEP 2019a). Typically, peer review means that scientists review the outputs of other scientists. Nowadays, many science-policy interfaces also involve other non-science actors, such as policymakers, stakeholders, non-governmental organisations

(NGOs), intergovernmental organisations (IGOs). The GEO process, for example, prides itself with its "rigorous and comprehensive review process" in which UN Staff, scientific experts and governmental representatives participate (van der Hel and Biermann 2017). Here again, the risk of politicisation looms.

Third, a clear separation between science and politics ensures scientific credibility. In fact, this is an important design element that minimises the risk of politicisation. This requires to separate the scientific process and outputs (i.e. the knowledge assessments) on the one hand and the political evaluation of these knowledge assessments on the other hand (i.e. recommendations to or summaries for policymakers) (IPCP 2019: 79). This is also in the interest of scientists. If they issue recommendations such as thresholds for emissions or other extent of harmfulness, the discussions around such recommendations quickly become heavily politicised. The deliberations within the Rotterdam Convention's subsidiary science body CRC on the issue of chrysotile asbestos is a case in point. Here, several member states refused to list the recommendations in Annex III of the Convention (see: Federico 2019). The separation between science and politics also requires to separate the peer review through scientists and the (possible) peer review through non-science actors (IPCP 2019, p. 80). Otherwise, the scientific insights and conclusions risk being conflated with their political evaluation. Policymakers and other non-science actors may then side-line those scientific insights in the knowledge assessments that they (for whatever reasons) dislike or reject. In the worst case, these insights may completely vanish from the knowledge assessments in response to concerns of policymakers and/ or other actors. This would heavily undermine the scientific independence of the science-policy interface and therefore also its overall credibility. Keeping the scientific outputs and peer review process separate from political evaluations makes these differences apparent. It therefore increases the credibility of science-policy interfaces.

Fourth, the scientific credibility of a science-policy interface depends on whether and how it provides access to knowledge, data and information that inform its knowledge assessments. The provision of this access constitutes not only one of the five core functions of any science-policy interface. It also increases their credibility. It is so important because it enables users to assess the quality of knowledge assessments, to better evaluate their results or even to replicate the research (Beck 2012, p. 162). Otherwise, the science-policy interface might become subject to criticism. In 2010, for example, critics complained about the IPCC for often being hesitant to share its underlying data with scientists that had diverging views on certain issues. This reduced IPCC's credibility (Beck 2012, p. 162).

Fifth, and related, the scientific credibility of a science-policy interface depends on what knowledge, data and information it draws in its knowledge assessments. Issue areas where non-traditional or non-peer-reviewed local and indigenous knowledge is relevant and helpful require more than the involvement of scientists in the preparation of knowledge assessments. They also require the participation of other stakeholders and other knowledge holders. Moreover, many of today's environmental challenges require the consideration of knowledge from a multiplicity of disciplines, ranging from natural science over social, behavioural and economic sciences to humanities. The IPBES and its knowledge assessments is a prominent example in this regard. They systematically recognize and consider local and indigenous knowledge on biodiversity and ecosystem services (Sarkki et al. 2019, p. 8).

Sixth, the source of funding of science-policy interfaces may affect their credibility. Yet, there is only little knowledge on this matter. Science-policy interfaces may receive funding from governments (like the IPCC and IRP), foundations, the public, industry or a mix thereof (like the IPBES). The existing knowledge suggests that in comparison to funding from governments or foundations, funding from industry may impair the credibility of a science-policy interface. It is less likely to promote the dissemination of an interface's findings than funding from governments or foundations (Jensen-Ryan and German 2019: 15).

Last but not least, a science-policy interface gains credibility if clear, commonly agreed and binding rules of procedure spell out the previous elements. This ensures an overall transparency and reliability of the interface's working methods. Moreover, if respected organisations or policymakers formulate and endorse the mandates of a science-policy interface this also increases its credibility and, as result, its impact (2019, p. 6). In case of the IPBES, the UNGA endorsed its mandate. This fact raised the impact of the intergovernmental panel (ibid.).

3.1.2 Legitimacy

Essentially, the legitimacy of a science-policy interface increases when a broad range of scientists and multiple stakeholder groups contribute to its work and develop ownership towards the results. Obviously, this overlaps with how science-policy interfaces gain credibility where, for example, geographical and disciplinary representativeness or gender balance are important in the selection of experts and where the participation of science and non-science actors in the peer review processes is conducive. Three specific elements in the design of a science-policy interface and related practices help to gain legitimacy.

First of all, a science-policy interface can ensure its legitimacy by including scientists from multiple disciplines and, where necessary and useful, also holders of indigenous and local knowledge. This avoids a potential disciplinary and scientific bias that might also impair the interface's credibility. Any new science-policy interface should gather scientists and other knowledge holders that in one way or another can contribute with their knowledge to the understanding of the environmental challenge in question and possible solutions (2016, p. 124). Here, in particular the use of open calls to invite scientists and other knowledge holders increases the legitimacy of a science-policy interface (Jensen-Ryan and German 2019, p. 15). The IRP follows this approach while in most other science-policy interfaces selected actors or groups of actors nominate experts without issuing open calls (see below).

Second, legitimacy increases when the science-policy interface opens its bodies (or some of them) not only to scientists and states but also to other stakeholders so that they can participate and influence the joint production of its outputs (Jensen-Ryan and German 2019, p. 15). This also improves the ability of a science-policy interface to respond to the needs of policymakers and stakeholders and thus increases the prospects that they take into account its advice in their considerations (see also salience). The IRP is good example for a rather comprehensive inclusion of more than scientists and governments in the work of a science-policy interface. Its bodies comprise a secretariat, hosted by UNEP, a steering committee, which consists of governmental representatives, and a scientific panel, which explicitly includes "scientists and governments from both developed and developing regions, civil society, industrial and international organizations" (UNEP 2019f). The IAASTD which ran between 2003 and 2008 adopted a similar approach. In its plenary, it granted non-governmental stakeholders access as observers, like nowadays for example at IPBES. Its Bureau consisted of government officials as well as representatives from civil society, the private sector and scientific institutions. Other science-policy interfaces let actors other than states participate in the nomination of experts. At IPBES and in the GEO process, for example, major stakeholder groups participate in the nomination of experts together with states (Akhtar-Schuster et al. 2016, p. 130). At the IPCC, governments and observer organisations nominate experts, including, inter alia, other global or regional IGOs, multilateral environmental agreements, NGOs, research institutions and economic associations. Like in case of scientists, in particular the use of open calls to invite these actors contributes to the legitimacy of a science-policy interface (Jensen-Ryan and German 2019, p. 15).

Third, a science-policy interface gains legitimacy when scientists, policymakers and other stakeholders jointly decide on the programme of work (IPCP 2019, p. 80). The 2030 work programme of IPBES, for example drew on requests from member states and relevant multilateral environmental agreements as well as inputs from other stakeholder groups. Like the previous design element, this facilitates the responsiveness of a science-policy interface to the needs of policymakers and other stakeholders, thereby increasing the likelihood that the work of the interface enters policy- and decision-making processes (see also salience).

Overall, the institutionalised participation of a variety of actors in a science-policy interface and their contribution to its work render it more likely that an interface realises one of the main benefits of such interfaces, namely the co-evolution and joint construction of knowledge. It does so by perpetuating and enabling the exchange between scientists, policymakers and other stakeholders. It thus also enables the interface to (more) effectively perform one of the core functions of science-policy interfaces.

3.1.3 Salience

Achieving salience means to ensure that policymakers and other stakeholders perceive the outputs of a science-policy interface as relevant for their decision-making processes. Some of those design elements of science-policy interfaces and related practices that increase credibility and legitimacy simultaneously also help achieving salience. Others are new.

Like credibility and legitimacy salience increases when the science-policy interface allows a broad range of scientists, policymakers and multiple stakeholder groups to contribute to its work and to develop ownership towards the results. Their participation ensures that the science-policy interface responds to their needs. If policymakers and stakeholders participate in the science-policy interface and have the opportunity to influence and contribute to its work, they can better ensure that they gain knowledge that they consider important and relevant for their decisions. The IRP, for example, ensures, inter alia, the salience of its outputs by timely responding to demands for scientific knowledge and policy advice (UNEP 2019a). Likewise, a design that ensures the representation of scientists from all relevant scientific disciplines and where necessary holders of indigenous and local knowledge helps strengthening salience and relevance. It ensures that the science-policy interface can effectively and adequately respond to the different knowledge needs of policymakers and stakeholders. Already the description of the core functions of science-policy interfaces revealed that such responsiveness is important for the successful operation of science-policy interfaces in global environmental governance.

Two observations illustrate these relationships between credibility and legitimacy on the one hand and salience on the other hand. First, the IPBES follows an inclusive and multidisciplinary approach (Diaz et al. 2015, p. 10) and is an outstanding example for how to make outcomes of science-policy interfaces relevant for policymakers (Jensen-Ryan and German 2019, p. 14). Whereas most science-policy interfaces produce outputs that are relevant only (or predominantly) for their direct principals (i.e. members of the COPs to their relevant Convention or of their governing bodies), IPBES outputs are relevant for many more actors. To name just a few, it regularly reaches national governments, other multilateral environmental agreements, the private sector, global financial institutions, development agencies and NGOs (UNEP 2020d). Second, some observations suggest a reverse relationship: a loss of legitimacy might reduce the salience and relevance of science-policy interfaces, like in the case of GESAMP and the UNCCD-SPI. Probably as result of a legitimacy loss, they encountered problems in reaching their target audience or the wider public and the salience and relevance of their output decreased (IPCP 2019).

In addition, communication strategies appear to contribute to salience. The IPBES and IPCC are cases in point. Both achieve a considerable salience and relevance and employ specific communication strategies with a considerable outreach (UNEP 2020d). For example, they broadcast their outputs via mass- and social media (UNEP 2020d). Also the IRP strives to ensure the salience of its outputs by "communicating them to the right audiences" (UNEP 2019a). The (mass) media certainly grew in importance to create salience not only for policymakers but also for the wider public, since it leads to greater dissemination of knowledge (Jensen-Ryan and German 2019, p. 22). At the same time, media outreach and corresponding increase of salience for stakeholders has implications in itself. The IPCC, for example, has from its outset been responsible both to science and to policy (2012, pp. 169–170). Over time it started however to become responsible to new audiences, such as bloggers and online-based citizen-scientists. Hence, once the audience expands, outreach efforts (need to) increase.

Last but not least, a few individual examples reveal three other dimensions of the work of science-policy interfaces that contribute to their salience. Through producing regional knowledge assessments, IPBES ensures that its work is salient not just at the global scale. By targeting and tailoring its knowledge assessments to regional needs, it also ensures its outputs' salience at regional levels. Moreover, GESAMP produces not only peer-reviewed outputs but also context-specific grey literature, thereby increasing its outputs' salience to its IGOs sponsors (IPCP 2019, p. 81). Finally, the IRP ensures the salience of its outputs by using in its knowledge assessments "the latest and most reliable peer-reviewed science available internationally" (UNEP 2019a).

3.1.4 Agility

Agility means the ability and flexibility of a science-policy interface to adapt to circumstances once they change. To achieve this, a science-policy interface essentially needs to have a built-in review mechanism that serves at least two goals (IPCP 2019, p. 81).

First, to achieve agility science-policy interfaces need to have a built-in review mechanism that enable them to quickly react to newly emerging issues and bring them onto their agenda. The IPBES and its practices are an outstanding example in this regard. It has a built-in review mechanism of its work programme, possibly as result from the lessons of a thorough review of the IPCC (see below) that informed its design. An internal review team and the independent International Council for Science conducted the first review four years after the creation of IPBES, following the completion of its initial work programme. The review led to a reform that allowed for greater flexibility of the IPBES to adapt to changing circumstances by publishing periodic calls on proposals for newly emerging issues. Prior to this reform, the adoption of the work programme defined (and fixed as well as limited) at the very outset and for several years the issues that IPBES could address in its work (IPCP 2019, p. 81). GESAMP and the UNCCD-SPI underscore the importance to be able to react promptly on new issues and provide examples for alternative design features that ensure this ability. GESAMP ensures this ability by its approach to establish working groups for a specific time and issue area (in relatively short time). Moreover, it leaves it to the working groups to meet ad hoc and to use online means for approval instead of insisting on large physical meetings. This also increases its members' agility to spontaneously react to newly emerging issues (IPCP 2019: 82). The UNCCD-SPI limits the number of issues under consideration to the most pressing ones, while it shortens the time period of work programs. This allows for more periodic revisions of the focus areas (IPCP 2019, p. 82). The general lesson is that shorter work cycles and a certain leeway for scientists to respond to newly emerging issues once these emerge increase the agility of science-policy interfaces.

Second, the agility of science-policy interfaces also benefits from review mechanisms that target not only the issues the interfaces address but extend to their working methods and processes. GESAMP's review mechanism is a case in point. Although the institutionalisation of its review mechanism is relatively weak when compared to IPBES' mechanism, it led to a thorough adaptation of its working methods and processes. This became visible in 1996 and 1999, when the UN Commission on Sustainable Development asked the GESAMP sponsoring organisations to critically review the effectiveness and comprehensiveness of GESAMP's interaction with scientific representatives of governments and major groups. In response to the review, GESAMP changed its mode of operation. It broadened and intensified the participation of and engagement with other relevant stakeholders. It also increased the user-friendliness of their outputs (GESAMP 2005). GESAMP thus changed two elements in its design that contribute to its legitimacy and the salience of its outputs.

By contrast, the lack of built-in review mechanisms impairs the agility of science-policy interfaces by delaying (if not preventing) their adaptation to changing circumstances. The experiences of the IPCC illustrate this point. It has not had a built-in review mechanism that could have ensured its ability to adapt to changing circumstances. In 2010, and thus not until 22 years after its creation, the UN

Secretary General and the Chair of the IPCC invited the InterAcademy Council to independently review the IPCC, focusing on the IPCC's policies and procedures (Beck 2012, p. 162). After the finalisation of the review, it took negotiations at three consecutive IPCC plenary meetings to finally implement the suggested changes "on improving its internal processes, procedures for peer review, quality control, and communication" (Beck 2012, p. 163). The fact that it took so long to initiate the review and to implement the recommendations shows that if science-policy interfaces lack an in-built review mechanism, the adaptation to changes can be a cumbersome and lengthy process.

3.1.5 Challenges in meeting key requirements: trade-offs and capacities

Meeting all key requirements to a satisfactory extent is challenging in any case. It requires a careful design and coordination of many different elements of a science-policy interface, let alone the successful establishment and internalisation of related practices. Also the IPBES struggles with such challenges even though many insights and lessons from year-long experiences at other prominent science-policy interfaces in global environmental governance informed its design. Two challenges stand out and complicate the achievement of some of the key requirements.

The most significant challenge lies in balancing the trade-off between credibility, legitimacy and salience that is inherently built into any science-policy interface. This trade-off results from a tension between achieving credibility on the one hand and legitimacy and salience on the other hand. The credibility of a science-policy interface depends largely on the independence of its scientific work and outputs. Most interfaces ensure this independence through an appropriate selection of experts, peer-review and the separation of scientific from political outputs and processes. The legitimacy and salience of science-policy interfaces largely depend on the involvement of policymakers and stakeholders in decisions on its work programme or their participation in the production of its outputs. An imbalance in the design in favour of either credibility or legitimacy and salience adversely affects the achievement of the other key requirement respectively.

