frontiers | Frontiers in Climate

TYPE Perspective
PUBLISHED 07 February 2024
DOI 10.3389/fclim.2024.1355224

OPEN ACCESS

EDITED BY
J. B. Ruhl,
Vanderbilt University, United States

REVIEWED BY
Carolina Arlota,
Sabin Center for Climate Change Law,
United States

*CORRESPONDENCE
Adam D. Orford
adam.orford@uga.edu

RECEIVED 13 December 2023
ACCEPTED 25 January 2024
PUBLISHED 07 February 2024

CITATION
Orford AD (2024) Blue carbon, red states, and Paris Agreement Article 6.
Front. Clim. 6:1355224.
doi: 10.3389/fclim.2024.1355224

Blue carbon, red states, and Paris Agreement Article 6

Adam D. Orford*

University of Georgia School of Law, Athens, GA, United States

Coastal U.S. states, including many that have opposed proactive U.S. climate policies, are contemplating entrance into the supply side of the international carbon credit markets by, among other things, hosting revenue-generating blue carbon projects on their submerged lands. The voluntary carbon credit markets already facilitate private investment in such activities, and the emerging Paris Agreement Article 6 framework is poised to generate investment interest at the national level as well. Reviewing these trends, this Perspective questions whether this is good climate, environmental, and social policy, and advises further oversight and accountability.

KEYWORDS

blue carbon, carbon credits, carbon offsets, carbon markets, Paris Agreement, Article 6

1 Introduction

U.S. state governments, including U.S. state governments that have traditionally opposed U.S. climate policies, are contemplating entrance into the supply side of the carbon credit markets (Orford, 2024). Coastal states, particularly, have begun to show interest in attracting investments into carbon credit generating activities on state-owned coastal submerged lands. These efforts are occurring largely without oversight, and raise novel and important questions about the commodification of public natural resources in the already highly contested carbon market space.

Emerging state interest is driven by the hope of new sources of state revenue. Coastal ecosystem conservation and restoration activities are increasingly understood to provide marketable carbon removal and sequestration benefits (Jessen et al., 2024). So-called "blue carbon projects," meaning activities that conserve and enhance coastal and marine carbon sequestration, have received increased attention as a potential source of high-quality tradeable carbon credits (Orford, 2024). Although many questions remain regarding the integrity of such credits—from their permanence in the face of sea level rise (Wylie et al., 2016), to their certainty in the face of unresolved legal title, (Porter, 2024) to their equity within larger processes of dispossession (Lovelock and McAllister, 2013; Vierros, 2017)—creditable blue carbon projects are now being developed around the world, including, most recently, in the United States (Zeng et al., 2021; Verra, 2022). Demand for these credits is only predicted to grow, and U.S. states, which own vast areas of forested and submerged lands, are uniquely positioned to respond.

These developments, furthermore, are emerging concurrently with the painstaking finalization of the Paris Agreement Article 6 market mechanisms, governing transfer of "mitigation outcomes" between nations (UNFCCC, 2015; Chandrasekhar et al., 2022). Countries have already announced their intention to use the Article 6 market system to enhance their publicly announced emissions reduction commitments, meaning they will be entering the carbon markets on the demand side (Jung, 2023). Others, including the United States, have reserved the right to do so (United States, 2021) and UNFCCC parties are increasingly integrating "nature-based solutions," including blue carbon projects, into their national mitigation

commitments (UNFCCC, 2023). Blue carbon projects, therefore, are likely to become an important generator of Article 6 mitigation outcomes, and thus national climate progress claims, in the years to come. Interest, demand, and funding will only increase as this system begins operating, and, again, U.S. states are positioned to benefit.

Yet, the propriety of the use of U.S. state public lands to generate credits for the international carbon markets has gone almost totally unexamined. What risks do such activities pose? What conditions should be placed on them? Can they really provide simultaneous environmental, climate, and social benefits? Or might they divert resources away from more important climate mitigation efforts, undercut existing natural resource protection programs, and serve to reward state governments that are also most heavily invested in the industries that cause climate change in the first place? If so, should anything be done?

