# Supplementary Material

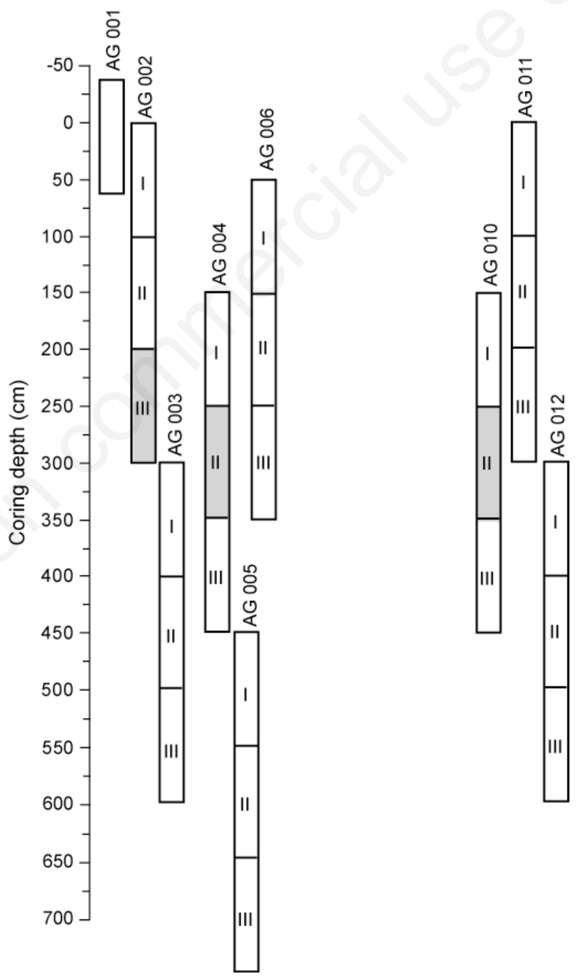
## Site description

### Vegetation

The flat and humid areas of the lowlands around LGA are at present dominated by *Alnus glutinosa*, *Ulmus minor*, *Quercus robur*, *Robinia pseudacacia*, and *Salix alba*. On the hills *Q. pubescens* occurs together with other drought-adapted plants (such as *Opuntia vulgaris*) on south-exposed slopes, while cooler and moister slopes are dominated mainly by *Q. robur* and *Castanea sativa*. Above ~600 m, *Fagus sylvatica* and *Abies alba* occur where chestnut trees are absent (Finsinger and Tinner, 2006).

