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Organic carbon sequestration in coastal sediments across the Baltic Sea over the last 150 years

David Ryves (1), Jonathan Lewis (1), Peter Rasmussen (2,3), Kaarina Weckström (3,4), Elinor Andrén (5), Annemarie Clarke (6), Thorbjørn Andersen (7), Handong Yang (8), Susanah Hietanen (4), Tom Jilbert (4), Juris Aigars (9), and N. John Anderson (1)

(1) Centre for Hydrological and Ecosystem Science, Department of Geography, Loughborough University, Loughborough, UK, (D.B.Ryves@lboro.ac.uk; J.P.Lewis@lboro.ac.uk; N.J.Anderson@lboro.ac.uk), (2) Environmental Archaeology and Materials Science, National Museum of Denmark, Brede Værk, Lyngby, Denmark, (Peter.Rasmussen@natmus.dk), (3) Department of Marine Geology and Glaciology, Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark, (Peter.Rasmussen@natmus.dk; Kaarina.Weckstrom@helsinki.fi), (4) Department of Environmental Sciences, Faculty of Biological and Environmental Sciences, University of Helsinki, Finland. (Kaarina.Weckstrom@helsinki.fi; susanna.hietanen@helsinki.fi; tom.jilbert@helsinki.fi), (5) School of Natural Sciences, Technology and Environmental Studies, Södertörn University, Huddinge, Sweden, (elinor.andren@sh.se), (6) APEM Aquatic Scientists Ltd, Stockport, UK, (annieclarke2771@yahoo.co.uk), (7) Section of Geography, University of Copenhagen, Copenhagen, Denmark (tja@ign.ku.dk), (8) Department of Geography, University College London, London, UK (handong.yang@ucl.ac.uk), (9) Latvian Institute of Aquatic Ecology, Rīga, Latvia, (juris.aigars@lhei.lv)

Coastal areas are extremely vulnerable to impacts from changing marine conditions, which are increasingly being driven by human activity (e.g. nutrient cycling, salinity, hydrography, sea level, climate change). Recent research into the complex and dynamic cycling of carbon in many increasingly nutrient-enriched coastal systems has suggested that they have switched from being net C sources to net C sinks over the last ∼150 years. This study seeks to explore carbon sequestration rates over the last 150 years from several key regions across the coastal Baltic Sea by synthesising organic carbon (OC) inventories from multiple well-dated sedimentary records from Baltic coasts. Such data will provide insight into long-term coastal change and how terrestrial human impact is influencing the ecology and biogeochemistry of the Baltic Sea.

To examine past and present rates of carbon burial in key coastal areas of the Baltic Sea, a synthesis of 30-40 sediment cores from across the Baltic Sea is presented here from Baltic Denmark, Germany, Latvia, western Sweden and southern Finland, and are primarily from near-shore and shallow fjord/estuarine sites. The majority of sites span the last ∼100-150 years and the majority (>75%) are independently dated using 210Pb. Unsupported 210Pb inventories also allow raw sedimentation rates to be corrected for sediment focussing, permitting regionally reliable estimates of OC accumulation rates to be calculated and provide a plausible basis for upscaling OC accumulation rates within these key regions of the Baltic. Preliminary data analyses suggest a major step-change in system behaviour during the 20th century following low, stable (∼10 g OC m-2 yr-1 focussing corrected, OCFC) rates pre-1900. The initial rise in burial rates occurs early in the 1900s though is punctuated by a slight fall during the 1930s/1940s. After 1950, burial rates dramatically rise (consistently up to ∼45 g OCFC m-2 yr-1; 4 x pre-1900 rates), a pattern which is repeated across the dataset.

Comparison with multiproxy data for these sites and other regional environmental data (including nutrient/pollution records) shows this rapid rise coincides with major changes in algal communities, suggesting fundamental ecosystem change with nutrient loading. Furthermore, these coastal sites also show similar trends to OCFC burial rates in north-western European lakes over the last 150 years, where OCFC burial rates peak in the 1980s before declining as catchment nutrient management strategies have been developed in many countries. This supports the hypothesis that the main driver of coastal eutrophication, primary productivity increase and OC burial is terrestrial nutrient loading (and that most coastal OC is autochthonous rather than allochthonous, terrestrial C), although in the Baltic this is complicated by internal nutrient (especially P) recycling under increasing anoxia and North Sea inflows, and in the northern part, drainage from DOC-rich boreal catchments with low population density and little agriculture.. Finally we also compare our data to offshore, deep water carbon burial rates in the Baltic Sea to assess if OC burial rate estimates for the Baltic Sea region need revising due to under-estimation of the coastal carbon sink.