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Decompacting Holocene deltas to quantify their (proper) weight

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Most of the world major deltas are threatened by relative sea level rise, i.e. land subsidence and sea level rise, caused by a combination of anthropogenic pressures and natural processes. This study focuses on the natural components of land subsidence directly and indirectly related to the Holocene delta stratigraphy. Firstly, subsidence is caused by natural compaction of the Holocene sediments following deposition over time under their own weight. Secondly, subsidence is caused by the visco-elastic deformation of the Earth crust driven by cumulative load of the Holocene delta (so-called Sediment Isostatic Adjustment). These two processes are obviously connected and call for a proper evaluation of the weight of (the Holocene portion of) a delta. This requires a proper quantification of specific weight and degree of compaction of Holocene deposits with depth to arrive at a first-order assessment of Holocene delta weight.

This study proposes an innovative methodology to address the following two questions: 1) What is the proper weight of a (Holocene) delta? 2) How much have deposits been compacted since their deposition during Holocene delta formation? Our approach integrates knowledge and data on deltaic depositional environments, stratigraphic information, geomechanical properties and other characteristics of the Holocene sequence.

The developed approach is applied to eight major deltas worldwide selected from a larger database according to the availability of lithostratigraphic and geomechanical information. The analysis is conducted at the scale of an entire delta, thus required the upscaling and interpolation of datasets generally available from a few wellbores only. Lithostratigraphic data is combined with a backwards modelling procedure to decompact the Holocene delta sequence to their decompacted thickness to provide a proper estimation of their weight, which takes into account the (computed) in-situ compaction degree. The results show a large variability in compaction and specific weight distribution for the different deltas which underscores the substantial role of natural compaction on delta evolution.