Applicability of 2009 and 2013 Amendments to the London Protocol to the Transboundary Sub-Seabed Sequestration & Storage of Carbon Dioxide

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CEL acknowledges the traditional custodians of the land that Macquarie University now occupies: the Wallumattagal clan of the Dharug nation. We acknowledge that the land was never ceded. The Wallamutagal people's cultures and customs have nurtured, and continue to nurture, this land since the Dreamtime. We pay my respects to Elders past, present, and emerging.

Summary

This submission outlines certain international law requirements applicable to the sub-seabed sequestration and storage of carbon dioxide (CO2) in the transboundary context i.e., where CO2 streams are exported and/or imported across boundaries for the purpose of sub-seabed sequestration and long-term geological storage. This submission highlights perceived environmental benefits and risks associated with these practices. It also explains how the 2009 and 2013 Amendments to the London Protocol strengthen the existing environmental regulatory framework for sub-seabed CO2 sequestration, specifically in the transboundary context.

1 Background to Sub-Seabed CO_2 Sequestration and Storage

Sub-seabed CO_2 sequestration and storage, also known as carbon capture and storage (CCS), is a technology used within a series of processes in which CO_2 is captured from large-scale emitting sources (including power plants, cement and steel manufacturing, etc.); transported through pipelines and other transport methods (such as trains, trucks, and ships) to a determined storage site; and, then, sequestered in deep underground spaces on land or in the ocean. This technology aims to securely isolate, inject, and permanently trap the CO_2 in the target storage site. A key feature is its long-term storage capability, which can last for hundreds or thousands of years. The oil and gas industry has used CO_2 capture, transport, and sequestration to enhance oil recovery (EOR) for decades. However, EOR uses temporary storage to increase oil production. Conversely, CO_2 sequestration and storage features permanent sequestration and requires a more extensive pipeline system.

Three potential geological locations for permanent carbon sequestration are being explored: (1) saltwater aquifers, (2) coal seams that cannot be mined; and (3) depleted or nearly depleted oil and gas reservoirs. Depleting offshore petroleum reservoirs appear as the most promising option for long-term CO_2 storage for multiple reasons.[1] First, the geology of oil and gas fields is well understood. Second, a robust subsurface injection infrastructure is in place. Third, the CO_2 would fill the same space as the hydrocarbons which were previously extracted, and these fields have successfully stored hydrocarbons for millions of years. If the geological seal which contained the hydrocarbons has not been compromised, the reservoir should be able to store securely the injected CO_2.

2 Instances of Transboundary CO_2 Sequestration and Storage

Some countries may not have suitable storage sites and associated infrastructure within their borders for long-term storage of CO_2. As a result, they may opt to export their CO_2 streams to other countries. Several possibilities exist for transboundary CO_2 sequestration and storage.[2] For instance, capturing could occur in State A, transportation through State B, and final sequestration in State C. The most simple transboundary scenario involves capturing CO_2 in

[1] IEAGHG, 'Interaction of CO_2 Storage with Subsurface Resources' (Report 8 April 2013) http://ieaghg.org/docs/General_Docs/Reports/2013-08.pdf.
[2] Park, 'Study on Legal Systems for Transboundary CCS Implementation and Transboundary Environmental Liability Regarding CCS' (2020) 16(1) Loyola University Chicago International Law Review 45.

State A and exporting to State B for permanent sequestration and storage. Alternatively, States A and B could agree to jointly sequester the CO_2 into a common sub-seabed storage site. The storage site could be a geological deposit on either side of the international maritime boundary. The storage site could also be a straddling deposit subject to a joint development regime across the agreed maritime boundary, such as the Greater Sunrise Special Regime between Australia and Timor-Leste. In this last scenario, all States with a right of access to the common sub-seabed storage site must collaborate closely on a range of issues and procedures, including site selection, licensing, environmental impact assessments, and long-term monitoring.[3]

Europe is a useful case-study for transboundary CO_2 sequestration and storage. Europe is composed of numerous smaller States bordered by each other on land and/or at sea. Thus, many borders may need to be crossed to connect CO_2 sources to suitable storage locations. As Prof Langlet writes:

> The need for attaining a sufficient scale for any CCS project to make financial sense (to the extent that it makes such sense all) may also necessitate the clustering of CO_2 sources across national boundaries as well as other forms of cooperation between operations in two or more states.[4]

To establish the required framework of cooperation, the European Union (EU) enacted Directive 2009/31/EC (EU CCS Directive).[5] It sets out a uniform set of legal requirements for the safe and ecologically sound sub-seabed storage of CO_2, including provisions for monitoring and reporting and for granting authorisations for CO_2 transport, sequestration, and storage projects.[6] The EU CCS Directive is 'the first comprehensive legal framework for the management of environmental risks related to CCS.'[7]

The EU CCS Directive requires that CCS storage be rock-based and not water-column-based; the sequestered CO_2 volumes must be contained. Article 1(2) sets out the objectives of CO_2 storage:

> The purpose of environmentally safe geological storage of CO_2 is permanent containment of CO_2 in such a way as to prevent and, where this is not possible, eliminate as far as possible negative effects and any risk to the environment and human health.

