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When erosion ruins the chronology

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Human land-use has considerably shaped the landscape of north-western Germany over the past millennia. Deforestation and agriculture created a predominantly open scenery preserved until today with only a few remnants of former landscape elements such as woodlands, peat bogs, heath lands and lakes. Here we present a multi-proxy approach including sedimentological and geochemical parameters (e. g. element concentrations and stable isotopes) as well as biological proxies (pollen, macro fossils and diatoms) combined with an archaeological site analysis to investigate the effects of prehistoric land-use on lake systems and their catchment areas with a special focus on changes of the water quality, e. g. eutrophication and acidification and its natural regeneration during phases of weaker land-use impact. The study reveals a millenia-long history of erosion processes caused by successive selective woodland clearances starting in Neolithic Times. The geochemical evidence of soil erosion is recorded by distinct peaks of the terrigenic elements K and Ti. However, due to (1) the low sensitivy of the XRF scanner for Si and (2) the prevalence of diatom related biogenic silicon XRF-scanning of highly organic lake sediments fails to reflect the actual sand input caused by erosion. Particularly single quartz grains are not detected in the organic sediment matrix. Therefore we make successful use of mineral grain analysis which previously has only been applied to record aeolian input in bogs. K and Ti concentrations are not correlated with the content of mineral grains which suggest two different erosion processes. Our efforts to construct robust age-depth relationships based on AMS 14C-dates of terrestrial plant macrofossils reveal a specific dating issue of northwest German lakes. Especially in younger sediments we observe 14C-dates which are on the one hand too old and on the other hand among themselves roughly contemporaneous. We explain this feature with the extensive bog growth since Neolithic times which eventually reached the lake shores and water level fluctuations of the lakes. Successive erosion of the bog margins in the course of anthropogenic disturbance of wetland sites caused the observed contamination of lacustrine sediments with older material. Amino acid dating, OSL-dating and tephrochronology are suitable alternatives to surmount the dating difficulties inherent in northwest German lakes.