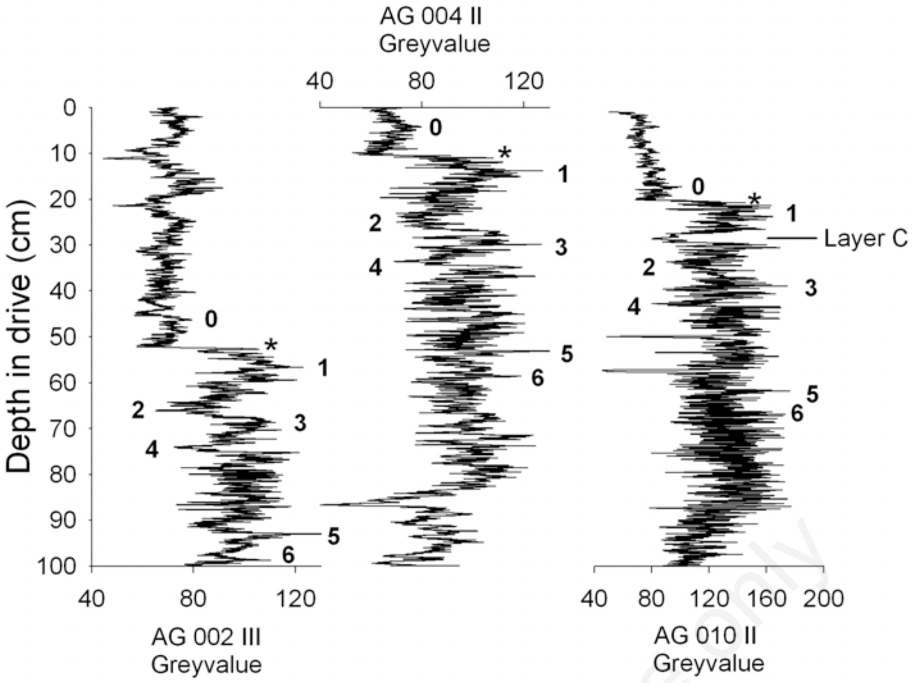
## METHODS

Two sets of parallel and overlapping cores were taken with a piston corer operated from a floating platform (UWITEC) in the central part of the basin at a water depth of ~25 m at ~50 m horizontal distance from each other. The correlation of the cores allowed the building of a continuous composite core. The correlation was established based on the drive depths (Fig. S1). The more detailed correlation of the drives analysed in this study was established using the greyscale records (see Fig. S2), distinct marker beds identified during the varve counting, and the µXRF records.





**Supplementary Fig. 1.** Sediment cores (labeled 'AG 0xx'; each 3-m long) retrieved from Lago Grande di Avigliana and their coring depths. Core segments (each 1-m long) were labeled with roman numbers. Segments that are highlighted in grey are those that were used in the present study (see Supplementary Fig. 2).




**Supplementary Fig. 2.** Correlations between segments AG004-II, AG010-II, and AG002-III based on their greyscale records. Numbers (1-6) indicate correlation points; *sediment-colour transition from light sediment (high greyscale values) to darker sediment colour (lower greyscale values).



**XRF**

The ITRAX µXRF core scanner was equipped with a 3kW Mo X-ray tube set to 30 kV and 30 mA to analyze semi-quantitative variations of elements. µXRF-scanning was performed at 500 µm (AG010-II) and 1 mm resolution (AG004-II) and an exposure time of 20 seconds. Detection limits of the ITRAX range between 22,000 ppm for Al and 5 ppm for heavier elements like Sr or Rb (Croudace *et al*., 2006). Sediment radiographs of the cores were made at 200 µm resolution, running the scanner with 55kV, a current of 35mA, and an exposure time of 500/600 ms.

**Greyscale analysis**

Colour images of the unprepared core halves were transformed to greyscale images and a greyscale profile was plotted with the ImageJ v1.41o software (http://rsbweb.nih.gov/ij/). Greyscale values were measured each pixel and averaged over 3 cm sediment width in order to minimize the influence of small cracks on the sediment surface. Colour images taken with the ITRAX scanner had a resolution of ~50 pixels $cm^{-1}$, whereas colour images of segment AG002-III, that were taken with a digital camera under homogeneous light conditions at the EAWAG (Dübendorf, Switzerland), have a resolution of ~120 pixels $cm^{-1}$.

**Macrocharcoal analysis**

For the macrocharcoal analysis, samples were treated with HCl (3%), then sieved (150 µm mesh size), washed, and subsequently treated with 2.6% bleach (NaClO). Macrocharcoal particles were counted and measured using the program WinSeedle v2009a (Regent Instruments Inc.). The macrocharcoal accumulation-rates record (CHAR) was decomposed into a background ($C_{back}$) and a peak ($C_{peak}$) component using a locally weighted regression (loess) smoother with a 400 yrs smoothing window with the program CharAnalysis v1.0 (Higuera *et al.*, 2009). The smoothing window of 400 yrs was appropriate for the decomposition approach as it guaranteed a good global signal-to-noise index (SNI = 0.79) (Higuera *et al*., 2009).