The examination of potential CO_2 storage sites must be rigorous. Per Article 4(4), a 'geological formation shall only be selected as a storage site, if under the proposed conditions of use there is no significant risk of leakage, and if no significant environmental or health risks exist.'

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[3] 2006 IPCC Guidelines for National Greenhouse Gas Inventories Ch.5 'Carbon Dioxide Transport, Injection & Geological Storage' <https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_5_Ch5_CCS.pdf>

[4] David Langlet, 'Transboundary Dimensions of CCS: EU Law Problems and Prospects' (2014) 8(3) Carbon and Climate Law Review 198-207.

[5] Directive 2009/31/EC of the European Parliament and the Capture and Storage Technology in Europe (2013/2079(INI)).

[6] For a comprehensive study, see Roggenkamp and Woerdman (eds), *Legal Design of Carbon Capture and Storage, Developments in the Netherlands from an International and EU Perspective (*Intersentia 2009).

[7] 'UNFCCC, 'Transboundary Carbon Capture and Storage Project Activities' (Technical Paper, 1 November 2012) Doc FCCC/TP/2012/9.

Additional rules are in place to prevent environmental harm. For example, EU Member States must cooperate to prevent transboundary injuries. In alignment with the Arhus Convention, Article 26 requires Member States to make available 'public environmental information relating to the geological storage of CO_2.' Article 28 also mandates that EU Member States ensure that 'effective, proportionate and dissuasive' penalties are brought to bear on the operators operating within and across EU borders.

3 Perceived Benefits and Environmental Risks

The main source of emitted CO_2 globally is the combustion of fossil fuels, such as coal, crude oil, and natural gas, for energy production. Fossil fuels remain the world's dominant energy source, representing 80% of the global energy supply according to 2022 data.[8] New energy technologies are constantly sought and explored. Recent events have highlighted the importance of finding new pathways to energy transition. These include notably the COVID-19 pandemic and the war in Ukraine which has led to instability in energy prices, shortages, and energy security concerns. Australia and other energy-hungry nations must navigate between a Scylla of limited domestic energy resources and a Charybdis of bad energy options, such as carbonaceous fossil fuels and risky uranium-fuelled nuclear power plants to power industrial sectors. Australia and other countries must meet their Paris commitments to reduce carbon emissions without compromising their energy security. Alternative ecological pathways are required to cut through that Gordian knot of low-carbon energy transitions, whilst addressing energy supply concerns.

The large-scale implementation of CCS projects can expedite the transition to low-carbon energy systems.[9] CCS can decarbonise a variety of industrial processes. In the future, CCS could be used to remove CO_2 from the atmosphere or store it while generating energy from biomass. The United Nations Framework Convention on Climate Change (UNFCCC) recognizes CCS as a crucial component in reaching the 2-degree goal and CCS projects may be eligible as project activities under the clean development mechanism.[10]

Despite its potential, the global community has yet to embrace fully CCS to combat climate change. This hesitation stems primarily not from the lack of technology, but from fear of environmental liabilities in the event of faulty implementation. There is strong scientific evidence that CO_2 can be securely stored for very long periods exceeding centuries. However, it is also clear that, under certain circumstances, migration and, sometimes, escape of the captured CO_2 volumes from these reservoirs is possible.[11] Increased risks from CCS are associated both with the sheer volume of injected material and the specific properties of CO_2.[12]

[8] BP Statistical Review of World Energy 2022.
[9] IEA, 'Carbon Capture and Storage: Legal and Regulatory Review' (May 2011); OECD/IEA, 'Technology Roadmap: Carbon Capture and Storage' (July 2013).
[10] UNFCC, <https://unfccc.int/resource/climateaction2020/tep/thematic-areas/carbon-capture/index.html>; Zakkour, Scowcroft, and Heidug, 'The Role of UNFCCC Mechanisms in Demonstration and Deployment of CCS Technologies' (2014) 63 Energy Procedia 6945–6958.
[11] Metz et al, 'IPCC Special Report on Carbon Dioxide Capture and Storage' (CUP 2010).
[12] Klass and Wilson, 'Climate Change and Carbon Sequestration: Assessing a Liability Regime for the Long-term Storage of Carbon Dioxide' (2008) 58 Emory Law Journal 103, 119.