2 U.S. states as suppliers of blue carbon credits

2.1 Emerging state initiatives to commodify the coast

The United States has an enormous coastline, and much of the submerged land near the coast is held by U.S. state governments. Many of the states with the longest coastlines, including Alaska, Florida, and Texas, are "red states," meaning states consistently represented by the more conservative Republican Party, which traditionally has opposed proactive climate policy at the state and national level.[1] Yet several of these states have begun innovating in the climate law space by developing new legal mechanisms for generating state revenue through carbon credit investment.

The most important of these new initiatives recently occurred in Alaska. In January 2023, Alaska Governor Mike Dunleavy introduced legislation that, he said, would unlock Alaska's "potential to generate additional revenue… through biologic carbon storage projects" (Office of Alaska Governor, 2023a,b). Emphasizing carbon credit revenues already generated by Alaska Native regional corporations, Dunleavy argued that the legislation would provide the state with "maximum flexibility to participate in this evolving industry" by hosting carbon sequestration projects that "could occur both on state lands and potentially in state waters off of our coasts" (Office of Alaska Governor, 2023b). The bill, which passed into law in May 2023, opens the state's coastal and forest lands to leasing by third parties for carbon credit projects, and also permits state-run carbon credit projects (Office of Alaska Governor, 2023c). The primary conditions are that the projects, whether public or private, must generate revenue for the state and cannot be inconsistent with the state's timber, mining, and oil and gas industry interests. The legislation does not specify environmental compliance obligations for such projects, although it does not exempt them from, for example, existing aquaculture permit requirements. The program will be run by the state's Department of Natural Resources, which will be responsible for developing contracts with third parties to generate carbon credits and therefore revenue via silvicultural, agricultural, and aquacultural activities. According to Governor Dunleavy, the bills represent "the means to fund services, lower the cost of living and improve our quality of life, to create wealth and billions of dollars in economic activity without taxing Alaskans…." (Office of Alaska Governor, 2023a).

Alaska is the first, and currently only, U.S. state to pass a law specifically to facilitate state carbon credit revenue from state coastal resources. It is, however, unlikely to be the last. Other, similarly situated states have indicated similar interests. Most notably, Texas's 2023 Coastal Resiliency Master Plan has, for the first time, attempted to quantify the alleged carbon sequestration value of all of the state's ongoing coastal conservation and restoration programs. Texas, furthermore, "is working with potential partners to investigate new opportunities to bring in funding from private investors to bear for living shoreline projects" in the state (Texas General Land Office, 2023). Similarly, Louisiana's 2022 Climate Action Plan called for the integration of carbon sequestration quantification into all of the state's existing coastal management projects. The state intends to develop interest in investment in its coastal wetlands resources particularly, in order to "maximize investment in carbon sequestration [and] wetland restoration" in the state, as the "the natural carbon sequestration potential of Louisiana's coastal habitats is too valuable to be entirely precluded from market-based systems" (Louisiana Climate Initiatives Task Force, 2022). These emerging activities are intended to position these states to benefit from future carbon market investment, and, by their own terms, are motivated primarily by the revenue opportunities that such activities provide.

Other coastal states have not yet acted. Florida is of particular interest, given its huge coastline and conservative state government, but coastal states from Georgia to Maine also control significant submerged land resources that could host carbon credit projects. Nor will interest be limited only to red states—although they have been innovating, revenue is universally attractive. The next new law may come in Washington state, where a proposed bill focused primarily on forests has proceeded without significant opposition during the current legislative session (Breda, 2023). The emerging consensus appears to be that if there is money to be made from carbon sequestration, U.S. state governments would be leaving money on the table if they did not get involved.

1 The United States is a federal republic with a great deal of authority vested in its states. U.S. states not only retain all governmental power not vested in the national government, but also exert power over the national government through the U.S. Senate, power in which is apportioned equally between the states, not state populations. In this context, U.S. political debates often involve disagreements over the scope of the federal government's authority to act. U.S. politics is also dominated by two political parties which, today, tend to reflect strongly opposed conservative and progressive political agendas and positions. Thus, conservative states, meaning states with state governments and federal delegations dominated by the more conservative Republican Party, have tended to oppose federal action, including federal climate action, and have largely prevented the United States from acting as a leader in international climate policy. In the U.S., these states tend to be called "red states," the color indicative of Republican Party victory on election maps since about the year 2000.