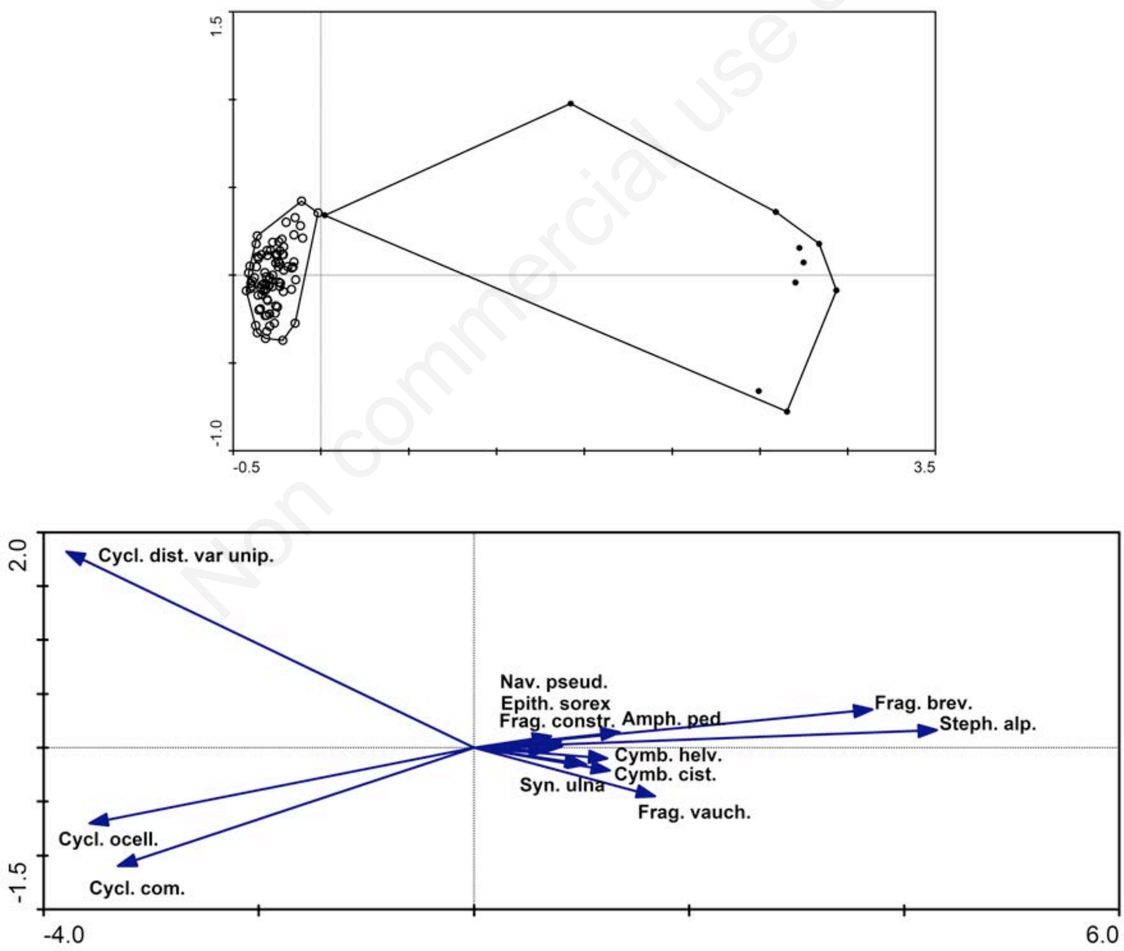
**Pigment analysis**

About 2 g wet sediment was extracted overnight in 90% acetone with a nitrogen atmosphere, clarified by centrifugation (4000 g $min^{-1}$ for 10 min) and used for High-Performance Liquid Chromatography (HPLC) pigment analysis. The reverse-phase HPLC procedure as described by Mantoura and Llewellyn (1983) and Lami *et al*. (2000) allowed the separation of Zeaxanthin from Lutein and ß-carotene from Phaeophytin *a*. Identification of pigments isolated from sediments was confirmed by comparison of spectral characteristics and chromatographic mobility of pigments with those obtained from: TLC analysis (Züllig, 1982; Guilizzoni e*t al*., 1986), commercial standards (Sigma Chemical Co.), water samples of known phytoplankton composition, and published values on max O.D. (Davies, 1976; Züllig, 1982; Mantoura and Llewellyn, 1983). Pigments concentrations were calculated on the basis of molar extinction coefficients at the detection wavelengths. The molar extinction coefficient E1% 460 nm and E1% 656 nm was applied and is derived from the E1% max reported in Davies (1976) and Wright *et al.* (1991). All analyses were performed at the CNR ISE Institute, Verbania-Pallanza, Italy.