Accidents resulting from errors in CO_2 storage could result in severe and irreversible environmental harm.

Significant liabilities may arise from uncertainties in the international legal framework. From a legal and policy perspective, the issue of who would be responsible for compensating for the environmental damage in case of injury is complex. This would be further complicated where the CO_2 storage site operator has become insolvent or no longer exists.[13] Thus, while the potential benefits of sub-seabed CO_2 sequestration and long-term storage are seemingly numerous, the regulatory landscape for such activities could pose a challenge for large-scale CO_2 storage deployment across countries.

Across the Pacific, the Japanese government has initiated a massive research and development programme to assess the viability of injecting post-industrial CO_2 into deep-sea aquifers off the coast of Japan. This programme is known as the Tomakomai CCS Demonstration Project. The findings of the Tomakomai Report, released in May 2020, suggest that sub-seabed sequestration and storage is a technologically feasible option for decarbonising energy systems.[14] The Tomakomai Report highlights that, nonetheless, Japan currently lacks specific laws, regulations, and supportive policies to manage potential risks and encourage public and commercial investment in sub-seabed sequestration and storage technologies. Given the domestic legal uncertainties, the Japanese government is exploring exporting CO_2 for storage in offshore Australia via Singapore.[15]

Significant regulatory progress has been made to address CO_2-related liabilities. However, 'long-term liability issues associated with the leakage of CO_2 to the atmosphere and local environmental impacts are *generally unresolved'* (emphasis added).[16] Transboundary environmental risks posed by carbon sequestration and storage activities could result in environmental harm in both the short and long terms.[17] Environmental harm could include groundwater contamination, geologic hazards, injuries to marine ecosystems, harm to human health, and other damages resulting from hydrocarbons where CO_2 injection is linked with EOR operations.[18] For instance, in shared geological reservoirs, where CO_2 storage occurs across an international boundary, one State's CO_2 sequestration operations on one side of the

[13] For a comprehensive analysis, see Faure and Partain, *Carbon Capture and Storage: Efficient Legal Policies for Risk Governance and Compensation* (MIT Press 2016).
[14] Ministry of Economy, Trade and Industry, 'Report of Tomakomai CCS Demonstration Project' (May 2015).
[15] 'Chevron, Japan's MOL to study CO_2 transportation from Singapore to Australia' (Reuters, 10 Nov 2022) <https://www reuters.com/business/sustainable-business/chevron-japans-mol-study-CO_2-transportation-singapore-australia-2022-11-10/> .
[16] Metz et al, 'IPCC Special Report on Carbon Dioxide Capture and Storage' (CUP 2010), 15; see also Hawkins, Peridas and Steelman, Twelve Years after Sleipner: Moving CCS from Hype to Pipe' (2009) Energy Procedia 4403; for developments in international and national law up to 2014, see Dixon, McCoy, and Havercroft, 'Legal and Regulatory Developments on CCS' (2015) 40 International Journal of Greenhouse Gas Control 431-448.
[17] Faure notes, long-term risks related to CO_2 storage 'entails that there could be negative effects and potential damage resulting from CO_2 in a distant future…This long-term character always creates problems from a liability and compensation perspective. This raises inter alia the question how financing can be made available when damage would occur at the time when operators may no longer be in business', Faure, 'Liability and Compensation for Damage Resulting from CO_2 Storage Sites' (2016) 40 William & Mary Environmental Law and Policy Review 287.
[18] Klass and Wilson, 'Climate Change and Carbon Sequestration: Assessing a Liability Regime for the Long-term Storage of Carbon Dioxide' (2008) 58 Emory Law Journal 103, 119.

boundary could nullify a neighbouring State's ability to store CO_2 on the other side of the boundary. [19]

The two most critical issues to mitigate transboundary environmental harm are a) avoiding poor storage locations and b) preventing transboundary operational events which could convert good storage sites into poor ones.[20] Risks are higher for transboundary CO_2 sequestration operations, where the geological storage formation is used by more than one party or is located in an undelimited maritime area. Any uncoordinated action in this context could result in transboundary harm. Addressing these short-term and long-term environmental risks requires a comprehensive legal regime, including detailed rules for monitoring, verification, and liability.

