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River flooding and landscape changes impact water quality and species composition in a lake catchment of the Rhine-Meuse delta, The Netherlands

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A 400-year sediment record from a deep water scour hole near the Meuse River in the Netherlands (Haarsteegse Wiel) was investigated for past changes in water quality, flooding regime and landscape change using a combined geochemical and micropaleontological (diatom and pollen analyses) approach. The results are highly significant for determining natural water quality, the impact of (atmospheric) pollution on the (aquatic) flora and the study of the impact and signals related to river floods. The sediment was dated by combining 137Cs activity measurements, biostratigraphical ages and historically documented floodings indicated by the magnetic susceptibility of the sediment. The first flooding event is indicated in the sediment at AD 1610 when the lake was created by water masses bursting through a dike. The extent of large historical river floods are well described in historical chronicles and present an opportunity to study how a flood signal is represented in the lake catchment and provide an additional age calibration point. The resulting chronology is highly accurate and shows that sedimentation rates decrease sharply with the widespread change from wheat cultivation to pasture land from around AD 1875 as a direct result of falling wheat prices and intensified cattle farming.

Water quality changes and absolute phosphorous concentrations are reconstructed using diatom-based transfer function. Results show that the currently nutrient rich lake water has mostly been in a mesotrophic state prior to AD 1920, with the exception of several sharp eutrophication events. These events generally occur in sediments deposited during river floods. The river flooding also impacts the vegetation composition by importing allochtonous components such as Nymphaea candida (non-native waterlillies), and indirectly by the deposition of nutrients which have a clear impact on vegetation composition and richness.

Magnetic susceptibility changes and pollen data show that from AD 1610-1730, within the Little Ice Age period, a higher number of previously undocumented floods seem to have occurred which requires further study. Documentation of the flooding signals in a high-resolution archive present the possibility to detect flooding regimes further back in time. Measured records of river flooding in the Netherlands span maximally 150 yr and are extrapolated and used to calculate the frequency of (extreme) flooding events. By ground-truthing the extrapolated observational data with long-term records of river dynamics from natural archives we can reduce the uncertainties in the return times of floods and study the effect of long-term climate changes and human impact on the river catchment.