

Lake archives: reconstructing long-term response to global change

Lami Andrea

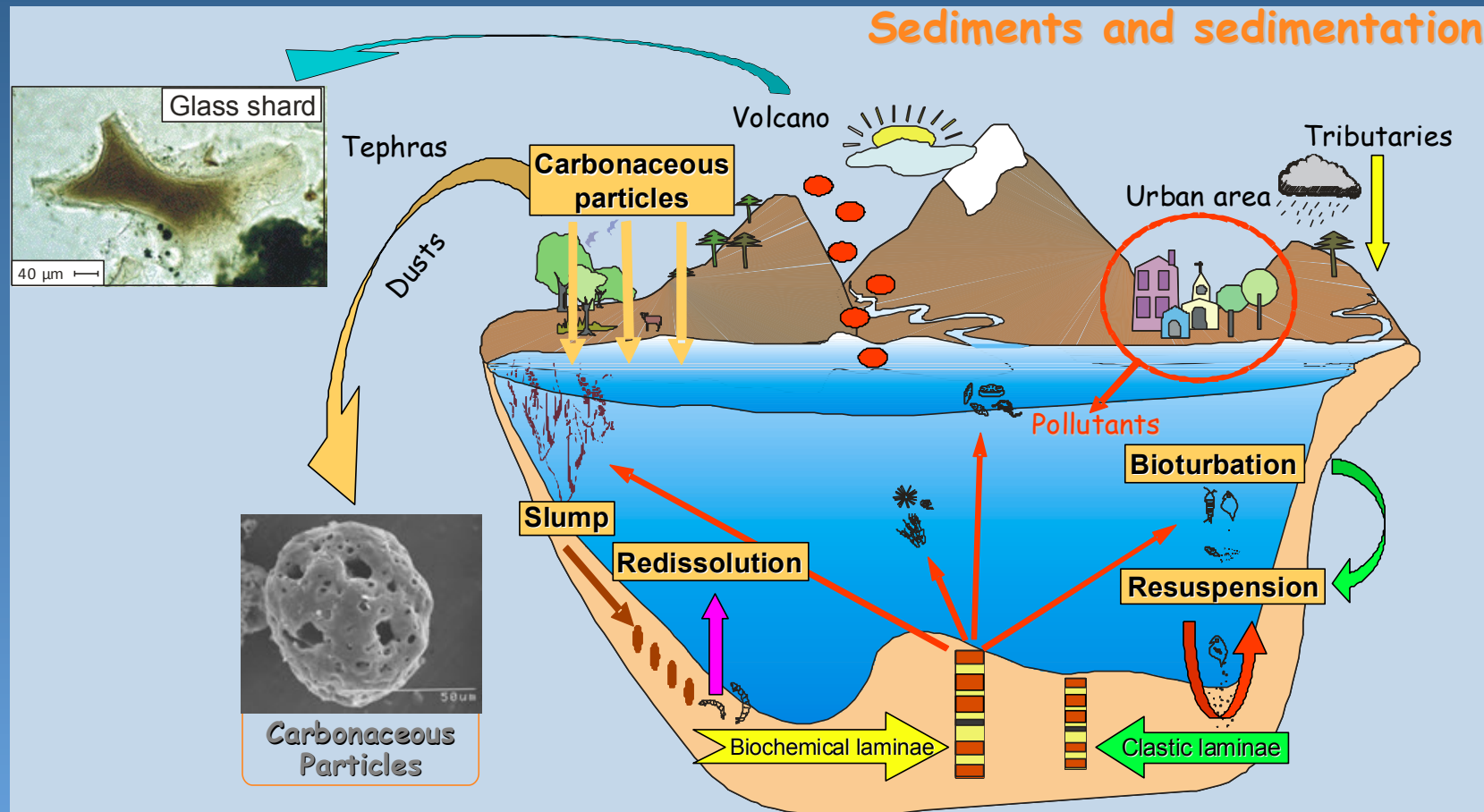
CNR-Istituto per lo Studio degli Ecosistemi (ISE) – Verbania, Italia



Climate variability in Italy during the last two millennia – Italy 2k
December 1st-2nd 2014 - Accademia dei Lincei, Roma

Proxy-records

Virtually all biological, chemical and physical processes that are studied in limnology leave evidence in sediments, but sedimentary records are subject to information loss because of many factors, including those that affect variable distribution of sedimentary constituents and post-depositional changes (Cohen, 2003).

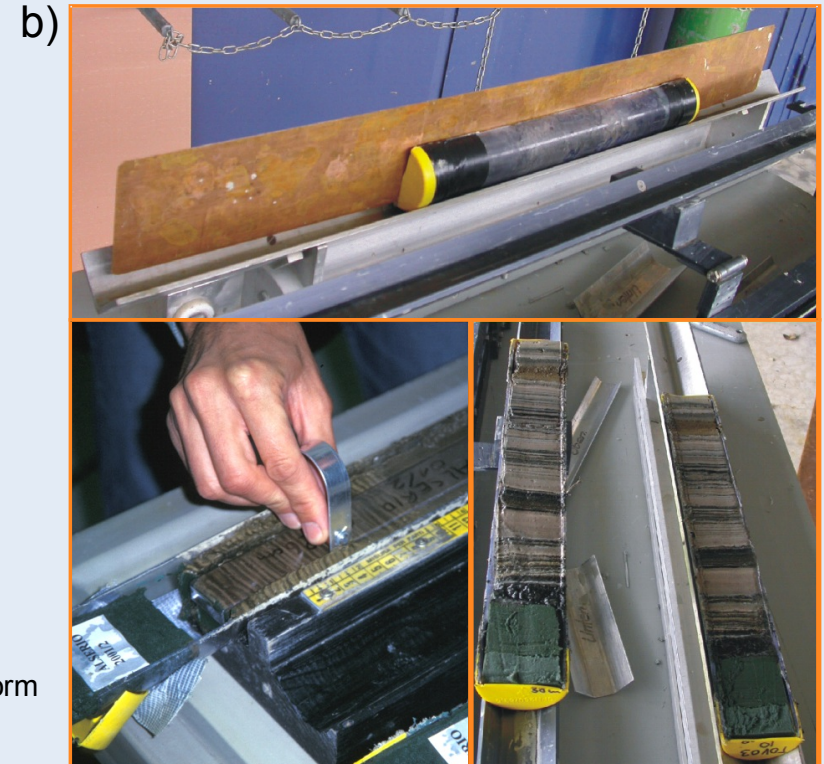


Sediment: an ecosystem's memory



Lake sediment cores are taken using corers operated from a boat or platform (Photo a).