4 International Law on Transboundary Sub-Seabed Sequestration and Storage

Transboundary cooperation always takes place within the broader legal and regulatory framework of international law. This submission, therefore, now turns to the international legal regime applicable to transboundary CCS.

1982 UN Convention on the Law of the Sea (UNCLOS)

The UN Convention on the Law of the Sea (UNCLOS) does not provide detailed rules on sub-seabed CO_2 sequestration and storage. However, it sets out a basic legal framework of rights and obligations of relevance to this matter.

Under UNCLOS, the sovereignty of a coastal State extends to the territorial sea: a zone extending up to 12 nautical miles (nm) from the coast. The Exclusive Economic Zone (EEZ) extends out to a maximum of 200 nm from the coastal baselines. The EEZ is not considered sovereign territory, but the coastal State has exclusive sovereign rights in the EEZ for exploring, exploiting and managing the natural resources of the seabed and its subsoil. This is subject to 'due regard' obligations with respect to the rights and duties of other States. EEZ rights include the establishment and use of artificial islands, installations, and structures; marine scientific research; and the protection and preservation of the marine environment. EEZ rights would also, arguably, cover activities relating to CO_2 sequestration and sub-seabed storage.[21]

The coastal state's sovereign rights over seabed resources in the EEZ must be exercised in accordance with Part VI of UNCLOS, which governs the continental shelf regime and applies to all seabed resources. Part VI was included to ensure harmonization between the EEZ and the continental shelf regime. Importantly, the coastal state's jurisdiction over these matters in the EEZ is limited to the provisions specified in the relevant parts of UNCLOS, including Part V on the EEZ, Part VI on the Continental Shelf, Part XII on the Protection and Preservation of

[19] Birkholzer, Oldenberg, and Zhou, 'CO_2 migration and Pressure Evolution in Deep Saline Aquifers' (2015) 40 International Journal of Greenhouse Gas Control 203, 209.
[20] Faure and Partain (2016) 43.
[21] UNCLOS Articles 56, 61(2), 64, 65, 66, 117, 118, 123, 194, & 197–201.

the Marine Environment. Part XII enshrines a general duty to cooperate with respect to the protection of the marine environment. This duty would be important for CO_2 sub-seabed sequestration.

General International Law

International law recognises a general legal obligation to cooperate in relation to shared, transboundary, resources.[22] Geological structures which can be used for CO_2 sequestration and storage by multiple States would arguably constitute shared resources. The common sub-seabed geological 'container', as it were, forms the shared natural resource.

States must 'co-operate in the…harmonious utilization of natural resources shared by two or more States', as recognised in resolutions by the UN Environment Programme[23] and later the UN General Assembly.[24] These resolutions are not legally binding. However, they have been widely implemented in State practice and serve as evidence of customary international law in relation to shared resources, including straddling hydrocarbon deposits.[25] Indeed, 'under customary international in the absence of a conventional obligation, no State may exploit…a common liquid deposit before negotiating the matter with neighbouring States in good faith with a view to concluding an agreement'.[26]

The duties associated with the general obligation to cooperate over 'shared resources' encompass both procedural and substantive duties. The procedural duties include exchanging information on the shared resource; informing others of any proposed actions that may affect them; conducting an environmental impact assessment if transboundary effects are expected; holding discussions to address any concerns arising; and negotiating or finding peaceful ways to resolve disputes. There may also be a duty to monitor the usage and condition of the resource and share the information gathered. Substantive duties include using the shared resource equitably and reasonably; protecting the environment; and avoiding causing harm to the shared resource or affecting other States' interests in it.[27]

It must be noted here that States must seek to negotiate in good faith to control shared environmental risks. However, under international law, there is no positive duty to conclude agreements on CO_2 sequestration and storage. In other words, failure to reach an agreement will not in itself constitute a breach of the duty to cooperate.

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[22] International Law Commission, 'Draft Articles on the Law of Transboundary Aquifers, with commentaries' Adopted at the ILC 60th Session (2008).
[23] Decision 6/14 of the Governing Council of UNEP (19 May 1978).
[24] GA Res 34/186 (1979) <https://undocs.org/en/A/RES/34/186>.
[25] D Ong, 'Joint Development of Common Offshore Oil and Gas Deposits: "Mere" State Practice or Customary International Law?' (1999) 93(4) American Journal of International Law, 771-804.
[26] J Crawford, *Chance, Order, Change: The Course of International Law* (Hague Academy of International Law, 2014) 504.
[27] For a discussion, see N Bankes, 'The Use of Sub-Seabed Transboundary Geological Formations for the Disposal of Carbon Dioxide' in C Banet (ed) *The Law of the Seabed Access, Uses, and Protection of Seabed Resources* (BRILL 2020) 397-430.