An overemphasis of legitimacy and salience impairs the scientific credibility of a science-policy interface. This might reduce its ability to effectively advance the understanding and knowledge on the issue at hand in an open-ended manner, i.e. without politically motivated constraints. It might also reduce its ability to bring newly emerging issues onto the agenda of the science-policy interface. Instead, the science-policy interface then runs risk of being politicised. In the worst case, the science-policy interface eventually operates only as servant to the preferences, priorities and needs of its political principals and delivers only politically acceptable and desirable knowledge. Yet, and in reverse, an overemphasis of scientific credibility and a neglect of legitimacy and salience might reduce the usefulness and impact of the scientific work and advice of the science-policy interface for political decision-making processes. The reason is that such an overemphasis might cause the science-policy interface to be less responsive to the needs of policymakers and stakeholders. In either case, the science-policy interface is then hardly able to realise the benefits that such interfaces typically provide in global environmental governance. As result, the overall effectiveness of the science-policy interface suffers.

There is no easy or single-best solution to this challenge. One option is to separate the scientific and political processes and outputs in the science-policy interface to the best extent possible. This makes apparent the differences but also the overlaps from which joint processes and outputs then can start and on which they can build. This solution is common practice in many science-policy interfaces. The separation does however not completely avoid or balance the trade-offs and their risks. The IPCC, for example, clearly separates the scientific processes and outputs from political processes and outputs. Only when it finalised its assessment reports, negotiations between scientists and policymakers start on the summaries for policymakers that outline the most important findings and their political implications. On the one hand, this makes the knowledge assessments scientifically more credible and the summaries politically more acceptable (Akhtar-Schuster et al. 2016). On the other hand, opposing stakeholders insisted in the past on including findings from scientists negating anthropogenic climate change in these summaries, thereby undermining the scientific credibility and independence of IPCC's work (Sarkki et al. 2019). The IPBES has met a similar fate and may have a problem in providing neutral space for negotiations, once issues become deeply political (Sarkki et al. 2019).

Moreover, this solution does not apply to decisions on the work programme for science-policy interfaces. These have however more far-reaching effects. In most science-policy interfaces, state representatives decide on the work programme and thus define (and limit) the issues on which science-policy interfaces work. This ensures the necessary and desirable responsiveness of the interface to their needs. However, it also gives policymakers the opportunity to side-line or ignore issues that conflict with their preferences, priorities and needs at the very outset of the work of science-policy interfaces. To some extent, the heterogeneity of state preferences, priorities and needs weaken here the risk of a one-sided politicisation of science-policy interfaces. Yet, other safeguards against politicisation are advisable. Four are conceivable. First, scientists in science-policy interfaces could have an institutionalised opportunity to bring newly emerging issues or issues that they consider important and urgent onto the agenda of a science-policy interface. This is already the case in many existing science-policy interfaces, for example GESAMP. Second, an institutionalised and regular exchange between scientists, policymakers and stakeholders specifically on the work programme could promote decisions by states that take into account the different inputs on and ideas for issues to work on. A few existing science-policy interfaces follow this procedure, for example the IRP. Third, scientists could have the possibility to include a limited number of issues in the work programme that states cannot reject or to seek independent funding for the work on these issues, e.g. by a group of interested states, IGOs or other sources. Fourth, and possibly most fundamentally, scientists, policymakers and stakeholders could jointly negotiate and decide on the work programme.

Another challenge are lacking scientific capacities that complicate the inclusion of experts from developing countries and countries with economies in transition into the scientific discourse and in science-policy interfaces (IPCP 2019). This adversely affects the achievement of credibility and legitimacy as they both rely on inclusiveness and representativeness in the selection of experts. The solution to this problem is at first sight relatively easily: capacity-building. This is generally also one of the core functions of science-policy interfaces in global environmental governance. The IPBEs is a case in point. Capacity building features prominently in both its first and the second work programme. Possibly the most prominent activity during the first cycle of work was the implementation of a fellowship programme. It strengthened access to the scientific (though perhaps not to the political) side of the science-policy interface (Gustafsson et al. 2020). Along similar lines, IPCC has initiated a doctoral scholarship programme, helping developing country students (IPCP 2019). Yet, capacity-building requires resources and not all science-policy interfaces have them. The UNCCD-SPI, for example, has problems with lack of developing or transition country representation, possibly due to a lack of resources (IPCP 2019: 83).

3.2 Transferring best practices and success conditions: lessons and implications for a global scientific mechanism on marine litter and microplastics

To ensure an effective operation of a global scientific mechanism on marine litter and microplastics to the best possible extent, it is essential that its design enables it to meet the four key requirements as well as to implement solutions to remaining challenges. To achieve this, a transfer of most design elements and related practices that ensure the successful operation of science-policy interfaces in global environmental governance is advisable without major changes. Nevertheless, there are exceptions where these elements and practices require adaptation to the context of marine litter and microplastics in order to follow the key imperative in the design of any science-policy interface: that the design takes into account and fits the underlying issue. Moreover, some of the elements and practices deserve particular attention in the design of a global scientific mechanism on marine litter and microplastics.

The transfer of best practices and success conditions therefore rests on two considerations:

1. Brief summary of all design elements and specific conditions that make a global scientific mechanism on marine litter and microplastics work effectively (in tables) and therefore should be taken into account in its design.
2. Brief discussion only of those design elements and conditions that deserve particular attention in the context of a global scientific mechanism on marine litter and microplastics and for what reasons.

3.2.1 Gaining credibility

Table 5 gives an overview on the design elements and specific conditions that enable a global scientific mechanism on marine litter and microplastics to gain credibility. While all design elements and specific conditions are important, several specific conditions deserve particular attention in the context of a global scientific mechanism on marine litter and microplastics (in bold).

First, the inclusion of scientists from all relevant disciplines in the selection of experts and an equal consideration of knowledge from all relevant scientific disciplines is highly important. The existing assessments of knowledge on marine litter and microplastics tended to review knowledge primarily from natural sciences at the expense of social, behavioural, legal and economic sciences as well as humanities. SAPEA's knowledge assessment emphasised however that the inclusion of disciplines other than natural sciences is indispensable to advance the understanding and knowledge on extent, sources, pathways, effects and governance of marine litter and microplastics (SAPEA 2019). This also would enable the scientific mechanism to review knowledge across the entire life cycle of plastics that ends up in the oceans and to develop and recommend solutions that cover the entire life cycle of plastics. An approach that many scientists, policymakers and stakeholders highlight as indispensable to effectively combat marine litter and plastic pollution.

Second, and related, the inclusion of holders of relevant non-traditional or non-peer-reviewed local and indigenous knowledge and the consideration of their knowledge deserves particular attention in the context of marine litter and microplastics. In particular, local knowledge from citizen science projects proved to generate relevant findings on this issue (Vince and Hardesty 2018, p. 8). Likewise, experts see the need to strengthen the role of indigenous knowledge in knowledge assessments on marine litter and microplastics (Marine Regions Forum 2019).

Table 5: How a global scientific mechanism on marine litter and microplastics might gain credibility

Key design element	Specific conditions
Appropriate selection of relevant experts	• Specific, transparent and publicly available criteria that maximise independence and inclusiveness • **Inclusion of scientists from all relevant disciplines** • **Inclusion of holders of relevant non-traditional or non-peer-reviewed local and indigenous knowledge** • Merit-based: international recognition and qualification of experts • **Geographical representativeness** • Gender balance • Conflict of interest policies
Independent peer review	• Through scientists • Through non-science actors, such as policymakers, stakeholders, NGOs, IGOs, etc.
Separation between science and politics	• Separation of knowledge assessments from political assessments • Separation of peer review through scientists from (possible) peer review through non-science actors
Access to knowledge, data and information	• **Establishment of clearing-house mechanism**
Use of knowledge, data and information	• **Scientific knowledge from all relevant disciplines** • **Relevant non-traditional or non-peer-reviewed local and indigenous knowledge**
Source of funding	• Governments • Public funds • Foundations
Rules of procedure	• Commonly agreed • Binding • Transparent • Specific

Third, the geographical representativeness of experts (and knowledge) is an important condition in the design of a global scientific mechanism on marine litter and microplastics. Otherwise, it becomes difficult to appropriately address the regional (and national and local) heterogeneity of the extent, sources, pathways, effects and solutions of marine litter and microplastics that characterises this problem. All related resolutions (UNEP 2019h) and many existing knowledge assessments (SAPEA 2019; UNEP 2016; GESAMP 2016a, 2016b) emphasise this heterogeneity and the need to adapt research and governance to it. The selection of experts for the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics provides a conceivable template for ensuring the representativeness of experts (and knowledge). In UNEA Resolution 3/7 on marine plastic litter clearly states that this group "will include experts with the relevant technical expertise from all member States, representation from international and regional conventions and organizations and relevant stakeholders" (UNEP 2019h, p. 10).

Fourth, establishing a clearing house mechanism to provide access to knowledge, data and information seems particularly advisable in the context of marine litter and microplastics. As the review of the existing scientific mechanisms and bodies in this issue area revealed, such a clearing-house mechanism is missing at global level. At regional levels only a very few exist. These could however serve as template for a global clearing house mechanism.

Fifth, and finally, in terms of funding, any scientific mechanism on marine litter and microplastics might lose credibility if solely or predominantly funded by industry. However, in line with the integrated approach to financing following from the 2030 Agenda, it would be one option to invite industry and other stakeholders, to contribute financial or in-kind resources to the body or mechanism.

3.2.2 Ensuring legitimacy

Table 6 gives an overview on the design elements and specific conditions through which a global scientific mechanism on marine litter and microplastics might ensure legitimacy. Several of the specific conditions deserve particular attention in the context of a global scientific mechanism on marine litter and microplastics (in bold).

Some of them overlap with those ensuring that such a mechanism gains credibility, namely the inclusion of scientist from all relevant disciplines and of holders of relevant local and indigenous knowledge. Like in the case of credibility and for similar reasons, they also deserve particular attention here when it comes to ensuring legitimacy. This once more underscores their importance in the context of a global scientific mechanism on marine litter and microplastics. In short, and like in the case of credibility, they ensure that the design of the mechanism effectively responds to three specific knowledge needs in the context of marine litter and microplastics: the need to consider knowledge from all relevant scientific disciplines, the need to take into account relevant local and indigenous knowledge and the need to reflect the regional heterogeneity of the issue.

In addition, the openness of the working and decision-making processes of a global scientific mechanism deserves particular attention in the context of marine litter and microplastics. It raises the question which policymakers and stakeholders should participate in the global scientific mechanism.

First of all, and given the regional (and national and local) heterogeneity of marine litter and microplastics, the design of the mechanism should strive for the best possible geographical representativeness of policymakers and stakeholders. This means that at least policymakers and stakeholders from all different UN regions should participate in one way or another in the mechanism. Only then, the mechanism is able to take into account and respond to the different needs and interests from the respective regions in its working and decision-making processes. The mechanism would certainly further benefit when it ensures in one way or another that the needs and interests from local policymakers and stakeholders also find consideration in its work and decisions. Marine litter and microplastics does not only affect local societies and economies differently. Local communities also contribute to varying extent to the problem. All UNEA resolutions on marine litter and microplastics emphasise this local dimension (UNEP 2019h), like many global knowledge assessments do (e.g., UNEP 2016).

Second, and as regards stakeholders, it is highly important that the new global scientific mechanism on marine litter and microplastics ensures that their representation in its work covers stakeholder groups across the entire life cycle of plastics. This helps the mechanism to effectively and legitimately adopt and benefit from the much needed life cycle approach to marine litter and microplastics. Such an approach would benefit from the participation of stakeholders from the production and pre-consumption stage in the plastic life cycle (upstream), including the extraction, refinement and processing of raw materials as well as plastic processors, manufactures, distributors and retailers. It would also gain from the inclusion of stakeholders from the consumption stage, for example packaging, textiles, building and construction, consumers, consumer product industry, food production and delivery, retail, etc.. Finally, the mechanism would need to open its working and decision-making processes to stakeholders from the post-consumption and end-of-life stage, such as municipalities, waste collection, recyclers, waste management facilities, etc..

Table 6: How a global scientific mechanism on marine litter and microplastics might ensure legitimacy

Key design element	Specific conditions
Inclusiveness as regards knowledge (holders)	• **Inclusion of scientists from all relevant disciplines** • **Inclusion of holders of relevant local and indigenous knowledge** • **Geographical representativeness** • Use of open calls to invite scientists and other knowledge holders
Openness as regards participation in production of outputs	• **Openness of working processes to scientists from all relevant disciplines and other holders of relevant knowledge, policymakers and stakeholders** • **Contributions of scientists from all relevant disciplines and other holders of relevant knowledge, policymakers and stakeholders to outputs** • Joint production of outputs
Openness as regards participation in decision-making	• **Openness of decision-making processes to scientists from all relevant disciplines and other holders of relevant knowledge, policymakers and stakeholders** • Joint decisions on work programme or input to decisions • Joint decisions on the nomination of experts or input to decisions

3.2.3 Making the outputs salient and relevant

Table 7 gives an overview on the design elements and specific conditions through which a global scientific mechanism on marine litter and microplastics might make its outputs salient and relevant. Obviously, some of them built on those ensuring that the mechanism gains credibility and achieves legitimacy, namely the conditions that contribute to the broad participation of different actors in the production of outputs. Like in the case of credibility and legitimacy, the inclusion of scientists from all relevant disciplines and other holders of relevant knowledge is also important here. Likewise, and like in the case of legitimacy, the participation of a broad range of policymakers and stakeholders remains essential here.

In other words, making the mechanism credible and legitimate also helps in making its outputs salient and relevant. To this end, the mechanism's design first of all needs to take into account the specific conditions for credibility and legitimacy and their particular implications in the context of marine litter and microplastics. Then, its working processes and the production of outputs should allow for broad participation of the variety of actors who contribute to the mechanism's credibility and legitimacy. On the one hand, this gives policymakers and stakeholders the opportunity to request and gain the knowledge that they need. On the other hand, it enables experts to effectively and adequately respond to the variety of possible requests and needs. Taken together, these two aspects facilitate the production of relevant and salient outputs.

Table 7: How a global scientific mechanism on marine litter and microplastics might make its outputs salient and relevant

Key design element	Specific conditions
Broad participation of relevant actors in production of outputs	• **Openness of working processes to scientists from all relevant disciplines and other holders of relevant knowledge, policymakers and stakeholders** • **Contributions of scientists from all relevant disciplines and other holders of relevant knowledge, policymakers and stakeholders to outputs** • Joint production of outputs
Tailor output to needs of audience	• **Consideration of specific needs of principals and other relevant actors** • **Consideration of variations in underlying issue**
Communication strategies	• Outreach beyond principals • Multiple channels of communication, such as mass and social media

Also the tailoring of the outputs to the needs of the audience deserves particular attention in the context of a global scientific mechanism on marine litter and microplastics. First of all, and given the current lack of a global agreement on plastic pollution, the determination of the mechanism's target audience is necessary. Depending on the institutional setting of the mechanism, the primary target audience might cover its own governing body, the governing bodies of related conventions and multilateral environmental agreements, and policymakers as well as stakeholders that participate and contribute to its work.

As regards the latter, the definition of whom to target in the first place depends, however, on how the mechanism seeks to ensure legitimacy, i.e. on the decision which policymakers and stakeholders eventually become part of it and contribute to its work. This decision precedes and also somewhat predetermines the definition of the possible target audience in the absence of a global agreement on plastic pollution. Against the background of previous considerations on the participation of policymakers and stakeholders and the mechanism's legitimacy, the target audience might cover policymakers and stakeholders at least at global and regional levels. If possible and feasible, it might also extend to policymakers and stakeholders at national and local levels. As regards the non-governmental stakeholders only, the coverage and targeting of major stakeholders groups across the entire life cycle of plastics is again highly important. This helps to effectively implement and benefit from the much needed life cycle approach to marine litter and microplastics also in the scientific work and advice on this issue. The mechanism's outputs then are likely to become salient and relevant to the variety of actors who contribute to the problem of marine litter and microplastics, its governance and possible solutions. Once a global agreement on plastic pollution is in place, its governing body and possible subsidiary bodies as well as its parties, observers and stakeholders are obviously a preferable and additional primary target audience.