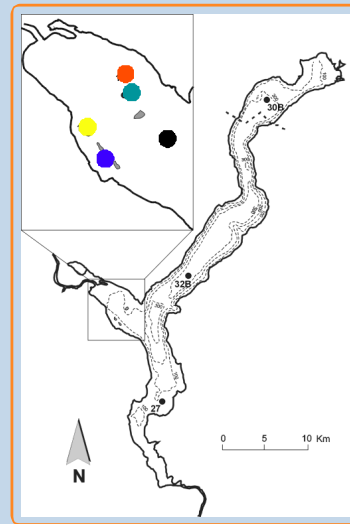
Cores are then cut longitudinally to reveal their internal structure (Photo b).



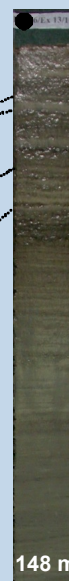
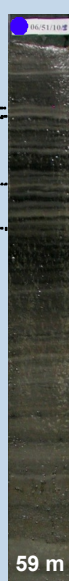
Aims

- To provide high-resolution, paleoenvironmental (e.g. pH, P) and paleoclimatic inferences using a range of chemical and biological proxies.
- To measure the temporal effect of climate change and anthropogenic impact on lake ecosystem structure and processes.
- To establish historical data that can be used to calibrate and validate numerical models.

Lake Maggiore cores



Water depth



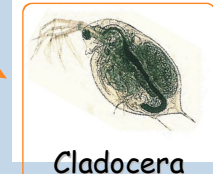
Proxy-records

Trophic status

Organic matter
N, P, CaCO_3
Biogenic silica

Clastic inputs
Metals

Glacier fluctuations
Erosion



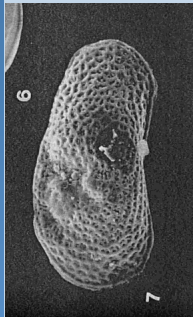
Cladocera

Biodiversity
Trophic status

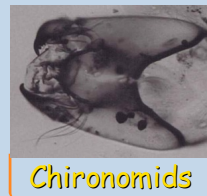


Pigments

Primary production
UV radiations
Redox conditions

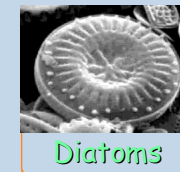


Ostracods



Chironomids

Water temperature
Lake water fluctuations
Trophic status



Diatoms

pH
Phosphorus
Salinity

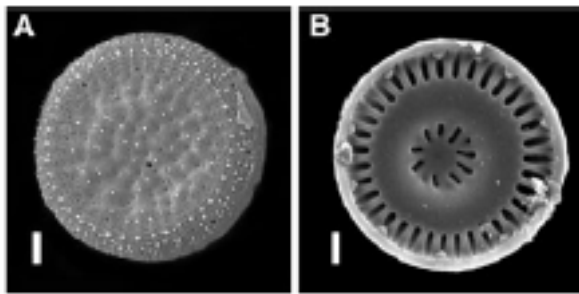
Geochemical and biological indicators we commonly analyze in sediment cores.

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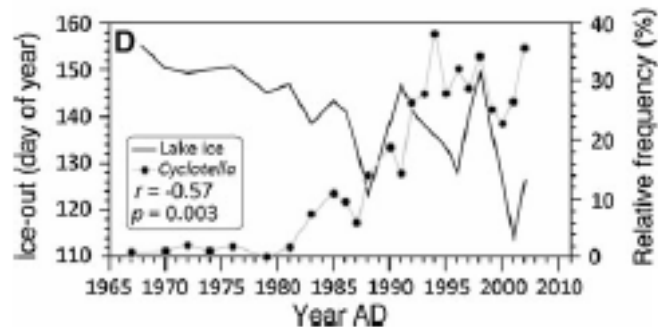
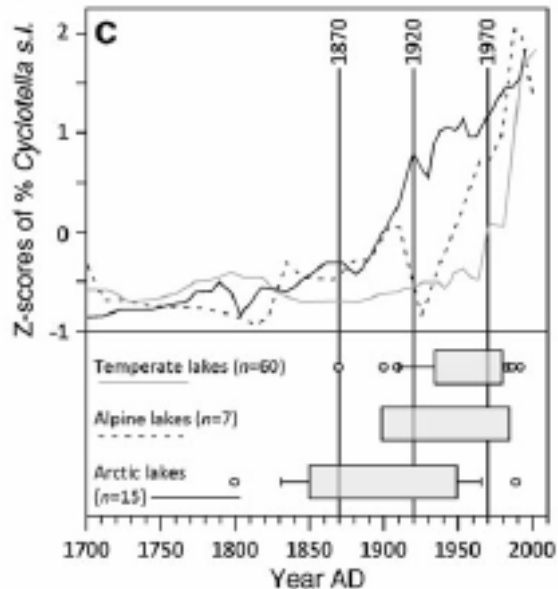
One example is the **increase in small planktonic diatoms** with climate warming (e.g. *Cyclotella sensu lato*, including representatives of *Cyclotella*, *Discostella*, and *Puncticulata*) (Ruhland et al. 2008).

Many studies have reported their increase and, in some cases, a **concomitant decline of large filamentous diatoms** (e.g. *Aulacoseira* taxa).

Increase in the length of the growing season and **periods of high stability of the water column** (compared to those of intense mixing).

These species, as any other respond neither directly to weather nor climate, but to proximal growing conditions hytoplankton species, respond (nutrients, light, temperature, mixing regimes, grazing), which can appear or disappear under different combinations of actors forcing the lake system.

Therefore, *Cyclotella* or any other diatom taxon cannot be used as a lake thermometer by itself.



Ruhland K, Paterson AM, Smol JP (2008) Hemispheric-scale patterns of climate-related shifts in planktonic diatoms from North American and European lakes. *Glob Change Biol* 14:2740–2754

Acceleration of cyanobacterial dominance in north temperate-subarctic lakes during the Anthropocene

Zofia E. Taranu,^{1-3*} Irene Gregory-Eaves,^{1,3} Peter R. Leavitt,⁴ Lynda Bunting,⁴ Teresa Buchaca,⁵ Jordi Catalan,^{5,6} Isabelle Domaizon,⁷ Piero Guilizzoni,⁸ Andrea Lami,⁸ Suzanne McGowan,^{9,10} Heather Moorhouse,⁹ Giuseppe Morabito,⁸ Frances Pick,¹¹ Mark A. Stevenson,⁹ Patrick L. Thompson¹ and Rolf D. Vinebrooke¹²

