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Managing the Ocean's role in CO_2 mitigation?

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Coastal and marine systems are major reservoirs in Earth's carbon cycle, storing many the amount of carbon in the atmosphere. As such they provide an essential service in maintaining a clement climate on Earth. Coastal systems such as mangroves and salt marshes have been reduced in area by as much as 90% through coastal development in the last century, reducing their capacity to take up atmospheric CO_2. As humans' activities further perturb the Earth System through CO_2 emissions and resulting temperature rise, offshore shelf and open ocean marine systems' capacity to sequester CO_2 may be increasingly impacted. Whilst the physical uptake of $CO_2$by the ocean, driven by thermodynamics as the atmospheric concentration increases will continue in a predictable (albeit non-linear) manner, the response of key biological processes in the various mechanisms which export carbon from the atmosphere to shelf sediments and the deep ocean are difficult to predict, given the complexity of the system. The potential denudation of these carbon-removing processes has potential to significantly hamper the effort to reduce atmospheric CO_2 in order to keep within the 1.5 degrees of warming agreed in the Paris convention.

At the same time, there is increasing interest across research, policy and commerce of the value of 'blue carbon' i.e. the carbon stored by coastal and marine systems, both as an incentive to protect coastal systems and natural marine carbon sinks and as a potential growth area for negative emissions (i.e. new CO_2 sequestration). In order to understand and realise this we need both the requisite process understanding of the system and the application of environmental economic methods to assess the benefits that humankind receives.

This paper examines the capacity of marine systems to mitigate the negative effects of CO_2 (warming, ocean acidification) in comparison to total emissions to 2100 under standard ICP scenarios. We demonstrate that coastal systems are only able to make a significant impact on future emissions under the most optimistic scenario, with minimal emissions and extreme reinstatement of coastal habitats. Shelf sea sea and open ocean systems have the potential to take up larger amounts of CO_2 through management actions and geoengineering activities; however the natural carbon sequestration services are orders of magnitude larger still and potentially at risk from climate change impacts. In order to protect and conserve natural sinks as well as gaining additional CO_2 sequestration from management activities under the current global economic model, integration of natural science and environmental economics is essential to value the servicesprovided and incentivise positive action.