1972 London Convention

The London Convention was the first international treaty to establish a global legal regime to prevent, reduce, and control pollution of the marine environment by prohibiting the dumping of certain hazardous materials. The London Convention with 87 State parties is the most widely ratified treaty on the dumping of waste at sea.

The London Convention included a so-called 'black-list/grey-list' approach. The black list contains substances prohibited from being dumped. The grey list contains substances which may be dumped provided that certain strict conditions are met. In 1993, State parties to the London Convention started a detailed review of the treaty. Amendments to Annexes I and II were adopted. These amendments prohibited the dumping of all radioactive wastes; the incineration at sea of industrial wastes and sewage sludge; and the dumping of industrial waste.

Article 1 of the 1972 London Convention defines dumping as 'any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or man-made structures at sea.' Under Article 1(3), 'at sea' means 'all marine waters other than the internal waters of States.' This definition does not specify whether the London Convention covers the sub-seabed and, thus, whether the prohibition of 'dumping' extends to the storage of CO2 into the seabed and sub-seabed geological structures.

1996 Protocol to the London Convention

In 1996, the review of the London Convention was completed with the adoption of the London Protocol. Although it built on the objectives of the London Convention, the London Protocol was created as a new and separate treaty, with the intention that it would eventually replace the Convention. The London Protocol modernised the principles developed under the London Convention and provided more stringent protection of the marine environment from pollution caused by dumping wastes and other matter at sea. The London Protocol has been in force since 24 March 2006 and has currently 53 State parties. Australia ratified the London Protocol in 2000.

The London Protocol broadened the definition of dumping to include 'the storage of wastes or other matter in the seabed and the subsoil thereof'. The London Protocol prohibited the dumping of all wastes, with only a few exceptions of permissible substances. CO_2 was not listed as one of those permissible substances. As a result, the London Protocol banned CO_2 sequestration into the seabed for storage and disposal purposes.

2006 Amendment

In 2006, the State parties to the London Protocol amended Annex I of the Protocol. This added 'carbon-dioxide streams from CO_2 capture processes for sequestration' to the list of wastes or other matter which may be considered for dumping and therefore regulated.[28] Thus, the 2006

[28] Resolution LP.1(1) (Adopted 2 November 2006).

Amendment allowed the geological sequestration of pure streams of CO_2. This practice would typically apply to large point sources of CO_2 emissions, including power plants and cement works. It excludes the use of such CO_2 waste streams for enhanced oil recovery in hydrocarbon production. The amendment entered into force in 2007.

However, the 2006 Amendment did not resolve all issues relating to the potential use of the seabed for CO_2 sequestration because the London Protocol prohibited the 'export of wastes'. Article 6 of the 1996 Protocol stated: 'Contracting Parties shall not allow the export of wastes or other matter to other countries for dumping or incineration at sea.' Article 6 aimed to stop State parties from exporting their waste to non-State parties for dumping. In other words, it prohibited transboundary transport. Thus, the export of CO_2 from one country for disposal in another country for sub-seabed geological storage was also caught by this export prohibition. However, it was identified that such export may be needed where a State party does not have sufficient suitable geological storage capacity, but it still wishes to use CCS technologies as an option to address climate change. It was agreed that the only way to remove this hurdle was an amendment.

2009 Amendment

In October 2009, the State parties agreed to amend Article 6 of the London Protocol to remove this restriction and allow sub-seabed geological formations for sequestration projects to be shared across national boundaries. This effectively allows the export of CO_2 streams for sequestration and long-term storage purposes, provided that all other London Protocol requirements are met.[29]

This amendment was crucial as it covers the scenario in which CO_2 is injected into a shared geological structure in State A and the CO_2 stream migrates from State A to State B, either on purpose by the States or inadvertently. The State parties to the London Protocol adopted a resolution specifying that such a transboundary migration of CO_2 should be permissible under the Protocol.[30] Thus, transboundary CO_2 transport, sequestration and storage is, in principle, a permissible form of CO_2 disposal under the 2009 Amendment.

