



GESAMP

Joint Group of Experts on the
Scientific Aspects of Marine
Environmental Protection

GESAMP 52/4/4
25 June 2025
ENGLISH ONLY

52nd Session
Agenda item 4

PLANNING OF GESAMP ACTIVITIES

Ocean interventions for climate change mitigation

Report of the Co-Chairs of Working Group 41

Activities of the Working Group

1 At the 51st annual session of GESAMP, held in Monaco, the IOC Technical Secretary for GESAMP noted the importance of sharing the latest information on the state of science with the Sponsoring Organization, particularly given the rapid developments and increasing stakeholder involvement in this field. Such a document could serve as a valuable resource for upcoming intergovernmental and other processes, including the third UN Ocean Conference (UNOC 3) and the seventh session of the United Nations Environment Assembly (UNEA 7), both in 2025.

2 In light of the above discussions, it was proposed that WG 41 develop a concise 'state of the science for marine carbon dioxide removal (CDR)' document, building on the information that the WG had provided to the recent IOC/UNESCO State of the Ocean Report. As a small group meeting of WG 41 members, scheduled to meet in November 2024 in Copenhagen to work on the Ocean Intervention Assessment Framework, agreed to also start work on developing the state of the science document.

3 The meeting took place from 18 to 20 November 2024 at Copenhagen University, hosted by IOC/UNESCO. Participants included five members of Working Group 41 alongside Henrik Enevoldsen and Kirsten Isensee from IOC/UNESCO. The meeting allocated time between two key objectives:

- .1 advancing the Ocean Intervention Assessment Framework; and
- .2 developing an outline for the state of science for marine CDR document, now titled 'The State of the Science for Marine Carbon Dioxide Removal (mCDR) – A Scientific Summary for Policy-Makers'. Tasks were assigned to members to address specific sections of the document.

4 Following the meeting, the State of the Science document was developed by a sub-group of members. The document was subsequently circulated to all WG 41 members for their review and feedback. An additional meeting of the sub-group was held at GEOMAR, Kiel, Germany, from 10 to 11 March 2025, during which the document was substantially finalized. After incorporating comments received the document was finalised and submitted to IOC/UNESCO for proof reading and formatting. The final version was printed in time to be presented to the One Ocean Science Congress and the third UN Ocean Conference in Nice, France, in June 2025. The document is now publicly available and can be downloaded at <https://unesdoc.unesco.org/ark:/48223/pf0000393817> as well as the GESAMP website.

5 The Ocean Interventions Assessment Framework (OIAF) is now ready to be presented in draft form to an expert workshop for review, subject to funding.

Engagement with the One Ocean Science Congress in Nice, 3 to 6 June 2025

6 At the One Ocean Science Congress, during a session launching the ocean panel report 'Principles for responsible and effective marine carbon dioxide removal development and governance', Ambassador Peter Thomson, the UN Secretary General's Special Envoy for the Ocean, highlighted the critical role of GESAMP in his closing remarks. He noted that GESAMP remains under-appreciated and he "...referred to the recent authoritative report on mCDR published by GESAMP".¹ Also, on 4 June, at the beginning of the session on 'Carbon dioxide removal approaches: effectiveness, durability, risks, as well as monitoring, reporting and verification', Mr. Vidar Helgesen, Executive Secretary of IOC/UNESCO and Assistant Director-General of UNESCO, commended the GESAMP State of the Science report to the audience.

6 A poster summarizing the 'The State of the Science for Marine Carbon Dioxide Removal (mCDR) – A Scientific Summary for Policy-Makers' document was prepared with the support of IMO, and displayed in the poster sessions of the One Ocean Science Congress.

7 Miranda Boettcher, member of GESAMP WG 41, presented an overview of the OIAF in the second session of the Congress on 'Carbon dioxide removal approaches: effectiveness, durability, risks, as well as monitoring, reporting and verification'.

Input into wider marine geoengineering activities

8 Since GESAMP 51, Chris Vivian, Co-Chair, has been invited to actively participate in the following meetings:

- .1 'Exploratory talks on marine carbon dioxide removal governance under the 1996 London Protocol' in Hamburg, Germany, on 4 November 2024, giving a presentation on 'Limitations of the London Protocol';
- .2 'Climate intervention Conference' webinar on 11 December 2024, giving a presentation on 'Ocean interventions for climate change mitigation' covering the work of GESAMP Working Group 41 and its interactions with the London Convention (LC) and London Protocol (LP);
- .3 Contributed to the discussions of the two LC/LP intersessional correspondence groups on marine geoengineering (the Legal Intersessional Correspondence Group and the Scientific Groups Correspondence Group on Marine Geoengineering), and attended the LC/LP governing bodies meeting held from 28 October to 1 November 2024 at IMO Headquarters in London, United Kingdom, to take part in the marine geoengineering discussions;
- .4 'CDRmare Annual General Assembly', 17 to 19 February 2025, giving a presentation on 'Marine CDR – do we need it and if so, what are the governance issues?';
- .5 The annual meeting of the EU Horizon Europe project 'SEAO2-CDR – Strategies for the Evaluation and Assessment of Ocean based Carbon Dioxide Removal' held in Leiden, Kingdom of the Netherlands, from 18 to 19 June 2025. Chris Vivian and Miranda Boettcher are members of the External Advisory Board for the project; and
- .6 IOC/UNESCO Ocean Science Day in Paris, France, on 30 June 2025, giving a keynote presentation on 'Ocean solutions for mitigating climate change'.

