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River Terraces as a Proxy for Glacio-isostasy?

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During the youngest glaciation substantial crustal movements ($>$ 100 m) occurred in Northern Europe and elsewhere. They were induced by the dynamic, isostatic response of the crust to the changes in mass distribution of ice and water. Glacio-isostatic models are constrained by data recording such movements and changes (e.g. sea level indicators as raised beaches, onset of peat growth, tilted lake shores, moraines etc). Unfortunately, these data are mainly confined to palaeo-coastlines and ice fronts. Hence, they do not have an optimal spatial distribution. We suggest that data on glacio-isostasy may also be obtained from river valleys: rivers are likely to respond to gradient changes induced by crustal movements, resulting in terrace formation or abandonment. As the crustal movements are ongoing, fluvial terraces gradually may become distorted after abandonment. In that way they preserve information on palaeo-gradients. The concept is demonstrated for a case study in the Rhine river catchment. The crustal movements are relatively well constrained there and data on a series of 3 terraces are available.

The Rhine-Meuse fluvial system is a lowland river that occupied a broad, continental shelf during the youngest glaciation. The shelf emerged largely due to eustatic sea level fall. We have been able to extend published longitudinal profiles of 3 Weichselian (LGM to Allerød) fluvial terraces into the Dutch offshore, using data from ca. 500 new offshore boreholes. The longitudinal profiles of the terraces are corrected to the palaeo-situation. The correction is made along the palaeo-river course by using published estimates of the crustal movements.

In comparison with the present-day (distorted) longitudinal profiles of the 3 terraces, all corrected palaeo-profiles show a more linear trend. A linear longitudinal profile points to equilibrium conditions at the time of terrace formation. The corrected profiles also show significantly steeper (palaeo-)gradients of ca. 23 cm/km. The palaeo-

gradient of the Lower Terrace is such that a river course through the English Channel is most probable. This is in line with the depth and presence of incised channels there. For the 2 younger terraces an alternative river course, running north parallel to the present-day British coast, seems as likely.

The results from the case study are promising. They indicate that the 3 Weichselian fluvial terraces indeed have become distorted after their formation. It seems that valuable information on crustal movements related to glacio-hydro-isostasy can be preserved in this way. Clearly, data from other mid- or high-latitude rivers are necessary to further test the concept.