Human activities have impacts on carbon cycle from different aspects. In addition to the direct emissions of greenhouse gasses through the burning of fossil fuels, changes in land-use have an impact on the carbon cycle and potentially a large impact on the climate. Human impacts on the ecosystems have been very extensive and intensive during the past 1000 years as a consequence of an increased population. Several human-induced disturbances including forest clearance, agriculture, urbanization and industrialization in lake catchments have impacts on the vegetation, soil erosion and the associated organic matter delivery from terrestrial to aquatic ecosystems (Kaushal & Binford 1999; Routh et al, 2004; Köster et al., 2005; Li et al., 2008). To analyze and predict human impacts on organic carbon cycling, which is fundamental for the development of environmental management strategies and ecosystem service, an increased understanding of organic matter transport between terrestrial and aquatic ecosystems in response to land-use is needed. Long-term records of environmental variation at centennial to millennial time scales are essential for the assessment of ecosystem dynamics in response to early and recent anthropogenic disturbances (Willis & Birks, 2006). Such records can be obtained from well-dated lake sediments, which consist of chronologically deposited materials originating from both within the lake (e.g., organic matter from macrophytes and planktonic algae) and the catchment area (e.g., soil organic matter, plant detritus, pollen and minerogenic material) (Koinig et al, 2003; Klamt et al., 2017), which allow us to reconstruct environmental changes in lakes catchment areas based on multi-proxy analysis of continuous lake sediment (Meyers, 2003).

In this study, a sediment sequence from Lake Skottenesjön, southern Sweden was investigated to reconstruct the effect of forestry and land-use on erosion rates and delivery of organic and minerogenic matter to the lake. Catchment-scale vegetation changes during the last 1000 years were reconstructed quantitatively using pollen analysis and the Landscape Reconstruction Algorithm (LRA). Organic matter in the lake sediments was analyzed using lignin phenols and bulk carbon stable isotopes. Changes in the delivery of minerogenic matter were analyzed using X-ray fluorescence scanning.

Variations in land cover history estimated by LRA model, lignin phenols and other geochemical proxies show that deforestation, agricultural activities and other human impacts on the lake catchment modified the organic and inorganic matter deposition in the lake. Between ca. AD 1000 and ca. AD 1350, the local land-use was characterized by small-scale agricultural activities associated with the medieval expansion. During this period, the woodland cover was dominated by deciduous trees, as revealed by both landscape reconstruction and high values in the ratio between syringyl and vanillyl phenols (S/V). Increased deposition of terrestrial organic matter was indicated by high values on both concentration and mass accumulation rate of lignin phenols. From AD 1350, much of the farmland was abandoned and coniferous woodland cover increased revealed by landscape
estimate and decreasing values of S/V ratio. After ca. AD 1600, both cultivated crops and pasture & meadows expanded in the catchment. The wood harvesting became highly intensified from ca. AD 1700, which was attributed to the high demanding of wood fuel from a steel factory set up in the 1700s. Substantial increases in lithogenic elements (K, Ti, Rb) together with lower TOC content and higher C/N ratios indicate enhanced soil erosion from ca. AD 1600 to ca. AD 1900. S/V ratios increased in concert with a distinct drop in coniferous woodland cover due to timber exploitation and the establishment of early successional forest dominated by *Betula*. The increase in Cinnamyl to vanillyl phenol ratios (C/V) is likely attributed to expansions of both grassland cover and early successional forest which have less wood productivity compared to old forest. The mass accumulation rate of lignin phenols increased drastically reflecting a distinct elevation of terrestrial organic matter input as a consequence of highly intensive human activities in the catchment. After ca. AD 1900, the study area was reforested with conifers, and the terrestrial organic matter input decreased rather quickly, within a few decades, after reforestation. This study illustrates that the combination of pollen and lignin phenols is useful for investigating long-term changes in terrestrial organic matter input to the lake responding to land use changes.

**Reference**