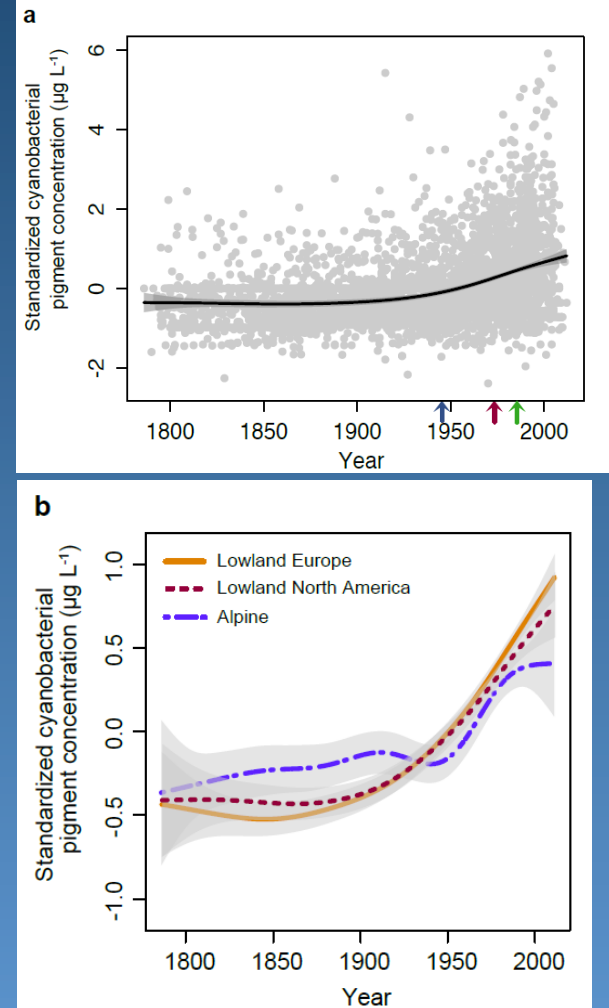
Increases in atmospheric temperature and nutrients from land are thought to result in the expansion of harmful cyanobacteria in lakes worldwide, yet to date there has been no quantitative synthesis of long-term trends.

To test whether cyanobacteria have increased over the past ~200 years and evaluate the relative influence of potential causal mechanisms, we synthesized 108 highly-resolved sedimentary time series and 18 decadal-scale monitoring records from north temperate-subarctic lakes.

We demonstrate that

- 1) cyanobacteria have increased significantly since ca. 1800 CE
- 2) they have increased disproportionately relative to other phytoplankton
- 3) cyanobacteria increased more rapidly post ca. 1945 CE.
- 4) Variation among lakes in the rates of increase was best explained by nutrient concentration, and temperature was of secondary importance.

Submitted to Ecology Letters



Analysis of fossil records containing biomarkers of both phytoplankton groups showed that non-linear increases after ca. 1945 CE were significantly ($\chi^2_{\text{year-pigment}}=14.3$, $P<0.0001$) and disproportionately larger for cyanobacteria than for diatoms.



Progetto SNAC

Elementi per l'elaborazione della Strategia Nazionale di Adattamento ai Cambiamenti Climatici

Settore: Ecosistemi di acque interne e di transizione: biodiversità, e funzioni e servizi dell'ecosistema

Coordinatore: Pierluigi Viaroli, Dipartimento di Bioscienze, Università di Parma

Consultazioni pubbliche sulla Strategia Nazionale di Adattamento ai cambiamenti climatici
Roma, 9 - 10 dicembre 2013



Ministero dell'Ambiente e della Tutela del Territorio e del Mare

Attuazione Direttiva Quadro sulle Acque 2000/60/CE

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Home page - ATTUAZIONE DIRETTIVA QUADRO SULLE ACQUE 2000/60/CE

HOME PAGE

- Testo della Direttiva 2000/60/CE
- Adempimenti e scadenze della direttiva
- Recepimento della direttiva in Italia
- Stato della pianificazione in Italia
- Partecipazione Pubblica

PIANI DI GESTIONE DEI SACINI IDROGRAFICI

- Aspetti Generali
- Stato delle attività ed elaborati di piano
- Linee guida piani di gestione

Distretti Idrografici

- Rapporto con la VAS



LA DIRETTIVA 2000/60/CE

La direttiva 2000/60/CE (Direttiva Quadro sulle Acque - DQA) che istituisce un quadro per l'azione comunitaria in materia di acque ha introdotto un approccio innovativo nella legislazione europea in materia di acque, tanto dal punto di vista ambientale, quanto amministrativo-gestionale. La direttiva persegue obiettivi ambiziosi: **prevenire il deterioramento qualitativo e quantitativo, migliorare lo stato delle acque e assicurare un utilizzo sostenibile**, basato sulla protezione a lungo termine delle risorse idriche disponibili. La direttiva 2000/60/CE si propone di raggiungere i seguenti obiettivi generali:

LINK UTILI

- Nazionali
- Regioni
- Ambiti Territoriali Ottimali
- Autorità di Bacino
- MINISTERO AMBIENTE

NOVITA'

CONTATTACI

The question:

Reference condition for phosphorus in the large Italian lakes

Paleolimnological approach:

Fossil diatoms

Sedimentary pigments



Asterionella formosa

Aulacoseira islandica

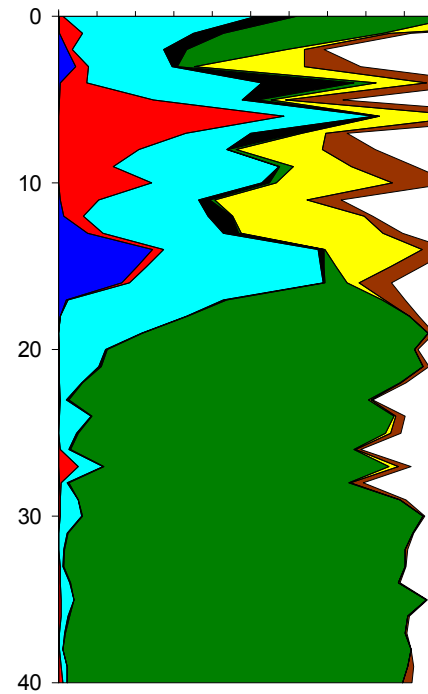
Diatoma tenuis

Cyclotella comensis

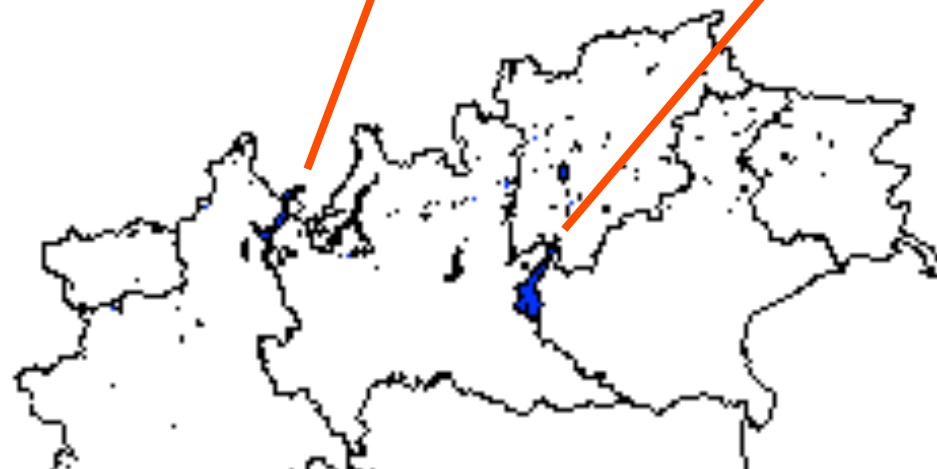
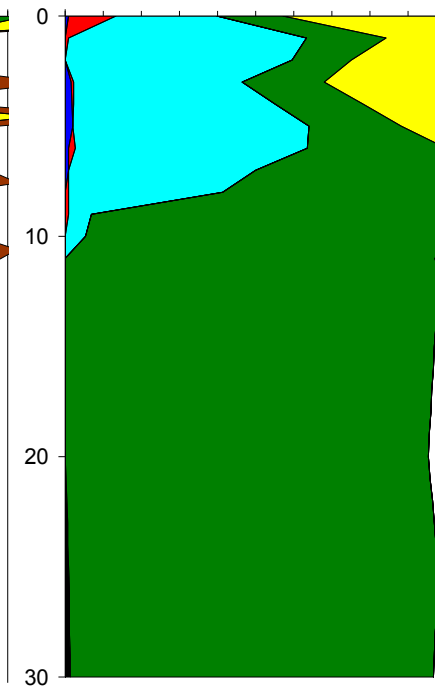
Fragilaria crotonensis

