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Historical land use caused carbon release in the Dutch coastal peatlands

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In many coastal and deltaic areas in the world, thick sequences of unconsolidated sediments have been deposited under conditions of Holocene sea level rise. In sediment-poor coastal and deltaic systems the created accommodation space was filled with peat instead of sediment. As a result, coastal and deltaic lowlands may comprise thick peat sequences and thus store large amounts of Holocene carbon in their shallow subsurface. In contrast to many other peatlands in the world, coastal and deltaic peatlands have been attractive areas for settlement by humans for thousands of years. Presently, they belong to the most densely inhabited areas in the world, exposing the carbon store as such to human influence. Human land use in peaty areas usually starts with dewatering, causing aeration and oxidation of peats. In this way, land use in coastal and deltaic areas is generally associated with release of carbon dioxide from the subsurface store to the atmosphere.

Most studies into the soil as a carbon sink or source focus on present-day processes, but especially in Europe, land use in coastal and deltaic areas has been intensive for some centuries. The historical carbon release is largely understudied and an estimation of the contribution of longer-term land use to the carbon levels in the atmosphere is lacking. This may be of importance because such values (i) are capable of providing a reference level for pre-industrial carbon levels in the atmosphere, and (ii) are offering a carbon-release potential for similar peaty areas elsewhere (e.g. in the tropics) that are under increasing human pressure.

This study explores the loss of carbon storage as a result of land use in The Netherlands. The Dutch actively drained the peat bogs and marshes of the coastal zone and the Rhine-Meuse delta since the 1100s AD and continued to dewater these areas by large scale pumping since the 1600s AD. This caused oxidation of the peat and subsequent emission of organic carbon. In addition to this, in the period 1500 – 1900 AD, the Dutch extensively excavated peat for combustion purposes. We applied a novel geo-computational bulk-volume approach to estimate the total volume of Holocene peat that has disappeared in historical times, by oxidation, extraction (+ combustion) and erosion. The result of this exercise is a first-order, large-scale and long-term approximation of human-induced carbon exchange between soil and the atmosphere for a coastal and deltaic lowland. We discuss the extent to which Dutch coastal peat deposits are a significant carbon source and consider the contribution of pre-industrial revolution carbon emission on present day carbon dioxide levels in the atmosphere. This provides a fresh view on the longer term human-environment relationship and on the functioning of the carbon cycle during the past centuries.