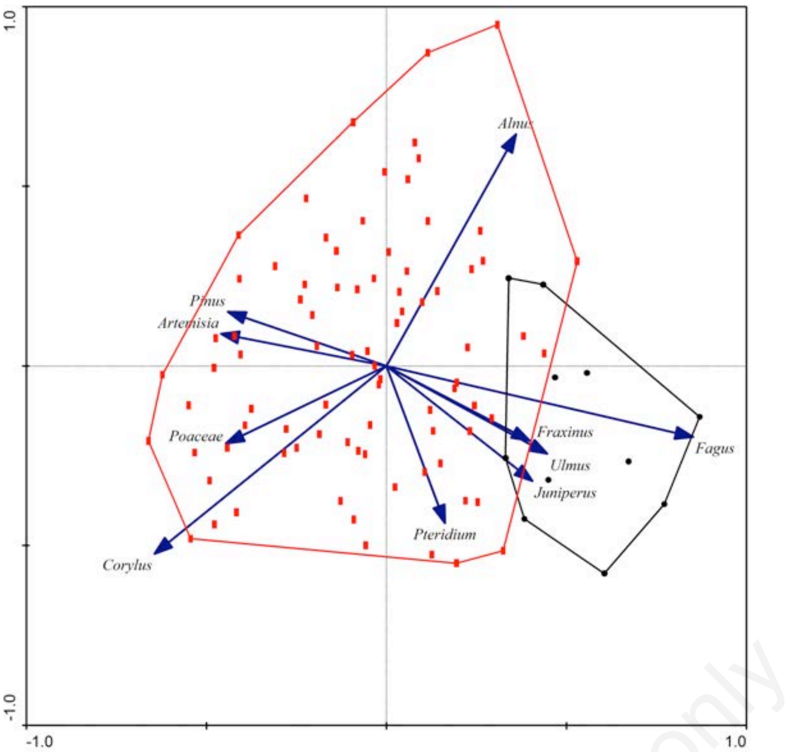
## RESULTS

**Ordinations (PCA) of diatom, pollen, µXRF, and pigment records**



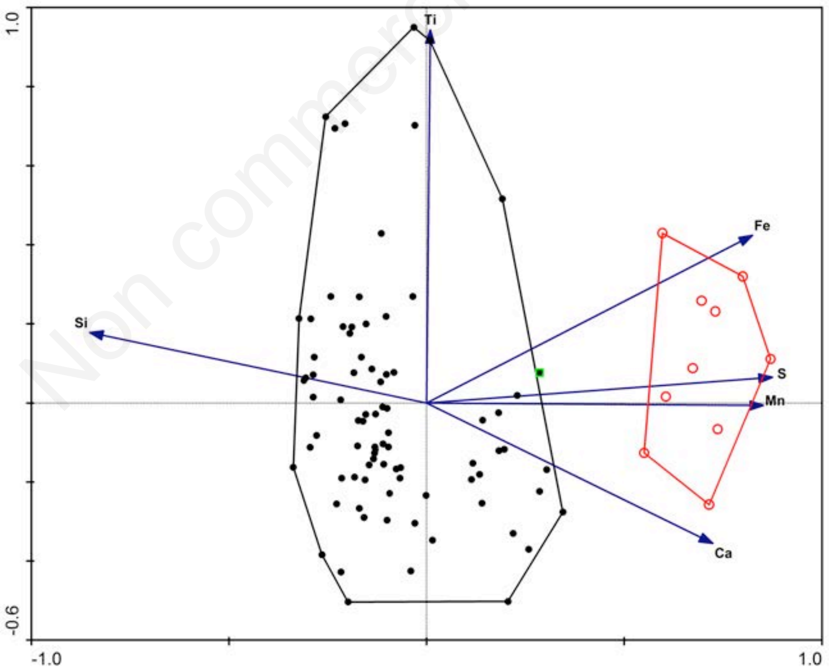



**Supplementary Fig. 3.** Principal component analysis (PCA) plots with all samples (top panel) and selected diatom taxa (bottom panel). Empty circles: samples before regime shift; full circles: samples after regime shift). The first and second PCA axes explain ~72% and 5% of the total variance in the diatom data set, respectively.

