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Blue Carbon in International Marine Public Opinion

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1. Introduction

"Blue carbon" is a relatively new term, and there are many who are likely unfamiliar with it. This term was first used in the United Nations Environment Programme (UNEP) report[1] (henceforth, "UNEP report") published in 2009. The term signifies carbon that is stored and sequestered by submerged coastal ecosystems such as seagrass beds represented by eelgrass, saltwater marshes, and mangrove forests. In the 12 years since the publication of the UNEP report, I believe that there have been increased opportunities for people to hear this word, even in Japan, in the context of climate change countermeasures; however, the dissemination of the term to the general public is still lacking.

First, this article briefly reflects on how the concept of blue carbon has developed following the UNEP report in the context of international maritime public opinion, climate change, and marine science and policy discussions. Next, an overview is provided of how Japan, the United States, Australia, and East Asian countries position blue carbon in terms of environmental policy. Finally, the perspectives needed for Japan to lead the international discussion on blue carbon is summarized in view of new scientific trends.

2. Developments in blue carbon in the context of international science and policy discussions

As mentioned above, the term blue carbon has been used frequently by the scientific community since its first mention in the 2009 UNEP report. This does not mean that carbon has a blue color. Rather, blue carbon is used to refer to the carbon absorbed by the ocean in order to differentiate it from the carbon absorbed and fixed by terrestrial forests and vegetation, which is now referred to as green carbon. The UNEP report indicated that the ocean absorbs over 50% of carbon dioxide, with approximately half of this stored in seagrass beds, salt marshes, and mangrove forests (particularly its soil), which constitute only 0.5% of the ocean area[2]. With this UNEP report as the trigger, there were over 150 papers published annually in 2019 compared to only a few papers published annually in 2010[3]. The Paris

Agreement was adopted at the 21st Conference of the Parties to the United Nations Framework Convention on Climate change (COP21) in December 2015. Perhaps also because of this, the number of scientific papers on blue carbon doubled in 2016.

The fact that blue carbon was addressed in the Intergovernmental Panel on Climate Change (IPCC) report was also an important scientific milestone. There were two important IPCC reports on blue carbon: one, the "2013 Supplement to the 2006 Guidelines for National Greenhouse Gas Inventories: Wetlands" (henceforth, "Wetlands Guidelines") published in 2013[4], and the other, the "Special Report on the Ocean and Cryosphere in a Changing Climate" (henceforth, "SROCC") published in September 2019[5]. The Wetlands Guidelines were created within an IPCC task force in 2011 in response to the request by the United Nations Framework Convention on Climate Change (UNFCCC) in 2011 to clarify the calculation method for wetlands with a focus on the rewetting and restoration of peatlands, and the guidelines were adopted in 2013[6]. As a result, the methodology for calculating blue carbon accumulated in the soil of coastal ecosystems as the amount of absorbed and emitted CO_2 was developed, and it was believed that there was an increased momentum for reflecting blue carbon in policy. The SROCC took up the issues of improving the conservation and management of blue carbon ecosystems that absorb, fix, and sequester carbon dioxide in coastal areas as a climate change mitigation measure that utilizes the marine ecosystem. Ten years after the UNEP report, it appears that there has been an accumulation of scientific knowledge on blue carbon, and that blue carbon has been addressed within the IPCC.

In recent years, Japan has also participated in the "High Level Panel for a Sustainable Ocean Economy," a conference that was launched in 2018 under the leadership of Norway and is attended by leaders of 14 major maritime nations. Last year, the conference published 16 blue papers and special reports. One of these was "The Ocean as a Solution to Climate Change"[7]; among the five solutions using the ocean, blue carbon (expressed as coastal and marine ecosystems) was suggested as one option. As can be seen from Table 1, in order to keep post-industrial revolution temperature increases within 1.5 ℃, ocean-based mitigation measures were evaluated as being able to contribute a total of 4-12% by 2030 and 6-21% by 2050. The contributions of marine-based renewable energy were estimated to be very large in 2050 as the scale of offshore wind power generation was expected to expand in the long term. However, considering the next 10 years until 2030, it can be seen that the potential of blue carbon ecosystem conservation and regeneration is relatively large. As described later, the blue carbon ecosystem has various benefits other than climate change mitigation (co-benefits); therefore, setting its conservation and regeneration as a major goal for the countries that have these resources is thought to be reasonable.

