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Can a global fund help solve the global marine plastic debris problem?

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1. Introduction

The environmental and socio-economic effects of marine plastic pollution are experienced in all maritime jurisdictions. Plastic waste that enters the marine environment can sink to the seabed or be transported far from the source by winds and ocean currents, presenting challenges in identifying the actors and thereby influencing the effectiveness of national policy responses. Maintaining the status quo is likely to result in greater inputs from land (Jambeck et al., 2015). The long-term impacts become more alarming with each discovery of new sources (Boucher and Friot, 2017) and ocean sinks (Jamieson et al., 2017). The lack of progress has been partly attributed to a failure of current legal and policy frameworks to address the global marine debris problem (Borrelle et al., 2017; Simon and Schulte, 2017; UNEP, 2016; UNGA, 2012). Increased public perception is leading to a need to prioritise effective litter reduction over the need for more scientific evidence of the impacts (Williams et al., 2005), as was the case for ozone depleting substances. This is illustrated by the groundswell in many States where the public urges governments to implement bans on plastic bags, microbeads and polystyrene take-away containers, as well as campaigns to implement container deposit schemes. In addition to land-based sources of marine plastic debris, sea-based sources include vessel garbage, derelict fishing gear (FAO, 2016; Macfadyen et al., 2009) and microplastics (FAO, 2017), which also contribute to the global stock of marine plastic debris.

Without global action, the transboundary nature of marine plastic debris means progress in one region may be negated by the status quo being maintained in another. Some regions may be a sink more than a source, making local indicators a challenge to establish and creating uncertainty in meeting national reduction targets. The issue of marine plastic debris has steadily gained attention at the international level. However, implementation remains a national activity. Discussions at the global level have not yet identified and merged all necessary measures into a single comprehensive preventive approach. The cost of such measures is largely unknown, including how these could be financed.

The oceans are a global common requiring global action. The challenge of financing the protection of the global commons is not new. It is therefore timely to investigate whether a global fund is a feasible mechanism to progress the historically poor implementation of abatement measures to reduce plastic waste

entering the world's oceans. First, it is necessary to model the funding mechanism itself.

It may be argued that the feasibility and effectiveness of a global funding mechanism to prevent marine plastic debris would require an associated international legally binding instrument to harmonise and guide action across coastal and land-locked States. A new international agreement would need to consider a broad range of elements. As per resolution UN/EA.2/11 on Marine Plastic Litter and Microplastics adopted at the second universal session of the UN Environment Assembly (UNEA), an assessment of current international and regional legal and policy frameworks was conducted. Gaps were identified, and options provided for combatting these pollutants at the global level. This included a new international architecture that combines binding and voluntary measures (UNEP/EA.3/INF/5). A model based on the Montreal Protocol on Substances that Deplete the Ozone Layer has also been proposed for the regulation of plastics at a global level (Raubenheimer and McIlgorm, 2017).

Without a new global agreement, there are limited options to regulate the full lifecycle of plastics within the current international legally binding framework (Raubenheimer and McIlgorm, 2018). International voluntary mechanisms exist, but these have had little success in curbing the global production of virgin plastics. Regional mechanisms also exist to strengthen and harmonise national action, but these suffer from resource deficiencies (UNEP, 2014). The current framework is therefore inadequate to address the necessary behaviour changes across the entire global lifecycle of plastics. This paper is the first to detail a high-level model for a conceptual global fund to address marine plastic debris, whether through existing mechanisms or a new global agreement.

Methods for determining national financial contributions to the fund are provided as well as suggested outputs from the fund. Although the proposed model would contribute to the knowledge required to prioritise outputs of the fund, it raises issues of fairness. Analogous funding mechanisms are therefore considered as alternate options for determining national financial contributions.

2. Is an international agreement needed to support a global fund?

The establishment of funding mechanisms has underpinned many collaborative efforts that aim to address global issues. The objectives of these initiatives range

from capping and reducing environmentally harmful activities to improvements in human health. Examples include the International Oil Pollution Compensation Funds, the Multilateral Fund for the Implementation of the Montreal Protocol, the various funds to finance climate change mitigation and adaptation, as well as the Global Fund to fight AIDS, Tuberculosis and Malaria.

