Geophysical Research Abstracts
Vol. 12, EGU2010-4706-1, 2010
EGU General Assembly 2010

Consequences of land use and climate changes on sediment deposition in estuaries during the last centuries

Clément Poirier (1), Eric Chaumillon (1), Fabien Arnaud (2), Evelyne Goubert (3), Pierre-Guy Sauriau (1), and Florence Caurant (1)

(1) LIENSs, Université de La Rochelle, CNRS, 17000 La Rochelle, France (clement.poirier@univ-lr.fr), (2) EDYTEM, Université de Savoie, CNRS, Pôle Montagne, 73376 Le Bourget du Lac Cedex, France, (3) Université Bretagne Sud, 56017 Vannes, France

Estuaries are the downstream end-member of fluvial systems. They are experiencing high sedimentation rates, thus providing good opportunities for high resolution studies of Holocene environmental changes at the land/ocean interface. From a thorough literature survey, it appears that a rapid siltation and/or an increase in sedimentation rate were recorded in many estuarine environments, concomitantly to major migrations of human population throughout the world, both in time and space. It has been clearly related to an increase in sediment supply to estuaries in Minor Asia (Bronze Age, e.g. Spezzaferri et al, 2000) and in North America and Southwest Pacific (18th and 19th centuries, e.g. Goff, 1997), in response to deforestation on catchment areas. However, this relationship is less obvious in Europe (Sorrel et al., 2009), because deforestation occurred concomitantly to climate changes of the last millennium (climate instability at the end of Medieval Warm Period, Little Ice Age) that can also explain an increase in soil erosion. Indeed, these hypotheses have been proposed to explain a similar change in Marennes-Oléron Bay (Atlantic coast of France), which consists in the sudden deposition of a few meters-thick mud drape on basal mixed mud and sand bodies (Billeaud et al., 2005).
The methods used to investigate this estuarine bay so far (very high resolution seismic stratigraphy, grain size analysis and radiocarbon dating) provided relevant information about recent environmental changes, but new data are now needed for further investigation. In the present study, we provide a multi-proxy analysis of the Marennes-Oléron Bay mud drape. A new 8 m-long core (M7UC01) was sampled on an intertidal flat, its location being determined on the basis of seismic stratigraphy. Core processing included visual description, physical measurements, grain size analysis every 2.5 to 5 cm, AMS radiocarbon dating, XRF core scanning, clay mineralogy and Rock Eval analysis. Fossil molluscs and foraminifers were also recovered to provide paleoenvironmental reconstructions.
Clay mineralogy of the mud drape is similar to that of the turbid plume of the Charente River, which is an important source of terrestrial sediment in the bay, and to surrounding marsh soils. Examination of sediment smear slides shows that the sediment contains abundant plant debris. The very low values of Hydrogen Index determined by Rock-Eval analysis (mean HI: 150 $\pm$ 25 mg HC.g-1 TOC) are typical of organic matter derived from land higher plants. These three results strongly suggest that the Marennes-Oléron Bay mud drape is composed of soil relicts derived from the watershed. The mud drape started to deposit at 1400 AD, which coincides with the start of the Spörer minimum. Fossil mollusc and foraminifer assemblages provide evidences of another environmental change dated to 1670 AD, which corresponds to the Maunder minimum. These data suggest a strong impact of Little Ice Age climate changes, superimposed to land reclamation and deforestation, on the increase of sediment supply in the study area. These results, compared with the detailed literature survey performed meanwhile, would provide new insights into the impact of simultaneous land use and climate changes on the sediment deposition in estuaries during the last centuries.

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