2.2 Rising market demand for blue carbon credits

Although this new state revenue stream is real, it is also, at this point, somewhat theoretical. State governments are, like the rest of the world, responding to external signals and incentives, and for the purposes of coastal resources the most important of these is the rise of the "blue carbon credit" as a valuable commodity in the voluntary carbon markets.

A "carbon credit" is a tradeable unit representing a specific quantity of carbon removed from the atmosphere. Carbon credit "projects" are activities conducted to generate carbon credits, and many carbon credit projects involve, at base, planting or protecting forests, grasslands, and other plant-covered landscapes that extract and sequester atmospheric carbon. Credits generated by such projects have formed the basis of trading under the Kyoto Clean Development Mechanism (Gillenwater and Seres, 2011), corporate emissions reductions strategies using the voluntary carbon markets (Streck, 2021) and to a much smaller extent, governmental emissions reductions strategies in state and national compliance markets (Badgley et al., 2022; Shrestha et al., 2022).

The new trend has been the recognition that coastal and marine landscapes have the potential to provide such carbon benefits equally or even better than forest or agricultural lands, resulting in so-called "blue carbon" credits and projects. Although healthy coastal ecosystems are understood to provide many natural benefits, including climate resilience (Spalding et al., 2014; Sutton-Grier et al., 2015) and ecosystem services (Liquete et al., 2013; Seitz et al., 2014), they are also increasingly recognized for their atmospheric carbon removal value (Nellemann et al., 2009; Macreadie et al., 2021). Although no compliance market yet accepts credits generated by blue carbon projects (Orford, 2024), the voluntary carbon markets have no such limitations, and blue carbon credits are becoming more actively traded worldwide (Friess et al., 2022). Most of these credits are developed according to carbon methodology developer Verra's standard VM-0033, *Methodology for Tidal Wetland and Seagrass Restoration*, first released in 2014 (Verra, 2023a). The first blue carbon project in the United States, a seagrass restoration in Virginia led by the Nature Conservancy, is currently seeking accreditation under that standard (Verra, 2022). In other words, the coastlands of the United States are being used, for the first time, to generate tradeable commodities representing their carbon sequestration value, and ongoing activities, including efforts to inventory and map the U.S.'s coastal carbon resources (EPA Region 1, 2023) and to develop pathways to scale the carbon markets' incorporation of blue carbon projects (Johnston, 2021; Taskforce on Scaling Voluntary Carbon Markets, 2021), are facilitating the creation of even more.

The blue carbon credit market is poised to grow significantly in the next decades. The World Bank, for example, has predicted that global seaweed cultivation activities alone may provide billions of dollars in untapped carbon sequestration value (World Bank, 2023). In any event, blue carbon credits are understood to represent higher-quality sequestration value and thus attract a premium on global markets (Carbon Credits, 2023a,b). And U.S. states have clearly taken notice.

2.3 The emerging Article 6 market framework

Although pressure for blue carbon credit project development has so far come from the voluntary carbon markets, the ongoing creation of the Paris Agreement's international carbon market has the potential to supercharge this process by bringing nations to the demand side of the market as well. In its own language, Paris Agreement Article 6 creates mechanisms for "voluntary cooperation" between nations seeking to reduce their greenhouse gas emissions. Parties are authorized to use "internationally transferred mitigation outcomes" (ITMOs) to achieve their "nationally determined contributions" (NDCs). Although the Paris Agreement intentionally avoids controversial terms such as "credits," "allowances," and "markets," the Article 6 market provisions boil down to the same thing: the authorization of an international carbon credit market for purposes of demonstrating national emissions reductions (Marcu, 2016). The "Article 6 Rulebook," the parties' collected decisions on implementation of Article 6,[2] points toward the international exchange of carbon credits between nations for purposes of demonstrating national emissions reductions and reduction commitments (Chandrasekhar et al., 2022).