The World Bank's Pollution Management and Environmental Health (PMEH) Trust Fund includes a component titled *Integrated Solid Waste Management including Protection of the Marine Environment*. As of 2016, some pilot studies specific to plastic waste were underway, but global progress is limited. Upstream prevention of marine plastic debris through regulation of industry is not targeted by this program (World Bank Group, 2016). A recent Scientific and Technical Advisory Panel (STAP) report promoted the role of the Global Environment Facility in promoting circular economy principles within the plastics sector. The report noted that substantial investment would be required to develop the waste management systems needed to enable a circular economy for plastics, necessitating public-private partnerships and support from Multilateral Development Banks. The report also recognised plastics manufacturing as an important source of greenhouse gas emissions (Barra and Leonard, 2018). In addition, the breakdown of the two most commonly used plastics produces methane and ethylene, both greenhouse gases (Royer et al., 2018).

The global production of plastics continues to outpace recycling efforts, particularly for plastic packaging (World Economic Forum, 2016). The issue therefore requires international cooperation to reach a sustainable global lifecycle of plastics, from design to end-of-life treatment. This will call for greater coordination than can be achieved through funding of waste management improvements alone with no fundamental shift towards long-term preventive measures.

The Secretariat of the Convention on Biological Diversity co-published a study that emphasises the failure of the current legal and policy framework to provide a single agreement that assigns jurisdictional responsibility throughout the entire lifecycle of plastic from production to disposal as well as clean-up activities. The report suggests that successful waste management practices cannot solve the challenge alone, but must be supported by corresponding upstream innovations to reduce the volume and potential impact of plastic products. Improvements would be required in infrastructure and enforcement as well as standards for sustainable

production and consumption behaviours (Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel—GEF, 2012).

It may be argued that a new international legally binding instrument is not necessary to drive a global fund to prevent marine plastic debris. This would be analogous to the Global Fund to fight AIDS, Tuberculosis and Malaria, for which a corresponding international agreement was not adopted. However, without a global framework to promote sustainable consumption and production of plastic, progress on preventive measures has been slow and fragmented. This is despite decades of scientific research supporting the need to eliminate further contributions to the stock of plastic waste in our oceans. In addition, the regional approach has not yielded the basic data across all regions required to set global baselines, targets and timelines. Harmonising the management of the lifecycle of plastics across regions and across all land- and sea-based sectors will require a coordinated international approach, whether binding or voluntary or a combination thereof.

3. Developing a model for a global marine plastic debris fund

A simple model for a global fund would suggest that each State's waste discharge into the global stock of marine plastic debris would dictate their contributions to the fund. Measurement of waste and hence payments would be in proportion to the quantity of plastic emitted as estimated by best available scientific information. This funding method is likely to place an unfair burden on developing States with limited capacity and competing priorities for public funding. In addition, some of these developing States are major importers of plastic scrap, reducing the cost for developed States of dealing with their domestic waste and placing a globally disproportionate burden on the importing State.

Analogous funding mechanisms may provide options to consider for determining national financial contributions. The issues and possible approaches discussed here are not intended to be prescriptive or exhaustive but are intended to begin discussions on a comprehensive and global way forward to prevent further growth of the stock of marine plastic debris through the development of a global fund. Several key areas are examined for consideration.

4. Determining state inputs to the global stock of debris and hence the global fund

Marine debris models have mostly focused on the amount of plastic waste collected on beaches or within specific geographic locations (Hinojosa and Thiel, 2009; Klein et al., 2015; Lechner et al., 2014; Moore et al., 2011; Morritt et al., 2014; Rech et al., 2014; Reisser et al., 2013). Some have attempted to quantify the amount of plastic already in the oceans (Cózar et al., 2014; Eriksen et al., 2014; GESAMP, 2015), while others have estimated the amount entering the oceans on a global scale from land (Jambeck et al., 2015; Ocean Conservancy, 2015) and from rivers (Schmidt, 2017).

The amount of marine litter originating from land-based sources was modelled in the South East Pacific region, using estimations of persistent materials present in municipal garbage that is not collected and what fraction may reach the oceans per year (CPPS, 2007). A more recent global study (Jambeck et al., 2015) also factored in the amount of mismanaged waste¹ that may “leak” into the oceans, focussing on the plastic component of waste generated. The first model assessed population size and the rate of garbage production within those municipalities that face the sea, an estuary or a gulf, whereas the second used annual waste generation rates for 2010 and population density within 50km of the coast. These models provide a basis that can be expanded on, not only to provide more accurate calculations, but also to facilitate further discussion and action on abatement measures appropriate to different geographic, physical and socio-economic circumstances.