Equally important, tailoring the mechanism's outputs to the needs of the audience requires the definition of the scope of its work, particularly its knowledge assessments as its main output. Here, four basic categories help to structure the different options to tailor the mechanism's output to the needs of its audience.

First and obviously, the mechanism might tailor its outputs to the needs of audiences at different governance levels. As a global mechanism, it should of course provide all necessary outputs that target the global audience. As previous consideration on possible key outputs of the mechanism suggest, it could however also provide outputs targeting at audiences at regional, national and local levels. Given the regional heterogeneity of marine litter and microplastics, it could, for example, conduct regional knowledge assessments, like the IPBES does. Since several scientific mechanisms and bodies already exist at regional level, it could however also leave the conduct of regional knowledge assessments to these mechanisms and bodies and only harmonise or provide guidance to them. At national (and local level) such outputs that provide guidance and harmonisation are also a, if not the only, worthwhile option.

Second, the mechanism might tailor its outputs along the stages in the life cycle of plastics or environmental compartments. For example, it might conduct knowledge assessments that target at audiences either in the pre-consumption, the consumption or the post-consumption stage. If advisable, necessary and valuable, it might even produce outputs that target at individual sectors within each stage.

Third, the mechanism might tailor its outputs along specific knowledge needs or scientific disciplines. For example, it could tailor its knowledge assessments by prioritising certain knowledge needs, like effective response options or effects of marine litter and microplastics on human health, and then provide separate knowledge assessments on these. It might also produce knowledge assessments that draw on a single or a few selected scientific disciplines that contribute to the understanding and knowledge on the problem of marine litter and microplastics. In doing so, it might focus on scientific disciplines that have so far been neglected and that deserve particular attention, like social, behavioural and economic sciences, thereby strengthening the related knowledge base.

Fourth, the mechanism might tailor its outputs along different dimensions of the problem of marine litter and microplastics and environmental compartments. For example, it might conduct knowledge assessments that focus on either extent, sources, causes or effects of marine litter and microplastics. It could also produce outputs that assess the knowledge on plastic pollution in either air, soil, freshwater, oceans or sediments, to name just a few.

Finally, the mechanism might tailor its outputs by combining any of these options with one or several other options across all four categories.

3.2.4 Creating an agile mechanism

Table 8 gives an overview on the design elements and specific conditions through which a global scientific mechanism on marine litter and microplastics achieves agility. Two specific conditions deserve particular attention in the context of a global scientific mechanism on marine litter and microplastics.

Previous considerations suggested that a number of uncertainties and knowledge needs characterise the science on marine litter and microplastics, even though there is sufficient knowledge to warrant action. Hence, it is conceivable that issues newly emerge that neither scientists, nor governmental and other stakeholders currently even thought of. This has two important implications for the design of a global mechanism on marine litter and microplastics.

Table 8: How a global scientific mechanism on marine litter and microplastics might ensure agility

Key design element	Specific conditions
Built-in mechanism for regular and independent reviews	• Comprehensive review of working methods, processes and procedures • Agenda-setting by scientists • **Identification of newly emerging issues**
Flexibility in scientific work	• **Leeway for scientists to respond to newly emerging issues** • **Quick institutional responses to newly emerging issues**

First, it is worthwhile to institutionalise a procedure that renders the identification of issues less random and instead provides an established approach, such as regular scoping activities or horizon scanning processes, like at GESAMP. This might also include issuing periodic calls on proposals for newly emerging issues, like the IPBES does. Second, it underscores the importance that the mechanism's design provides for sufficient flexibility in the working processes, for example by granting some leeway for scientists working on an issues to independently respond to such newly emerging issues, once they emerge. Or by enabling the mechanism to quickly establish working groups on newly emerging issues with a limited time frame and working mandate, like at GESAMP.

In general, the time intervals between such review activities increase with the scope of the review subject. A broad-scale institutional and procedural review could be foreseen after three to four years, or at the end of every work-cycle. Reviews on smaller scales, such as of the programme of work or the division of work among experts might take place every two years. Any review activity that serves to identify newly emerging issues might take place every year. These can take place even more often when the mechanism does not undertake these activities itself but issues calls for proposals on newly emerging issues.

3.2.5 Coping with challenges

Table 9 gives an overview on the design elements and specific conditions through which a global scientific mechanism on marine litter and microplastics might cope with the challenges that typically characterise science-policy interfaces.

Like any other science-policy interface, a global scientific mechanism on marine litter and microplastics faces the challenge of balancing the trade-off between its scientific independence and the responsiveness of science to the needs of policymakers and stakeholders (or more generally between credibility, legitimacy and salience). As the previous considerations on this trade-off revealed, there is neither an easy nor a single-best solution to this challenge that is inherently built into any science-policy interface. Essentially, two basic options exist for the new mechanism.

On the one hand, its design can follow the common practice of many science-policy interfaces to balance the trade-off. In this case, the mechanism would separate the scientific process and outputs (in particular the knowledge assessments) from the political evaluation of these knowledge assessments (above all recommendations to policymakers, for example in form of summaries for policymakers) (solution 1 in table 9). Moreover, the mechanism would provide some relatively weak and largely informal avenues for scientists to influence (but not to decide on) its agenda and work programme (solution 2 and 3 in table 9). States or other state-driven sponsors, like IGOs, would however take the ultimate decision on the work programme, without any formal decision-making power for any other actor.

On the other hand, the mechanism's design could envisage more innovative (and far-reaching) approaches to cope with the tension between its independence, politicisation and responsiveness. These approaches more or less significantly increase the formal opportunities of scientists (and possibly stakeholders) to influence decisions on the mechanism's agenda and work programme (solutions 4 to 6 in table 9). Joint negotiations and decisions on the work programme by scientists, policymakers and stakeholders would grant the highest degree of such influence to actors other than states (solution 6 in table 9). Nevertheless, even in this case it is advisable to also separate the scientific processes and outputs from political processes and outputs (solution 1 in table 9).

Table 9: How a global scientific mechanism on marine litter and microplastics might cope with characteristic challenges of science-policy interfaces

Key challenge	Possible solutions
Balancing trade-off between scientific independence and responsiveness of science to policy	• Separation of scientific processes and outputs from political processes and outputs • Opportunities for scientists to influence agenda • Exchange between scientists, policymakers and stakeholders on the work programme • Possibility for scientists to seek independent funding for work on certain issues • Possibility for scientists to propose a limited number of issues in the work programme that states cannot reject • Scientists, policymakers and stakeholders jointly negotiate and decide on work programme
Lacking capacities	• Training • Education • Skill development • Technical Support • Resources

Again like any other science-policy interface, a global scientific mechanism on marine litter and microplastics faces the challenge of lacking capacities in certain regions and groups of countries to provide scientific knowledge on the issue, let alone to conduct knowledge assessments. Several observations substantiate this conclusion. Overall, and like in the case of research on many other global environmental challenges, the references in existing knowledge assessments suggest that developed countries also dominate the (peer-reviewed) science on marine litter and microplastics (cf. Lyons et al. 2020 for ASEAN). Moreover, the review of existing scientific mechanisms and bodies on marine litter and microplastics revealed that regional knowledge assessments are scarce, often outdated and one-time efforts. They mostly focus on a specific aspect of marine litter and microplastics, namely the occurrence of litter and microplastics in the ocean, but neglect sources, pathways and effects. They also draw on fewer references than assessments at global levels or assessments covering more developed countries. Hence, the design of a global mechanism on marine litter and microplastics should in one way or another address capacity-building at regional and national level. The IPBES and the GEO process provide certainly useful templates in this regard. Given this lack of capacities, it might however also be advisable to assign a global scientific mechanism on marine litter and microplastics with the conduct of regional knowledge assessments in those regions that lack the sufficient capacities.

A more specific challenge in the design of a global scientific mechanism on marine litter and microplastics lies in the question on how to best and efficiently ensure the representativeness of relevant experts, policymakers and stakeholders in its work. As the previous considerations on credibility, legitimacy and salience revealed, an effective global scientific mechanism ideally requires a representativeness of a considerable variety of experts, policymakers and stakeholders. As regards all three groups of actors, the regional heterogeneity of marine litter and microplastics suggests at least their regional representativeness in the mechanism, including the balanced consideration of actors from developed and developing countries as well as their gender. As regards experts, scientists from a large number of relevant disciplines as well as holders of non-traditional or non-peer-reviewed local and indigenous knowledge contribute to the understanding of and knowledge on marine litter and microplastics and therefore merit representation in the mechanism. As regards stakeholders, the suggested, necessary and politically desired life cycle approach to marine litter and microplastics implicates the participation of a large variety of stakeholders from all stages in the plastics life cycle.

Against this background, an all-encompassing approach to representativeness and inclusiveness at global level seems hardly desirable, if it is feasible at all without impairing the capacity of the mechanism to work and arrive at decisions. It might therefore be worthwhile to consider a vertical differentiation of representativeness between the global and regional level. One option would be to establish regional committees or commissions, or to draw on existing ones, for example within the framework of the RSP. These could then perform some of the core functions of the mechanism at regional level, like for example the nomination of experts. They could also be responsible for conducting the regional knowledge assessments, either independently from the global mechanism or on behalf of it, depending on whether a "purely global" scientific mechanism is established, which operates only at global level, or a "catch-all" mechanism, which operates at global and regional levels. In any case, at the regional level, it would be easier to maximise the representativeness without overburdening the working and decision-making processes.

The work and decisions of these regional bodies could then be linked to the global bodies in two different ways. They could prepare inputs to the global level. Or they could "elect" delegates from the various groups of actors that then represent the different views and interests at global level. The Food and Agriculture Organisation (FAO) and its regional conferences might provide a template here, although it is not related to a science-policy interface.

In addition, and in order to reduce the risk of overburdening the mechanism's working and decision-making processes, the mechanism could feature thematic committees that deal with issues of more limited scope. These could then be linked to the overarching working and decision-making process in the same way as the regional committees or commissions. Again, the FAO and its thematic committees provide a good template for this approach, even if not in the area of science-policy interfaces.

4 Options for the institutional setting

The suggested key functions, outputs, requirements and design elements of a global scientific mechanism on marine litter and microplastics enable it to work more effectively and to realise the key benefits of science-policy interfaces in global environmental governance. Nevertheless, they leave the question about its specific institutional setting open.

Prior to a description and comparison of the three most conceivable options, two aspects of the institutional setting that cut across all options deserve a more in-depth consideration, namely

1. the relationship between the institutional setting and the effectiveness of science-policy interfaces; and
2. the scope of the mandate.

The discussion of the first aspect addresses the question whether there is one institutional setting that outperforms all other options in terms of effectiveness. The consideration of the second aspect discusses the advantages and disadvantages that might occur when the new scientific mechanism on marine litter and microplastics operates as a "catch-all" or "one-stop" science-policy interface that performs all related core functions at global *and* regional levels. It also discusses the advantages and disadvantages of the new mechanism performing the core functions only at global level, as a "pure" global science-policy interface.

The three conceivable basic options that are discussed after the elaboration on the cross-cutting aspects are:

1. An intergovernmental panel (along the lines of the IPCC or IPBES)
2. A scientific body under a multilateral agreement (along the lines of the UNCCCD-SPI or SAP)
3. An integrated scientific mechanism under an IGO (along the lines of the IRP or the GEO process)

Each option represents a typical model that already exists in other issue areas and features several distinct elements and characteristics (UNEP 2020d). These are neither prescriptive nor mutually exclusive. A "hybrid option" that combines and integrates selected elements and characteristics from two or all three options is thus also conceivable.

Their detailed description and comparison addresses three key aspects and, where possible, uses examples from existing science-policy interfaces to illustrate these:

1. Core features
2. Main advantages and disadvantages
3. Implications in the context of a global scientific mechanism on marine litter and microplastics

4.1 Cross-cutting aspects

4.1.1 Relationship between institutional setting and effectiveness

To state it clearly at the beginning: No institutional option as such is superior to the other options in terms of effectiveness since the effectiveness of a science-policy interface hardly depends on its basic institutional setting. Already the observation that there is no one-size-fits-all solution for the design of an effective science-policy interface suggested this conclusion. The effectiveness of science-policy interfaces instead primarily depends on whether their design implements the specific elements and conditions that enable them to perform the key functions and to meet the key requirements of effective science-policy interfaces to a satisfactory extent. Their implementation is possible under any of the three options, be it an intergovernmental panel, a scientific body under a global agreement, or an integrated scientific mechanism under an international organisation.

Comparably, whether a global scientific mechanism on marine litter and microplastics becomes politicised, primarily depends on its ability to balance the trade-off between scientific independence and the responsiveness of science to the needs of policymakers and stakeholders. The risk of politicisation is inherently built into any science-policy interface as they operate as two-way interfaces between science and policy. Under certain circumstances either science or policy might dominate this relationship with adverse consequences on the overall effectiveness of their interface. The institutional setting of a science-policy interface itself does however not provide any safeguards against the risk of politicisation. It merely defines whether a science-policy interface is a stand-alone body, like in the case of intergovernmental panel such as IPCC, or whether it is embedded into a multilateral agreement or international organisation, like in the case of the IRP or the GEO process. Instead, it is the specific design elements that reduce the risk of politicisation, such as the separation of scientific processes and outputs from political processes and outputs.

To be clear, in practice, differences in the effectiveness of science-policy interfaces might and also do coincide with differences in the institutional setting. These differences are however not systematically related to the institutional setting. For example, the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the Convention on Biological Diversity (CBD), was subject to criticism early on because its meetings turned into "Mini-COPs". The heavily politicized meetings rather resembled negotiations on draft decisions than exchanges on knowledge and scientific advice (Koetz 2011, p. 49). Yet, another subsidiary body, the SAP of the Montreal Protocol, received hardly any such criticism. Moreover, also the IPCC and the IPBES, both being stand-alone intergovernmental panels, also suffer from politicisation from inside but also from outside (Sarkki et al. 2019).

Overall, these considerations underscore how important it is that the design of a global scientific mechanism on marine litter and microplastics incorporates the specific elements that make science-policy interfaces work effectively. To create an effective mechanism, the careful implementation of these specific design elements deserves more attention than the question of the institutional setting.

4.1.2 Scope of the mandate: "catch-all" or "purely global" science-policy interface

Mandating a "catch-all" global scientific mechanism to perform all functions at global and regional levels has an obvious advantage. Through the centralisation, it could better ensure consistency and coherence in content, procedures, methods, and design. This would increase the authoritativeness and effectiveness of the mechanism and the likelihood that policymakers and stakeholders use its advice in their decision-making processes. The option has however also two obvious disadvantages. It is costly. And it might provoke conflicts over and competition for already scarce resources among the different international and regional organisations that until today populate the landscape of scientific bodies and mechanisms on marine litter and microplastics.

Mandating a "purely global" scientific mechanism to perform all functions only at global level also has an obvious advantage. It builds on existing capacities and reduces duplication of work. Yet, it also comes with disadvantages. Given the regional heterogeneity, an effective strengthening of the global science and knowledge on marine litter and microplastics also requires to strengthen the regional science and knowledge base. Under these circumstance, a "purely global" scientific mechanism would simultaneously require substantial investments into the capacities of existing regional bodies and mechanisms. As previous considerations revealed, many of them lack capacities and often do not perform all five key functions. Moreover, this option also comes with a significant increase in costs as coordination requirements increase and capacity building might become necessary. It is also possible that with this option, conflicts among the different bodies and mechanisms emerge over the allocation of necessary resources and the responsibility for regional knowledge assessments. Finally, this option probably requires major reforms of and interventions to the regional mechanisms and bodies, their design and their governance structure.