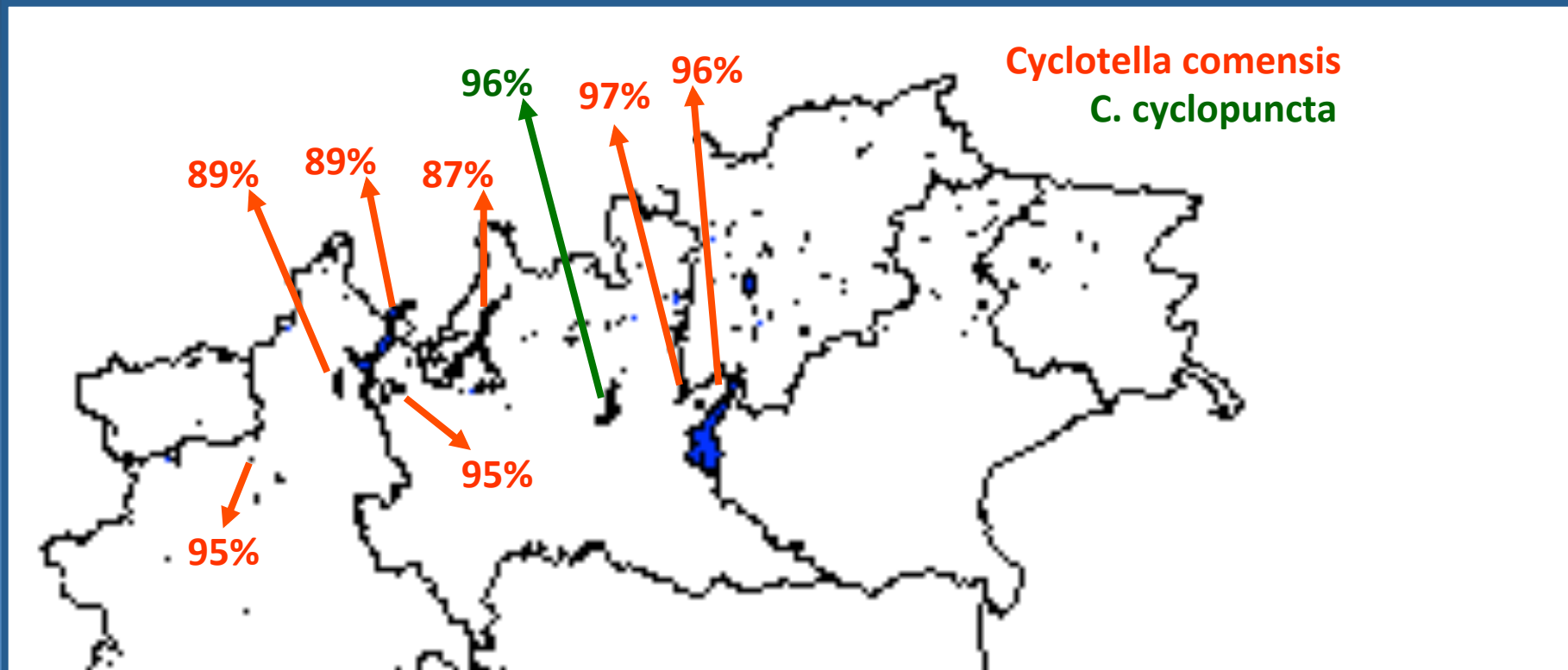
Stephanodiscus minutulus & *S. hantzschii*