A global fund designed to reduce the worldwide flow of plastic waste into the oceans would require a model that describes the stock or “currency” to be controlled. Inputs and reductions to the global stock of plastic debris can then be defined. The total quantity of plastics in the oceans would represent the stock within the model. The amount of mismanaged plastic waste entering the oceans would be the measure of inputs to that stock, and any efforts that effectively divert plastic waste from entering the oceans would be considered a reduction in stock (McIlgorm et al. 2009; 2011). Estimates required to measure progress would be the volumes of plastics entering the oceans each year from various land- and sea-based sources (model inputs) and the volumes prevented from entering the oceans (model

¹ Mismanaged waste was defined in the study as that which is not captured and therefore dumped on land.

outputs). These can be determined with a higher degree of certainty than is possible for the existing stock already in the ocean. Such methods are also within reach of States lacking the capacity to conduct monitoring of the ocean surface, mid-water and seabed.

In its simplest form, the model would base a State's contribution to a financial mechanism on their physical contribution to the controlled stock. A number of socio-economic factors may influence such a basic model. Multilateral agreements that have associated financial mechanisms must determine a fair and agreeable system of contributions by member States. In many cases, negotiations result in contributions being made primarily by a subset of members to the agreement, as for the Multilateral Fund for the Implementation of the Montreal Protocol. Only member States not operating under Article 5 of the Montreal Protocol are required to make financial contributions to the Multilateral Fund. The marginal costs for assisting "Article 5 countries" to convert to the approved substances could be calculated with some certainty, whereas the costs of preventing marine plastic debris on a global scale would likely be significantly higher and more challenging to determine. The economic benefits of reducing ozone-depleting substances were also calculated by estimating costs to government health systems resulting from harm to humans as a result of depleted ozone. Calculating the benefits, both human and environmental, of preventative measures for marine plastic debris is a significant challenge, partly because harm to humans has not been confirmed, let alone quantified.

In comparison, the various climate change funds initiated under the UN Framework Convention on Climate Change employed a system of payments that are a voluntary percentage contribution based on UN membership, national income and forecasted annual budgets. The latter system has not been as successful as hoped in receiving timely payments committed to by Parties.²

A system of financial payments based purely on a State's physical contribution to the stock of marine plastic debris or as a proportion of Gross Domestic Product (GDP) is likely to be regarded as oversimplified and considered unfair by the global community. The motivation for such a system, however, would be threefold.

² Further discussion on analogous funding mechanisms to deal with global issues can be found in Raubenheimer, K., *Towards an Improved Framework to Prevent Marine Plastic Debris* (Doctoral Thesis, University of Wollongong, Australia, 2016) <<http://ro.uow.edu.au/theses/4726/>>.

Firstly, the system would require a transparent calculation of each participating State's contribution to the problem because damage from marine debris can be considered as a small fraction of GDP (McIlgorm et al. 2011). Secondly, a public acknowledgement of the level of a State's emissions would induce more accountability and create a duty to contribute financially to the solutions. Thirdly, and most importantly, States could be motivated to implement effective domestic measures to reduce their generation of plastic waste in order to reduce the leakage thereof and thereby reducing their national contribution to the global fund.

In summary, GDP could be a feasible way to initially set fees for the fund. The measurement of actual emissions is made complex by the many pathways of this pollutant to the sea. Obtaining this significant body of information may delay the fund's operation. It is likely there is currently inadequate information on the quantity of plastic emitted to meet the best available scientific information criterion. This suggests an initial flat fee may be required to start the fund, progressing to fee contributions in proportion to emissions as information becomes available through national self-declared emission estimates with possible verification through regional organisations. Alternative approaches may also assist.

5. Expanding on existing models for waste input

Jambeck et al provided a global model that assessed populations living within a 50km coastal strip as a basis to calculate an annual volume of "mismanaged plastic waste" generated that could potentially enter the ocean (Jambeck et al., 2015). The countries with the highest potential to contribute to the global stock of marine plastic debris were also classified by their economic status as per World Bank definitions based on 2010 Gross National Income. The study provided a foundation for a very challenging exercise.

