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Analysis

Blue carbon: Knowledge gaps, critical issues, and novel approaches

Sebastian Thomas *

School of Geography, Planning, and Environmental Management, The University of Queensland, Brisbane 4072 QLD Australia

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ABSTRACT

Blue carbon – the carbon stored and sequestered in mangrove forests, seagrass meadows, and tidal salt marshes – is considered a cost-effective means to achieve positive climate change mitigation and adaptation outcomes. Blue carbon is therefore of considerable interest to the scientific and policy communities, and is frequently discussed in relation to carbon markets and climate finance opportunities. This paper identifies peer-reviewed and 'gray literature' documents that discuss blue carbon in the context of finance and market mechanisms. The document set is analyzed both quantitatively and qualitatively, and the principal scientific, economic, regulatory, social, and management issues that emerge are discussed. The study reveals that (1) the blue carbon literature is dominated by technical and policy commentary, with a dearth of research into practical social considerations and a stark absence of private sector perspectives; (2) there is confusion over the nature and role of important concepts including private and public sector finance and instruments; and (3) understanding of the important issues of investment priorities and risk considerations is also limited. This paper therefore identifies gaps in the blue carbon literature, clarifies critical concepts and issues, and proposes novel pathways for blue carbon research and project development.

1. Introduction

'Blue carbon' refers to mangrove forests, seagrass meadows, and tidal salt marshes — vegetated coastal ecosystems that represent significant carbon stocks, and which are disappearing or becoming degraded as a result of continuing development pressures (Pendleton et al., 2012). The idea of blue carbon is attractive, indeed exciting, to many in the conservation and policy communities, because it appears to be a cost-effective strategy to achieve not only genuine reductions in greenhouse gas emissions but a host of 'co-benefits' as well: providing habitat for valuable food species, filtering and treating run-off and chemical pollution from industry and agriculture, and providing effective defense against storms and extreme weather events (Grimsditch et al., 2013; Nellemann et al., 2009). Given the mitigation and adaptation benefits that result from protection or restoration of blue carbon resources, and the limited public and private sector investment in projects to date, it is worth investigating the financial and economic aspects of project development. Blue carbon is an ideal case study in ecological economics and the political economy of climate change.

This paper seeks to answer two principal research questions: (1) What is the state of the literature on blue carbon? (2) What is the role of the private sector in blue carbon project activities? The paper presents a detailed analysis of existing literature on blue carbon, with the aim of understanding how this topic is being discussed: by whom and in which disciplinary areas; whether as a peer-reviewed scientific discussion, speculation about potential business opportunities, or as a policy issue; in what contexts; and by how large a community. The analysis is then extended to consider the inclusion of finance, market concepts, and the private sector in the blue carbon conversation. This study reveals the scientific, economic, regulatory, social, and management issues that emerge from the blue carbon conversation. Section 2 explains the methods used in the analysis, and Section 3 presents results. In Section 4 the findings are discussed in the context of critical issues involved in bringing blue carbon to market. Section 5 concludes the paper.

1.1. Background

In November 2009 the United Nations Environment Program published a landmark report titled *Blue carbon: A rapid response assessment* (Nellemann et al., 2009). The publication was an important milestone for three reasons: (1) it completed the process of global carbon accounting begun by the IPCC with the atmosphere, and then terrestrial biomes (most notably forests); (2) it raised the profile of vital marine and coastal zones by highlighting their significance in terms of carbon cycling and other ecosystem services, in contrast to the better understood terrestrial ecosystems; and (3) it made five key policy recommendations, the first of which was to establish a global blue carbon fund for protection and management of coastal and marine ecosystems and ocean carbon sequestration. In other words, the report proposed using climate finance – the basis of the international market-based approach to climate change mitigation – as the foundation of strategic efforts to achieve sustainable futures for the social and ecological systems

* Tel.: +61 498130782.
E-mail address: seth.thomas@uq.edu.au.

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(the biodiversity, communities, and livelihoods) that depend on the ocean.

The blue carbon discussion quickly gained momentum. A 'Blue Carbon Initiative' was established in 2010 by the United Nations and non-government partners,[1] with the aim of promoting climate change mitigation through restoration and sustainable use of coastal and marine ecosystems. The Initiative comprises two working groups, one on scientific and technical issues, the other investigating policy matters. The policy group has made a number of recommendations, the first two of which are: (1) to integrate blue carbon activities fully into the international policy and financing processes of the United Nations Framework Convention on Climate Change (UNFCCC) as part of mechanisms for climate change mitigation; and (2) to integrate blue carbon activities fully into other carbon finance mechanisms such as the voluntary carbon market as a mechanism for climate change mitigation. At the Rio + 20 United Nations Conference on Environment and Development in June 2012 the International Oceanographic Commission (IOC) released the *Blueprint for Ocean Sustainability*. Of the 10 proposed measures to achieve ocean sustainability, the first relates to mitigating and adapting to acidification, while the second, Objective 1b, advocates the creation of "a global blue carbon market as a means of creating direct economic gain through habitat protection" (IOC, 2011:33).