The 2009 Amendment has not yet entered into force because it has not received enough ratifications. As a result, while the London Protocol permits the sub-seabed geological sequestration and storage of CO_2 at the domestic level, it currently prohibits the transboundary storage of CO_2 across countries.[31] The lack of acceptance and ratification has been described as an obstacle to the development of many planned CCS projects across the world, hindering the use of this technology at scale as a tool for mitigating climate change.[32]

[29] Resolution LP.3(4) (Adopted 30 October 2009).
[30] Resolution LP.3(4), 30 October 2009, Recital 12.
[31] Only a few countries have accepted the 2009 amendment including, Denmark, Estonia, Finland, Iran, Netherlands, Norway, Sweden, and the United Kingdom.
[32] see also J Garrett and S McCoy, "Carbon capture and storage and the London Protocol: Recent efforts to enable transboundary CO_2 transfer," Energia Procedia 37 (2013): 7747–7755

For this reason, the State parties to the London Protocol adopted in 2019 a resolution allowing for the 'provisional application' of the 2009 Amendment to Article 6. This enabled them to export streams of CO_2 for sequestration and storage across boundaries. However, the State parties stressed that this resolution was only an 'interim solution', pending sufficient acceptance by contracting parties, enabling countries, wishing to do so, to implement the provisions of the amendment in advance of its entry into force.[33]

For instance, Norway and the Netherlands have already declared their provisional application of the 2009 Amendment, enabling them to export CO_2 for storage purposes. Although no large-scale project has been carried out, there are indications that the transboundary movement of CO_2 is on the horizon in Europe and across the world. [34] However, so long as the 2009 Amendment is not in force and there is no universally uniform and legally binding framework, more bilateral agreements and arrangements between States will be needed on the export and import of CO_2 for storage.

2012 Specific Guidelines

Given the environmental risks inherent in the transboundary sub-seabed sequestration and storage of CO_2 and to establish a more consistent approach to this emerging issue, the State parties to the London Convention agreed to a set of guidelines in 2012 specifically addressing the transboundary sub-seabed storage and sequestration of CO_2 (Specific Guidelines).[35]

The Specific Guidelines address the disposal of CO_2 as geological waste and contain specific provisions on disposal into geological formations where there is potential for transboundary movement of sequestrated CO_2. They cover topics such as waste prevention audits; waste management options; characterisation of the waste stream; a screening process for determining acceptability for dumping; site selection and assessment; risk management and monitoring; and permit requirements and conditions.

Article 1(10) of the Specific Guidelines enshrines a crucial rule. The mere ***existence*** of a geological formation which ***could*** be used by more than one State or the mere ***potential*** for transboundary CO_2 migration triggers the operational responsibility of the State where the migration/injection occurs.

Article 1(10) underscores that the injecting State should seek consent from all other States with jurisdiction over the shared sub-seabed geological formation. This article does not prescribe the form that the consent must take. It could be a treaty or an agreement between the respective regulatory authorities of the State parties, or simply an exchange of diplomatic notes. This article does not either stipulate the legal ramifications of failing to obtain the consent of the

[33] IMO, 'Report of the Forty-first Consultative Meeting and the Fourteenth Meeting of Contracting Parties LC 41/17, Section 6 and Annex 8, (IMO 2018).
[34] J Harrison, 'C. Ocean Dumping' (2002) Yearbook of International Environmental Law 1–5.
[35] 'Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-seabed Geological Formations' (IMO 2012).

other States. Notably, it does not use the formulation 'should be sought and obtained'. In other words, this provision implies that one State must seek consent, but it does not need to receive such consent to proceed. Article 1(10) is silent on the circumstances in which such consent may be withheld.

There is a question as to whether the Specific Guidelines are binding. The general view is that they are not legally binding and serve only as a source of guidance.[36] However, upon closer examination, these Guidelines outline established general principles related to sub-seabed sequestration of CO_2 in cross-border situations. They may form the commonly accepted standards in this area. Arguably, the Specific Guidelines are closely related to UNCLOS, which is a legally binding treaty and can be used to determine compliance with UNCLOS's substantive and procedural environmental legal obligations.[37]

2013 Amendment

The 2013 Amendment provided further clarity on the environmental regulation of 'marine geoengineering activities',[38] such as ocean fertilisation.[39] It specifies specific environmental requirements for the sound assessment and management of the environmental impacts of these activities. This includes the obligation to conduct environmental impact assessments; the development of site-specific management plans; and the monitoring and reporting of activities and their impacts.[40]

The 2013 Amendment requires that State parties assess the environmental impacts of CO_2 disposal, including the potential effects on marine life and the ocean's chemistry. It also establishes a framework for monitoring and verifying the amounts of CO_2 being disposed of at sea and the effects of that disposal. This includes requirements for monitoring and reporting on the levels of CO_2 in the water column and on the seafloor, as well as the potential impacts on marine life and the ocean's chemistry.