4.2 Option 1: An intergovernmental panel

4.2.1 Core features

Under this option, a separate and independent international agreement would establish and design an intergovernmental panel. All states that wish to become members of the panel would need to ratify this agreement. As a stand-alone body, it would have its own governing body, representing all member states (and possibly other actors), for taking relevant decisions, as well as its own secretariat, budget, and rules of procedure. The IPCC and IPBES are prominent examples for this option.

To work effectively, an intergovernmental panel usually needs interlinkages with other existing and appropriate international environmental institutions, for example multilateral environmental agreements or IGOs. On the one hand, this serves to ensure that the panel provides policy-relevant knowledge and responds to the needs of these other institutions to the best extent possible. On the other hand, it facilitates the uptake of its assessments and their findings for decisions in related international institutions.

4.2.2 Main advantages and disadvantages

The main advantage of an intergovernmental panel lies in its high degree of independence from other international environmental institutions, in particular when compared to the other options. The independence has two important benefits. On the one hand, it is able to set its own agenda, decide independently what issues it takes into account in its work and how it responds to recommendations or requests by other international institutions. It thus operates largely outside the political, institutional and financial constraints and path-dependencies of other institutions. On the other hand, an intergovernmental panel does not require the existence of a multilateral agreement or an IGO to being established and to which it provides its advice. In fact, the establishment of an intergovernmental panel might precede negotiations on a new global agreement on the issue at hand. For example, governments might agree on the need to enhance the knowledge base and create an intergovernmental panel, but cannot yet agree on the need or final design for a new global agreement.

Only at first sight, the independence puts at jeopardy a key benefit of such mechanisms in global environmental governance: the responsiveness of the scientific mechanism to the needs of policymakers and other stakeholders. As the previous considerations on key design elements revealed, the openness of a panel's decision-making body to different actors significantly reduces this risk, for example by ensuring an appropriate representation of states and/or other relevant stakeholders. The more inclusive this representation, and the broader the spectrum of interests that it covers, the smaller the risk that the intergovernmental panel fails to respond to the needs of policymakers and stakeholders. The necessary establishment of interlinkages between the panel and other international environmental institutions further reduces this risk. It ensures the panel's responsiveness also to needs of policymakers and stakeholders from outside the panel.

Two major disadvantages stand out. First, intergovernmental panels require the highest amount of resources for administrative and organisational support relative to the other two options. The operation of an intergovernmental panel requires more resources for the meetings of the governing body and possible subsidiary bodies, as well as for the secretariat, than the other two options. For example, according to its 2019 budget statement (IPCC-LII/Doc. 2), the IPCC's overall budget amounted to US$ 11.6 million in 2019, of which US$ 4.4 million were allocated to administrative and organisational support, including US$ 2.8 million for its governing body and US$ 2.1 million for its secretariat (IPCC 2020a).[8] In comparison, administrative and organisational costs for the GEO in the two years between 2018 and 2019 were calculated to amount to roughly US$ 2.5 million (latest and only numbers available) (UNEP 2018a).[9] This is less than half of the costs that the IPCC's administrative and organisational support incurred in only one year. Of course, an intergovernmental panel, like the other two options, also requires resources to cover costs for workshops and meetings in the preparation of knowledge assessment or other substantive activities, including the travel costs for scientific experts. These depend however on the scope and number of activities, not on the institutional setting. The

8. IPCC's budget is calculated in Swiss Francs. Indicated amounts in $US were calculated on basis of the exchange rate as of December 15, 2020.
9. It is impossible to get more numbers or more precise numbers on the overall costs of the other two options, let alone cost statements that differentiate between administrative and organisational costs on the one hand and substantive activity costs on the other hand.

resources for administrative and organisational support are the only costs that differ between the three options of institutional settings.

Second, and again in comparison to the other options, the creation of an intergovernmental panel faces the highest hurdle to political feasibility since it has to overcome the widespread and general reluctance of states to establish new institutions. This even more so when a new institution incurs more costs than other available institutional options, as intergovernmental panels are likely to do. Moreover, negotiations might take several years and turn out to be costly, too, and risk to fail completely. The case for an intergovernmental panel therefore requires a convincing framing of the issue that it will address, and communicating clearly the need for such a panel and its added value compared to other options.

4.2.3 Implications

For a possible intergovernmental panel on marine plastic litter and microplastics, several implications follow from the previous considerations.

First of all, establishing an intergovernmental panel requires a decision by an appropriate body to launch negotiations, and possibly also the establishment of an intergovernmental negotiating committee. In case of marine litter and microplastics, a resolution by UNEA, a UNGA resolution or another intergovernmental organization might launch the negotiations.

Second, one of the general advantages of an intergovernmental panel turns out to be an even greater advantage in the context of marine litter and microplastics. Its operation does not depend on the adoption of a global agreement. And so far, there is no global agreement on marine litter and microplastics or plastic pollution more generally. While there are growing indications that states are willing to start negotiating such an agreement, they have not yet done so. Once they do, it might however still take several years to its adoption. In this context, an intergovernmental panel on marine litter and microplastics could strengthen the global science and knowledge base on this issue before states adopt such a global agreement or before they start negotiating it. It could then even facilitate and bolster the negotiations of the agreement because its outputs might highlight the necessity to act more decisively at global level.

Third, an intergovernmental panel on marine plastic litter and microplastics requires decisions on its interlinkages with other international environmental institutions that are likely to use its outputs in their policy- and decision-making. If and once states adopt a new global agreement on plastic pollution, this would be the obvious and primary choice for such interlinkages. If there is no or not yet a global agreement on plastic pollution, UNEA, the World Health Organisation, the FAO, the IMO, the CBD, the BRS conventions, and/or the RSP are conceivable choices. In general, these decisions could take into account the need for a life cycle approach to marine litter and microplastics that looms so large in current scientific and political discussions. This means that they could aim at interlinkages with those international institutions that are relevant for policymaking in one or several stages in the life cycle of plastics and that address in their work one or several dimensions of the problem of marine plastic pollution.

Fourth, and finally, the creation of an intergovernmental panel on marine plastic litter and microplastics needs to have a convincing framing that helps overcoming the likely reluctance of states to establish a new institution, in particular when this results in more costs than other institutional alternatives. In case of marine plastic litter and microplastics such a framing might already exist. On the one hand, and due to its possible adverse effects on marine life and human health, the issue has a high public and increasingly political profile. As the summary of findings in existing knowledge assessments revealed, there still remain sufficient uncertainties and knowledge needs when it comes to specific aspects of extent, sources, pathways, effects and trends of marine plastic pollution as well response options. The framing can easily refer to these in order to warrant serious efforts at providing scientific advice through a new panel. Of course, this framing can also support the creation of a global scientific mechanism on marine litter and microplastics under the other two options.

The framing for the creation of an intergovernmental panel on marine litter and microplastics might however resort to an additional option. It could link the creation to another relevant science-policy interface that is currently being discussed in the intersessional process on the sound management of chemicals and waste beyond 2020. This process is dealing with the future of the Strategic Approach to International Chemicals Management (SAICM). It has sparked discussions about a science-policy interface on chemicals and waste that goes far beyond the very specific work done by the Chemicals Review Committee (CRC) under the Rotterdam Convention and the Persistent Organic Pollutants Review Committee (POPRC) under the Stockholm Convention. Linking this initiative with the proposal to establish an intergovernmental panel on marine litter and microplastics might lead to sufficient support for the establishment of a new institution that covers both issues. As an intergovernmental panel, it could focus on plastics throughout their life-cycle, while also providing assessments on further chemicals- and waste-related issues (Wang et al. 2021) . Such panel could serve the urgent need for better scientific advice in both issue areas. If bringing the two initiatives together is not an option, closely interlinking them might also benefit both initiatives.

4.3 Option 2: A scientific body under a multilateral agreement

4.3.1 Core features

Under this option, member states of a multilateral agreement would establish a scientific mechanism as a subsidiary body to its governing body and decide on its design, budget and rules of procedure. The governing body of the multilateral agreement would then typically also operate as the subsidiary body's governing body and take all relevant decisions, unless it delegates some decision-making power to the scientific body or other subsidiary bodies. The secretariat of the multilateral agreement, if there is one, would provide its services also to the subsidiary scientific body. Beyond this very small common ground, a range of models exist that differ in many details. It is therefore rather difficult to establish a template. Three basic approaches can however be distinguished.

Many existing subsidiary bodies are rather comparable to the governing body of an intergovernmental panel. They are political bodies dealing with matters closely related to science. Usually, they comprise governmental representatives of an agreement's parties. Some of them are open to non-governmental stakeholders, either as observers or as active participants. These subsidiary bodies do however hardly, if at all, act as scientific assessment panels, conducting their own knowledge assessments. Nevertheless. they have a scientific function that becomes manifest in two ways. First, they might commission scientific studies, including knowledge assessments by expert panels. Second, they often provide the links between the multilateral agreement and an intergovernmental scientific panel of the sort described above.

The SBSTTA of the CBD and the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the UNFCCC are prominent examples for this approach. Both SBSTA and SBSTTA have their own bureau to prepare sessions and decisions. The SBSTTA has the mandate to conduct scientific and technical assessments; identify innovative technologies and provide know-how on conserving biodiversity; provide advice on scientific programmes and international cooperation in research and development; and respond to scientific, technical, technological and methodological questions put forward by the COP or its subsidiary bodies. The SBSTTA may convene ad hoc technical expert groups for conducting assessments, and is thus best compared to the governing body of an intergovernmental scientific panel. The SBSTA works on impacts, vulnerability and adaptation matters, deals with technology transfer, and works on the guidelines for greenhouse gas emission inventories. In addition, SBSTA is the link between scientific bodies, including the IPCC, and the COP of the UNFCCC, collecting relevant scientific information and preparing relevant COP decisions. In this capacity, SBSTA occasionally requests reports or information from the IPCC (UNFCCC 2020).

Other forms of subsidiary bodies take over significantly more scientific work than the SBSTTA or the SBSTA and come closer to perform functions that science-policy interfaces in global environmental governance usually perform. A case in point is the UNCCD-SPI (Akhtar-Schuster et al. 2016). It was established after prolonged discussions on how to enhance science-based decision-making in the UNCCD. Its tasks are to analyse, synthesize and translate relevant scientific findings; to interact with existing scientific mechanisms; assist the Bureau of the Committee on Science and Technology (CST); to organize scientific conferences; provide the CST with guidance on scientific knowledge requirements; draft terms of reference; and select experts for upcoming scientific work. The UNCCD-SPI is not a subsidiary body, but is connected to CST, a subsidiary body of the COP. In other words, the UNCCD-SPI is a mechanism under the authority of a subsidiary body of a convention. In comparison, IPCC and IPBES are independent intergovernmental panels linked to conventions through subsidiary bodies of these conventions.

Somewhere in between these two approaches lie the subsidiary bodies in chemicals and waste governance that mostly feature a more confined mandate. They typically provide technical advisory services or assess relatively narrow areas, rather than conducting comprehensive global knowledge assessments. Examples for this kind of mechanism include the Stockholm Convention's POPRC and the Rotterdam Convention's CRC. The Stockholm Convention's POPRC is a good example for the narrower mandate of these bodies. It reviews chemicals that are proposed for listing in one of its Annexes A, B, or C. Article 8 of the convention stipulates how the review process ought to be conducted, and Annexes D, E, and F describe which information is needed for the review. Another example for this approach are the Montreal

Protocol's SAP, Technology and Economic Assessment Panel and Environmental Effects Assessment Panel.

4.3.2 Main advantages and disadvantages

Two advantages characterise this option.

First, the responsiveness of subsidiary scientific bodies to the needs of policymakers and other stakeholders is comparatively high since they receive their request directly from the decision-making bodies of the agreement to which they belong. This helps increasing the relevance and salience of its work, at least to the parties and other participants in the convention. As previous considerations on the effectiveness of science-policy interfaces suggested, this makes scientific mechanisms and their advice more effective from a policymaking perspective. Comparable to the independence of an intergovernmental panel this advantage has however a potential downside, only in the reverse direction. The high responsiveness to the needs of policymakers and other stakeholders might put at risk the scientific independence of a subsidiary body's work and the many advantages for its impact, such as credibility or the ability to identify newly emerging issues. In fact, the risk of politicisation looms large in many accounts of subsidiary bodies (e.g., Koetz 2011). Yet, as previous considerations suggested, politicisation is a more a matter of specific design elements of a scientific body or mechanism than it is related to its institutional setting. In other words, an appropriate design of a subsidiary body might reduce this risk if it provides for safeguards against politicisation, like for example the separation of scientific processes and outputs from political processes and outputs or an institutionalised opportunity for scientists to bring newly emerging issues on the agenda.

Second, subsidiary scientific bodies incur lower costs for the administrative and organisational support than intergovernmental panels. Whether they do also incur lower costs for their substantive activities, like expert workshops and meetings, is not a matter of the institutional setting but depends on the scope and number of their activities. They incur lower administrative and organisational costs since they provide better opportunities to exploit synergies within the broader institutional framework. Of course, they also require decisions about the work programme by their governing body and need to convene in meetings. To this end, they do however not need to operate and fund a separate governing body like intergovernmental panels do. Their governing bodies, usually the COP to the multilateral agreement, often take decisions on their work programme at their annual or biennial sessions when they meet anyway to discuss and decide on all other issues in the context of the multilateral agreement. Typically, the meetings of the subsidiary bodies then take place back-to-back to these sessions. In this case, this also implies a lower burden to governmental officials (and the environment) than an intergovernmental panel since state delegates do not need to undertake additional travels to sessions of a separate standalone governing body. Some bodies also hold one additional and separate meeting every year, like for example the SBSTA of the UNFCCC.

Neither do subsidiary scientific bodies need to run a separate secretariat but instead receive support by the secretariat of the multilateral agreement of which they are part.[10] In general, the cost advantage of course decreases the more frequent the subsidiary scientific bodies hold separate meetings, i.e. not back-to-back to the multilateral agreement's COPs, and the more support they request and receive from the secretariats of the multilateral agreements.

The main disadvantage of this option is that it requires the negotiation, adoption and coming into being of a multilateral agreement. As a matter of course, a subsidiary scientific body is no valid option in issue areas where no agreement exists. In contrast to an intergovernmental panel, a subsidiary scientific body thus cannot facilitate and bolster the negotiations of an agreement. It can provide its scientific input to policymaking only when major political decisions have already been taken, such as the adoption of a multilateral agreement.

4.3.3 Implications

The previous considerations have two implications in the context of a scientific mechanism on marine litter and microplastics.

First and foremost, the main disadvantage of this option is also its most limiting factor in the context of marine litter and microplastics: there is not yet a global agreement on plastic pollution and therefore no institutional framework of which it can become the subsidiary scientific body. Even though states appear to be on the brink to start negotiations on a global agreement on plastic pollution, it is uncertain if and when negotiations on such an agreement begin, when they finish, and whether a scientific body is then already part of the agreement or supposed to be carved out later. An intergovernmental panel is likely to yield earlier results than a subsidiary body, since it is not contingent on the negotiation and adoption of an overarching institutional framework.