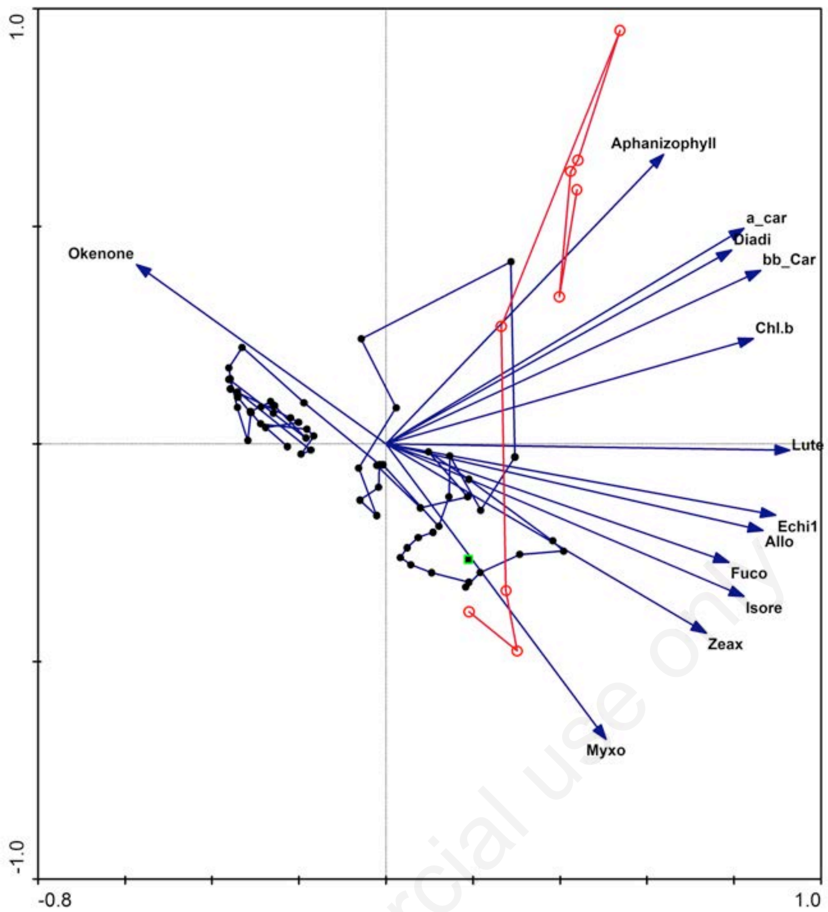



**Supplementary Fig. 4.** Principal component analysis (PCA) biplot with all samples and pollen types (arrows). Red rectangles: samples before regime shift; full circles: samples after regime shift). The first PCA axis explains ~16% of the total variance in the pollen data set. Only taxa with highest loading on the first two PCA axes are shown.



