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MARINE PLASTIC POLLUTION AS A PLANETARY BOUNDARY THREAT

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ABSTRACT

Plastic pollution has accumulated in the marine environment due to an exponential rise in its usage in contemporary civilization and insufficient waste management. There is mounting evidence of a variety of mechanisms via which marine plastic pollution has an impact at many levels of biological organization. Ecological communities and ecosystem functioning will inevitably be impacted. One unanswered question is whether, today or in the future, the concentration of plastic in the ocean will reach levels above a critical threshold, causing global effects in vital Earth-system processes, allowing marine plastic pollution to be considered a key component of the planetary boundary threat associated with chemical pollutants. The impacts of plastic pollution in marine ecosystems, as well as the 'core planetary limits,' biosphere integrity, and climate change, are reviewed and evaluated to see if there are any possible solutions to this issue. Because marine plastic pollution is irreversible and ubiquitous throughout the world, two critical criteria for a planetary boundary danger have already been fulfilled. Plastic pollution's effects on the Earth system are yet unknown, although routes and mechanisms for thresholds and global systemic change have been discovered. Regardless of whether plastic is recognized as a new entity in the planetary boundaries paradigm, marine plastic pollution is undeniably linked with global processes to the point that it requires careful control and prevention.

KEYWORDS: *Chemical, Environment, Marine, Plastic, Pollution.*

1. INTRODUCTION

1.1 Anthropocene danger of marine plastic pollution:

Human actions have the potential to alter the regular functioning of Earth-system processes in ways that increase the hazards to global societies. The production, usage, and disposal of plastic is one of the most visible human activities. Plastic has become so pervasive in the environment that it is now regarded a geological marker of the Anthropocene, the coming era in which human activities have a significant impact on the status, dynamics, and future of the Earth system[1].Since the 1950s, mass manufacturing of plastic has exploded, influencing the evolution of contemporary civilization. Plastic resin output grew from about 1.5 million tonnes in 1950 to 322 million tonnes in 2015.

According to estimates, between 4.8 and 12.7 million tonnes of poorly managed land-based plastic trash entered the seas in 2010. Due to the numerous diverse origins and environmental

transport routes, the absolute quantity is difficult to quantify, but marine plastic pollution (MPP) is now widespread in the marine environment. It has been shown to have detrimental consequences for species, ecosystems, human health, and economical sectors including tourism, aquaculture, and navigation. The increased number of MPP research in recent years indicates increasing awareness about its consequences. The origins, fates, and consequences of microplastic in the seas have been assessed for the first time, emphasizing the need for policy and societal action and outlining important research objectives to guide this action[2], [3].

Plastics have recently attracted scientific interest as a possible planetary boundary hazard. The planetary boundaries framework establishes precautionary limits for a variety of anthropogenic perturbations, aiming to prevent thresholds or changes in Earth-system functioning that might result in increased hazards for the world's civilizations. The framework creates a worldwide 'safe operating environment' for humankind by defining quantifiable control factors and establishing limits. Chemical pollution/novel entities were identified as problems of concern in the scientific synthesis and subsequently, but no defined planetary limit was suggested[4], [5].

The new entities border is increasingly being addressed in the scientific community, alongside attempts to operationalize the planetary limits as a global sustainability policy integration framework. Expanded on the reasoning for the chemical pollution limit, addressing a broader spectrum of new synthetic or manmade substances discharged into the environment. However, due to a lack of consensus on the types of thresholds that should not be crossed, the wide variety of substances released into the environment, and the high uncertainty about their individual and interacting behavior, no boundary has been proposed, despite the fact that the planetary threat posed by chemical pollution is widely acknowledged as an unaddressed societal task. MPP is likewise subject to these strong knowledge limitations[6], [7].