In any case, the new global agreement on plastic pollution would require an institutional setup that allows for the creation of subsidiary bodies, either by establishing the subsidiary body already in the convention, or by giving authority to create one to the COP. For example, the Stockholm Convention contains provisions for POPRC and stipulated that at the first COP member states were to establish the committee. Yet, the convention left it to the COP to decide its terms of reference, organization and operation. If the subsidiary body is not already part of the agreement, the COP would need to negotiate and adopt a resolution establishing the subsidiary body. This might again take a while during which the landscape of global science and knowledge on marine litter and microplastics would largely remain as it is. However, as the review of the existing landscape suggested, there is an urgent need to strengthen it since it remains unsatisfactory in several areas and is not suitable to advance the knowledge and understanding of the problem of marine litter and microplastics and its governance.

Second, the design and the mandate of a subsidiary scientific body under a global agreement on plastic pollution would need to go beyond the typical approaches. As the description of their core features suggested, existing subsidiary scientific bodies

---

10. It is impossible to get numbers on the overall costs of the work of subsidiary scientific bodies, let alone cost statements that differentiate between administrative and organisational costs on the one hand and substantive activity costs on the other hand. Their costs are typically not listed in any of the financial statements multilateral agreements provide.

typically have relatively limited mandates. Yet, if the aim is to maximise its scientific and policy impact of the new subsidiary body, its design and mandate need to ensure to the best extent possible that is able to perform all five core functions and to meet the key requirements of effective science-policy interfaces. Only then, it has the potential to effectively strengthen the global science and knowledge base on marine litter and microplastics and increase its policy impact. While this is of course possible if the COP of a global agreement on plastic pollution takes appropriate decisions, the widespread and common practice of such decisions has been mostly different so far.

4.4 Option 3: An integrated scientific mechanism under an IGO

4.4.1 Core features

Under this option, an IGO would establish a scientific mechanism through a decision of its governing body, typically a resolution. Usually, all states that are members of the IGO would thus decide on its mandate, design, budget and rules of procedure. The mechanism would take the form of a regular scientific assessment process or expert body that the IGO funds and governs. The IGO secretariat would provide its services also to the scientific mechanism, unless the IGO decides to create a separate secretariat for the mechanism. It is also possible that two or more IGOs establish and manage such a mechanism collectively. Like in the case of subsidiary scientific bodies, it is difficult to establish a single template since a range of models exist that differ in many details. Two basic models exist however for this option: a permanent model and an ad hoc model.

For the permanent model, the IRP and GESAMP provide examples. Since 2007, the IRP operates under UNEP. The Steering Committee gathers representatives from governments, the European Commission and UNEP. It provides guidance, makes sure reports are policy-relevant, contributes to the annual work plan and is in charge of overseeing the budget. The current 36 panel members are mostly scientists and participate in their personal capacity, not as organizational representatives. Another example is GESAMP. It gathers 17 experts from a wide range of relevant scientific disciplines, acting in their independent and individual capacity. Its Executive Committee oversees, administers and manages GESAMP's work on behalf of the ten sponsoring UN organisations, which each have representative in this committee. Unlike the IRP, GESAMP has its own secretariat, the GESAMP office.

For the ad hoc model, well-developed templates are the GEO, the Global Chemicals Outlook (GCO) or the Regular Process for Global Reporting and Assessment of the Marine Environment (here: Regular Process). GEO and GCO require a mandate provided by a UNEA resolution. While "ad hoc" suggests that such processes have limited time frames or are one-time efforts, the GEO process shows relative high stability and permanence. Its first assessment report came out in 1997, GEO 6 in in 2019, showing a continuity in such decisions first by the UNEP Governing Council and lately by UNEA. The GCO likewise has seen a second edition, yet a GCO-III is uncertain. The Regular Process is a global mechanism under the authority of UNGA and provides an example for a science-policy interface that is part of one of the six UN principal organs. Since 2010, an Ad Hoc Working Group of the Whole oversees the Regular Process. So far, the UNGA mandated two process cycles. The first cycle ran from 2010 until 2014 and ended with the publication of the First Global Integrated Marine Assessment, or World Ocean Assessment I. In 2015, the UNGA launched the second cycle, including the Programme of Work for 2017-2020 which entails the Second World Ocean Assessment, and as a second output, support for other ocean-related intergovernmental processes.

Though permanent and ad hoc mechanisms may seem quite different at first, in reality the differences are not that large. In both cases, governing bodies have to provide funding and agree on a work programme. While permanent bodies may seem to be more stable, ad hoc processes like the GEO have shown to be very stable as well and to be conducted regularly.

4.4.2 Main advantages and disadvantages

This option comes with three main advantages. Two of them mirror the advantages of the subsidiary scientific bodies under a multilateral agreement (Option 2).

To start with, scientific mechanisms under an IGO also ensure a high responsiveness to the needs of the policymakers and other stakeholders since they receive their mandate and work programme directly from their governing body, similar to subsidiary scientific bodies under a multilateral agreement. The responsiveness on the one hand makes the outputs of the scientific mechanisms under an IGO relevant and salient, at least for the member states and other stakeholders in the IGO and its governing body, thereby strengthening their likely impact on policymaking. On the other hand, and similar to the case of their counterparts under a multilateral agreement (Option 2), the high policy responsiveness might however adversely affect their scientific independence, thereby possibly impairing their scientific credibility and ultimately their impacts. Again, the occurrence of these effects also here depends on the specific design of this option and is not inherently built into the institutional setting. Therefore, safeguards in the specific design of the scientific mechanisms can mitigate these effects and ensure scientific independence of a mechanism while operating under an international organisation. The IRP is a good example for such safeguards. At IRP, the scientific panel initiates the research or assessment process by independently identifying issues that fall into its mandate and that the scientific experts in the panel consider to require an assessment. Then, the scientific panel establishes a team of experts from its members and invites external experts who will conduct the assessment. Of course, exchanges between the scientific panel and the steering committee with policymakers and other stakeholders also take place. An important share of the scientific agenda-setting power rests however with the scientific panel, enabling it to independently initiate scientific work.

Second, scientific mechanisms under an IGO also incur lower costs for the administrative and organisational support than intergovernmental panels, like scientific bodies under a multilateral agreement. They are better able to exploit synergies within the larger setting of their host IGO(s). Usually, there is no need for separate meetings of the IGO governing bodies to decide on the work programme of a scientific mechanism. Most IGO governing bodies decide on these issues in the context of their annual or biennial meetings during which they also adopt resolutions or other decisions relevant for the IGO work. This also limits the burden on government officials (and the environment) since they have not to travel to different governing bodies. Of course, this advantage holds only as long as no additional and separate meetings of IGO delegates are necessary to manage the scientific mechanism. Likewise, scientific mechanisms under an IGO use and receive services and support from the IGO secretariat. The estimated budget for GEO, for example, refers to in-kind contributions from UNEP in the form of staff. Similar to the other two options, costs for the substantive activities of scientific mechanism under an IGO are irrelevant for an assessment of their cost implications since they depend on the scope and number of their activities, but not on their institutional setting.

The third advantage of scientific mechanisms under an IGO lies in the absence of a requirement that characterises intergovernmental panels in particular but also – under certain circumstances – scientific subsidiary bodies under a multilateral agreement. Scientific mechanisms under an IGO do not require the negotiation, adoption and implementation of an additional multilateral institution, like a convention or treaty in case of the subsidiary scientific bodies under a multilateral agreement (if there is none) or a separate overarching body in case of intergovernmental panels. Instead, states integrate a scientific mechanism into an IGO through a decision of the governing body that follows well established and known procedures and processes. This is likely to facilitate and speed up related decisions, once the IGO member states in general agree on the need to establish such a scientific mechanism. Of course, when a multilateral convention or treaty already exists, this advantage also applies to the scientific subsidiary bodies under a multilateral agreement.

One major disadvantage stands out. First, and in particular under the ad hoc model of this option, scientific mechanisms under an IGO often lack a reliable, stable and continuous source of funding. In comparison to the other two options, their funding faces greater risks to fall victim to shifting priorities or political conflicts (even over unrelated issues) in the IGO governing body. More or less constantly, this risk threats the stability and continuity of scientific mechanisms under an IGO. Once an increasing number of states withdraw their support for whatever reasons, the IGO governing body might reduce funds below levels that ensure an effective operation of the scientific mechanism or even decide to stop their funding completely. GEO 5, for example, was unable to secure sufficient funding and suffered from a funding gap of more than $US 2.2 million (UNEP 2014). At the same time, the GEO process shows that even the ad hoc model under this option not necessarily suffers from insufficient stability or continuity. Since the first GEO in 1997, the process ran through five more cycles. The last one ended in 2019 with the publication of GEO 6. Nonetheless, a revision is currently under way, the "Future of GEO" process, the outcome of which is hitherto unknown.

The permanent model under this option provides slightly better safeguards against this risk. In this model, the scientific mechanism is no longer part of the IGO work programme or any other specific decisions that states need to adopt or reaffirm from time to time. It can thus not (so easily) fall victim to a shift in political priorities or political conflicts. GESAMP underscored this assessment in 2018, when it celebrated its 50th anniversary. The permanence of GESAMP might also be due to its diversified funding structure, currently consisting of ten UN organisations.

In general, this is not to say that the other two basic options for an institutional setting do not face any risks in funding. Yet, their higher degree of institutionalisation better protects them from these risks, although even the legal status does not guarantee sustained and sufficient funding (Stokstad 2017). Such higher degree of institutionalisation does however provide a more effective protection from decisions to stop funds completely. Such fundamental institutional changes and decisions are usually more difficult to reach than to decide on a reduction or discontinuation of funding.

4.4.3 Implications

In the context of a global scientific mechanism on marine litter and microplastics, two implications follow from the previous considerations.

To start with, establishing such a mechanism under an IGO requires a decision by states under which IGO the mechanism would operate. This decision warrants careful consideration as it may more or less severely affect the scope of the matters with which the scientific mechanism deals. Two basic options are conceivable against the background of the existing practices.

First, states could decide that several IGOs sponsor, guide and oversee the global scientific mechanism on marine litter and microplastics. This is likely to lead to the most comprehensive approach of the mechanism. It might best enable it to effectively meet the widespread demands for a life cycle approach to marine litter and microplastics in science and policy. Of course, this depends on the ultimate set of selected IGOs, namely on the extent to which their work and policies collectively cover the different dimension of the problem of marine plastic pollution and the different stages in the life cycle of plastics. As by-product, this decision could also lead to more continuity and stability in funding the mechanism since it would considerably diversify the funding sources. A practical option in this regard would be to upgrade GESAMP's working group on plastics and microplastics in the oceans and extend its mandate.

Second, states could decide to embed the mechanism into a single IGO. Potential candidates are UNEP, IMO, FAO or WHO. Embedding the global scientific mechanism into UNEP might still lead to a relatively comprehensive approach of the scientific mechanism, given UNEP's relatively broad mandate and activities. The mechanism's approach might however be less comprehensive than when several IGOs share responsibility for the mechanism. Embedding the mechanism into IMO, FAO or WHO might constrain the mechanism's approach even more and to a more limited range of aspects, namely those that feature prominently in their overarching and, relative to UNEP, more limited mandates and focus areas.

Equally important, states would need to decide on whether they prefer an ad hoc or a permanent global scientific mechanism on marine litter and microplastics, irrespective of where they eventually embed the mechanism. In general, a permanent mechanism appears preferable. It reduces the risk that the mechanism faces a major funding crisis or even its dissolution when states more or less suddenly withdraw their support for whatever reason.

Yet, there are also arguments for an ad hoc model. It could operate as temporary solution for the time during which states negotiate a global agreement on plastic pollution (if they do start these negotiations). If and once states adopt the agreement, they could decide to establish a subsidiary scientific body as part of the agreement (if this is then their preferred solution). If negotiations of the agreement fail (or do not start at all), states could decide to upgrade the mechanism into a permanent model (or alternatively create an intergovernmental panel). Even irrespective of the negotiations of a global agreement on plastic pollution, states could also initially establish an ad hoc global scientific mechanism on marine litter and microplastics and upgrade it later when its previous work met their expectations.

4.5 Comparison of options

Two general lessons derive from the preceding consideration on the three options, their advantages, disadvantages and implications in the context of marine litter and microplastics.

First, there is no option that is overall more advantageous than all other options. Each option comes with trade-offs, features a range of advantages and disadvantages, and faces more or less severe constraints with regard to feasibility (see Table 5). Second, specific design features may provide effective safeguards against some disadvantages of each option. Ultimately, the choice of an option therefore rather depends on the aims and priorities that underlie the establishment of a global scientific mechanism on marine litter and microplastics.

Whether a global scientific mechanism successfully performs the key functions of a science-policy interface and whether it meets the key requirements that make it work effectively, depends more on its specific design than on its institutional setting. This applies to all three options.

If the aim is to establish such a mechanism rather sooner than later, the most promising option is certainly to integrate the scientific mechanism into an existing IGO or into several existing IGOs. In this case, one could more or less easily upgrade and perpetuate existing mechanisms and processes at GESAMP or UNEP. The least suitable option for a timely establishment is the integration of the scientific mechanism into a possible new global agreement on plastic pollution. The negotiation and adoption of such an agreement will take some time, even if it starts soon. In comparison, the negotiation and adoption of an agreement that establishes an intergovernmental panel is likely to take less time. If there is however a global agreement on plastic pollution, the establishment of an intergovernmental panel will take more time than to integrate the mechanism into that global agreement.

If the aim is to establish a mechanism that reduces the risk to fall victim to possible shifts in policy priorities and ensures stability and continuity, the most promising option is certainly an intergovernmental panel, followed by a subsidiary scientific body under a multilateral agreement. A scientific mechanism under an IGO provides significantly less safeguards against shifts in policy priorities and faces the greatest risks in terms of secure funding, stability and continuity.

If the aim is to establish a global scientific mechanism that limits additional costs and burdens, the most promising option is to embed the mechanism into either a global agreement on plastic pollution or existing IGOs. Even though the costs of an intergovernmental panel might not be significantly higher, it is the most costly solution when compared to the other two options. If states do not adopt a global agreement on global plastic pollution, the option to integrate the mechanism into existing IGOs thus is likely to be the less costly one.

If the aim is to make sure that a mechanism is established at all and all other aims or concerns are subordinated to this aim, the most promising option is certainly to embed the mechanism into an IGO as an ad hoc process. This option requires the least changes to the existing institutional architecture. It does not require the negotiation, adoption and creation of a new institution, as the other two options do. Yet, whether the reluctance to create new institutions is actually a hurdle in the context of marine plastic litter and microplastics is difficult to assess. Currently, there seems to be a rather high public and increasingly political profile of the issue and its possible adverse effects on marine life and human health that might be effectively used to weaken the opposition to create a new institution.

Table 10: Comparison of options for institutional setting

	Intergovernmental panel	Subsidiary scientific body under an international agreement	Scientific mechanism under an international organisation
Core features	• Established through a separate and independent international agreement • Own governing body that decides on work of programme, budget and rules of procedure • Own secretariat	• Established through decision of governing body of the agreement • Governing body of agreement decides on work programme, budget and rules of procedure • Secretariat of agreement provides services	• Established through decision of governing body of the IGO • Governing body of IGO decides on work programme, budget and rules of procedure • IGO secretariat provides services
Main advantage(s)	• High independence from other institutions • No need for a host IGO or multilateral agreement or IGO	• High responsiveness to the needs of policymakers	• High responsiveness to the needs of policymakers
Main disadvantage(s)	• Reluctance of states to create new institutions	• Requires adoption of a multilateral agreement prior to its establishment	• Lack of reliable, stable and continuous source of funding
Cost implications	• Highest administrative and organisational costs • Costly negotiations prior to establishment	• Lower administrative and organisational costs than intergovernmental panel but comparable to scientific mechanism under IGO	• Lower administrative and organisational costs than intergovernmental panel but comparable to subsidiary scientific body under multilateral agreement
Political feasibility	• Needs a convincing framing to overcome reluctance of states to create new institutions	• Requires existence of multilateral agreement, no option if not	• Highest among the three options
Most promising option if the aim is to ...	• establish a continuous and stable mechanism with secure funding	• limit additional costs and burdens	• limit additional costs and burdens; • establish a mechanism in short time; and/or • make sure that a mechanism is established at all and all other aims are subordinated to this aim

5 Conclusions

Obviously, the knowledge base on marine plastic litter and microplastics needs to be strengthened. This is not only a widespread political demand of an increasing number of actors, including states, civil society and science. It is also necessary against the background of what is known about marine plastic litter and microplastics and what is not or hardly known. To be clear, the available knowledge undoubtedly warrants political action at all governance levels. Yet, there is an urgent need to learn more about promising levers and entry points for effective political and technical interventions across the entire of life-cycle of plastics.