Table 1. Potential of blue carbon as an ocean-based climate change mitigation measure[8]

Areas of ocean-based climate action	2030 mitigation potential ($GtCO_{2e}$/year[9])	2050 mitigation potential ($GtCO_{2e}$/year)
1. Ocean-based renewable energy	0.18-0.25	0.76-5.40
2. Ocean-based transport	0.24-0.47	0.9-1.80
3. Coastal and marine ecosystems	0.32-0.89	0.50-1.38
4. Fisheries, aquaculture, and dietary shifts	0.34-0.94	0.48-1.24
5. Carbon storage in the seabed	0.25-1.0	0.50-2.0
Total	1.32-3.54	3.14-11.82
Total percentage contribution to 1.5 ℃ target	4-12 %	6-21%
Total percentage contribution to 2 ℃	7-19%	7-25%

To date, explanations on the climate change "mitigation" functions of blue carbon ecosystems through CO_2 fixation have been provided. However, blue carbon ecosystems also have "adaptation" functions where local residents and communities respond to climate change and reduce damage. Adaptation functions include protection from storms and rising sea levels, prevention of coastline erosion, regulation of coastal water quality, provision of habitats for marine life (including commercially important fish and endangered species), and food security for coastal communities. These varied human benefits or ecosystem services other than mitigation effects are collectively called co-benefits.

3. Characteristics of blue carbon policies in various countries

In the previous section, the development of blue carbon on an international scale and the interaction with policies (e.g., UNFCCC) and science (e.g., IPCC) was outlined as a node that links climate change countermeasures and sustainable use of the ocean. This section outlines the characteristics of the blue carbon ecosystem and the handling of blue carbon relating to national emission reduction targets in Australia and the United States, which are advanced countries with regard to blue carbon policy, and East Asian countries, including Japan, which have many blue carbon ecosystems and are highly dependent on these ecosystems.

① Australia

Australia is a blue carbon powerhouse with the world's largest seagrass bed area (52,051 ㎢)[10], second largest mangrove forest area (9,780 ㎢)[11], and second largest salt marsh area (13,259 ㎢)[12]. The establishment of the International Partnership for Blue Carbon led by the Australian government in the 2015 COP21, where the Paris Agreement was adopted, is believed to be a reflection of this blue carbon potential. Australia is one of the few countries to use the Wetland Guidelines of the IPCC to voluntarily report on blue carbon (carbon sequestration associated with coastal wetlands) and set numerical targets for emissions reduction by blue carbon ecosystems[13].

Meanwhile, there has also been criticism that Australia has used blue carbon as a cover, where they would use it for diplomatic purposes or in creating credit by spending trivial amounts on island nations and conservation of blue carbon ecosystems, which is then used for Australian offsets, and subsequently doing nothing to control carbon dioxide emissions[14].

② United States

The United States has the largest salt marsh area in the world (18,849 ㎢)[15]. Like Australia, the United States uses the IPCC Wetland Guidelines to calculate blue carbon ecosystems in the National Greenhouse Gas Emissions and Absorption Inventory, which indicates numerical targets for emissions reductions[16]. Blue carbon in the United States has recently been advanced through many wetland restoration projects led by a non-profit organization called Restore America's Estuaries[17], in cooperation with the National Oceanic and Atmospheric Administration (NOAA). Demonstration tests of the voluntary carbon market by carbon offset projects have been conducted through regeneration activities in the Herring River estuaries[18]. Increasing the number of success stories in the voluntary carbon market and entering the compliance market in the long-term are thought to help increase the value of offsets generated by wetland restoration and provide additional financial support to recovery projects[19].

③China

In recent years, coastal blue carbon ecosystems have been attracting attention even in China as a mitigation and adaptation measure. It has been estimated that 9,236-10,059 ㎢ of blue carbon ecosystems such as mangroves, salt marshes, and seagrass beds have been lost in China from 1950 to the present day. Currently, 1,326-2,149 ㎢ have been reported as natural ecosystems, and 2-15 ㎢ as regenerated or created[20]. Furthermore, seaweed aquaculture has been estimated to comprise an area of 1,252-1,265 ㎢, which is approximately equal to that of natural blue carbon ecosystems. Annual CO_2 absorption was estimated to be 151.8 × 1000 tCO_2 for seagrass beds, 960–2,720 × 1000 tCO_2 for salt marshes, and 399 × 1000 tCO_2 for mangroves[21].

China's seaweed aquaculture production has become the largest in the world at approximately 18 million tons in recent years, which is far ahead of Indonesia's 10 million tons, the second largest[22]. Therefore, there has been increasing interest in the inclusion of seaweed aquaculture as blue carbon. In addition, increases in the scale of seaweed aquaculture have necessitated anchor systems with a buoyancy adjustment function in order to conduct aquaculture in offshore areas where waves are in a high-energy environment. This in turn requires additional investments. New technologies for brown algae (*Sargassum fusiforme*) aquaculture have been demonstrated in Dongtou District, Wenzhou city. It is anticipated that the creation of carbon credits for these additional investments would contribute to the sustainability of aquaculture operators. The cultivated seaweed is currently mainly used for food; however, consumption results in its return in the form of CO_2, thereby limiting the mitigating effects. It has been indicated that maximizing climate change mitigation through seaweed aquaculture requires biofuel production with the seaweed yields, design of long-lasting products, and biochar production from residues in order to improve soils[23]. The inclusion of blue carbon ecosystem surveys, monitoring, standardization, and the promotion of international cooperation in the vision for marine cooperation in the Belt and Road Initiative has also been reported[24].

