Plastics in blue carbon ecosystems: a call for global cooperation on climate change goals

Blue carbon ecosystems (BCEs; figure), comprising tidal marshes, mangrove forests, and seagrass meadows, contribute more than 50% of the total organic carbon buried in global marine sediments, despite occupying only 0·5% of the sea floor.[1] The ability of BCEs to sequester carbon dioxide into large amounts of stored sediment carbon[1] makes them important nature-based solutions for climate adaptation and mitigation.[2] The features that make BCEs important carbon sinks (ie, their global distribution and capacity to trap and preserve a large amount of carbon dioxide at the land and ocean interface) also make them an important sink of plastic-carbon. As of 2015, about 8300 million metric tonnes of virgin plastics were produced globally,[3] which is equivalent to 6900 million metric tonnes of plastic-carbon. Approximately 50–80 million metric tonnes of plastic-carbon accumulate within natural systems each year due to plastic mismanagement.[4] By comparison, BCEs accumulate about 100 million metric tonnes of blue carbon each year.[5] The current stocks of plastic-carbon in the global coastal systems are about 3–10 million metric tonnes,[5] with growing reports of plastic-carbon within BCEs.[6–8] If the present cubic growth trend for plastic accumulation and uncertain socioeconomic factors continue, amounts of plastic-carbon stock within the Earth system are projected to rise to 14 000 million metric tonnes by 2035, meaning that the amount of plastic-carbon will be equivalent to global blue carbon stock.[5]

The probable effects of plastics on chemical, physical, and biological processes within BCEs puts us in unchartered territory, raising questions about how plastic-carbon accumulation in BCEs might affect global blue carbon storage and sequestration capacity in future. Plastics and microplastics affect terrestrial soil ecosystems during microbial processes, plant growth, and litter decomposition, and release carbon dioxide into the atmosphere.[9] Importantly, at least 28 countries consider the conservation and restoration of BCEs, as substantial carbon dioxide sinks, as part of the nationally determined contributions (NDCs) to adapt and mitigate to climate change.[10] However, any disturbance of such carbon dioxide sink within BCEs in the presence of plastics could release a disproportionate amount of accumulated carbon into the atmosphere and hamper global climate goals. Despite their important global ecological, environmental, social, and economic contributions, BCEs are also considered among the most threatened ecosystems on Earth,[2] with a global annual loss of about 340 000–980 000 hectares[11] and loss rates ranging from 0·03% to more than 1%, which is 2-times higher than those of tropical forests.[1] Therefore, the effect of multistressors (ie, habitat loss, climate change, and plastic) to BCEs can further downgrade their capacity to sequester carbon dioxide and hamper global climate targets.

Plastic-carbon needs to be considered as part of the gloabl carbon cycle.[12] Carbon dioxide and other greenhouse gases emit at every stage of the plastic lifecycle, for instance, during fossil fuel extraction and transport, plastic refining and production, and management and disposal of plastic waste; all stages of emission have consequences for our soil, atmosphere,

For more on the **UN Environment World Conservation Monitoring Centre** see https://data.unep-wcmc.org/

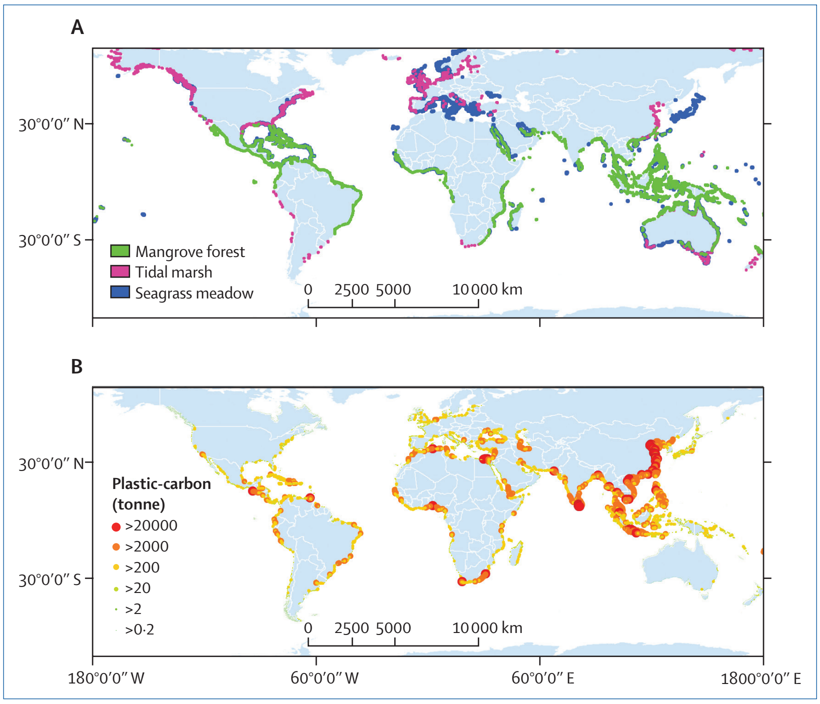

Figure: **(A) Global distribution of BCEs with data derived from the UN Environment World Conservation Monitoring Centre, (B) modelled mass of plastic-carbon discharged to global oceans through rivers and coastal areas[4] and plastic waste to plastic-carbon conversion along the land-ocean boundary[12]**

waterways, and oceans.[5] Despite the potential of plastic-related activities to release greenhouse gases, Earth system models or integrated assessment models do not take account of plastic-carbon emissions. A comprehensive quantification of overall greenhouse gas emissions from the plastic sector and an understanding of its effects on BCEs, global carbon budget, and climate goals are urgently needed. Developing such an estimate is a crucial next step for pinning down and communicating the relevance of plastic-related carbon dioxide emissions to decision makers in order to stop plastic use.

The 26th United Nations Climate Change Conference of the Parties (COP26) held in 2021 put plastics on its agenda. We call for broader commitment from all levels to tackle the plastic problem in order to safeguard global oceans and BCEs, and quantify plastic-related greenhouse gas emissions in the global carbon budget. This year commemorates the 50th anniversary of the Convention on Wetlands (Ramsar Convention), and the UN Environment Programme will be 50 next year. Reflection on the past five decades is crucial to simultaneously control plastic pollution and protect, conserve, and restore global oceans and BCEs in future. The Kunming Declaration of the UN Biodiversity Conference of the Parties to the Convention on Biological Diversity 15th meeting (COP15, Part 1) held in 2021 emphasised the combined importance of reducing waste and pollution, enhancing the restoration of ecosystems, mitigating climate change, among others for the post-2020 global biodiversity framework. We urge further strong commitment from global leaders to acknowledge plastic-carbon in the global climate targets and also commit to scaling down and stopping the release of plastics into oceans and BCEs in the fifth session of the UN Environment Assembly (UNEA-5.2), the second part of COP15 and the UN Ocean Conference to be held in 2022. The United Nations Decade of Ocean Science for Sustainable Development and the UN Decade on Ecosystem Restoration will run until 2030, which is also the deadline for the Sustainable Development Goals. Therefore, a joint action from these global initiatives can provide a unique framework, policy interventions, and financial support to manage and restore BCEs, and stop plastics being released to marine ecosystems at the local, regional, and global scales.

I declare no competing interests.

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