Paragraph 10 of the 2013 Amendment establishes a binding rule of transboundary cooperation:

> Where the placement activity proposed for consideration by a Contracting Party may have any effect in any area of the sea in which another State is entitled to exercise

[36] Dixon, McCoy, and Havercroft, 'Legal and Regulatory Developments on CCS' (2015) 40 International Journal of Greenhouse Gas Control 431.
[37] Redgwell, 'Mind the Gap in the GAIRS: The Role of Other Instruments in LOSC Regime Implementation in the Offshore Energy Sector' in Bankes and Trevisanut (eds), *Energy from the Sea: An International Law Perspective on Ocean Energy* (Brill 2014).
[38] Art 1(5), "Marine geoengineering" is defined as 'a deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long-lasting or severe.'
[39] Ocean fertilisation involves adding nutrients, such as iron or nitrogen, to nutrient-depleted areas of the ocean to increase plankton production. The idea is that the phytoplankton will absorb large amounts of carbon dioxide from the atmosphere through photosynthesis and that the carbon will then be stored in the ocean for long periods of time, mitigating the effects of climate change.
[40] See also W Burns, 'Governance of Ocean-Based Carbon Dioxide Removal Research under the United Nations Convention on the Law of the Sea' (2023) 75(1) University Of Maine Law Review 38, 66.

> jurisdiction in accordance with international law or any area of the sea beyond the jurisdiction of any State, potentially affected countries and *relevant regional intergovernmental agreements and arrangements should be identified and notified and a plan should be developed for ongoing consultations on the potential impacts, and to encourage scientific cooperation* (emphasis added)

Finally, the 2013 Amendment requires that marine geoengineering activities be conducted in accordance with the precautionary principle. This means that, in the absence of scientific certainty, activities must be designed and managed to minimise harm to the marine environment.

5 Sequestration & storage of CO_2 in a Straddling Geological Reservoir

To illustrate the practical application of the above legal considerations, let us consider the scenario where two States share a common international maritime boundary. An EEZ delimitation agreement sets out the jurisdictional limits of each state. The EEZ delimitation agreement also includes provisions on the procedure to be followed where a geological deposit is discovered which extends from the maritime jurisdictional zones of one State to that of the other. For instance, Article 8 of the Australia-Timor-Leste Maritime Boundary Treaty provides that:

> If any Petroleum deposit extends across the continental shelf boundary as defined in Articles 2 and 3 of this Treaty, the Parties shall work expeditiously and in good faith to reach an agreement as to the manner in which that deposit is to be most effectively exploited and equitably shared.[41]

In addition to straddling deposit clauses, our two hypothetical States could also establish a framework transboundary resource management arrangement, providing a detailed regime for the treatment of all straddling petroleum deposits in a designated area. Article 7 of the Australia-Timor-Leste Maritime Boundary Treaty provides for the establishment of the 'Greater Sunrise Special Regime' in which the State parties 'shall jointly exercise their rights … of jurisdiction … as set out in the Greater Sunrise Special Regime.' The Greater Sunrise Special Regime provides for the joint development, exploitation, and management of the resource, as well as the sharing of revenue by the two States.[42] Annex B of the Australia-Timor-Leste Treaty establishes a governance and regulatory structure and details the exercise of jurisdiction in the Special Regime Area over matters such as customs, immigration, quarantine, security, and crime. Such clauses and related arrangements are common in State practice and mirror the requirement under international law to seek collaboration in the development and sound environmental management of shared resources among neighbouring coastal states.

[41] Treaty Between Australia and the Democratic Republic of Timor-Leste Establishing Their Maritime Boundaries in the Timor Sea (signed 6 March 2018; entered into force 30 Aug 2019).
[42] For an analysis, see Davenport, 'The Development of the Greater Sunrise Special Regime' in Phan et al (eds) *Timor-Leste/Australia Conciliation: A Victory for UNCLOS And Peaceful Settlement of Disputes (*World Scientific 2019) Ch 6.

The question which then arises is whether existing straddling deposit clauses and associated hydrocarbon agreements extend to the environmental regulation of transboundary CO_2 storage operations.[43] Alternatively, are the terms of the London Convention, and its Protocol and relevant amendments, also applicable?