Blue carbon credits can and likely will fall neatly into this emerging system. The emerging Article 6 market mechanisms are necessarily informed by the lessons of prior, similar systems, including particularly the Kyoto Protocol's alternative compliance mechanisms. Notwithstanding decades of controversy, the Kyoto parties developed rules for counting the carbon-sequestration benefits of agriculture, forestry, and land use activities toward national emissions reduction commitments, and also developed a system of voluntary payments intended to reduce emissions through avoided deforestation (UNFCCC Secretariat, n.d.a,b). Consequently, a complex system of self-regulation developed to govern carbon accounting in forestry, agriculture, and other land use contexts (Kollmuss et al., 2010). Although the legal details are still under intense debate (Tamme, 2022, 2023), the old rules are at least conceptually translatable to blue carbon in the Article 6 context: from a carbon management perspective, mangrove or seagrass cultivation is conceptually similar to reforestation and

2 The "Article 6 Rulebook" refers to an evolving series of implementing decisions on Article 6. They include Dec. 2/CMA.3 (*Guidance on Cooperative Approaches referred to in Article 6, Paragraph 2, of the Paris Agreement*), Dec. 3/CMA.3 (*Rules, Modalities and Procedures for the Mechanism Established by Article 6, Paragraph 4, of the Paris Agreement, and Decision*), and Dec. 4/CMA.4 (*Work Programme under the Framework for Non-Market Approaches referred to in Article 6, Paragraph 8, of the Paris Agreement*) adopted at COP26 in Glasgow in 2021, published in U.N. Doc. FCCC/PA/CMA/2021/10/Add.1 (March, 2022) and Dec. 6/CMA.4 (*Matters Relating to Cooperative Approaches referred to in Article 6, Paragraph 2, of the Paris Agreement*), Dec. 7/CMA.4 (*Guidance on the Mechanism Established by Article 6, Paragraph 4, of the Paris Agreement*), and Dec. 8/CMA.4 (*Matters relating to the Work Programme under the Framework for Non-Market Approaches referred to in Article 6, Paragraph 8, of the Paris Agreement*), adopted at COP27 in Sharm al-Sheik, published in U.N. Doc. FCCC/PA/CMA/2022/10/Add.2 (March 17, 2023).

afforestation, and avoided wetlands degradation and destruction is conceptually similar to avoided deforestation and degradation. Thus, although the treatment of blue carbon under Article 6 will not be certain until contentious definitional questions are resolved by the parties to the Paris Agreement, it would be very surprising to see blue carbon projects excluded.

In the event that blue carbon projects are successfully incorporated into the Article 6 market framework, it is no longer theoretical that these market mechanisms will be used. South Korea, for example, has announced its intention to use Article 6 market actions to supplement its NDCs (Jung, 2023). Even the Biden Administration, which announced that the U.S. does not currently intend to use the Article 6 mechanisms, did so in language that leaves the possibility open in the future (Jung, 2023) and the partisan nature of U.S. international climate policy means that a new administration could very easily choose to do so. In their most recent NDCs, scores of nations have incorporated a strong commitment to "nature-based solutions" not only in their adaptation, but also mitigation strategies (UNFCCC, 2023). This can mean little else beyond national efforts to promote carbon removal and sequestration through biological processes. On land this means agriculture, forestry, and land use. On the coast and in the ocean, this means blue carbon equivalents of the same activities. As nations engage with the Article 6 market system, therefore, it will not be surprising to see them "transferring the mitigation outcomes" of blue carbon projects. If U.S. states develop carbon sequestration value, it is at least possible that the United States could transfer this sequestration value to foreign nations for pay.

The emergence of the Article 6 market system means that carbon credit suppliers, working with national partners, might now compete with each other to provide carbon credits to other nations in return for payments. And unlike prior programs that were limited to projects in and for the benefit of so-called developing nations, the Article 6 market mechanisms will have no such restrictions. In other words, the Article 6 market mechanisms appear to provide a pathway for Texas, say, to sell the carbon sequestration value of its coastlands to a wealthy foreign nation. Although the exact parameters of such transactions are not yet clear, and their governance implications are almost totally unexplored, some U.S. states are beginning to prepare themselves for whatever opportunities might arise.

3 Discussion

In sum, U.S. states are preparing to use their public lands to generate revenue by creating marketable credits for the international carbon markets, with little oversight. These activities pose significant risks that deserve more attention than they have yet received.