This research builds on the concepts presented in three previous studies that have highlighted the problem of defining a planetary limit for marine plastic pollution and considers the consequences for environmental management and policy. Physical-biological interactions may play a deciding role in the large-scale and long-term destiny of marine plastics and ecological processes from sub-cellular to ecosystem scales may be affected in a variety of ways by marine plastics. These papers provide forth a study agenda for determining the origins, routes, degradation, and final fates of plastic in the ocean. The evaluation of whether and how MPP meets the criteria to be classified as a sub-border of the new entities boundary is informed by combining these various perspectives and concentrating on the ways that MPP influences Earth-system processes.

1.2 Justification: the Earth-system viewpoint on new things:

1.2.1 A scientific and governance gap in Earth systems:

The Earth system is made up of the dynamic interactions of Earth's physical and biological components at their most basic level. According to the planetary boundaries paradigm, this is a linked social-ecological system in which the world's societies are progressively influencing Earth's biophysical trajectory.

"New chemicals have the potential for undesirable geophysical and/or biological effects," according to the definition. They claimed that new creatures become a planetary concern when they show permanence, cross-scale dispersion, and the ability to disrupt critical Earth-system processes. The primary concern in looking into MPP as a planetary boundary threat is not its effects on people or even marine organisms in general, but rather the biophysical behavior of the

Earth system as a whole, with the added challenge for policy and operationalization that the behavior of concern is, by definition, unprecedented.

There are many unanswered scientific issues regarding which elements of planetary behavior are important and over what timeframes. The Holocene offers a baseline of comparative climatic and biological stability for most planetary boundary processes. There is no equivalent baseline for new entities, though. They exist because of contemporary humanity's creativity, ability, and technology for overcoming numerous physical and material limitations in the environment. The integration of human activity in Earth-system science's conceptual frameworks has remained a challenge, and the development of new entities exposes the limits of existing scientific knowledge. Thresholds or regime changes within ‘components' of the Earth system, such as ecosystem collapses, and in the dynamic connections between system components, such as ‘shifting gears' between physical and ecological processes, may constitute MPP a global boundary danger.

Plastic pollution is just beginning to be recognized as a worldwide systemic issue. Recent evaluations continue to record problems from an anthropocentric standpoint, such as human health or presently commercially important ecosystems, rather than Earth's resilience. They also draw attention to significant gaps in our understanding of the destiny of plastics and their geophysical and biological consequences.

Policy on marine plastics is also currently developing in this context. The necessity for a global agreement on marine plastic waste or debris is now being debated. The London Convention2, particularly its 1996 London Protocol3, and MARPOL both of which are enforced via national legislation in signatory countries, are important international agreements dealing with sea-based pollution. The Stockholm, Rotterdam, and Basel Conventions are global mechanisms that regulate land-based pollution, but not particularly plastic pollution. Only the United Nations Convention on the Law of the Sea8 establishes a wide overarching obligation to avoid all marine pollution from land-based sources. Plastic pollution is addressed at the European level via the Marine Strategic Framework Directive (Descriptor 10)9 and Article 9 of the Joint Communication on international ocean governance, both of which promote UN Agenda 2030's Sustainable Development Goal 14. Despite the increased focus on marine plastic in these settings, policy integration and consistency remain a major governance deficit[8].

1.2.2 A novel method for determining boundary lines

This investigation on the possibility of categorizing marine plastic pollution as a sub-border adds to the current debate over the classification of chemical pollution and new entities as a planetary boundary. To be deemed a planetary border, an entity must concurrently fulfil three suggested criteria and related scenarios. These criteria were first suggested for chemical pollution, mainly caused by synthetic chemicals, where there is a greater degree of consensus on how to define toxicity and danger. Two main difficulties emerge when applying this conceptual approach to MPP, both of which are related to substantial knowledge, governance, and policy shortages[9], [10].