④Indonesia

Indonesia also has extensive blue carbon ecosystems with 42,550 ㎢ of mangrove forests[25] and 30,000 ㎢ of seagrass beds[26]; moreover, Indonesia's mangroves are said to comprise 23% of the world's mangrove forests. It is estimated that mangrove conservation can reduce annual emissions by 0.2 $GtCO_{2e}$ or 30% of the country's annual terrestrial emissions[27]. Indonesia's production of seaweed aquaculture is also the second largest in the world, after China as discussed above.

Thus, Indonesia with such a large potential for blue carbon, naturally has a high interest in blue carbon. For example, the Indonesia Blue Carbon Strategic Framework was formulated for the "National Medium Term Development Plan 2020-2024," where this will be implemented by organizations overseeing development/planning, marine policy, fisheries, and natural resource conservation[28]. A presidential decree has also set a goal of restoring 1.82 million ha of mangrove ecosystems by 2045, with a numerical target of 60,000 ha needing to be restored annually in order to achieve this. Indonesia is aiming to integrate blue carbon into its national greenhouse gas inventory. However, it has been indicated that the logging rate of mangrove forests exceeds the rate of planting and regeneration, and that this downward trend continues[29].

⑤Japan

The extent of Japan's seagrass beds, salt marshes, mangrove forests, and seaweed beds are estimated to be 620 ㎢, 470 ㎢, 30 ㎢, and 1720 ㎢, respectively, and the total annual CO_2 absorption is estimated to be 1,320-4,040 × 1000 tCO_2[30]. These estimates are on the same scale as those reported for China in the earlier section. However, in Japan, the seaweed beds included as part of the calculations mainly comprise natural seaweed beds, whereas in China, farmed beds are predominant.

Japan does not include the sea in its greenhouse gas inventory and does not calculate coastal wetlands according to the Wetland Guidelines[31]. The "Blue Carbon Study Group," which consists of academic experts and related organizations, was established in 2017 in order to overcome this issue, and the group focused on the estimation of CO_2 absorption by blue carbon ecosystems. In response to the results of this Study Group, the "Promotion of efforts toward the utilization of blue carbon ecosystems - Establishment of the Study Group on the Role of Blue Carbon which Contributes to the Prevention of Global Warming" was established in 2019 as a national study group led by the Marine and Environment Division, Port Bureau, Ministry of Land Infrastructure, Transport and Tourism. This group has advanced specific studies in order to utilize blue carbon as an absorption source[32].

Furthermore, in July 2020, the Japan Blue Economy Association was established as an authorized national corporation (i.e., overseeing minister) called the Collaborative Innovation Partnership, in which the Sasakawa Peace Foundation (with which the author is affiliated) has also participated as a member to promote research. We are conducting research and development on system design for the examination, certification, and issuance of newly credited blue carbon in order to accelerate initiatives for climate change mitigation and climate change adaptation in the role of blue carbon ecosystems as CO_2 sinks as well as in other coastal and marine areas[33].

⑥Participating countries in the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)

The PEMSEA comprises 11 government organizations, including Cambodia, China, Indonesia, Japan, Laos, North Korea, the Philippines, South Korea, Singapore, East Timor, and Vietnam, as well as non-governmental partners such as the Sasakawa Peace Foundation Ocean Policy Research Institute (OPRI), International EMECS Center, NOWPAP, and PEMSEA Network of Local Governments (PNLG). The situation in PEMSEA participating countries such as China, Indonesia, and Japan have been outlined above. East Asia, where PEMSEA is located, is a global hotspot with rich coastal blue carbon ecosystems, but the high loss rates observed in the region are problematic.

The new framework of the NDC under the Paris Agreement, which is a national commitment to climate change, is also believed to create strong incentives to action among PEMSEA countries, and almost all the PEMSEA participating countries have begun initiatives for blue carbon ecosystems in the NDC[34].

4. Future developments for blue carbon and expectations for Japan

As mentioned above, the use of blue carbon as a climate change mitigation/adaptation strategy is expected to greatly promote science and the policies/behaviors based on it over the next 5-10 years as initiatives for achieving a net-zero impact society. In Japan, including coastal blue carbon ecosystems in the greenhouse gas inventory by the next NDC submission in 2025 will be important for utilizing the current momentum, improving the accuracy and amount of reporting of the extent of blue carbon ecosystems and CO_2 absorption amount, and simultaneously revising the associated laws and regulations.

Meanwhile, it is thought that Japan should learn regulation designs from its international predecessors such as Australia and the United States, which have already calculated blue carbon ecosystems in their inventory and set numerical targets for emissions reductions. In addition, Japan should lead the discussion on how to enjoy the co-benefits of blue carbon and how to implement conservation and regeneration alongside ecosystem utilization while also considering the society, culture, economy, and environment that is unique to the East Asian region. The dissemination of Japan's blue carbon policy to the world together with its East Asian partners is envisaged and it is expected to serve as a basis for the formation of international rules as well as foster technology- and policy-based dialogue, mainly in the participating PEMSEA countries. (End)

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