Integrating blue: Challenges and solutions in including blue carbon into Nationally Determined Contributions

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Area being submitted to *7. Coastal ecosystem-based solutions: Climate-change adaptation and mitigation*

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This template is an example of how to prepare an abstract for the 2020 MASTS Annual Science Meeting, to be held online during the week of **5-9 October 2020**.

The Paris Agreement requires signatory countries to submit Nationally Determined Contributions (NDCs) that lead to adaptation and mitigation measures against climate change. Submissions for the second round of NDCs are now occurring, with increasing ambitions from the first round in 2015. Using Nature-based Solutions (NbS) in climate change mitigation has the potential for large benefits to both biodiversity and society (IUCN, 2020) with blue carbon habitats being among the most important marine habitats for mitigation and adaptation (Macreadie et al., 2019).
This talk explores the challenges and some potential solutions in including blue carbon ecosystems in NDC submissions. We will describe some of the mechanisms for how local community projects may be integrated with national policies, discuss options for approaches that encourage co-operation and mutual support between local and national levels and describe the use of the voluntary carbon market through Article 6 of the Paris Agreement (UNFCCC.2015) and how this might expand in future.

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Researchers at ENU exploring challenges and solutions in including blue carbon into Nationally Determined Contributions through our project 'Local Roots and Global Branches' #integratingblue #bluecarboninndcs #article6parisagreement #climatechangemitigation #MASTSasm2020
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Acknowledgements

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Source to Sea: Organic carbon transport from forested environments to coastal waters

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ABSTRACT

Understanding and quantifying global carbon stores is vital to assess the earth's natural capacity to uptake carbon. This research aims to understand the geochemical mechanisms controlling coastal carbon burial and how land use can influence this. There is a global drive to increase forestry, and this is evident in Scotland through the new ten-year forestry strategy (Scottish Government, 2019). Large areas of forestry have been, and will be, planted in catchments of sea lochs / fjords, areas that have recently been identified as significant carbon stores (Smeaton and Austin, 2017). Furthermore, there is strong evidence that iron geochemistry plays a large role in the preservation of organic carbon in sediments (Lalonde et al., 2012).

This study aims to address the gap in our knowledge regarding the lateral transport of organic carbon from land to sea, particularly in areas of forestry. Here we show the approach this project will take to fulfill this aim. We will combine several analytical techniques such as Mössbauer spectroscopy, SEM, elemental analysis and lignin analysis to trace the movement and interactions of organic carbon across terrestrial and marine environments.

With this data we aim to improve our understanding of source to sea processes for fjord systems throughout the northern hemisphere, which will enable improved quantification of local and national carbon stocks. A better understanding of carbon burial mechanisms allows us to tailor land use and management around fjord environments to maximize carbon storage.

Tweetable Abstract
Twitter handle: **@celestethelion**

We focus on lateral carbon transport from #sourcetosea to understand the influence of #forestry on #coastalcarbon storage in fjord systems. A suite of geochemical tools enables us to analyse the role iron plays in the transport and burial of organic carbon #MASTSasm2020

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Historical patterns of saltmarsh extent change reveal the long-term value of coastal habitats

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Coastal ecosystems like salt marshes and mangrove forests are now globally recognized for their value to society; they protect us from coastal flooding, absorb and lock CO_2 in the ground, and provide spaces for spiritual healing.

However, coastlines are also dynamic places. Saltmarshes, for example, can erode by tens of meters in a single storm event, and rapidly recolonize the tidal flat by the following season. Human activity also has a huge effect on marsh extent, causing both losses through reclamation, and gains through restoration. Studies on long-term and large-scale trends of marsh change can help predict how the value of marshes will change into the future. However, few such studies exist to date.

Our study took advantage of the legacy of historical maps and aerial photographs which exist for the UK, in order to track how the largest collection of marshes across Scotland, England and Wales have changed in extent since the 1850s. We also used hydrological, sedimentological, and climatological data gathered since the 1970s to understand which processes were most important in driving marsh change.

We found that marshes along southern, western and north-east Britain expanded between 1846 and 2016. South-east Britain was the only region to consistently lose marsh cover. We found that having a positive sediment supply plays a crucial role in explaining large-scale and long-term trends of lateral marsh expansion (Ladd et al. 2019).

A future research direction is to examine whether historical marsh dynamics impact upon ecosystem service delivery. Preliminary results from soil cores gathered across historically stable and dynamic portions of saltmarshes reveal that organic carbon content is strongly related to the frequency of marsh erosion-expansion cycles. The value of saltmarshes as blue carbon stores therefore needs to account for long-term and large-scale marsh dynamics.

Twitter abstract

@cailadd et al. show how British saltmarshes have eroded and expanded since the 1850s, and how sediment supply is needed to ensure marsh survival. Examining historical marsh change can help predict how the value of marshes to society will change in the future

Acknowledgements

We thank Prof. Tom Spencer from Cambridge University and Dr Jonathan Malarkey, Prof. Jaco Baas, Prof. Hilary Kennedy, and Prof. Stuart Jenkins from Bangor University for their help with this work.

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Scaling Seagrass Restoration in Scotland: Coastal Hubs for Community-Driven Restoration Success

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The United Nations has declared 2021-2030 "The Decade on Ecosystem Restoration." With this in mind, effective, natural, ecosystem-based solutions are highly sought after to mitigate problems resulting from anthropogenic pressures and climate change as a whole.