Maggiore



Garda



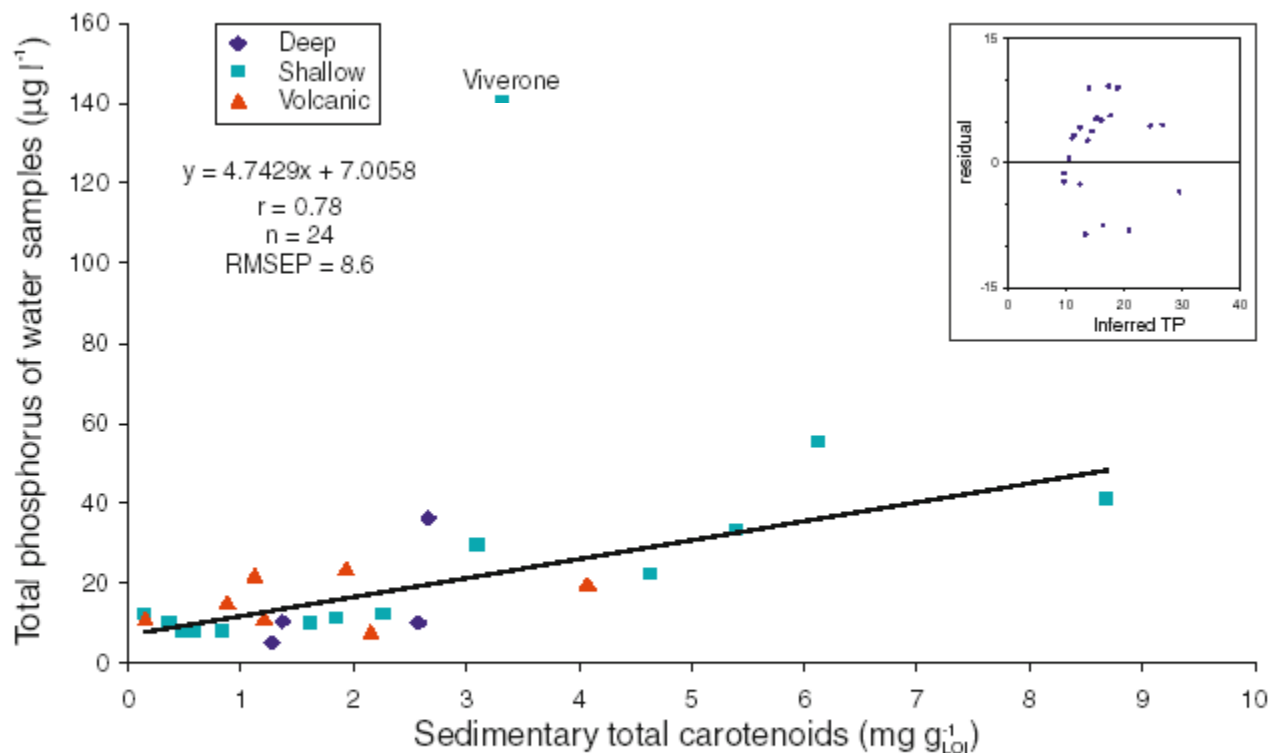


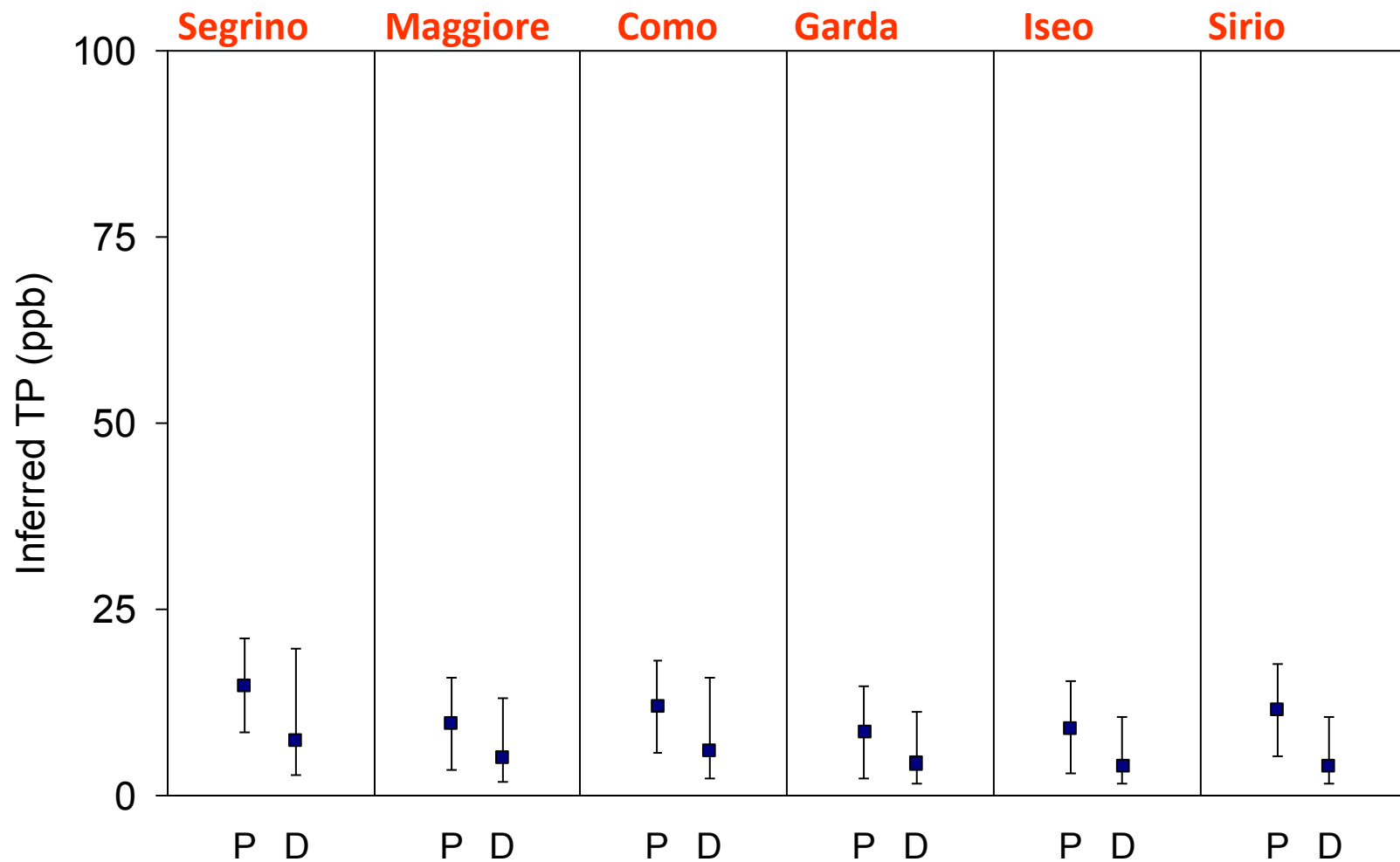
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Use of sedimentary pigments to infer past phosphorus concentration in lakes

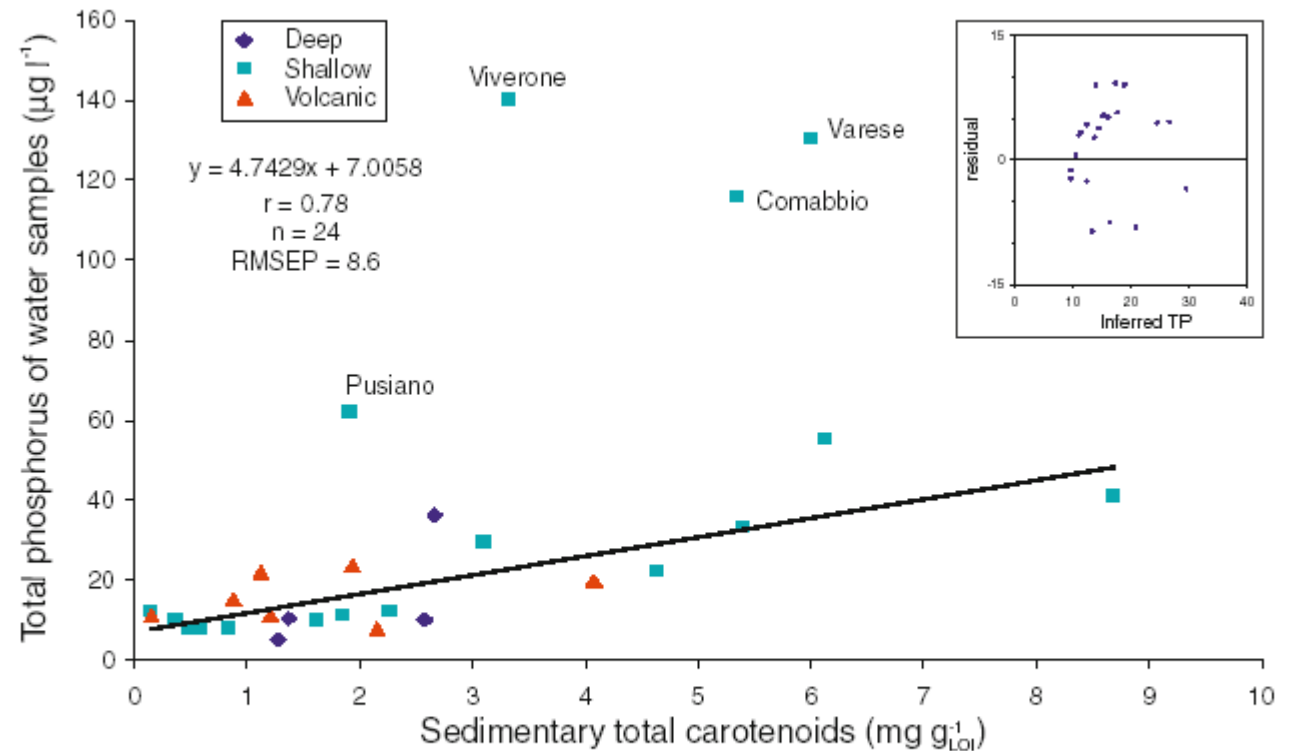
Piero Guilizzoni · Aldo Marchetto ·
Andrea Lami · Stefano Gerli · Simona Musazzi