The ocean plays what is arguably the single most significant role in planetary climate dynamics. 93% of carbon dioxide in the planetary system is stored and cycled through the ocean, and the ocean absorbs 90% of new thermal energy (Balmaseda et al., 2013). In addition, marine and coastal habitats provide food, fuel, energy, hazard protection, waste processing, recreational opportunities, and cultural values (Beaudoin and Pendleton, 2012; Lau, 2012). A substantial current policy challenge is valuing these ecological services in order to integrate natural systems with human economic structures; the failure to acknowledge the true costs of the destruction of marine ecosystems is a potentially serious threat to human societies (Failler and Pan, 2007). Given the significance of the ocean in climate dynamics, and the importance of marine and coastal ecosystems to human social and economic institutions, the rapidly growing interest in blue carbon seems entirely reasonable. Nations have pledged substantial funds towards climate mitigation efforts and adaptation efforts, and private sector finance is expected to represent a substantial proportion of these contributions (O'Sullivan et al., 2011; Stadelmann et al., 2013). This high level advocacy for market-based instruments (MBIs) to support blue carbon activities suggests that policy theorists and decision-makers recognize the importance of private sector commercial interests, as well as public agencies, to the blue carbon conversation.

1.2. Clarifying the Blue Carbon Discussion

It is important to recognize distinctions in the meaning of terms such as 'finance' and 'markets'. While finance obviously refers to the monetary resources necessary to establish and manage projects, it can be delivered from both public and private sources, and these will have very different expectations around accountability, governance, return on investment, and stakeholder engagement. Similarly, markets involve trade and exchange of goods and services that have values determined by levels of supply and demand. Markets are an emergent property of regulatory frameworks and the commercial activity that occurs within them, but the term is also used to refer to transactions between nation-states, as well as private firms. Similarly, there are differences between markets for ecosystem services (MES) – emissions trading or wetland mitigation banking,[2] for instance – and PES – watershed protection or carbon sequestration – in that MES are more likely to have a commercial (for-profit) aspect (Corbera et al., 2009; Gómez-Baggethun et al., 2010). Many of the papers included in this analysis conflate different types of economic and regulatory mechanisms within the term 'market'.

Stadelmann et al. (2013:720) define climate finance as "financial flows mobilized by industrialized country governments and private entities that support climate change mitigation and adaptation in developing countries". This definition excludes the internal investments made by governments in non-industrialized states. *The Landscape of Climate Finance 2012* report (Buchner et al., 2012) provides useful clarity, identifying sources, intermediaries, instruments, and uses. This analysis is limited to climate-specific finance, meaning money targeted towards low carbon development or climate adaptation, and excluding investment in the areas of research and development, manufacturing, and deployment, with the rationale that these may not result in verifiable emission reductions. The report found that the total amount of climate finance from all sources was US$343–385 billion in 2010–2011 (average US$363 billion). Public sources and intermediaries (including governments, development institutions, and international climate funds) account for a quarter of this (26%), with the private sector (project developers, corporate and institutional investors, commercial financial institutions, households, and venture capital and private equity) contributing the majority (74%) (Buchner et al., 2012).

In this study 'climate finance' will be defined as financial flows mobilized by governments, non-government organizations, and private sector commercial entities to support climate change mitigation and adaptation in developing and industrialized countries. 'Markets' by definition involve multiple actors and flexible rates of exchange with the opportunity for profit. In other words, not all climate finance operates in a market context. Investment by development banks, for instance, is not a for-profit commercial activity. All investment decisions, however, are made after consideration of factors including rates and types of return, governance and accountability, and overall risk. 'Investment' can therefore be a commercial activity, or not, depending on whether the expected returns are financial or otherwise. This paper distinguishes between public, private, and hybrid sources of finance, and the roles and responsibilities of nations and organizations, with the goal of enhancing the clarity of the blue carbon discussion, and facilitating further interest and investment in blue carbon project activities.

2. Methods

The analysis was conducted in three stages. First, a review of existing literature on blue carbon was conducted to identify the range of material available on the topic. This systematic, quantitative literature review (Pickering and Byrne, 2014) identified 46 articles and papers that examine blue carbon and make at least some reference to the role or potential role of international climate finance or global carbon markets in supporting blue carbon project activities. Definitions of climate finance are discussed in Section 1.

English language research papers and technical or policy-oriented reports relevant to the topic of blue carbon were identified by searching online databases including Science Direct, the Web of Science, EBSCO, ProQuest and Google Scholar. These databases cover the major literature sources across the biological, geographical, and social sciences, along with governance, economics, and business disciplinary areas. The search was conducted over an extended period, but was finalized in July 2013. The principal keyword search term was 'blue carbon', referring to carbon storage or sequestration in marine and coastal

[1] The Blue Carbon Initiative was established by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization (IOC-UNESCO), in partnership with Conservation International (CI) and the Internal Union for the Conservation of Nature (IUCN). Information on the Initiative is available at http://thebluecarboninitiative.org. Another relevant site is http://bluecarbonportal.org, a point of contact and information for the global blue carbon community.

[2] Mitigation banking involves a regulatory requirement for project developers to offset their environmental impacts by restoring, improving, creating, or in some cases protecting an ecosystem area. See for example http://water.epa.gov/lawsregs/guidance/wetlands/mitbanking.cfm.