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A Sedimentary Carbon Inventory for a Scottish Sea Loch

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Coastal oceans are sites of biogeochemical cycling, as terrestrial, atmospheric, and marine carbon cycles interact. Important processes that affect the carbon cycle in the coastal ocean include upwelling, river input, air-sea gas exchange, primary production, respiration, sediment burial, export, and sea-ice dynamics. The magnitude and variability of many carbon fluxes are accordingly much higher in coastal oceans than in open ocean environments. Having high-quality observations of carbon stocks and fluxes in the coastal environment is important both for understanding coastal ocean carbon balance and for reconciling continent-scale carbon budgets. Despite the ecological, biological, and economic importance of coastal oceans, the magnitude and variability of many of the coastal carbon stocks are poorly quantified in most regions in comparison to terrestrial and deep ocean carbon stocks.

The first stage in understanding the carbon dynamics in coastal waters is to quantify the existing carbon stocks. The coastal sediment potentially holds a significant volume of carbon; yet there has been no comprehensive attempt to quantitatively determine the volume of carbon held in those coastal sediments as echoed by Bauer et al., (2013) “the diverse sources and sinks of carbon and their complex interactions in these waters remain poorly understood”.
We set out to create the first sedimentary carbon inventory for a sea loch (fjord); through a combination of geophysics and biogeochemistry. Two key questions must be answered to achieve this goal; how much sediment is held within the loch and what percentage of that sediment carbon?

The restrictive geomorphology of sea lochs (fjords) provides the perfect area to develop this methodology and answer these fundamental questions. Loch Sunart the longest of the Scottish sea lochs is our initial test site due to existing geophysical data being available for analysis. Here we discuss the development of the joint geophysics and biogeochemical methodology and how it was applied to Loch Sunart.

The methodology was applied to seismic geophysics data collected in 2009 (Baltzer et al. 2010,) and data compiled through biogeochemical analysis of sediment cores collected from Loch Sunart. Through the combination of these datasets we have undertaken calculations to quantify the total sediment mass and the percentage of carbon contained in that sediment.
Through this work we have created the first holistic sedimentary carbon inventory for a sea loch; which is the first step to tackling the larger questions around coastal carbon.

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Bauer, JE, Cai, W-J, Raymond, P a, Bianchi, TS, Hopkinson, CS and Regnier, P a G 2013, The changing carbon cycle of the coastal ocean., Nature, 504, (7478), pp. 61–70.