As a threshold matter, there is a risk that the commodification of the carbon sequestration services on the U.S. coastline will occur without sufficient discussion, in a victory by fait accompli for market logic over other possible frames. The conceptual conversion of coastal resource conservation into an analog for state forestry activities is consistent with nineteenth-century conceptions of conservation as a means toward resource extraction and revenue generation. Non-monetary environmental values such as wildness, inherent beauty, ecological connection, and habitat for species deserving of moral consideration even if they are not directly beneficial to human beings, go almost entirely unconsidered in economized discussions of market systems. Rare attempts to integrate the consideration of these values as the "co-benefits" of marketable ecosystem services still places them, if at all, into distinctly secondary roles. Transforming the ocean into yet another substrate for globalized financialization, monetization, and commodification of natural resources should be seen as a choice rather than as an inevitability, and the downsides of this conversion ought to be examined and debated on their own terms.

That said, in a world already largely committed to such commodification, it is also necessary to confront the risks of the market system as it is actually evolving. If the coastline and ocean is understood primarily as a potentially productive source of carbon sequestration service revenues, the questions become, for example, whether or to what extent state commodification of carbon sequestration services will provide real, rather than chimerical, environmental, climate, and social benefits—and there is real risk that the answers are negative.

In this author's view, these risks become particularly acute when state climate policy is focused primarily on revenue generation. Current debate rages over the integrity of credits issued under existing voluntary standards (Cadman and Hales, 2022; Greenfield, 2023; Verra, 2023b). But states interested in revenue generation have largely ignored the well-known measurement, additionality, and permanence problems of blue carbon credits, and states entering the market on the supply side have problematic incentives to downplay these quality concerns. Even setting aside the long-debated propriety of using carbon offsets as part of a mitigation strategy in the first instance, state participation also poses real risks of double-counting. If a private company develops a carbon removal project in a lease arrangement in U.S. state waters, and then sells that credit to a foreign nation, who claims the carbon removal value? Ideally, only the purchaser. But what mechanisms exist to prevent the state, or the company, or the United States itself, from also claiming the reduction at various points? And how will this private transaction be accounted for under the Article 6 system? Again, states with a primary interest in revenue generation are unlikely to have strong internal incentives to answer such questions.

With respect to other environmental benefits, there is also risk that normalizing compensation for conservation will undercut existing uncompensated conservation efforts, while being less effective. Although blue carbon projects are often viewed by coastal conservation interests as a potential source of much-needed funding, it is important to consider whether U.S. state access to carbon market conservation finance might have unintended consequences. Conservation-for-pay should be recognized as a significant departure from past practice of conservation for the public good. Must we, now, begin to pay our states, and our counties, and our communities, to not cut down their trees, and not dig up their wetlands, and not contribute to climate change? And if so, how much? And for how long? What happens, furthermore, if the market does not value such conservation more than development alternatives? Won't a market system that values only carbon sequestration be blind to other important values, such as biodiversity, or

social equity, that may also be protected by conservation. These are not new observations (Crook and Clapp, 1998; Arsel and Büscher, 2012; McAfee, 2012; Allen, 2018), but they become particularly acute as states actually begin to prepare to sell their ecosystem services.

With respect to social benefits, there is risk that U.S. participation diverts resources inequitably and rewards the same parties that are actually causing the problems of climate change. The entrance of wealthy U.S. states into the supply side of the credit market puts them in direct competition with so-called developing nations which have traditionally been the recipients of this investment. U.S. states, furthermore, are likely to be potent competitors, as they have technical capacities that may make them attractive investment partners for project developers. Should the state governments of the United States—the world's largest historic contributor to the problem of climate change—also be the recipient of a large portion of the world's carbon sequestration investment? How does U.S. state participation impact the other social goals of the international climate governance system?

To the extent that these problems require response, there are several potential points of intervention. The first is the emerging Article 6 market itself. It is possible, although currently unlikely, that rules could be developed in this system to devalue carbon credits generated in industrialized countries, or even within U.S. states that are not actively pursuing direct emissions reductions. The second is via the standard-setting organizations such as Verra, which create the rules for carbon credit project accreditation. Although they are likely reluctant to do so, it is at least possible that rules for high-integrity carbon credit development could begin to account for political and historic responsibility factors in the same way that they currently can and should be made to account for social justice factors. A third possibility is U.S. federal law, which could, among other things, set minimum standards for the integrity of carbon credits developed in the U.S. states, and provide for oversight by competent regulatory authorities. A more aggressive approach could involve conditioning certain federal funding access on the state-level adoption of such standards. A fourth potential avenue of intervention could be regulatory, for example in standards or guidance for coastal carbon accounting under Coastal Zone Management Act programs. And finally, states themselves can and should work to develop their own legislation and regulations to ensure that carbon credits developed and sold on their public lands are of high quality.