This requires, inter alia, more knowledge on how much different sources contribute to marine plastic pollution, on how and to what extent plastic the various and known pathways transport litter and microplastics into the oceans, and on the effectiveness of political interventions at all stages of the plastics life cycle. It also requires an authoritative scientific mechanism that reviews and synthesises such knowledge, translates it into effective scientific policy advice, guides future research, and is responds to the needs of policymakers and other stakeholders.

Such an authoritative scientific mechanism is however missing at global and regional levels. Instead, the current landscape of scientific mechanisms and bodies on marine litter and microplastics is heavily fragmented. It also lacks a sufficient institutionalisation, coordination and continuity. Significant gaps in knowledge assessments at global and regional levels impair the provision of policy-relevant scientific knowledge. Several key functions that typically make such mechanisms in global environmental governance effective are performed only unsatisfactorily, if at all, and are unevenly distributed across the different existing scientific bodies and mechanisms. As result, the current landscape of scientific mechanisms and bodies on marine plastic litter and microplastics can only partially realise the benefits that scientific mechanisms in global environmental governance typically provide.

The best option to overcome this status quo lies in the establishment of a global scientific mechanism on marine litter and microplastics. More precisely, it lies in the establishment of a mechanism that operates as the central global science-policy interface and unites the performance of all typical key functions of such interfaces. The biggest advantage of such a global mechanism lies in its potential to increase the authoritativeness of scientific outputs and advice. It is then also easier to establish a common, shared, reliable and consolidated knowledge base that provides more unambiguous and effective guidance for policymaking and future research. As result, policymakers and other stakeholders will be more inclined to use the scientific advice and will also have a more obvious choice of whom to turn to when seeking scientific advice. Overall, the establishment of a global scientific mechanism has the greatest potential to strengthen and improve the knowledge base on marine plastic litter and microplastics and to realise the benefits that scientific mechanisms provide.

To fully exploit this potential and to overcome the status quo, the global scientific mechanism needs to overcome the shortcomings of the current landscape of scientific mechanisms and bodies. This requires several decisions on its mandate, its design and its institutional setting.

First of all, the mandate needs to empower the mechanism to perform all five key functions that science-policy interfaces in global environmental governance typically provide. Namely, and irrespective of its institutional setting, the mechanism needs to be mandated to

- conduct timely and periodic knowledge assessments;
- catalyse and guide knowledge generation;
- enable two-way exchange between scientists, policymakers and stakeholders;
- facilitate access to and exchange of information and data; and
- improve capacities to conduct knowledge assessments at regional and national levels.

Again irrespective of the institutional setting, the mandate furthermore needs to empower the scientific mechanism to

- promote the use of life cycle approaches to marine litter and microplastics;
- to consider the regional heterogeneity of the problem;
- increase the coherence and consistency in knowledge assessments;
- develop harmonised and standardised methodologies to monitor and assess the extent, sources, pathways and effects of marine litter and microplastics;
- conduct knowledge assessments on the effectiveness of policy interventions;
- catalyse and guide research on the effective mitigation strategies;
- institutionalise the exchange between scientists, policymakers and stakeholders; and
- create a clearing-house mechanism that provides easy access to scientific knowledge, data and information on the environmental problem and governance options.

Finally, the mandate needs to clarify whether the global scientific mechanism performs these functions only at global level or also at regional level.

Apart from the mandate, the global scientific mechanism needs to have a design that ensures its greatest possible impact by meeting the key requirements of any effective science-policy interface: credibility, legitimacy, salience, and agility. Once more irrespective of its institutional setting, this means above all that its design needs to ensure

- a selection of experts that includes scientists from all relevant disciplines and holders of local and indigenous knowledge with a view on geographical representativeness;
- the use and equal consideration of knowledge from all relevant sciences and relevant local and indigenous knowledge;
- the openness of its working and decision-making processes to scientists from all relevant disciplines, other holders of relevant knowledge, policymakers and stakeholders (across all stages in the life cycle of plastics);
- the consideration of needs of policymakers and other stakeholders;
- the consideration of regional variations in the problem of marine plastic pollution;
- a built-in review mechanism that enables scientists to identify, bring onto the agenda and quickly respond to newly emerging issue;
- the tailoring and communication of its outputs to specific audiences;
- an appropriate balance between scientific independence of the mechanism and its responsiveness to the needs of policymakers and stakeholders; and
- capacity building in regions that need it.

Last but not least, the global scientific mechanism requires a decision on its institutional setting, be it an intergovernmental panel, a subsidiary scientific body under a multilateral agreement, or a scientific mechanism under an IGO. This decision is less a question on whether the mechanism is able to perform the key functions of an effective science-policy interface or to meet its key requirements. This depends more on its mandate and specific design. The decision on the setting is above all a question of political priorities and aims.

- An intergovernmental panel is the most promising option, if the aim is to establish a continuous and stable mechanism with secure funding.
- A mechanism under a multilateral agreement is the most promising option, if the aim is to limit additional costs and burdens.
- A mechanism under an IGO is the most promising option, if the aim is to establish a mechanism in short time; to limit additional costs and burdens; and/or to make sure that a mechanism is established at all and all other aims are subordinated to this aim.

Nevertheless, no decision on the institutional setting necessarily precludes it from being scaled-up or re-settled at a later point in time. In addition, hybrid options of institutional setting are possible and offer the potential of getting the best out of several worlds.

6 Publication bibliography

ACMEN (African Ministerial Conference on the Environment) (2019): Report of the ministerial segment. AMCEN/17/9. African Ministerial Conference on the Environment (ACMEN). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/30786/AMCEN_17L1.pdf?sequence=1&isAllowed=y, checked on 8/13/2020.

Akhtar-Schuster, Mariam; Amiraslani, Farshad; Morejon, C.F. Diaz; Escadafal, Richard; Fulajtar, Emil; Grainger, Alan et al. (2016): Designing a new science-policy communication mechanism for the UN Convention to Combat Desertification. In Environmental Science & Policy 63, pp. 122–131. DOI: 10.1016/j.envsci.2016.03.009.

Araújo, Miguel B.; Anderson, Robert P.; Márcia Barbosa, A.; Beale, Colin M.; Dormann, Carsten F.; Early, Regan et al. (2019): Standards for distribution models in biodiversity assessments. In Science Advances 5 (1), eaat4858. DOI: 10.1126/sciadv.aat4858.

Barnardo, Toshka; Ribbink, Anthony (2020): African Marine Litter Monitoring Manual. Edited by African Marine Waste Network, Sustainable Sea Trust. Available online at https://www.wiomsa.org/wp-content/uploads/2020/07/African-Marine-Litter-Monitoring-Manual_Final.pdf, checked on 10/7/2020.

Beck, Silke (2012): Between Tribalism and Trust: The IPCC Under the "Public Microscope". In Nature + Culture 7 (2), pp. 151–173. DOI: 10.3167/nc.2012.070203.

Belgrano, A. (2018): Biodiversity and Ecosystem Services in Nordic Coastal Ecosystems: An IPBES-Like Assessment. Volume 1: The General Overview. Edited by P. Clausen, G. Ejdung, L. Gamfeldt, H. Gundersen, M. Hammer, K. Hancke et al. Copenhagen, Denmark (TemaNord). Available online at http://norden.diva-portal.org/smash/get/diva2:1219782/FULLTEXT01.pdf, checked on 11/3/2020.

BSC (Black Sea Commission) (2007): Marine litter in the Black Sea Region: A review of the problem. Istanbul, Turkey (Black Sea Commission Publications, 2007-1). Available online at http://www.blacksea-commission.org/Downloads/Marine_Litter_Report_final.pdf, checked on 8/28/2020.

Caporusso, C.; Hougee, M. (2019): Harmonizing marine litter monitoring in the wider Caribbean Region. A hybrid approach. United Nations Environment Programme (UNEP); Caribbean Environment Programme (CEP). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/27901/Marine_LitWCR-en.pdf?sequence=1&isAllowed=y, checked on 10/21/2020.

Caribbean Community (CARICOM) (7/6/2019): CARICOM Heads adopt St. Johns Declaration to address plastic pollution in Caribbean Sea. Nicholls, Alicia. Available online at https://caribbeantradelaw.com/2019/07/06/caricom-heads-adopt-st-johns-declaration-to-address-plastic-pollution-in-caribbean-sea/, checked on 8/13/2020.

CBD Secretariat (Secretariat of the Convention on Biological Diversity) (2012): Impacts of marine debris on. Understanding, preventing and mitigating the significant adverse impacts on marine and coastal biodiversity. Convention on Biological Diversity (CBD). Montréal (CBD Technical Series, No. 67). Available online at https://www.cbd.int/doc/publications/cbd-ts-67-en.pdf, checked on 10/20/2020.

_ (2016): Marine debris. Understanding, preventing and mitigating the significant adverse impacts on marine and coastal biodiversity. Convention on Biological Diversity (CBD). Montréal (CBD Technical Series, No. 83). Available online at https://www.cbd.int/doc/publications/cbd-ts-83-en.pdf, checked on 7/7/2020.

Cheshire, Anthony; Adler, Ellik; Barbière, Julian; Cohen, Yuval; Evans, Sverker; Jarayabhand, Srisuda et al. (2009): UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. United Nations Environment Programme (UNEP); International Oceonagraphic Commission (Regional Seas Reports and Studies, No. 186). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/13604/rsrs186.pdf?sequence=1&isAllowed=y, checked on 10/21/2020.

Chotte, J. L.; Aynekulu, E.; Cowie, A.; Campbell, E.; Vlek, P.; Lal, R. et al. (2019): Realising the Carbon Benefits of Sustainable Land Management Practices: Guidelines for Estimation of Soil Organic Carbon in the Context of Land Degradation Neutrality Planning and Monitoring. A report of the Science-Policy Interface. United Nations Convention to Combat Desertification (UNCCD). United Nations Convention to Combat Desertification (UNCCD). Bonn, Germany. Available online at https://knowledge.unccd.int/sites/default/files/2019-10/191016_EN_UNCCD_SPI_2019_Report_1_1_Web.pdf, checked on 11/4/2020.

COBSEA (Coordinating Body on the Seas of East Asia) (2008): Marine litter in the East Asian Seas Region. United Nations Environment Programme (UNEP). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/29105/ML2008.pdf?sequence=1&isAllowed=y, checked on 10/21/2020.

CPPS (Permanent Commission for the South Pacific) ; UNEP (United Nations Environment Programme) (2007): Marine litter in the Southeast Pacific Region: a review of the problem. Permanent Commission for the South Pacific (CPPS); United Nations Environment Programme (UNEP). Guayaquil, Ecuador. Available online at http://cpps.dyndns.info/cpps-docs-web/planaccion/docs2014/publicaciones/documentos-tecnicos/programa_basura_marina_ingles.pdf, checked on 9/28/2020.

Diaz, Sandra; Demissew, Sebsebe; Carabias, Julia; Joly, Carlos; Lonsdale, Mark; Ash, Neville et al. (2015): The IPBES Conceptual Framework - connecting nature and people. In Current Opinion in Environmental Sustainability 14, pp. 1–16. DOI: 10.1016/j.cosust.2014.11.002.

Diez, Sylvia Michele; Patil, Pawan; Morton, John; Rodriguez, Diego J.; Vanzella, Alessandra; Robin, David et al. (2019): Marine pollution in the Caribbean. Not a minute to waste. World Bank Group. Available online at https://gpml-caribe.org/download/32/reports/1498/marine-pollution-in-the-caribbean-not-a-minute-to-waste.pdf, checked on 10/20/2020.

EC (European Commission) (2020a): Circular Economy Action Plan. For a cleaner and more competitve Europe. European Union (EU). Available online at https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf, checked on 11/3/2020.

_ (2020b): Scientific Advice Mechanism. Rules of procedure of the Group of of Chief Scientific Advisors. European Commission (EC). Available online at https://ec.europa.eu/, checked on 10/22/2020.https://ec.europa.eu/info/sites/info/files/research_and_innovation/groups/sam/rules_of_procedure_group_of_chief_scientific_advisors_sep2020.pdf, checked on 10/22/2020.

_ (2020c): Leading the way to a global circular economy: state of play and outlook. SWD(2020) 100 final. European Union (EU). Available online at https://ec.europa.eu/environment/circular-economy/pdf/leading_way_global_circular_economy.pdf, checked on 11/3/2020.

EIA (Environmental Investigation Agency) ; CIEL (Center for International Environmental Law) ; GAIA (Global Anti-Incinerator Alliance) (2020): Convention on Plastic Pollution. Toward a new global agreement to address plastic pollution. Center for International Environmental Law (CIEL). Available online at https://www.ciel.org/wp-content/uploads/2020/06/Convention-on-Plastic-Pollution-June-2020-Single-Pages.pdf, checked on 7/7/2020.

ENB (Earth Negotiations Bulletin) (2020): Fourth Meeting of the Ad-hoc Open-ended Expert Group on Marine Litter and Microplastics: 9-13 November 2020. 16th ed. Edited by IISD Reporting Services (154). Available online at https://enb.iisd.org/download/pdf/enb16154e.pdf.

Environment and Climate Change Canada, Health Canada (Government of Canada) (2020): Draft Science Assessment of Plastic Pollution. Available online at https://www.canada.ca/content/dam/eccc/documents/pdf/pded/plastic-pollution/Science%20Assessment%20Plastic%20Pollution.pdf, checked on 7/7/2020.

EP (European Parliament) (2019): EU Pollinators Initiative. European Parliament resolution of 18 December 2019 on the EU Pollinators Initiative (2019/2803(RSP)). European Union (EU). Available online at https://www.europarl.europa.eu/doceo/document/TA-9-2019-0104_EN.pdf, checked on 11/3/2020.

FAO (Food and Agriculture Organization of the United Nations) (2017): Microplastics in fisheries and aquaculture. Status of knowledge on their occurrence and implications for aquatic organisms and food safety. With assistance of Amy Lusher, Peter C. H. Hollman, Jeremy Mendoza-Hill. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy (FAO Fisheries and Aquaculture Technical Paper, 615). Available online at http://www.fao.org/3/a-i7677e.pdf, checked on 8/25/2020.

Federico, Jennifer (2019): IPEN Views of Rotterdam Convention COP9 6 May 2019. Available online at https://ipen.org/sites/default/files/documents/ipen_views_of_rotterdam_convention_cop9_6_may_2019.pdf, checked on 10/20/2020.

G20 (2017): G20 Action Plan on Marine Litter. Available online at https://www.mofa.go.jp/mofaj/files/000272290.pdf, checked on 7/8/2020.

G20 (2019): G20 Implementation Framework for Actions on Marine Plastic Litter. Available online at https://www.mofa.go.jp/policy/economy/g20_summit/osaka19/pdf/documents/en/annex_14.pdf, checked on 8/25/2020.