Research indicates the levels of plastic within waste streams may be based on national income levels, with the plastic fraction shown to be higher in middle- and high-income States than low- and middle-income States (Hoornweg and Bhada-Tata, 2012). Affluence levels in urban areas are found to vary from national income and larger rural populations may distort national figures for waste composition compared to national income (Hoornweg and Bhada-Tata, 2012). To provide a more accurate calculation of national stock contribution, the model may need to factor in the percentage of low-, lower middle-, upper middle- and high-income sectors within coastal urban populations, as well as those situated along major

waterways that lead to the oceans. Thus, fees to the fund could be related to more readily available GDP measures. This would potentially ameliorate the cost burden experienced by less developed nations.

Waterways are a known upstream source of marine litter and bordering population density would influence the amount of plastic waste reaching the oceans, particularly in States with poorer waste management practices. For example, 70-90% of illegally dumped waste in the Philippines was estimated to enter waterways, mostly because almost 100% of the population lives near a major waterway. In comparison, under 60% of the Chinese population lives near a major waterway, with 20-40% of illegally dumped waste estimated to enter these waterways (Ocean Conservancy, 2015). This will affect the per capita contribution to the global stock but population size will still determine overall national contributions.

In some areas, over 75% of annual waste is generated during the tourist season (European Commission, 2011). Separate indicators will therefore be required for seasonal variations in waste generation resulting from tourism along the coastline and waterways of States. Variables in clean-up activities may also be included, such as regular clearing of trash on private tourist beaches but not necessarily on all public beaches (European Commission, 2011).

Further categorisation of plastic consumption rates has been determined in some regions, such as for the packaging, construction and development, automotive and agricultural sectors. Parameters for selected industries operating within each state could include total volume of plastic consumed, plastic waste generated and the percentage waste actually reused and recycled. The percentage of recycled content within all plastic components of final products, as well as packaging used throughout the lifecycle of the product, could also be considered, although recycled material is not necessarily sourced domestically.

Infrastructure for waste management is likely to be a large component of the outputs of the global fund to prevent marine plastic debris. Careful consideration should therefore be given to the indicators selected for this category. Indicators chosen must encourage preferred technologies based on full lifecycle impact assessments. Indicators must also provide options for measuring overall effectiveness in reducing inputs to the global stock of marine plastic debris. Parameters would include the presence of formal and informal waste management

systems and the capacity of existing waste infrastructure to effectively manage the volume and types of plastic waste generated domestically as well as imported waste. Preferred end-of-life treatment processes must be agreed at the global level and volumes of waste committed to each process reported on. This includes primary, secondary and tertiary recycling, quaternary recycling (Hopewell et al., 2009) or incineration with appropriate environmental controls, as well as the number and size of sanitary landfills that accept plastic waste. Rural areas and informal settlements with little or no waste management infrastructure must also be factored into the model, particularly those bordering waterways.

Port reception facilities can be included in the category of waste management infrastructure. Ratings could assist and be based on sorting, managing and responsible disposal of the plastic waste discharged from the fishing industry, ferries, cruise ships and many other maritime industries.

The spread of plastic waste throughout a river network is affected by flow, vegetation overhang and other obstructions. High rainfall can also have a cleansing effect on rivers (Balas et al., 2001). The flow of major watercourses through large urban zones, point source inputs to the watercourses, such as stormwater outlets, rainfall patterns, impervious surfaces and obstructions could all be quantified and included in the model. Movement of plastic waste can be restricted to shorter distances by watercourse obstructions (Balas et al., 2001). Obstructions may be natural or man-made, such as traps and booms, both within the network of the river and at the point of entry of the river to the marine environment. Natural obstructions may be more difficult to quantify and subject to fluctuations as the natural environment changes. Man-made landscapes, such as hard surfaces, may result in greater volumes of water runoff (Melbourne Water, 2015), contributing more litter to waterways faster and transportation over greater distances.

Measurements of inputs from land are more achievable on a global scale than are measurements of the stock of plastic debris already in the oceans. Models must also include flows of microplastics (Siegfried et al., 2017) and sea-based sources of plastic waste. Efforts are ongoing to address sea-based sources, particularly enforcement of the existing global instruments to prevent disposal of operational garbage including fishing gear (MARPOL Annex V, 2011) and the dumping of waste generated on land (London Protocol, 1996). This applies to all vessels and artificial platforms operating within areas of national jurisdiction as well those operating on the high seas that are under the control of the State. Compliance with

these instruments should result in maritime waste being disposed of in port reception facilities where it is subject to national efforts to prevent mismanaged of land-based waste entering the waterways and oceans. Thus, outputs from the fund should include improved enforcement and monitoring of existing international agreements for sea-based sources of marine plastic debris.