For now, however, these issues are not being carefully considered as the community of nations follows the private sector into the business of purchasing the ability to claim credit for the removal of carbon from the atmosphere through coastal and marine biological processes, and U.S. states begin to move to profit from this market. Further oversight and accountability are needed.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

AO: Writing – original draft.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Allen, K. (2018). Why exchange values are not environmental values: explaining the problem with neoliberal conservation. *Conserv. Soc.* 16, 243–256. doi: 10.4103/cs.cs_17_68

Arsel, M., and Büscher, B. (2012). Nature™ Inc.: changes and continuities in neoliberal conservation and market-based environmental policy. *Dev. Change* 43, 53–78. doi: 10.1111/j.1467-7660.2012.01752.x

Badgley, G., Freeman, J., Hamman, J. J., Haya, B., Trugman, A. T., Anderegg, W. R. L., et al. (2022). Systematic over-crediting in California's forest carbon offsets program. *Glob. Change Biol.* 28, 1433–1445. doi: 10.1111/gcb.15943

Breda, I. (2023). *DNR Wants in on WA's Emerging Carbon-Credit Market*. The Seattle Times. Available online at: https://www.seattletimes.com/seattle-news/environment/was-dnr-wants-in-on-emerging-carbon-market-to-sell-credits-instead-of-timber/ (accessed January 30, 2024).

Cadman, T., and Hales, R. (2022). COP26 and a framework for future global agreements on carbon market integrity. *Int. J. Soc. Qual.* 12, 76–99. doi: 10.3167/IJSQ.2022.120105

Carbon Credits (2023a). *What are Blue Carbon Credits? Everything You Need to Know*. Available online at: https://carboncredits.com/what-are-blue-carbon-credits-everything-you-need-to-know/ (accessed January 30, 2024).

Carbon Credits (2023b). *Voluntary Carbon Credit Buyers Willing to Pay More For Quality*. Available online at: https://carboncredits.com/voluntary-carbon-credit-buyers-willing-to-pay-more-for-quality/ (accessed January 30, 2024).

Chandrasekhar, A., Dunne, D., Gabbatiss, J., Goodman, J., Evans, S., Zhang, Z., et al. (2022). *COP27: Key Outcomes Agreed at the UN Climate Talks in Sharm El-Sheikh; Carbon Brief*. Available online at: https://www.carbonbrief.org/cop27-key-outcomes-agreed-at-the-un-climate-talks-in-sharm-el-sheikh/ (accessed January 30, 2024).

Crook, C., and Clapp, R. A. (1998). Is market-oriented forest conservation a contradiction in terms? *Environ. Conserv*. 25, 131–145. doi: 10.1017/S0376892998000186

EPA Region 1 (2023). *The Blue Carbon Reservoirs from Maine to Long Island, NY*. Available online at: https://www.northeastoceandata.org/files/metadata/Themes/Habitat/EPABlueCarbonReport.pdf (accessed January 30, 2024).

Friess, D. A., Howard, J., Huxham, M., Macreadie, P. I., and Ross, F. (2022). Capitalizing on the global financial interest in blue carbon. *PLoS Clim*. 1, e0000061. doi: 10.1371/journal.pclm.0000061

Gillenwater, M., and Seres, S. (2011). The clean development mechanism: a review of the first international offset programme. *Greenh. Gas Meas. Manag*. 1, 179–203. doi: 10.1080/20430779.2011.647014

Greenfield, P. (2023). *Revealed: More than 90% of Rainforest Carbon Offsets by Biggest Certifier Are Worthless, Analysis Shows*. The Guardian. Available online at: https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe (accessed January 8, 2023).

Jessen, B., Hill, K., and Orford, A. (2024). Proceedings of the blue carbon law symposium. *Sea Grant Law Policy J*. 13, 1.