To begin with, the overwhelming majority of plastic has long been thought to be ‘safe' (nontoxic or low toxicity). Chemical hazard assessment techniques presently in use place a greater emphasis on organism exposure than on the Earth system's multi-scale ecological functioning. A planetary limits approach should concentrate on characterizing the "hazardous paths" that may change Earth-system dynamics, rather than attempting to define "dangerous levels."

Second, the impacts of plastic on the Earth's system are inextricably complicated, with poorly predicted environmental behavior, destinies, and interactions with other chemical compounds – both natural and manufactured.

While some data on the amount of plastic material generated and discharged is accessible, there is still a great deal of misunderstanding and ambiguity regarding the paths that plastic takes in the marine environment. This investigation focuses on two possible pathways or scenarios: ecological effects on food webs and biogeochemical effects on marine carbon sequestration, both of which have a solid body of scientific evidence and where the direct, indirect, and cascading effects that combine to alter Earth-system dynamics can be distinguished fairly clearly. Figure 1 the Conditions under which marine plastic pollution can be regarded as a planetary boundary threat.

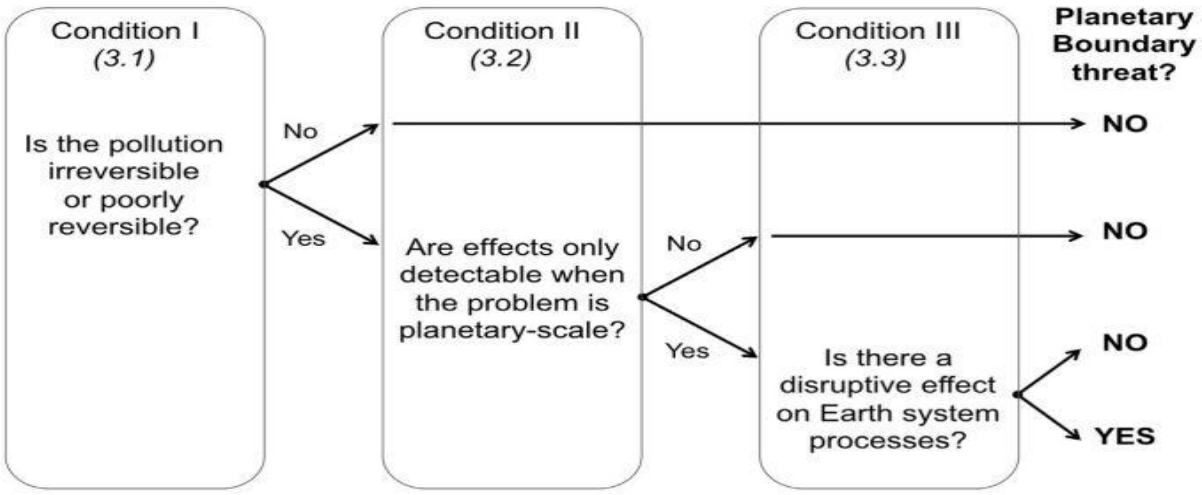

Figure 1: The above figure shows theconditions under which marine plastic pollution can be regarded as a planetary boundary threat.

1.3 Why are marine plastics included in the context of planetary boundaries?

Multiple worldwide anthropogenic disturbances are grouped together in the planetary boundaries idea in research and policy discourse. It is being addressed in policy settings such as the United Nations General Assembly, Europe's 7th Environment Action Programme, which outlines a vision of living well "within the limitations of the earth," and national sustainability plans. As a framework for human-caused Earth-system change, it should encompass the most visible and globally pervasive changes in the contemporary world, and this present review suggests that the environmental destiny of plastic trash is one of them.

MPP is a worldwide sustainability issue, a clear example of the tragedy of the commons, and one that is difficult to manage and regulate on a global scale.