1 https://www.linkedin.com/posts/peter-thomson-b5379b27_mcdr-oceanpanel-gesamp-activity-7335944473161420800-Ahqm/

9 Philip Boyd (Co-chair) and Chris Vivian have been online observers at a wide range of meetings/webinars of various marine CDR methods such as EXOIS (United States) and Gigablue (Israel).

Research by SOLAS

10 WG 41 has secured funding through the United States philanthropy organisation IconiQ for four three-year postdoctoral researchers enabling significant advancement in Ocean Alkalinity Enhancement (OAE) research. Teams at the University of Dalhousie (Canada) and the University of Tasmania (Australia) are employing a combination of laboratory and field work to address knowledge gaps identified by modellers on OAE. Their findings are contributing to the improvement of model parameterisations with progress and results reported to the Surface Ocean Lower Atmosphere Study (SOLAS). This iterative process between laboratory/field scientists and modellers will continue over the next twenty months.

Future meetings and funding

11 The Working Group has not convened a full meeting since May 2023 due to insufficient funding availability. This prolonged gap between meetings has hindered the effective utilization of the Working Group's diverse expertise. In 2024, the limited available funding was allocated for convening meetings towards the preparation of 'The State of the Science for Marine Carbon Dioxide Removal (mCDR) – A Scientific Summary for Policy-Makers' and the production of the poster on the topic for display at the One Ocean Science Congress. To maximise the Working Group's contributions, it is essential to secure additional funding. This would involve a two and a half day workshop to review the (OIAF) followed by a full Working Group meeting to finalize the framework, totalling five days of collaborative engagement. Given the scale of this proposed meeting, it will be necessary to seek supplementary funding from new sources beyond those previously supporting the work, as well as potential contributions from governmental funding streams.

Action requested of GESAMP

12 GESAMP is invited to consider the information provided and take action as appropriate.

ANNEX 1

TERMS OF REFERENCE FOR GESAMP WORKING GROUP 41 ON 'OCEAN INTERVENTIONS FOR CLIMATE CHANGE MITIGATION' (WG 41)

Lead Agency: IMO

Co-sponsors: IOC/UNESCO and WMO

Co-Chairs: Chris Vivian (United Kingdom) and Philip Boyd (Australia),

Technical secretary: Andrew Birchenough (IMO)

The second phase of the GESAMP Working Group 41 study should:

- 1 Develop a flow chart and questionnaire with associated guidance to elicit information from proposers of ocean interventions for climate change mitigation or other purposes consistent with the London Protocol's definition of marine geoengineering, to enable a preliminary assessment (including constructive feedback) of their techniques by regulators, policy makers, funders or anyone considering or permitting proposals. The flow chart and questionnaire with associated guidance will be aimed to facilitate the London Protocol 'Guidance for consideration of marine geoengineering activities' (IMO, 2015). The Working Group should also consider additional incentives that can be provided to proposers of ocean interventions for climate change mitigation to comprehensively report their approaches in the permanent public record, drawing upon the discussions of these incentives in the Working Group report. Examples of such incentives to proposers of ocean interventions for climate change mitigation include modelling assessments (externally funded) that straddle conceptual, box models on to more complex approaches such as CDRMIP (Carbon Dioxide Removal Model Inter-comparison Project).
- 2 Develop a framework to integrate inputs from natural sciences and societal disciplines into a holistic assessment of ocean interventions for climate change mitigation or other purposes consistent with the London Protocol's definition of marine geoengineering, to be used by regulators, policy-makers, funders or anyone considering or permitting proposals, exploring the use of a systems approach framework such as that presented at the March 2019 workshop (see Elliott et al., 2015; Cormier and Elliott, 2019; Barnard and Elliott, 2015).
- 3 Provide advice to the London Protocol Parties:
 - a) identifying promising ocean interventions for climate change mitigation or other purposes i.e. those consistent with the London Protocol's definition of marine geoengineering, that might be worthwhile to consider for listing in the new annex 4 of the Protocol, including techniques having the potential to move to field testing;
 - b) developing an outline of the specific issues to be addressed in an assessment framework for each of a subset of techniques identified 11.3(a) above, using the London Protocol Assessment Framework for Scientific Research Involving Ocean Fertilization as a template;
 - c) providing an initial assessment of monitoring and verification approaches, including the difficulties and challenges, for each of the techniques, meriting detailed scrutiny, identified under 11.3(a) above; and