6. Outputs from the global fund to prevent marine plastic debris

The focus of the global fund would be to enhance adoption of preventative measures. The fund is not envisaged to provide compensation to those communities or industries affected by such pollution, as is the case for the Oil Compensation Funds. The feasibility of a new fund will be strengthened by separating the issues and solutions by those that fall under the responsibility of government and those that industry must take the lead in. Strong policy is required to incentivise research and investment and to engage industry long-term. Simply waiting for industry to develop plastics that have minimal to no impact on human health and the environment may be wishful thinking while oil prices are low and no alternative products exist that are as economical to manufacture. The success of the Montreal Protocol was largely due to economically feasible alternatives.

The first output of a new global fund for the prevention of marine plastic debris is likely to be an analysis of accumulation hotspots, as recommended by GESAMP (GESAMP, 2015). Some hotspots may become evident while gathering data to calculate State contribution to the global stock of marine plastic debris. These hotspots can be prioritised when assessing projects submitted by national governments or regionally coordinated submissions. Hotspots for pollution from land-based sources have already been identified in the Regional Seas assessment reports of Eastern Africa (UNEP and WIOMSA, 2008), the East Asian Seas (Sien and Kirkman, 2000) and Russia (Arctic Council, 2009). A similar scheme is underway in the Mediterranean where the European Investment Bank is financing projects that address pollution hotspots (Barcelona Convention, 2018). A gap analysis of highly sensitive areas was listed as a priority action in the Regional Plan on Marine Litter Management for the Wider Caribbean Region (UNEP-CAR/RCU, 2014).

Research has highlighted five potential approaches the fund could prioritise in order to maximise the reduction of inputs to the stock of marine plastic debris.

These are: 1) improving collection services, 2) closing leakage points in collection facilities, 3) incineration, 4) gasification,³ and 5) recycling (Ocean Conservancy, 2015). As the report highlights, options such as gasification and incineration have high capital costs and require a minimum guarantee of input stock, potentially limiting their application to areas that produce high volumes of plastic waste. Incineration and gasification are also not favoured due to the release of toxins, but for the purpose of the fund's outputs, they raise the need to assess possible risks for capital investment in infrastructure such as material recovery, sorting and separation, as well as recycling facilities. The viability of any solution, and therefore the ability to attract investors, will be subject to the cost of local resources as well as the selling price of the final product compared to the cost of alternative options (Ocean Conservancy, 2015)(p. 29).

Natural disasters such as extreme weather events can result in significant volumes of waste entering waterways and oceans (Murray et al., 2018). However, it is recognised that some States are historically less responsible for climate change that is arguably the cause of such disasters. It may therefore be more politically sensitive to exclude such events from input calculations and rather factor them in the outputs of a global fund with regards disaster preparedness and post-event cleansing.

7. Fund operational units

It is recognized that the management of problems that affect a global public good must become more issue focused, breaking down complex problems into subunits (Kaul, 2013). Similar to the different funds established under the UNFCCC, each with a specific focus, a global fund to prevent marine plastic debris may be more manageable if divided into subunits, each with its own dedicated fund and board to direct funding expenditure. Each subunit should also have a technical committee to advise the board. Categorising the issues in such a way would allow donors to select an area of focus close to their values, expertise and special interests. Each subunit can clearly link risk with costs and benefits to alleviate the concerns of donors, investors and stakeholders. Expenditure can be operationalised after calculating the benefits of each subunit for issues such as sustainable consumption

³ The report defines incineration as “Waste-treatment technology used to burn mixed municipal waste and generate electricity.” Gasification is defined as “Waste-treatment technology used to convert municipal waste with high calorific content (e.g., plastics) to synthetic gas.”

and production, waste management, human health and other social outcomes, biodiversity conservation, sea-based sources, endocrine disruptors, and savings in water, energy and non-renewable resources through enhanced closed-loop processes. Subunits may thus be able to move into an operational phase more quickly.