Johnston, W. (2021). *What are Blue Carbon Credits and How to Maximise Their Impact*. Davos: World Economic Forum Davos Agenda. Available online at: https://www.weforum.org/agenda/2021/09/how-to-maximise-blue-carbon-credits/ (accessed January 30, 2024).

Jung, J. (2023). *Paris Agreement Article 6 and Implications for Korea's NDC Implementation; World Economy Brief 23–39*. Sejong City: Korea Institute for International Economic Policy. Available online at: https://econpapers.repec.org/paper/riskiepwe/2023_5f039.htm (accessed January 30, 2024).

Kollmuss, A., Lee, C., and Lazarus, M. (2010). How offset programs assess and approve projects and credits. *Carbon Manag*. 1, 119–134. doi: 10.4155/cmt.10.6

Liquete, C., Piroddi, C., Drakou, E. G., Gurney, L., Katsanevakis, S., Charef, A., et al. (2013). Current status and future prospects for the assessment of marine and coastal ecosystem services: a systematic review. *PLoS ONE*. 8, e67737. doi: 10.1371/journal.pone.0067737

Louisiana Climate Initiatives Task Force (2022). *Louisiana Climate Action Plan*. Available online at: https://gov.louisiana.gov/assets/docs/CCI-Task-force/CAP/Climate_Action_Plan_FINAL_3.pdf (accessed January 30, 2024).

Lovelock, C. E., and McAllister, R. R. (2013). 'Blue carbon' projects for the collective good. *Carbon Manag*. 4, 477–479. doi: 10.4155/cmt.13.50

Macreadie, P. I., Costa, M. D. P., Atwood, T. B., Friess, D. A., Kelleway, J. J., Kennedy, H., et al. (2021). Blue carbon as a natural climate solution. *Nat. Rev. Earth Environ*. 2, 826–839. doi: 10.1038/s43017-021-00224-1

Marcu, A. (2016). *Carbon Market Provisions in the Paris Agreement (Article 6)*. Brussels: Centre for European Policy Studies.

McAfee, K. (2012). The contradictory logic of global ecosystem services markets. *Dev. Change* 43, 105–131. doi: 10.1111/j.1467-7660.2011.01745.x

Nellemann, C., Corcoran, E., Duarte, C. M., Valdés, L., De Young, C., Fonseca, L., et al. (eds.). (2009). *Blue Carbon. A Rapid Response Assessment*. United Nations Environment Programme, GRID-Arendal. Available online at: https://wedocs.unep.org/handle/20.500.11822/7772

Office of Alaska Governor (2023a). *Governor Dunleavy Introduces Carbon Management and Monetization Bills Creating Statutory Structures*. Available online at: https://gov.alaska.gov/governor-dunleavy-introduces-carbon-management-and-monetization-bills-creating-statutory-structures/ (accessed January 30, 2024).

Office of Alaska Governor (2023b). *Governor Dunleavy Outlines Carbon Management Bill Package*. Available online at: https://gov.alaska.gov/governor-dunleavy-outlines-carbon-management-bill-package/ (accessed January 30, 2024).

Office of Alaska Governor (2023c). *Legislature Passes Governor Dunleavy's Carbon Offset Legislation*. Available online at: https://gov.alaska.gov/legislature-passes-governor-dunleavys-carbon-offset-legislation/ (accessed January 30, 2024).

Orford, A. (2024). Blue carbon law. *Sea Grant Law Policy J*. 13, 1.

Porter, R. (2024). Overcoming legal and carbon market challenges to blue carbon projects on public lands. *Sea Grant Law Policy J*. 13, 1.