One solution lies with the protection and restoration of *Zostera marina* eelgrass beds. Once plentiful, *Z. marina* populations decreased by 90% in the early 1930s due to coastal development and a seagrass wasting disease, and have never truly recovered. When healthy beds are present, they provide a wide range of highly valuable ecosystem services, including sediment stabilisation, wave attenuation, provision of nursery habitat, and carbon sequestration. Together, these benefits represent an effective, natural coastal management solution to combat pressing issues linked to climate change.

Scotland in particular has a high potential for seagrass restoration success. Seagrass beds were once plentiful along its coasts, and with proper marine spatial planning, could flourish once more. This study analyses a number of key physical, biological, and social factors in order to create a Habitat Suitability Index (HSI) for those places along the Scottish coast that are most likely to achieve restoration success. This study was undertaken using entirely open source software and datasets, and serves as an example for anyone who wishes to see how *Z. marina* restoration projects in their own sites of interest may fare. Furthermore, the HSI template shown here can be adjusted to incorporate additional parameters or higher resolution datasets. One key to long-term success may lie in effective community education and involvement, cultivating local buy-in and enthusiasm for the project. By showing the general public how accessible both the tools and the ecosystems are, this study aims to encourage citizen scientists and project developers to investigate how their own restoration goals might be best achieved.

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Tweetable Abstract

Scotland has high potential for long-term seagrass restoration success—coastal community buy-in may be one key to achieving it. A new habitat suitability index yields insights into how different social and environmental factors may influence future restoration success.

Twitter: @emmartin0510

Blue carbon: policy context and ecological economics

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Carbon markets and social costs of carbon attempt to internalise the current externalities of global ecosystem services into global economies. By doing so they also provide blue carbon with an integral route for climate change mitigation. Carbon sequestered by blue carbon can be quantified, evaluated, and credits generated therein can traded to allow countries to meet specified emissions targets.

There have been, however, issues with the incorporation of blue carbon into policy mechanisms and financial trading. These issues revolve around the lack of quantifiable data, stakeholder engagement, sustainable development, and how these link to fundamental limitations in resources, economic growth, and governance. Blue carbon policy now attempts to provide a multilateral approach incorporating, and evaluating, the co-benefits of these habitats with stakeholder engagement and sustainable development goals to consider the full value chain. This creates additional considerations of blue carbon habitats based on the ecosystem services they provide in addition to carbon sequestration. In some cases, the values of co-benefits may exceed those from carbon sequestration. The scope of what may be considered 'blue carbon' may then expand to previously dismissed habitats to internalise more externalities of economic systems. Additionally, as most blue carbon policy has focused on developing countries, the expansion of blue carbon policy in developed countries may present novel challenges.

Blue carbon may act as a microcosm of wider climate change mitigation; blue carbon mechanisms require the integration of ecological, economical, and social values linked across the full value chain of stakeholders. This presentation provides an overview of blue carbon, the various pathways with which it might be incorporated into funding mechanisms, key issues and data gaps, and recommendations for future blue carbon policy in Scotland and the UK.

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Understanding establishment thresholds of mangrove pioneer species in North Sumatra: implications for restoration

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Mangrove forests, one of the most productive ecosystems worldwide, exist within highly dynamic sedimentary environments and are subject to frequent disturbances (i.e. tidal flooding, wind exposure and sediment redistribution), yet they are able to colonize and shape ecosystems along (sub-) tropical coastlines. Over the last decades, the extensive loss of mangroves (~35% of their total cover) has led to intensive restoration efforts, often carried out through diaspore dispersal or nursery cultivation and transplanting programs. In many cases, restorations fail and need reassessment, highlighting the urgency to fully understand natural coastal dynamic processes, where the positive feedbacks between vegetation and substrates can aid as a cost-effective tool for successful recovery.

Natural colonisation of bare mudflats, where hydrodynamic forcing limits establishment whilst sea water adds physiological stress, starts when two detrimental conditions meet in time and space: first, there is availability of pioneer species diaspores (i.e. seeds of light demanding and fast-growing species), and second, windows of opportunity events occur (disturbance free periods where diaspores can germinate and securely anchor to the sediments, further referred as WoO). In this study, we evaluated the duration and frequency of WoO periods that are optimal for the early establishment of the mangrove pioneer species *Avicennia alba* in North Sumatra (Indonesia), with the aim of strengthening our knowledge on natural on establishment thresholds that modulate natural colonization, and thus, regeneration processes.

We combined field monitoring of tidal inundation and natural seedling establishment along elevation gradients with mesocosm experiments that mimicked flooding, waves and salinity. Further, *a posteriori* length and frequency of roots helped determine root attributes that influence establishment success. Our results show that, while establishment can occur in WoO>1 day at low salinities (10 ppt) irrespective of mild hydrodynamic forcing, WoO between 3 and 5 days are optimal under salinity values of 30 ppt. Establishment was correlated to both root length and root frequency; the longer the roots and the higher the number of roots produced, the higher the establishment success. While salinity limits root growth rates, WoO > 5 days represent an added stress for development through dehydration, potentially further reducing establishment rates. WoO of 3 days ensure enough time to develop the first roots whilst warrantying water availability that reduces sun exposure and overheating. In the field, the seasons with highest frequency of WoO ≥ 3 days was recorded for the periods between February- May and coincided with the season of major diaspore availability for the region, suggesting potential phenological synchrony with tidal inundation patterns.

Identifying WoO through the assessment of hydroperiods, along with an understanding of local pioneer species phenology and biology, can aid efforts to facilitate natural ecosystem regeneration without active planting.

Twittable abstract: The synchrony between phenology and windows of opportunity can facilitate mangrove natural regeneration

Twitter handle @Vovides1

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