G7 (2018): Ocean plastics charter. Available online at https://www.consilium.europa.eu/media/40516/charlevoix_oceans_plastic_charter_en.pdf, checked on 7/8/2020.

Galgani, François; Hanke, Georg; Werner, Stefanie; Oosterbaan, Lex; Nilsson, Per; Fleet, David et al. (2013): Guidance on monitoring of marine litter in European seas. Luxembourg: Publications Office of the European Union (EUR (Luxembourg), 26113 EN). Available online at https://mcc.jrc.ec.europa.eu/documents/201702074014.pdf, checked on 10/21/2020.

GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental

Protection) (2005): The new GESAMP. Science for sustainable oceans. A strategic vision for the IMO/FAO/UNESCO-IOC/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. International Maritime Organization (IMO). London. Available online at http://www.gesamp.org/site/assets/files/1256/newgesamp.pdf, checked on 7/8/2020.

_ (2016a): Sources, fate and effects of microplastics in the marine environment. A global assessment. Edited by Peter J. Kershaw. International Maritime Organization (IMO) (Reports to GESAMP, No. 90). Available online at https://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/GESAMP_microplastics%20full%20study.pdf, checked on 7/8/2020.

_ (2016b): Sources, fate and effects of microplastics in the marine environment. Part 2 of a global assessment. Edited by Peter J. Kershaw, Chelsea M. Rochman. International Maritime Organization (IMO) (Reports to GESAMP, No. 93). Available online at http://www.gesamp.org/site/assets/files/1275/sources-fate-and-effects-of-microplastics-in-the-marine-environment-part-2-of-a-global-assessment-en.pdf, checked on 7/8/2020.

_ (2019): Guidelines for the monitoring and assessment of plastic litter in the ocean. Edited by Peter J. Kershaw, Alexander Turra, François Galgani. United Nations Environment Programme (UNEP) (Reports to GESAMP, No. 99). Available online at http://www.gesamp.org/site/assets/files/2002/rs99e.pdf, checked on 7/8/2020.

_ (2020): Scoping activities. International Maritime Organization (IMO). Available online at http://www.gesamp.org/work/scoping-activities, updated on 2020, checked on 10/22/2020.

Gustafsson, Karin M.; Díaz-Reviriego, Isabel; Turnhout, Esther (2020): Building capacity for the science-policy interface on biodiversity and ecosystem services: Activities, fellows, outcomes, and neglected capacity building needs. In Earth System Governance 4 (June), pp. 1–10. DOI: 10.1016/j.esg.2020.100050.

HELCOM (Baltic Marine Environment Protection Commission) (2009): Marine Litter in the Baltic Sea Region. Assessment and priorities for response. Baltic Marine Environment Protection Commission (HELCOM). Helsinki, Finland. Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/7716/-Marine_Litter_in_the_Baltic_Sea_Region_Assessment_and_priorities_for_response-2009marine_litter_in_the_baltic_region.pdf.pdf?sequence=3&isAllowed=y, checked on 10/21/2020.

_ (2017): HELCOM Guidelines for monitoring beach litter. Baltic Marine Environment Protection Commission (HELCOM). Available online at https://helcom.fi/media/documents/Guidelines-for-monitoring-beach-litter.pdf, checked on 10/21/2020.

_ (2018): State of the Baltic Sea. Second HELCOM holistic assessment 2011-2016. Baltic Marine Environment Protection Commission (HELCOM) (Baltic Sea Environment Proceedings, 155). Available online at https://helcom.fi/media/publications/BSEP155.pdf, checked on 9/29/2020.

ICES (International Council for the Exploration of the Sea) (2020): Data portal DOME (Marine Environment). International Council for the Exploration of the Sea (ICES). Available online at https://www.ices.dk/data/data-portals/Pages/DOME.aspx, updated on 11/6/2020, checked on 11/6/2020.

IISD (International Institute for Sustainable Development) (2018): Brazil Launches First Assessment on Biodiversity, Ecosystem Services. International Institute for

Sustainable Development (IISD). Available online at http://sdg.iisd.org/news/brazil-launches-first-assessment-on-biodiversity-ecosystem-services/, updated on 11/3/2020, checked on 11/3/2020.

IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) (2017): IPBES Capacity-building Rolling Plan. IPBES/5/15. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Available online at https://ipbes.net/sites/default/files/ipbes_capacity-building_rolling_plan_and_executive_summary_0.pdf, checked on 11/4/2020.

_ (2018): IPBES Guide on the production of assessments. IPBES secretariat. Bonn, Germany. Available online at https://ipbes.net/sites/default/files/180719_ipbes_assessment_guide_report_hi-res.pdf, checked on 11/4/2020.

_ (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Edited by S. Díaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard et al. IPBES secretariat. Bonn, Germany. Available online at https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf, checked on 11/4/2020.

_ (2020a): Assessing knowledge IPBES. Available online at https://ipbes.net/assessing-knowledge, updated on 10/21/2020, checked on 10/21/2020.

_ (2020b): Regional/subregional assessments on biodiversity and ecosystem services IPBES. Available online at https://ipbes.net/regional-assessments, updated on 12/14/2020, checked on 12/14/2020.

_ (2020c): Multidisciplinary Expert Panel IPBES. Available online at https://ipbes.net/multidisciplinary-expert-panel, updated on 12/14/2020, checked on 12/14/2020.

IPCC (Intergovernmental Panel on Climate Change) (2011): IPCC Conflict of Interest Policy. Available online at https://archive.ipcc.ch/pdf/ipcc-principles/ipcc-conflict-of-interest.pdf.

_ (2013): IPCC Factsheet: How does the IPCC select its authors? Available online at https://www.ipcc.ch/site/assets/uploads/2018/02/FS_select_authors.pdf.

_ (2018a): Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

_ (2018b): Summary for Policy makers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla et al. (Eds.): Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Geneva, Switzerland. Available online at https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_HR.pdf, checked on 11/4/2020.

_ (2020a): IPCC Trust Fund Programme and Budget. IPCC-LII/Doc. 2, Rev.1, Corr. 1. Available online at https://www.ipcc.ch/site/assets/uploads/2019/12/250220201133-Doc2.Rev1_.Corr_.1Budget.pdf.

_ (2020b): Reports — IPCC. Available online at https://www.ipcc.ch/reports/?rp=ar6, updated on 10/21/2020, checked on 10/21/2020.

IPCP (International Panel on Chemical Pollution) (2019): Strengthening the science-policy interface in international chemicals governance. A mapping and gap analysis. International Panel on Chemical Pollution (IPCP). Available online at https://www.ipcp.ch/wp-content/uploads/2019/02/IPCP-Sci-Pol-Report2019.pdf, checked on 6/2/2020.

IUCN (International Union for Conservation of Nature) (2017): Primary microplastics in the oceans: A global evaluation of sources. With assistance of Julien Boucher, Damien Friot. International Union for Conservation of Nature (IUCN). Gland, Switzerland.

Jensen-Ryan, Danielle K.; German, Laura A. (2019): Environmental science and policy: A meta-synthesis of case studies on boundary organizations and spanning processes. In Science and Public Policy 46 (1), pp. 13–27. DOI: 10.1093/scipol/scy032.

Knutti, Reto; Abramowitz, Gabriel; Collins, Matthew; Eyring, Veronika; Gleckler, Peter J.; Hewitson, Bruce; Mearns, Linda (2010): Good Practice Guidance Paper on Assessing and Combining Multi Model Climate Projections. In T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, P. M. Midgley (Eds.): Meeting Report of the Intergovernmental Panel on Climate Change Expert Meeting on Assessing and Combining Multi Model Climate Projection. Bern, Switzerland. Available online at https://www.ipcc.ch/site/assets/uploads/2018/05/expert-meeting-assessing-multi-model-projections-2010-01.pdf, checked on 11/4/2020.

Koetz, Thomas (2011): Institutional dynamics of science-policy interfaces in international biodiversity governance. Dissertation. ICTA, Barcelona. Available online at https://core.ac.uk/download/pdf/13323675.pdf, checked on 10/21/2020.

Koetz, Thomas; Bridgewater, Peter; Miller, Clark; Norgaard, Richard; Pielke, Roger (2009): Science-policy interfaces for more effective governance of biodiversity and ecosystem services: institutinal mismatches, shifting paradigms, obstructions, and opportunities. Available online at http://sciencepolicy.colorado.edu/admin/publication_files/resource-2783-2009.40.pdf, checked on 8/24/2020.

Lane, SB.; Ahamada, S.; Gonzalves, C.; Lukambuzi, L.; Ochiewo, J.; Pereira, M. et al. (2007): A Regional Overview & Assessment of Marine Litter Related Activities in the West Indian Ocean Region. Report to the United Nations Environment Programme. Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/8764/-A%20Regional%20Overview%20&%20Assessment%20of%20Marine%20Litter%20Related%20Activities%20in%20the%20%20Western%20Indian%20Ocean%20Region-2007Regional_assessment_of_marine_litter_WIO_Region.PDF?sequence=3&%3BisAllowed=, checked on 10/21/2020.

Lyons, Youna; Neo, Mei Lin; Lim, Amanda; Tay, Yuke Ling; Dang, Vu Hai (2020): Status of Research, Legal and Policy Efforts on Marine Plastics in ASEAN+3: A Gap Analysis at the Interface of Science, Law and Policy. National University of Singapore (NUS); Coordinating Body on the Seas of East Asia (COBSEA). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/33383/NUS.pdf?sequence=1&isAllowed=y, checked on 8/28/2020.

Marine Regions Forum (Ed.) (2019): Achieving a Healthy Ocean. Regional Ocean Governance Beyond 2020. Conference Report. Available online at https://www.prog-ocean.org/marine-regions-forum/wp-content/uploads/sites/2/2020/02/MRF2019_Conference-Report_fin_04.02.2020.pdf.

McElwee, Pamela; Fernández-Llamazares, Álvaro; Aumeeruddy-Thomas, Yildiz; Babai, Dániel; Bates, Peter; Galvin, Kathleen et al. (2020): Working with Indigenous and local knowledge (ILK) in large-scale ecological assessments: Reviewing the experience of the IPBES Global Assessment. In J Appl Ecol 57 (9), pp. 1666–1676. DOI: 10.1111/1365-2664.13705.

Mendenhall, Elizabeth (2018): Oceans of plastic: A research agenda to propel policy development. In Marine Policy 96, pp. 291–298. DOI: 10.1016/j.marpol.2018.05.005.

Nordic Council of Ministers for the Environment and Climate (2019): Nordic ministerial declaration on the call for a global agreement to combat marine plastic litter and microplastics. Adopted on 10.04.2019. Reykjavik. Available online at https://www.norden.org/en/declaration/nordic-ministerial-declaration-call-global-agreement-combat-marine-plastic-litter-and, checked on 6/2/2020.

Norwegian Government (2020a): Group of Friends to Combat Marine Plastic Pollution. Available online at https://www.norway.no/en/missions/UN/news/news-from-norwayun/CombatMarinePlastic/, updated on 8/13/2020, checked on 8/13/2020.

_ (2020b): Group of Friends to Combat Marine Plastic Pollution. Concept Note. Norwegian Government.

NOWPAP (Northwest Pacific Action Plan) (2007): Guidelines for monitoring marine litter on the beaches and shorelines of the Northwest Pacific Region. United Nations Environment Programme (UNEP). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/27232/ML_Guideline_English.pdf?sequence=8&isAllowed=y, checked on 10/21/2020.

NOWPAP (Northwest Pacific Action Plan) ; MERRAC (Marine Environmental Emergency Preparedness and Response Regional Activity Centre) (2010): Guidelines for Monitoring Marine Litter on the Seabed in the Northwest Pacific Region. United Nations Environment Programme (UNEP). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/26159/GuidelinesmonitoringML.pdf?sequence=1&isAllowed=y, checked on 10/21/2020.

_ (2020): Understanding of Floating Marine Litter Sources and Flows in the NOWPAP Region. United Nations Environment Programme Regional Seas Programme (UNEP Regional Seas).

NOWPAP (Northwest Pacific Action Plan) ; POMRAC (Pollution Monitoring Regional Activity Centre) (2014): State of the Marine Environment Report for the NOWPAP region (SOMER 2). United Nations Environment Programme Regional Seas Programme (UNEP Regional Seas). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/26244/SOMER_2.pdf?sequence=1&isAllowed=y, checked on 10/7/2020.

(OSPAR Commission) (2009): Marine litter in the Northeast Atlantic Region. Assessment and priorities for response. OSPAR Commission. London, U.K. Available online at https://pdfs.semanticscholar.org/411a/7c97d29b5874d6799c58f7983149bcb049c6.pdf?_ga=2.126840205.1400079574.1601307094-584762775.1590846988, checked on 9/28/2020.

_ (2010): Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area. OSPAR Commission. Available online at https://www.ospar.org/ospar-data/10-02e_beachlitter%20guideline_english%20only.pdf, checked on 10/21/2020.

_ (2017a): Assessment document of land-based inputs of microplastics in the marine environment. OSPAR Commission. Available online at https://www.ospar.org/documents?v=38018, checked on 9/28/2020.

_ (2017b): Guidelines for monitoring marine litter washed ashore and/or deposited on coastlines (beach litter). OSPAR Commission. Available online at https://www.pame.is/document-library/desktop-study-on-marine-litter-library/additional-documents/desktop-study-list-of-references/459-ospar-commission-2017-cemp-guidelines-for-monitoring-marine-litter-washed-ashore-an-or-deposited-on-coastlines-beach-litter/file, checked on 10/21/2020.

_ (2019): Review of BAT and BEP in Urban Wastewater Treatment Systems focusing on the reductions and prevention of stormwater related litter, including micro-plastics, entering the Marine Environment. OSPAR Commission.

PAME (Arctic Council/ Protection of Arctic Marine Environment) (2019): Desktop Study on Marine Litter including Microplastics in the Arctic. Arctic Council/ Protection of Arctic Marine Environment (PAME). Available online at https://www.pame.is/images/03_Projects/Arctic_Marine_Pollution/Litter/Desktop_study/Desktop_Study_on_marine_litter.pdf, checked on 8/27/2020.

Pereira, Laura; Sitas, Nadia; Ravera, Federica; Jimenez-Aceituno, Amanda; Merrie, Andrew (2019): Building capacities for transformative change towards sustainability: Imagination in Intergovernmental Science-Policy Scenario Processes. In Elem Sci Anth 7 (1), p. 35. DOI: 10.1525/elementa.374.

PERSGA (The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden) ; UNEP (United Nations Environment Programme) (2008): Marine Litter in the PERSGA Region. The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA). Jeddah, Saudi Arabia.

Raubenheimer, Karen; McIlgorm, Alistair; Oral, Nilüfer (2018): Towards an improved international framework to govern the life cycle of plastics. In RECIEL 27 (3), pp. 210–221. DOI: 10.1111/reel.12267.

Raubenheimer, Karen; Urho, Niko (2020): Possible elements of a new global agreement to prevent plastic pollution. Nordic Council of Ministers. Copenhagen, Denmark (TemaNord, 2020, 535). Available online at https://pub.norden.org/temanord2020-535/temanord2020-535.pdf, checked on 11/3/2020.

Rochette, Julien; Schumm, Romain; Wrigth, Glenn; Cremers, Klaudija (2020): Combatting marine plastic litter: state of play and perspectives. Institute for Sustainable Development and International Relations (iddri) (Study, N° 3/20). Available online at https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20Iddri/Etude/202006-ST0320-plastic%20marine%20envt_0.pdf, updated on 6/9/2020, checked on 6/9/2020.

