Climate change efforts should focus on ocean-based solutions

October 4 2018

Ambitious and rapid action is needed to reduce climate change and its impacts—and the first broad-scale assessment of ocean-based solutions shows the focus should be on the oceans. The study looks at the feasibility of 13 ocean-based measures to reduce atmospheric carbon dioxide (CO_2), counteract ocean warming and/or reduce impacts like ocean acidification and sea-level rise. It identifies ocean-based renewable energy as the most promising, and several local marine conservation and restoration options as 'no-regret measures', that should be scaled-up and implemented immediately, but concludes all other measures are still too uncertain to recommend without further research. Published in *Frontiers in Marine Science* as part of the article collection 'Successes at the Interface of Ocean, Climate and Humans', the study highlights the trade-offs and governance issues associated with all solutions and emphasizes that the greatest benefit will come from combining global and local solutions through policy cooperation.

Current plans to reduce CO_2 emissions under the 2015 Paris Agreement are not enough to keep global temperatures below a 20C increase relative to pre-industrial levels. Despite the major role of oceans in climate regulation, ocean-based solutions to combat climate change have received relatively little attention compared to land-based solutions.

"The ocean already removes around 25% of anthropogenic CO_2 emissions—and could remove and store much more," says the study's lead author, Dr. Jean-Pierre Gattuso from the Centre National de la Recherche Scientifique (CNRS), France. "However little guidance is

currently available on which ocean-based interventions will work best to reduce the scale and impacts of climate change."

To fill this gap, Gattuso and an international team of experts collaborating on The Ocean Solutions Initiative assessed 13 global and local measures. These fell into four categories: reducing atmospheric CO2 concentrations; increasing the proportion of solar radiation reflected back to space; protecting marine ecosystems; and manipulating biological and ecological adaptation to climate change impacts.

The team analyzed each measure's potential to reduce three climate-related drivers—ocean warming, ocean acidification and sea-level rise—as well as its technological readiness, benefits, drawbacks, cost-effectiveness and governability. They also looked at the potential of each measure to reduce impacts on key marine ecosystems, namely warm-water coral reefs, mangroves and salt-marshes, seagrass beds and Arctic habitats, and key ecosystem services, namely fisheries, aquaculture and coastal protection.

A switch to ocean-based renewable energy stood out as having the highest potential for immediately addressing the causes of climate change.

"Not only do offshore wind farms, wave energy and other ocean renewables have a very large potential to reduce carbon emissions, but they are also cost-effective and ready to be implemented at a large-scale," says study co-author Dr. Alexandre Magnan from France's Institute for Sustainable Development and International Relations.

The study also identifies local efforts with moderate effectiveness to reduce ocean acidification and sea-level rise.

"Reducing marine pollution, stopping overexploitation of marine

resources, restoring hydrological flow and protecting marine habitats are all technologically ready and have significant benefits," says Gattuso. "Restoring and conserving coastal vegetation like mangroves, salt marshes and seagrass beds to enhance CO2 uptake and reduce further emissions is also already feasible with few disbenefits."

Other measures were found to have a high potential to address climate-change drivers, but low feasibility. One potentially large and permanent intervention to consume CO2 and/or neutralize ocean acidity is to add alkaline materials to the ocean. However, "the feasibility and benefits must be weighed against the financial costs and environmental impacts of mining or producing vast quantities of alkaline material distributed at global scales, and the potential impacts on marine life," points out Gattuso.

Large amounts of CO2 could also be removed by fertilizing the ocean with iron to increase the amount of phytoplankton—but this is difficult to implement and govern. Another approach is to apply foam to the ocean's surface to enhance reflection of solar radiation. However, the effect would only last as long as the foam remains in place, just days to months, and would have dramatic impacts on plants and animals.

"Our study shows that all measures involve trade-offs and decisions should consider their relevance in terms of costs, benefits and ease of governability," says Magnan. "The potential for ocean-based options to address climate change and its impacts is very high and depends on societies' ability, from local to international levels, to decide about the right combination of measures."

More information: *Frontiers in Marine Science*, DOI: 10.3389/fmars.2018.00337

Provided by Frontiers