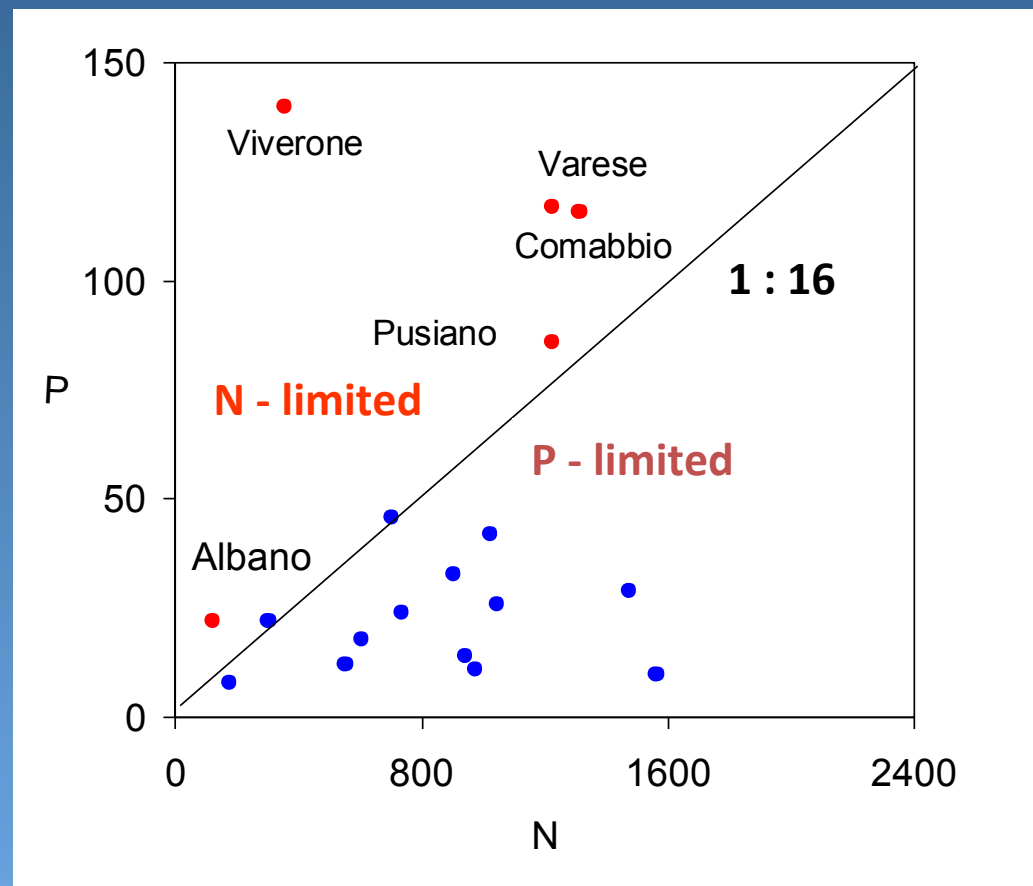


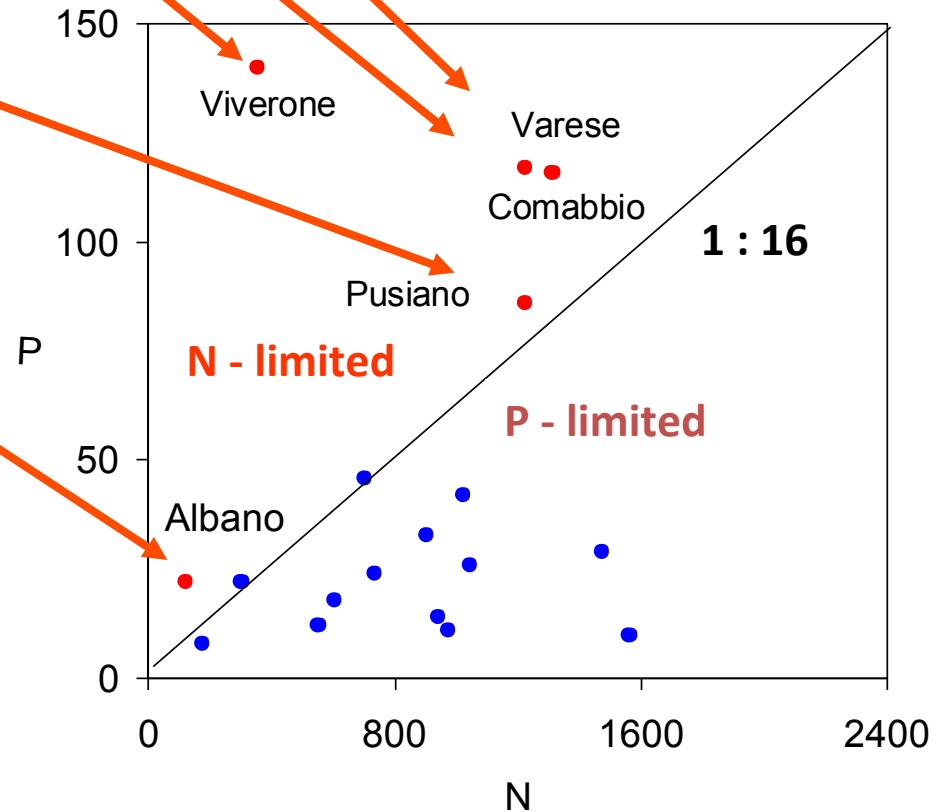
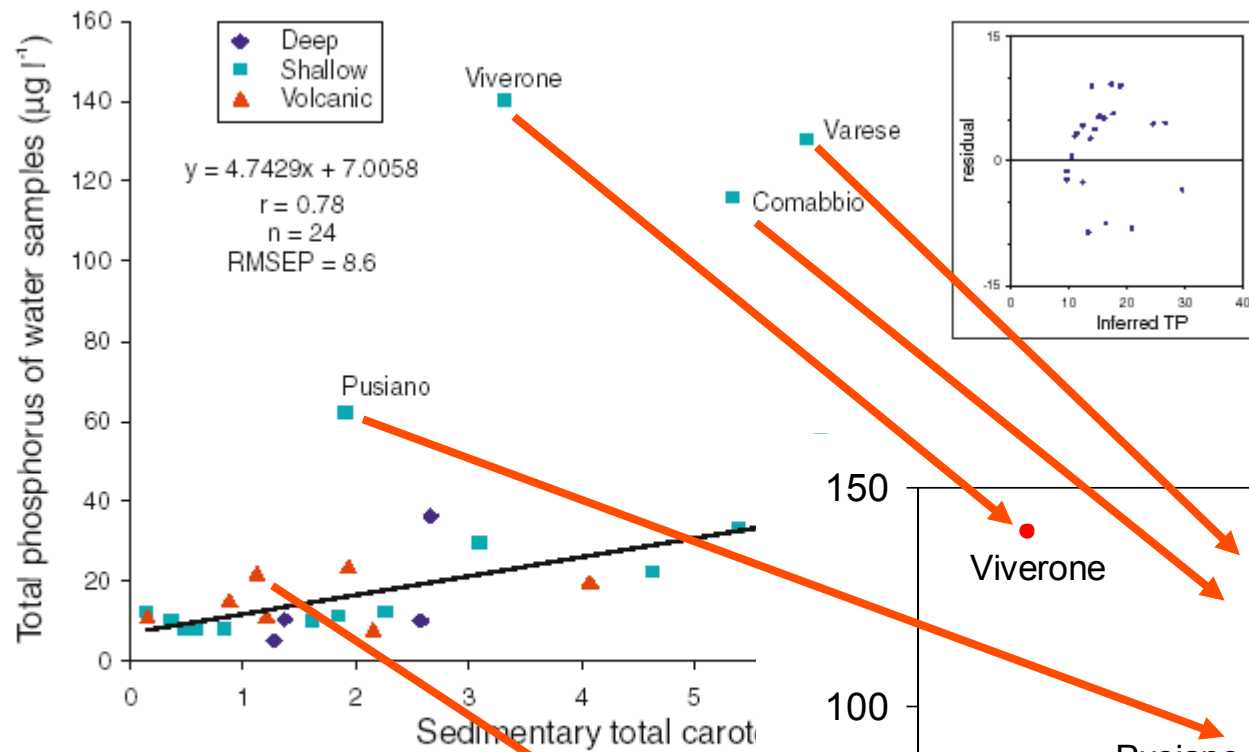