SACEP (South Asia Co-operative Environment Programme) (2007): Marine Litter in the South Asian Seas Region. Available online at http://www.sacep.org/pdf/Reports-Technical/2007.09-Marine-Litter-in-the-SAS-Region.pdf, checked on 8/27/2020.

_ (2019): Regional Marine Litter Action Plan for South Asian Seas Region. South Asia Co-operative Environment Programme (SACEP). Colombo, Sri Lanka. Available online at http://www.sacep.org/pdf/Reports-Technical/2019.11.06-Regional-Marine-Litter-Action-Plan-for-South-Asian-Seas-Region.pdf, checked on 9/28/2020.

SAPEA (Science Advice for Policy by European Academies) (2019): A scientific perspective on microplastics in nature and society. With assistance of Bart Koelmans, Gabriela Kalčíková. Science Advice for Policy by European Academies (SAPEA). Berlin (Evidence Report, No. 4). Available online at https://www.sapea.info/wp-content/uploads/report.pdf, checked on 6/2/2020.

_ (2020): A scientific perspective on microplastics in nature and society. Available online at https://www.sapea.info/topics/microplastics/.

Sarkki, Simo; Balian, Estelle; Heink, Ulrich; Keune, Hans; Neßhöver, Carsten; Niemelä, Jari et al. (2019): Managing science-policy interfaces for impact: Interactions within the environmental governance meshwork. In Environmental Science & Policy. DOI: 10.1016/j.envsci.2019.05.011.

SEI (Ed.) (2020): New voices, new readers: how the IPCC is adapting to the 2020s SEI. Available online at https://www.sei.org/featured/ipcc-faro-climate-impacts-adaptation-vulnerability/, updated on 7/1/2020, checked on 12/14/2020.

Simon, Nils; Knoblauch, Doris; Mederake, Linda; McGlade, Katriona; Schulte, Maro Luisa; Masali, Supriya (2018): No more Plastics in the Ocean. Gaps in Global Plastic Governance and Options for a Legally Binding Agreement to Eliminate Marine Plastic Pollution. Edited by ecologic, adelphi (Discussion Paper).

SPREP (Secretariat of the Pacific Regional Environment Programme) (2018): Pacific Regional Action Plan. Marine litter 2018-2025. Secretariat of the Pacific Regional Environment Programme (SPREP). Available online at https://www.sprep.org/attachments/Circulars/prap_marine_litter.pdf, checked on 9/28/2020.

The Ellen MacArthur Foundation (Ed.) (2020): UN Treaty. We call for UN member states to commit to the development of a UN treaty on plastic. Available online at https://www.ellenmacarthurfoundation.org/our-work/activities/new-plastics-economy/un-treaty, checked on 10/14/2020.

UK government (Her Majesty's Government) (2019): Green Finance Strategy. Transforming for a Greener Future. Government of the United Kingdom (UK government). Available online at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820284/190716_BEIS_Green_Finance_Strategy_Accessible_Final.pdf, checked on 11/3/2020.

UNEP/MAP (United Nations Environment Programme/ Mediterranean Action Plan) (2015): Marine litter assessment in the Mediterranean. 2015. United Nations Environment Programme/ Mediterranean Action Plan (UNEP/MAP). Athens, Greece. Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/7098/MarineLitterEng.pdf?sequence=1&isAllowed=y, checked on 8/25/2020.

_ (2016): Integrated Monitoring and Assessment Guidance. United Nations Environment Programme/ Mediterranean Action Plan (UNEP/MAP). Available online at http://www.rac-spa.org/sites/default/files/ecap/ig22_inf7.pdf, checked on 10/21/2020.

UNEP-CAR/RCU (United Nations Environment Programme Caribbean/ Regional Coordinating Unit) (2014): Regional Action Plan on marine litter management

(RAPMaLi) for the wider Caribbean Region 2014. United Nations Environment Programme Caribbean/ Regional Coordinating Unit (UNEP-CAR/RCU). Available online at https://www.cbd.int/doc/meetings/mar/mcbem-2014-03/other/mcbem-2014-03-115-en.pdf, checked on 9/28/2020.

UNEP (United Nations Environment Programme) (2014): Terminal Evaluation of the Project Fifth Global Environmental Outlook: Integrated Environmental Assessment. With assistance of Andy Rowe, Norah Ng'eny, Michael Carbon. United Nations Environment Programme (UNEP). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/300/Terminal_evaluation_of_the_UNEP_project_Fifth_Global_Environmental_Outlook_Integrated_Environmental_Assessment.pdf?sequence=1&isAllowed=y.

_ (2016): Marine plastic debris and microplastics. Global lessons and research to inspire action and guide policy change. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available online at https://plasticoceans.org/wp-content/uploads/2017/11/UNEP-research.pdf, checked on 6/2/2020.

_ (2017): Combating marine plastic litter and microplastics: An assessment of the effectiveness of relevant international, regional and subregional governance strategies and approaches. United Nations Environment Programme (UNEP). Available online at https://papersmart.unon.org/resolution/uploads/unep_aheg_2018_inf3_full_assessment_en.pdf, checked on 9/28/2020.

_ (2018a): Briefing on the sixth Global Environment Outlook. Progress and Budget Situation as of April 10th, 2018. Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/25336/CPR%20Briefing%20Note%20-%20Global%20Environment%20Outlook%20-%2010%20April%202018.pdf?sequence=16&isAllowed=y#:~:text=The%20current%20un%2Dsecured%20budget,process%20stands%20at%3A%202%2C451%2C624%20USD.

_ (2018b): Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available online at http://wedocs.unep.org/bitstream/handle/20.500.11822/27113/plastics_limits.pdf?sequence=1&isAllowed=y, checked on 8/25/2020.

_ (2018c): Mapping of global plastics value chain and plastics losses to the environment. With a particular focus on marine environment. With assistance of Morten W. Rybert, Alexis Laurent, Michael Hauschild. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available online at http://wedocs.unep.org/bitstream/handle/20.500.11822/26745/mapping_plastics.pdf?sequence=1&isAllowed=y, checked on 8/14/2020.

_ (2018d): Combating marine plastic litter and microplastics: an assessment of the effectiveness of relevant international, regional and subregional governance strategies and approaches. UNEP/AHEG/2018/1/INF/3. Nairobi, Kenya. Available online at https://papersmart.unon.org/resolution/uploads/unep_aheg_2018_inf3_full_assessment_en.pdf, checked on 7/8/2020.

_ (2018e): Discussion paper on environmental, social and economic costs and benefits of different response options. Note by the Secretariat. UNEP/AHEG/2018/1/4. United Nations Environment Programme (UNEP). Available online at https://papersmart.unon.org/resolution/uploads/unep_aheg_2018_1_4_costs_edited_0.pdf, checked on 9/28/2020.

_ (2018f): Discussion paper on national, regional and international response options, including actions and innovative approaches, and voluntary and legally binding governance strategies and approaches. Note by the secretariat. UNEP/AHEG/2018/1/3. United Nations Environment Programme (UNEP). Available online at https://papersmart.unon.org/resolution/uploads/unep_aheg_2018_1_3_responseoptions_edited_0.pdf, checked on 9/28/2020.

_ (2019a): About us. The International Resource Panel. Available online at https://www.resourcepanel.org/about-us, checked on 10/20/2020.

_ (2019b): Addressing Marine Plastics: A Systemic Approach. Recommendations for action. Edited by Philippa Notten. United Nations Environment Programme (UNEP).

UNEPUnited Nations Environment Programme (2019c): GEO 6 summary for policymakers. Cambridge: Cambridge University Press. Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/27652/GEO6SPM_EN.pdf?sequence=1&isAllowed=y, checked on 11/4/2020.

_ (2019d): Global Environment Outlook – GEO-6. Healthy Planet, Healthy People. United Nations Environment Programme (UNEP). New York. Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/27539/GEO6_2019.pdf?sequence=1&isAllowed=y, checked on 4/20/2020.

_ (2019e): Plastics and shallow coral reefs. Synthesis of the science for policy-makers. With assistance of M. Sweet, Stelfox, M. Lamb, J. United Nations Environment Programme (UNEP). Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/27646/plastic_corals.pdf?sequence=1&isAllowed=y, checked on 9/30/2020.

_ (2019f): The Panel. International Resource Panel. Available online at https://www.resourcepanel.org/the-panel, checked on 10/19/2020.

_ (2019g): Marine plastic litter and microplastics. Resolution adopted by the United Nations Environment Assembly on 15 March 2019. UNEP/EA.4/Res.6. United Nations Environment Programme (UNEP). Available online at http://wedocs.unep.org/bitstream/handle/20.500.11822/28471/English.pdf?sequence=3&isAllowed=y, checked on 5/29/2020.

_ (2019h): Compilation of United Nations Environment Assembly resolutions on marine litter and microplastics. Note by the Secretariat. UNEP/AHEG/2019/3/INF/2. United Nations Environment Programme (UNEP).

_ (2020a): Chair's Summary for the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics. Available online at https://papersmart.unon.org/resolution/uploads/chair_summary_final.pdf#overlay-context=Fourth-adhoc-oeeg.

_ (2020b): Integrated Environmental Assessment. United Nations Environment Programme (UNEP). Available online at https://www.unenvironment.org/global-environment-outlook/integrated-environmental-assessment, updated on 11/4/2020, checked on 11/4/2020.

_ (2020c): National guidance for plastic pollution hotspotting and shaping action - Introduction report. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available online at http://wedocs.unep.org/bitstream/handle/20.500.11822/33166/NGP.pdf?sequence=1&isAllowed=y, checked on 9/28/2020.

_ (2020d): Assessment of options for strengthening the science-policy interface at the international level for the sound management of chemicals and waste. Available online at https://wedocs.unep.org/bitstream/handle/20.500.11822/33808/OSSP.pdf?sequence=1&isAllowed=y, checked on 6/2/2020.

_ (2020e): Summary of the analysis of the effectiveness of existing and potential response options and activities on marine litter and microplastics at all levels to determine the contribution in solving the global problem**. Note by the Secretariat. UNEP/AHEG/4/4. United Nations Environment Programme (UNEP). Available online at https://papersmart.unon.org/resolution/uploads/k2002128_-_unep-aheg-4-4_-_advance.pdf, checked on 10/7/2020.

UNEP (United Nations Environment Programme) ; ICCA (International Council of Chemical Associations) (2019): OEWG3-INF-28-KMI. Submission of the International Council of Chemical Associations (ICCA) and the United Nations Environment Programme (UNEP): Knowlegde Management and Information Sharing for the Sound Management of Industrial Chemicals. Available online at http://www.saicm.org/Portals/12/Documents/meetings/OEWG3/inf/OEWG3-INF-28-KMI.pdf, checked on 10/21/2020.

UNFCCC (United Nations Framework Convention on Climate Change) : Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 11 December 2015. Addendum. Part two: Action taken by the Conference of the Parties at its twenty-first session. Available online at https://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf, checked on 10/21/2020.

_ (2020): Subsidiary Body for Scientific and Technological Advice (SBSTA) UNFCCC. UNFCCC. Available online at https://unfccc.int/process/bodies/subsidiary-bodies/sbsta, updated on 10/21/2020, checked on 10/21/2020.

UNGA (United Nations General Assembly) (2017): Oceans and the law of the sea. Resolution adopted by the General Assembly on 23 December 2016. A/RES/71/257. United Nations (UN). Available online at https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_71_257.pdf, checked on 8/25/2020.

United Nations (Ed.) (2017): The First Global Integrated Marine Assessment. World Ocean Assessment I. Cambridge: Cambridge University Press.

United Nations Conference on Trade and Development (UNCTAD) (7/27/2020): Growing plastic pollution in wake of COVID-19: how trade policy can help. Available online at https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2440, checked on 8/13/2020.

van den Hove, Sybille (2007): A rationale for science–policy interfaces. In Futures 39 (7), pp. 807–826. DOI: 10.1016/j.futures.2006.12.004.

van der Hel, Sandra; Biermann, Frank (2017): The authority of science in sustainability governance: A structured comparison of six science institutions engaged with the Sustainable Development Goals. In Environmental Science & Policy 77, pp. 211–220. DOI: 10.1016/j.envsci.2017.03.008.

Vasileiadou, Eleftheria; Heimeriks, Gaston; Petersen, Arthur C. (2011): Exploring the impact of the IPCC Assessment Reports on science. In Environmental Science & Policy 14 (8), pp. 1052–1061. DOI: 10.1016/j.envsci.2011.07.002.

Vince, Joanna; Hardesty, Britta D. (2018): Governance Solutions to the Tragedy of the Commons That Marine Plastics Have Become. In Front. Mar. Sci. 5, pp. 1–10. DOI:

10.3389/fmars.2018.00214.

Vince, Joanna; Hardesty, Britta Denise (2017): Plastic pollution challenges in marine and coastal environments: from local to global governance. In Restor Ecol 25 (1), pp. 123–128. DOI: 10.1111/rec.12388.

Wang, Juying; Baker, Maria Clare; Bera, Arsonina; Kim, Kiho; Lohmann, Rainer; Ofiara, Douglas; Zhao, Yuhui (2017): Marine Debris. In United Nations (UN) (Ed.): The First Global Integrated Marine Assessment. World Ocean Assessment I. Cambridge: Cambridge University Press, pp. 389–408. Available online at https://www.cambridge.org/core/services/aop-cambridge-core/content/view/F62BBAF26D6EDAC33D32A4D4970B38A9/9781108186148c25_p389-408_CBO.pdf/marine_debris.pdf, checked on 8/27/2020.

Wang, Zhanyun; Altenburger, Rolf; Backhaus, Thomas Covaci, Adrian; Diamond, Miriam L.; Grimalt, Joan O.; Lohmann, Rainer; Schäffer, Andreas; Scheringer, Martin; Selin, Henrik; Soehl, Anna; Suzuki, Noriyuki (2021): We need a global science-policy body on chemicals and waste. Science, Vol. 371, Issue 6531, pp. 774-776.

WHO (World Health Organization) (2019): Microplastics in drinking-water. World Health Organization (WHO). Geneva. Available online at https://www.who.int/water_sanitation_health/publications/microplastics-in-drinking-water/en/, checked on 8/25/2020.

WWF (World Wildlife Fund for Nature) (2019): Momentum building behind global treaty to combat marine plastic pollution. Available online at https://wwf.panda.org/wwf_news/press_releases/?354810/Momentum-building-behind-global-treaty-to-combat-marine-plastic-pollution, updated on 10/19/2019, checked on 10/14/2020.

WWF (World Wildlife Fund for Nature) ; (The Allen MacArthur Foundation) ; BCG (Boston Consulting Group) (2020): The business case for a UN treaty on plastic pollution. Available online at https://www.ellenmacarthurfoundation.org/assets/downloads/UN-Treaty.pdf.

About this publication

Strengthen the Global Science and Knowledge Base to Reduce Marine Plastic Pollution

Per-Olof Busch, Maro Luisa Schulte, Nils Simon

ISBN 978-92-893-7011-0 (PDF)
ISBN 978-92-893-7012-7 (ONLINE)
http://dx.doi.org/10.6027/temanord2021-519

TemaNord 2021:519
ISSN 0908-6692

Cover photo: DisobeyArt/ istock

Disclaimer

Rights and permissions

Nordic co-operation

Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland and Åland.

Nordic co-operation has firm traditions in politics, economics and culture and plays an important role in European and international forums. The Nordic community strives for a strong Nordic Region in a strong Europe.

Nordic co-operation promotes regional interests and values in a global world. The values shared by the Nordic countries help make the region one of the most innovative and competitive in the world.

The Nordic Council of Ministers
Nordens Hus
Ved Stranden 18
DK-1061 Copenhagen
pub@norden.org

Read more Nordic publications on www.norden.org/publications