Seitz, R. D., Wennhage, H., Bergström, U., Lipcius, R. N., and Ysebaert, T. (2014). Ecological value of coastal habitats for commercially and ecologically important species. *ICES J. Mar. Sci*. 71, 648–665. doi: 10.1093/icesjms/fst152

Shrestha, A., Eshpeter, S., Li, N., Li, J., Nile, J. O., Wang, G., et al. (2022). Inclusion of forestry offsets in emission trading schemes: insights from global experts. *J. For. Res*. 33, 279–287. doi: 10.1007/s11676-021-01329-5

Spalding, M. D., McIvor, A. L., Beck, M. W., Koch, E. W., Möller, I., Reed, D. J., et al. (2014). Coastal ecosystems: a critical element of risk reduction. *Conserv. Lett*. 7, 293–301. doi: 10.1111/conl.12074

Streck, C. (2021). How voluntary carbon markets can drive climate ambition. *J. Energy Nat. Resour. Law* 39, 367–374. doi: 10.1080/02646811.2021.1881275

Sutton-Grier, A. E., Wowk, K., and Bamford, H. (2015). Future of our coasts: the potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems. *Environ. Sci. Policy* 51, 137–148. doi: 10.1016/j.envsci.2015.04.006

Tamme, E. (2022). *The New IPCC Report – Carbon Removal Narrative*. Available online at: https://evetamme.com/2022/04/06/ar6-wgiii-report-carbon-removal/ (accessed January 30, 2024).

Tamme, E. (2023). *Challenges For Carbon Removal Under The UN Standard*. Available online at: https://evetamme.com/2023/05/21/challenges-for-carbon-removal-under-the-un-standard/ (accessed January 30, 2024).

Taskforce on Scaling Voluntary Carbon Markets (2021). *Final Report*. Available online at: https://www.iif.com/Portals/1/Files/TSVCM_Report.pdf (accessed 05 November, 2023).

Texas General Land Office (2023). *Texas Coastal Resiliency Master Plan*. Available online at: https://www.glo.texas.gov/coast/coastal-management/coastal-resiliency/resources/files/2023-tcrmp-book.pdf (accessed January 30, 2024).

UNFCCC (2015). *Paris Agreement to the United Nations Framework Convention on Climate Change*. Bonn: UNFCCC.

UNFCCC (2023). *Nationally determined contributions under the Paris Agreement. Synthesis Report*. Available online at: https://unfccc.int/documents/632334 (accessed January 30, 2024).

UNFCCC Secretariat (n.d.a). *Mechanisms under the Kyoto Protocol*. Available online at: https://unfccc.int/process/the-kyoto-protocol/mechanisms (accessed January 30, 2024).

UNFCCC Secretariat (n.d.b). *What is REDD+*. Available online at: https://unfccc.int/topics/land-use/workstreams/redd/what-is-redd (accessed January 30, 2024).

United States (2021). *Nationally Determined Contribution of the United States of America*. Available online at: https://unfccc.int/sites/default/files/NDC/2022-06/United%20States%20NDC%20April%2021%202021%20Final.pdf (accessed January 30, 2024).

Verra (2022). *VCS Project 2360: Virginia Coast Reserve Seagrass Restoration Project*. Available online at: https://registry.verra.org/app/projectDetail/VCS/2360 (accessed January 30, 2024).

Verra (2023a). *VM0033 Methodology for Tidal Wetland and Seagrass Restoration, v2.1*. Washington, DC: Verra. https://verra.org/methodologies/vm0033-methodology-for-tidal-wetland-and-seagrass-restoration-v2-1/.

Verra (2023b). *Verra Response to Guardian Article on Carbon Offsets*. Available online at: https://verra.org/verra-response-guardian-rainforest-carbon-offsets/ (accessed January 30, 2024).

Vierros, M. (2017). Communities and blue carbon: the role of traditional management systems in providing benefits for carbon storage, biodiversity conservation and livelihoods. *Clim. Change* 140, 89–100. doi: 10.1007/s10584-013-0920-3

World Bank (2023). *Global Seaweed: New and Emerging Markets Report*. Available online at: https://documents1.worldbank.org/curated/en/099081423104548226/pdf/P175786073c14c01609fe409c202ddf12d0.pdf (accessed January 30, 2024).

Wylie, L., Sutton-Grier, A. E., and Moore, A. (2016). Keys to successful blue carbon projects: lessons learned from global case studies. *Mar. Policy* 65, 76–84. doi: 10.1016/j.marpol.2015.12.020

Zeng, Y., Friess, D. A., Sarira, T. V., Siman, K., and Koh, L. P. (2021). Global potential and limits of mangrove blue carbon for climate change mitigation. *Curr. Biol*. 31, 1737–1743.e3. doi: 10.1016/j.cub.2021.01.070