The fund may be further divided into operational units. Examples are: 1) infrastructure development, 2) management of the plastics industry, and 3) policy development at the international, regional and sub-regional levels. Capacity building and the principles of sustainable consumption and production would underpin all subunits. The proposed subunit focusing on infrastructure could include technology transfers for improvements to waste management and sanitary landfills, as well as development of collection, sorting and recycling facilities suitable to domestic situations.

The industry management subunit would incorporate an innovation fund to progress development and market penetration of preferred technologies that contribute to a circular closed loop life-cycle for plastics. Self- or co-regulatory measures such as codes of practice, guidelines, certification schemes (e.g. recycled, recyclable and chemical content) can be developed in collaboration with various industry sectors and associations. Sectors responsible for significant plastic waste generation, such as tourism, fisheries, aquaculture and agriculture, could be prioritised.

The policy development subunit would drive development, implementation, compliance and review of regional and national policies and targets to prevent pollution of the marine environment from land-based sources of plastic waste. Developing States may require financial and technical assistance to adopt national regulations that give effect to regionally agreed measures, as well as monitor and report on progress. Ongoing review of the effectiveness of regional frameworks in adapting to emerging science and industry changes will be required so as to ensure efforts continuously meet the objective of preventing plastic waste entering the marine environment from all sources.

Capacity building would include, amongst others, training and development of institutions to negotiate and manage long-term public-private partnership contracts. The establishment of effective monitoring and enforcement programs is required in many regions. In addition, research and piloting of market-based instruments would

be of interest to many States with competing priorities for public funds. Assistance in the drafting of legislation may allow for lessons learned to be transferred between States.

The overarching principle of sustainable consumption and production would encourage, *inter alia*, a global reduction in the production of avoidable plastic products, more widespread design-for-environment practices and adoption of extended producer responsibility, polluter pays, and user pays schemes to incentivise industry and consumer behaviour changes.

The eighteen Regional Seas Programmes established under the UN Environment Program can be a major facilitator of the subunit outputs. These programmes already prioritise pollution of the marine environment from land-based sources. Where mandates overlap with institutions such as the International Maritime Organization (IMO), activities have been integrated in some instances. The full scope of outcomes envisaged by the proposed fund, particularly “upstream” measures, is not clearly within the mandate of all Regional Seas programmes. An overarching global body will therefore need to be established or strengthened to administer the fund. Support for the Regional Seas programmes would be a designated purpose of the fund.

Administration of the fund would require consideration of multiple components beyond the lifecycle end-point of marine plastic pollution. This includes ensuring positive social outcomes from policy interventions (particularly for disadvantaged communities), assessing trade agreements to enhance environmental outcomes are maximised through the import of plastic products and the export of plastic waste and, more importantly, that efforts are aligned with achieving all relevant Sustainable Development Goals (SDGs), not only SDG14. It is therefore suggested that an international governing body be established with representatives of various UN bodies, such as UN Environment (particularly the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities), UN Development Programme, UN Industrial Development Organization and UN Women.

8. Options for financing national inputs to the fund

Assistance in reviewing and strengthening legal and policy frameworks is closely linked to institutional capacity building. Activities at the national level that are

resourced by the global fund to prevent marine plastic debris may require modifications to adapt to domestic legal frameworks in order to establish clear and effective national policies and achievable targets for the regulation of pollution by plastic (Sien and Kirkman, 2000). It has long been suggested that such reviews should not focus only on environmental policies, but on all legislation related to the entire lifecycle of plastic products, including financial structures (UNEP, 2006). In addition, it has also long been recognised that taxation and subsidies that negatively affect the outcomes of funded projects may need reviewing (Montreal Declaration, 2001). National environmental, social and economic development policies should also be reviewed for integration of provisions to protect the marine environment (UN Agenda 21, 1992). These strategies are yet to be integrated into national policies to manage the lifecycle of plastics.

As mentioned, subunits of the fund could be tasked to provide expert advice to states in need of assistance for the development of the necessary legal and administrative measures (Guidelines, 1985). This includes legal and policy regimes to encourage and manage public-private partnerships (Colverson, 2011). Development of state-appropriate economic instruments will also be required for the prevention of marine plastic debris from land-based sources (CPPS, 2007).