Multinational frameworks, such as the Sustainable Development Goals, specifically Goal 14 ‘Life below water' and goals related to production and consumption; resolutions of the first and second United Nations Environment Assembly10; and the G7 and G20 marine litter action plans, are all addressing plastic waste. There is also talk on the necessity for a global instrument, such as a treaty on marine plastic pollution. Recognizing MPP as a worldwide issue may offer valuable policy advantage for the regulation of other high-risk chemical compounds. Recognizing the potential for a mismatch between risk perception and actual risk, global

ecological benefits could result if environmental plastic release is regulated in response to human public health concerns (e.g., about the effects of plasticizers like biphenyl A, which has been linked to cancers, endocrine and metabolic disorders, and behavioural disturbances).

Including MPP in the planetary limits framework may provide a shared framework for further developing and implementing these new policies while taking into account broader systemic impacts. It may also act as a catalyst for better global status and trend assessments, ecological monitoring, and management. Knowledge gaps must be filled before a marine plastics/novel entity planetary boundary can be made operational: basic information needed to define control variables about current stocks and effects of plastic debris in the marine environment, as well as its systemic effects, is lacking, particularly on the sustainability-critical issues in the planetary boundaries framework. The effect of marine plastic on connected social-ecological systems is a major knowledge gap. Only around 5% of the scholarly literature on marine plastic contamination discusses social or economic issues. Packaging and consumer/household products account for about two-thirds of overall plastics demand, with throwaway items accounting for a significant portion. Simultaneously, there is increasing worry about the impact of plastics and their additives on human health, food security, wealth, and well-being. Whether MPP worsens, increasing the danger of exceeding some Earth-system threshold, or is stopped and reduced, will be determined by people's consumption decisions and their prioritization of certain issues over others.

It is doubtful that the MPP issue has reached its pinnacle. Although oil, the primary raw material for plastic production, is a finite resource, if current rates of oil conversion into plastic continue until the estimated total cumulative oil production is reached, the final stock of marine plastic debris could be 2.3 times greater than what is currently in the oceans. There is no internationally systemic sustainability viewpoint, as shown by the increase in plastic manufacturing from other raw materials the large quantity of unmanaged plastic waste entering the seas, and the scarcely noticeable effect of clean-up operations worldwide. When there is a lack of knowledge regarding the disruptive impact that contaminants may have on Earth-system processes, care is required.

2. DISCUSSION

The author has discussed about the marine plastic pollution as a planetary boundary threat. Ecological groups and ecosphere health will undoubtedly be harmed. One unanswered question is whether the concentration of plastic in the ocean will reach levels above a critical threshold, causing global effects in vital Earth-system processes and allowing marine plastic pollution to be considered a key component of the planetary boundary threat associated with chemical pollutants, whether today or in the future. Plastic pollution's effects on marine ecosystems, as well as the "core planetary limits," biosphere integrity, and climate change, are all examined and evaluated to see if there are any potential solutions to this problem. Two vital criteria for a planets dividing line danger are already met but since industrial pollution is irrevocable and widespread around the world. The effects of plastic pollution on the Ecological systems are unknown, despite the discovery of pathways and mechanisms for baselines and global progressive change.

3. CONCLUSSION

Industrial pollution is irreparable and global in scope, meeting two of the three suggested necessary criteria for a planetary chemical pollution border. The evidence for the ecological effects of plastic pollution is increasing, but it is still unclear if MPP fulfils the third criterion and

has altered Earth system processes. The suggested danger conditions and scenarios that establish the criteria for a chemical pollutant to be considered a planetary boundary candidate have to be modified for MPP, since the solid-phase characteristics of plastic add to the complexity of chemical routes and ecological effects. The criteria may be interpreted in a variety of ways, especially in terms of time and space scales. Complex cross-scale processes such as trophic webs, ecosystem changes, and the carbon cycle exist. While it is clear that plastic is a global issue, there remains a great deal of ambiguity, if not outright misinformation, regarding its disruptive impacts on the Earth's ecosystem. The current literature lacks a comprehensive, holistic understanding of how sub-systems interact with one another and with the Earth-system processes that define Earth's self-regulating capability.

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