- d) identifying significant gaps in knowledge and uncertainties associated with each of the small suite of techniques identified 11.3(a) above that need to be addressed to assess their implications for the marine environment and, where appropriate, the atmosphere..4 Provide brief updates, based on new scientific evidence since the WG 41 report was published in March 2019 (in particular from the IPCC 'Special Report on the Ocean and Cryosphere in a Changing Climate' published in 2019, and the forthcoming IPCC 6th Assessment Reports) on:
 - i) any new proposed ocean interventions that may have potential for climate change mitigation or other purposes consistent with the London Protocol's definition of marine geoengineering such as fisheries enhancement, and their scientific practicality and efficacy; and
 - ii) the potential environmental and societal impacts of ocean interventions for climate change mitigation or other purposes consistent with the London Protocol's definition of marine geoengineering, on the marine environment and, where appropriate, the atmosphere.
- 4 Produce reports and potentially peer-reviewed scientific papers on the points above at appropriate points in the work plan.

ANNEX 2

Publications by WG 41 members

- Baatz, C.,...Böttcher, M*. ...Mengis, N*. ...Merk, C*. ...et al. (2025) A holistic assessment framework for marine carbon dioxide removal options. *Environmental Research Letters* 20 054047. <https://iopscience.iop.org/article/10.1088/1748-9326/adc93f>
- Boettcher*, M. and Brent, K, (2024) The potential of the BBNJ clearing house mechanism to enhance knowledge pluralism in marine carbon dioxide removal assessment. *Frontiers in Climate* 6 1497476. <https://www.frontiersin.org/journals/climate/articles/10.3389/fclim.2024.1497476/full>
- GESAMP WG 41 members (Vivian, C., Boettcher, M., Elliott, M., Mengis, N., Merk, C., Oeschlies, A., Boyd, P.W., Lancaster, A., Corry, C., Sugiyama, M. and Gupta, A.) (2025) 'The State of the Science for Marine Carbon Dioxide Removal (mCDR) – A Scientific Summary for Policy-Makers' produced by GESAMP Working Group 41 has now been published and can be downloaded at <https://unesdoc.unesco.org/ark:/48223/pf0000393817>
- Oeschlies, A*.and Ginzky, H. (2024) Effective control mechanisms of research on climate engineering techniques for the public good—The London Protocol regulatory approach as a role model. *Frontiers in Climate* 6 1474993. <https://www.frontiersin.org/journals/climate/articles/10.3389/fclim.2024.1474993>
- Oeschlies, A*. ...Mengis, N*. ...et al. (2025) Perspectives and challenges of marine carbon dioxide removal. *Frontiers in Climate* 6 1506181. <https://www.frontiersin.org/journals/climate/articles/10.3389/fclim.2024.1506181/full>
- Oeschlies, A*. et al. (2025) Potential impacts of marine carbon dioxide removal on ocean oxygen. *Environmental Research Letters* 20 073002. <https://iopscience.iop.org/article/10.1088/1748-9326/ade0d4>
- Vivian, C*, Böttcher, M*. and Boyd, P.W*. (2024) Potential of marine carbon dioxide removal (mCDR) to increase the ocean carbon sink. *IOC-UNESCO State of the Ocean Report, IOC Technical Series, 190, IOC-UNESCO, Paris, 55-58.* <https://doi.org/10.25607/4wbq-d349>
- Vivian*, C. and Del Salvio, L. (2024) The London Convention and Protocol: Adapting to Address the Ocean-Climate Crisis. *The International Journal of Marine and Coastal Law* 39(3): 519-527. <https://brill.com/view/journals/estu/aop/article-10.1163-15718085-bja10178/article-10.1163-15718085-bja10178.xml>

* GESAMP WG 41 members

ANNEX 3

MEMBERSHIP OF WG 41

Name	Affiliation	Country
Miranda Boettcher	German Institute for International and Security Affairs, Berlin	Germany
Philip Boyd*	University of Tasmania	Australia
Alejandro Buschmann	i-mar Research Center, Universidad de Los Lagos	Chile
Long Cao	School of Earth Science, Zhejiang University	China
Olaf Corry	School of Politics and International Studies, University of Leeds	United Kingdom
Mike Elliott	Department of Biological and Marine Sciences, University of Hull	United Kingdom
Aarti Gupta	Environmental Policy Group, Department of Social Sciences, Wageningen University	Kingdom of the Netherlands
Clare Heyward	Department of Philosophy, UiT: The Arctic University of Norway	United Kingdom
Rahanna Juman	Institute of Marine Affairs	Trinidad and Tobago
Alana Lancaster	Faculty of Law, University of the West Indies	Guyana
Nadine Mengis	GEOMAR, Helmholtz Centre for Ocean Research, Kiel	Germany
Christine Merk	Research Center Global Commons and Climate Policy, Kiel Institute for the World Economy	Germany
Andreas Oschlies	GEOMAR, Helmholtz Centre for Ocean Research, Kiel	Germany
Masahiro Sugiyama	Institute for Future Initiatives, University of Tokyo	Japan
Chris Vivian*	Retired from Cefas	United Kingdom
Guanqiong Ye	Ocean College, Zhejiang University	China

*Co-chairs