For example, current sequestration practices for enhanced oil recovery in a shared hydrocarbon reservoir do not necessarily require long-term monitoring or verification regime. However, as previously noted, transboundary sub-seabed sequestration of CO_2 for storage poses novel environmental risks and hazards, many of which are not present within the development of traditional hydrocarbons. Therefore, the regulatory and liability framework which would govern large-scale CO_2 storage operations across boundaries needs to be carefully scrutinised. The 'sub-surface elements of CO_2 projects…may present new issues in relation to environmental impact assessment (EIA) practice'.[44]

What is the applicable law where a transboundary project in a hydrocarbon reservoir, say the Great Sunrise Field, moves from a joint oil and gas exploitation to a joint CO_2 sequestration operation between Australia and Timor-Leste? What if one State wants to use the oil and gas fields within the designated joint development zone, or adjacent to the zone, for CO_2 sequestration and storage? What if one State wants to import streams of CO_2 for long-term sub-seabed storage, but other regional States raise concerns on resulting transboundary environmental risks?

Under the Australia and Timor-Leste Maritime Boundary Treaty, the State parties are required to reach agreement 'as necessary…for the purposes of environmental protection and compliance with either Party's domestic laws or regulations'. However, the agreement does not specify whether this applies to post-depletion CO_2 sequestration operations for storage purposes. A State may view CO_2 sequestration as incidental to, or closely associated with, ongoing oil and gas exploitation operations. In this view, existing straddling deposit clauses and other hydrocarbon arrangements would apply to such operations. Another view would consider transboundary CO_2 storage operations as separate from existing oil and gas exploitation operations. Presumably, the straddling deposit clauses were only designed for the exploitation of hydrocarbons for commercial gain by means of extraction – rather than exploitation by sequestration and CO_2 deposition into the seabed to address climate change. For instance, the Australia and Timor-Leste Maritime Boundary Treaty defines 'Petroleum Activities' as 'All activities undertaken to produce Petroleum and includes exploration, development, initial processing, production, transportation and marketing.' There is no mention of CO_2 storage.

Arguments exist both ways as to whether bilateral clauses found in maritime boundary agreements, such as those concluded between Australia and its neighbours, embrace CO_2 sequestration and storage operations. One could argue that CO_2 sequestration and storage is

[43] Bankes (2019).
[44] OECD/IEA, 'Carbon Capture and Storage Model Regulatory Framework (Information Paper, Nov 2010).

only the continued exploitation of a transboundary seabed formation. On the other hand, unlike straddling hydrocarbon resources, transboundary CO_2 storage operations are not explicitly regulated in international maritime boundary treaties, including those signed by Australia.

This legal uncertainty is problematic and may lead to future disputes over shared deposits and their transboundary implications. Many countries may wish to exploit depleting oil fields for CO_2 storage purposes, within and beyond their areas of maritime jurisdiction, or even in areas of joint jurisdiction. Indeed, as previous reports have indicated, many depleting offshore oil fields could be used by more than one country for CO_2 sequestration and storage.[45] In this case, the use of shared geological storage formations must be conditional on meeting clear legal requirements. Present international law establishes certain minimum legal standards. Indeed, the 2013 IMO Guidelines under the London Protocol stipulate that even non-State parties to the London Protocol must ensure that the standard of the London Protocol on permitting CO_2 geological storage is maintained.[46]

The 1972 London Convention and its 1996 London Protocol currently provide the most advanced global regulations for addressing carbon capture, sequestration, and storage in sub-sea geological formations. The London Protocol, as amended in 2006, 2009 and 2013, reflects an evolution in line with the core principles of international environmental law: the polluter pays principle, the precautionary principle, and a novel duty to 'not to transfer, directly or indirectly, damage or likelihood of damage from one part of the environment to another or transform one type of pollution into another.' The amendments to the Protocol follow the norms established in the London Convention with regard to enforcement of the rules and the provision of 'procedures regarding liability'.

6 Conclusion

To conclude, the 2009 and 2013 Amendments must be widely adopted and implemented to address the potential transboundary environmental risks associated with uncoordinated CO_2 sequestration, and storage. Their implementation and enforcement would result in a more consistent and robust regulatory approach to transboundary carbon storage.

[45] IEAGHG, 'Interaction of CO_2 Storage with Subsurface Resources' (Report 8 April 2013).
[46] IMO, 2013. Guidance on the Implementation of Article 6.2 on the Export of CO_2 Streams for Disposal in Sub-seabed Geological Formations for the Purpose of Sequestration. LC 35/15 Annex 6. 2013.