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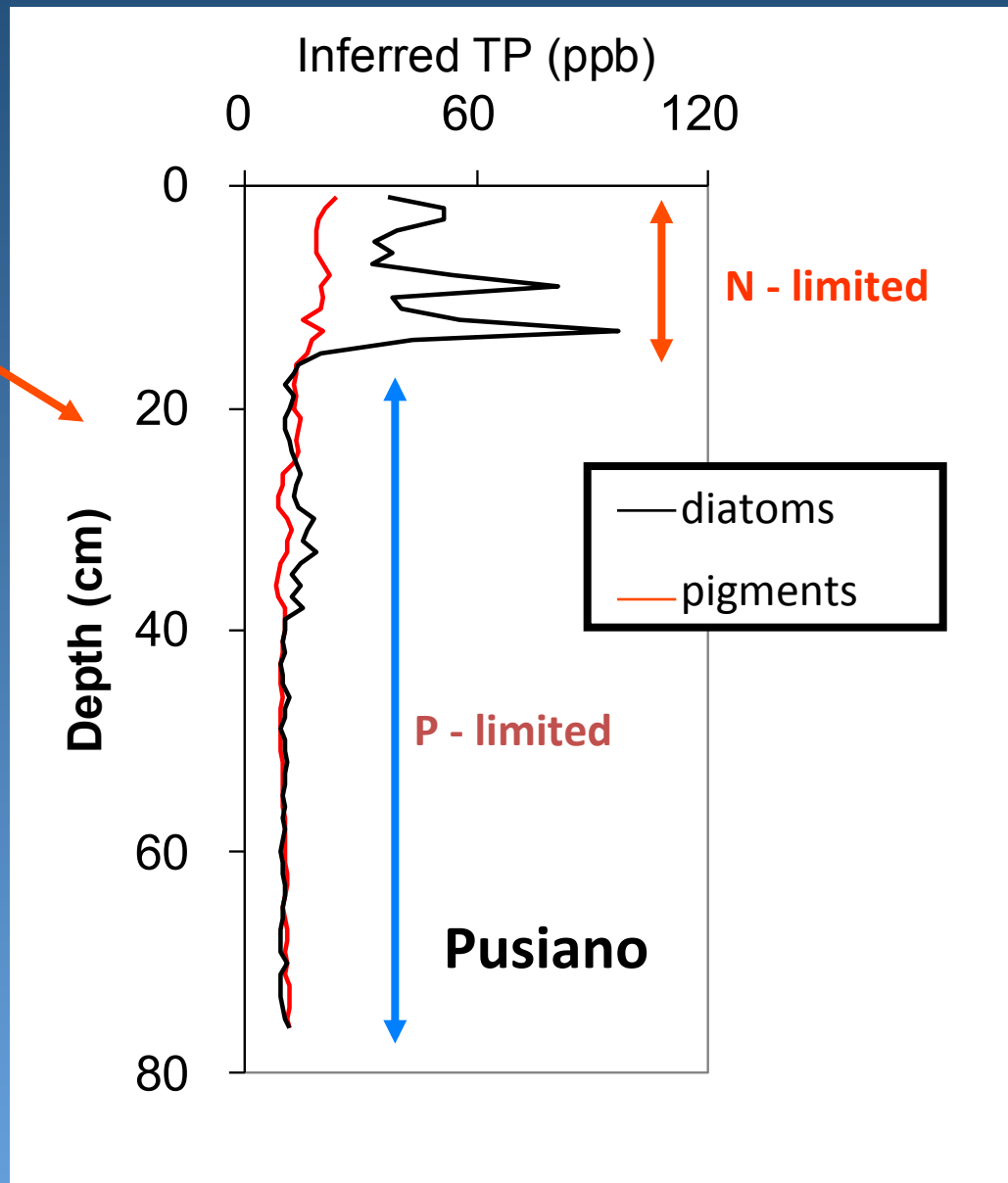
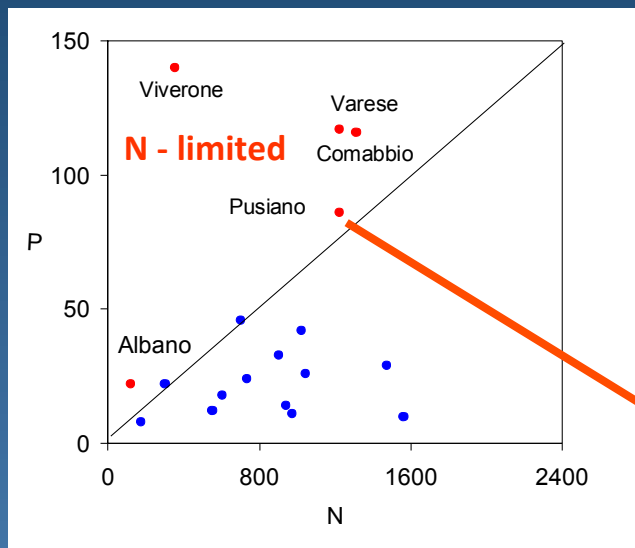