Economic incentives adopted at the national level can assist states in raising the necessary funds to meet their fund contributions. These policies should first stimulate the reduction of undesirable products on the market. For those products that remain on the market, increased rates of recycling would reduce the potential inputs to the global stock and therefore reduce financial contributions to the fund. Policies that stimulate the supply of recyclable material include taxes and bans on the landfilling of plastic waste. Supply must be complemented by policies that stimulate demand for recycled material. Examples include government procurement policies and tax incentives for manufacturers that incorporate recycled content in products. To reduce undesirable products on the market that cannot be easily recovered, reused or recycled, or that do not contain recycled content, taxes and contributions to special funds can be applied based on local circumstances.

Extended Producer Responsibility (EPR) schemes should not only shift the cost of collection from local government to the producer but must also stimulate change in design of products to reduce recycling costs. Such schemes should therefore not be viewed as a method to generate income to support national contributions to a global fund, but instead should be designed to assist in reducing

waste generation at the source and thereby reduce the national contribution to the global fund. An example of a suitable EPR legislation can be found in Norway's amended waste regulation for packaging. When packaging over a certain volume is placed on the Norwegian market, the contributing party must be financially responsible for the cost of collection, sorting, recycling and other processing of their waste packaging. Such packaging may only be placed on the Norwegian market if it complies with the design, reuse and recycling requirements as specified in the regulation. Annual reporting is also required that provides evidence of a decrease in waste generated from previous years (Government of Norway, 2017).

9. Measuring the effectiveness of fund outputs

The need for investment is reinforced through measured progress towards the desired outcome. Not all outputs of the fund may necessarily correlate back to a specific input parameter per the described model. They are, however, vital deliverables of a global fund. An example is a reduction in harmful chemicals used in the manufacture or end-of-life treatment of plastics. Although this is a desirable deliverable of the global fund because the impact of plastic waste on environment and human health is reduced, it does not necessarily contribute to a reduction in the global stock of marine plastic debris (the purpose of the model).

Measuring effectiveness of fund outputs may be challenging. Baseline information may not be available or may have been measured inconsistently for purposes of determining the effectiveness of policy measures adopted at a national level. A new model would therefore need to be ambitious in its deliverables but realistic in its measurements. Examples of targets specific to marine plastic debris are found in various existing instruments. The EU Marine Strategy Framework Directive requires EU Member States to achieve good environmental status (GES) for marine waters. With regard to marine litter, GES is achieved when “properties and quantities of marine litter do not cause harm to the coastal and marine environment” (MSFD, 2008). Galgani argues that without a definition of “harm” and qualification of what socio-economic harm may be, reaching GES may be difficult to assess. In addition, where monitoring and understanding of an impact are poor, Galgani notes the particular issue may not be included in Member State environmental targets (Galgani et al., 2013). Like any pollutant, different types of plastic have different damage functions in relation to the marine environment

(Koelmans et al., 2017; Lavender Law, 2017) and human health. Further clarification may be needed on which plastics and additives are most damaging and should therefore be prioritised for reduction via the global fund.

Other targets have incorporated representative species, such as the northern fulmar (*Fulmarus glacialis*) used in the OSPAR EcoQO.⁴ Not all states will have a suitable proxy species. Measurements may also not be able to account for marine plastic debris ingested outside the jurisdiction of a state yet affecting the national environmental target.

A global model would need to set environmental targets that can be achieved by the majority of states, irrespective of their economic and technical capacity. Global indicators should therefore be based on activities and surveys that can be undertaken on land and areas of the coastal zone that are easily accessible and not, for example, on the seabed. Where data is inadequate, targeted surveys may be funded for representative portions of the population and geographic locations to obtain statistics that are suitably scalable to a national level.

Examples of universally achievable indicators include monitoring the flow of plastic waste into waterways, at river mouths and at tourist hotspots. Social indicators, such as domestic consumption per capita and the volume of plastic waste diverted from landfill can be more easily determined. Thus, only local sources over which a state has control would affect the calculations of a state's contribution to the global stock. Measures implemented to achieve environmental targets in line with the proposed model should not be negatively affected by marine plastic debris originating from areas beyond national jurisdiction.