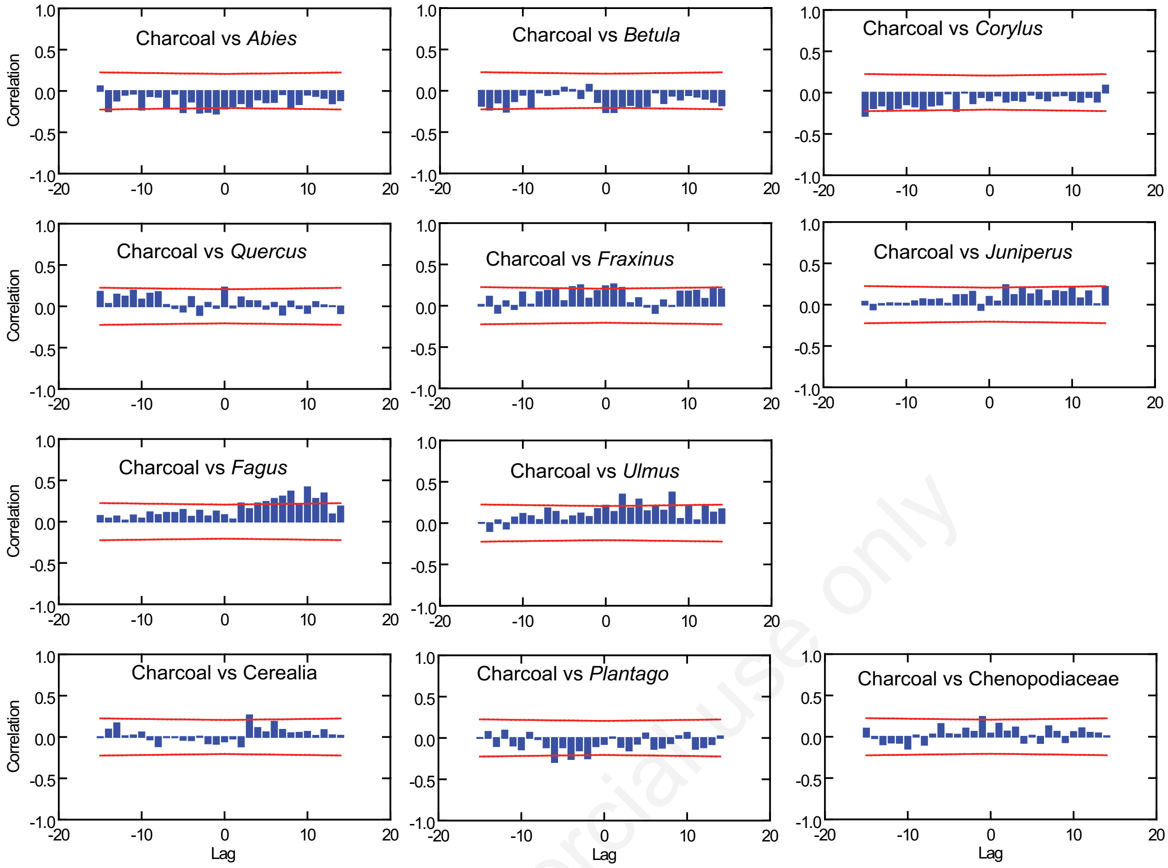



**Supplementary Fig. 5.** Principal component analysis (PCA) biplot illustrating changes of selected elements in the sediments of the LGA core section [sample 225 years before transition corresponding to Layer E (see Fig. 2) was omitted]. The PCA was calculated using the interpolated µXRF dataset as a standardized PCA (based on a correlation matrix) with focusing on inter-*species* correlations, dividing *species* by their standard deviation, no data transformation, and centering and standardizing by *species*. The first two PCA axes explain ~57% and ~20% of the total variance in the data set, respectively.




**Supplementary Fig. 6.** Principal component analysis (PCA) biplot illustrating changes of selected pigments in the LGA core section. PCA was calculated using the interpolated µXRF dataset as a standardized PCA (based on a correlation matrix) with focusing on inter-*specie'* correlations, dividing *species* by their standard deviation, no data transformation, and centering and standardizing by *species*. The first two PCA axes explain ~85% and ~11% of the total variance in the geochemistry data set, respectively.

**Cross-correlations between charcoal accumulation rates and pollen percentage records**




**Supplementary Fig. 7.** Cross-correlograms between macrocharcoal accumulation rates (as charcoal number $yr^{-1}$ $cm^{-2}$) and pollen percentages for selected pollen types. Only cross-correlograms are shown where a statistically significant correlation was detected between charcoal accumulation rates and pollen % at lags -10 to +10 (*i.e.*, -150 to +150 years).

## References

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