Geophysical Research Abstracts
Vol. 18, EGU2016-838-2, 2016
EGU General Assembly 2016

Ecological, biogeochemical and salinity changes in coastal lakes and wetlands over the last 200 years

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Shallow lakes provide extensive ecosystem services and are ecologically important aquatic resources supporting a diverse flora and fauna. In marginal-marine areas, where such lakes are subjected to the multiple pressures of coastal erosion, sea level rise, increasing sea surface temperature and increasing frequency and intensity of storm surges, environments are complex and unstable. They are characterised by physico-chemical variations due to climatic (precipitation/evaporation cycles) and dynamic factors (tides, currents, freshwater drainage and sea level changes). Combined with human activity in the catchment these processes can alter the salinity, habitat and ecology of coastal fresh- to brackish water ecosystems. In this study the chemical and biological stability of coastal lakes forming the Upper Thurne catchment in the NE of the Norfolk Broads, East Anglia, UK are seriously threatened by long-term changes in salinity resulting from storm surges, complex hydrogeology and anthropogenic activity in the catchment. Future management decisions depend on a sound understanding of the potential ecological impacts, but such understanding is limited by short-term observations and measurements. This research uses palaeolimnological approaches, which can be validated and calibrated with historical records, to reconstruct changes in the aquatic environment on a longer time scale than can be achieved by observations alone. Here, salinity is quantitatively reconstructed using the trace-element geochemistry (Sr/Ca and Mg/Ca) of low Mg-calcite shells of Ostracoda (microscopic bivalved crustaceans) and macrophyte and macroinvertebrate macrofossil remains are used as a proxy to assess ecological change in response to variations in salinity. δ^{13}C values of Cladocera (which are potentially outcompeted by the mysid *Neomysis integer* with increasing salinity and eutrophication) can be used to reconstruct carbon cycling and energy pathways in lake food webs, which alongside reconstructions of salinity and eutrophication can aid the disentanglement of environmental drivers and increase understanding on the interactions between ecology and biogeochemical cycles within the lake. Previous palaeolimnological work on the Thurne Broads system has suggested shifts between macrophyte abundance and loss within a framework of rising salinity (varying between 1.8-8.7‰ and eutrophication (phosphorus loading greater than 100μg^{-1}). A complex combination of salinity, eutrophication, toxicity and associated changes in habitat have acted as drivers for ecological change over the past 200 years, but these interactions have not previously been well understood. By combining reconstructions of palaeosalinity, biodiversity, food web dynamics, redox conditions and eutrophication, the interaction between and controls on long-term variations in shallow lake environments can be further explored.