10. Discussion

Negotiation of an international legally binding instrument to protect the marine environment from land-based sources of pollution has not yet been undertaken by the global community, most likely because of the additional financial burden this would place on multiple industries and on local governments (Ten Brink et al.,

⁴ As per OSPAR, 2009. *Marine litter in the North-East Atlantic Region: Assessment and priorities for response*. London, United Kingdom. , Section 3.1.2.1, "The proposed EcoQO for Fulmars has been set as: *There should be less than 10% of northern fulmars (*Fulmarus glacialis*) having more than 0.1 g plastic particles in the stomach in samples of 50 to 100 beach-washed fulmars found from each of 4 to 5 areas of the North Sea over a period of at least five years.*"

2009). Multilateral agreements that are considered successful at incentivising behavioural change on a global scale are those that have incorporated a funding mechanism to assist and monitor member compliance.

A global fund model would have to be specifically developed and would need to calculate national contributions to the global stock of marine plastic debris by applying the same input parameters to all states, irrespective of their capacity to rectify the causes of their debris emissions. Under this model, some nations will initially be large contributors to the fund, creating an incentive to reduce waste entering the oceans so as to reduce their contributions to the global fund. Such a model would be regarded as inherently unfair, presenting issues of equity and of capacity to address national emission levels. However, once state contributions have been established, individual state targets can be more accurately calculated.

The Principle of Common but Differentiated Responsibilities would apply, separating those states that can afford to contribute to the global fund from those States that qualify for access to assistance from the fund. Many developing states would therefore be exempted from financial contributions and be assisted by the fund to develop their waste management programs. This would lead to a more equitable system, while still gaining an understanding of the sources, reasons and volumes associated with land-based plastic waste entering the waterways and oceans, assisting in prioritising actions and in monitoring progress towards measurable targets.

Each nation will naturally weigh the costs with the benefits of contributing to a global fund. The benefits from decreasing inputs of marine plastic debris include reduced damage to maritime industries, as well as reduced damage to environments with amenity value and eco-system service values. Human health benefits will also be realised. Estimating these benefits would require specific studies as limited information is currently available (McIlgorm et al 2009; 2011).

The issue of procuring funds for capital investment to remediate marine debris may be problematic (United Nations Economic Commission for Europe, 2008), particularly in developing states. This includes infrastructure projects that aim to fulfil a social and environmental need and for which financial profits may be minimal. All forms of global fund contributions to qualifying states will require inclusion of financial repayments within national economies, often with interest. However, an option for each national government is to use the information on

plastic waste emissions to seek contributions to the national global fund payment through, for example, taxes. As discussed, these include taxes on the landfill of plastics, placing undesirable plastic products on the market (particularly disposable products) and environmental taxes (e.g. within the tourism sector).

The implementation of a global fund need not be delayed because a conclusive value for the global stock of marine plastic debris cannot be determined with absolute certainty. The Precautionary Principle is applicable in this context. The “currency” of the fund can be based on an agreed estimate of the “plastic stock” using the best available scientific research. Where statistics are not available, or collection of data is not feasible, proxies can be used.

The challenges in establishing a global response to marine plastic debris extend beyond financial concerns. States are unlikely to agree on the terms of a multilateral agreement if it leads to significant financial investment. States may not see the value in contributing to a fund that will facilitate solutions in other states. Marine plastic debris must compete against other impacts of a global scale, such as ocean warming and acidification. A global policy framework must therefore aim to redirect incentives that enable current processes, such as subsidies for fossil fuel extraction (OECD, 2018), towards collection, sorting and recycling processes. The full lifecycle of plastic is now global, from manufacturing to end-of-life treatment. The policy framework therefore requires an international architecture to integrate efforts and guide solution-based management strategies.

11. Conclusion

International cooperation has proved to be vital in solving some of the most complex global commons issues at the international level. For ozone depleting substances, this has been achieved through an international legally binding instrument with an associated fund to assist State compliance, particularly within developing States.

The issue of marine plastic debris has gained much attention at the international level, but little progress has been made globally to prevent the continued contribution to the current stock in the marine environment. Discussion at the international level must progress towards the contribution of industry to the solutions, from design to the sustainable treatment of plastic waste at end of life. Legal and policy frameworks must incentivise private investment in preventive

measures, particularly solid waste management services. The required investment may be beyond the capacity of some states. Estimation of the damage costs of marine plastic debris is the next step in global discussions. A global fund that supports the development of the necessary services and behaviour change, as well as the legal frameworks to support them long-term must also be considered. This would necessitate urgent consideration of the feasibility of a new international architecture to set the global standards and drive the progress in preventive measures that have been lacking for decades to the detriment of our global oceans.

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