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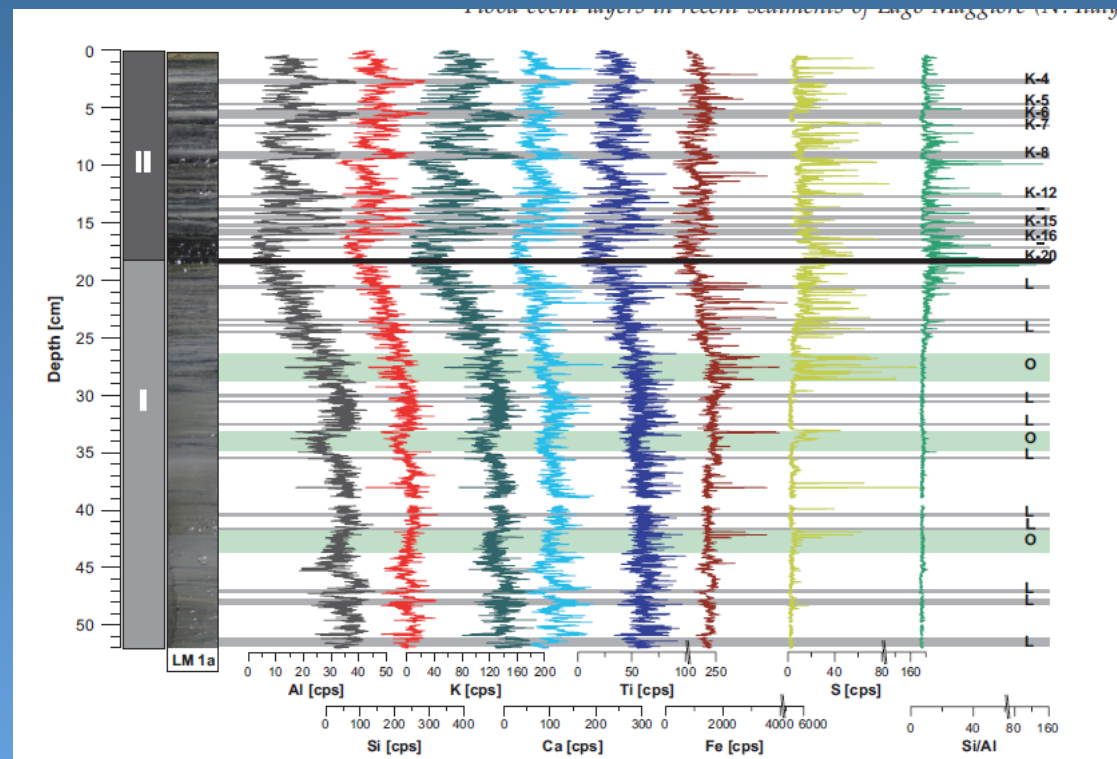
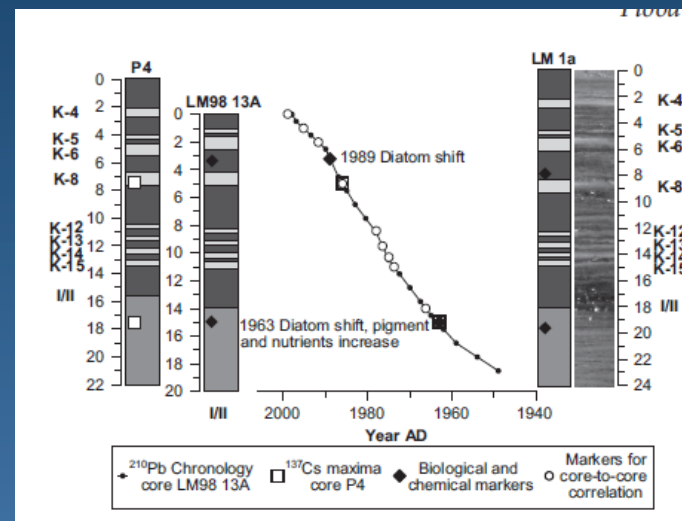
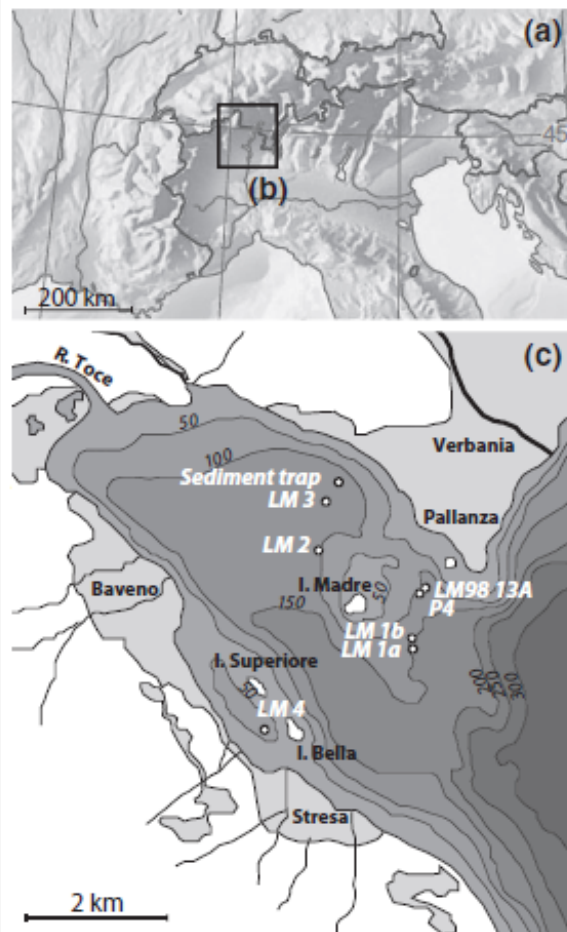


Detrital layers marking flood events in recent sediments of Lago Maggiore (N. Italy) and their comparison with instrumental data

LUCAS KÄMPF*, ACHIM BRAUER*, PETER DULSKI*, ANDREA LAMI†, ALDO MARCHETTO†, STEFANO GERLI†, WALTER AMBROSETTI† AND PIERO GUILIZZONI†

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Detrital layers marking flood events in recent sediments of Lago Maggiore (N. Italy) and their comparison with instrumental data

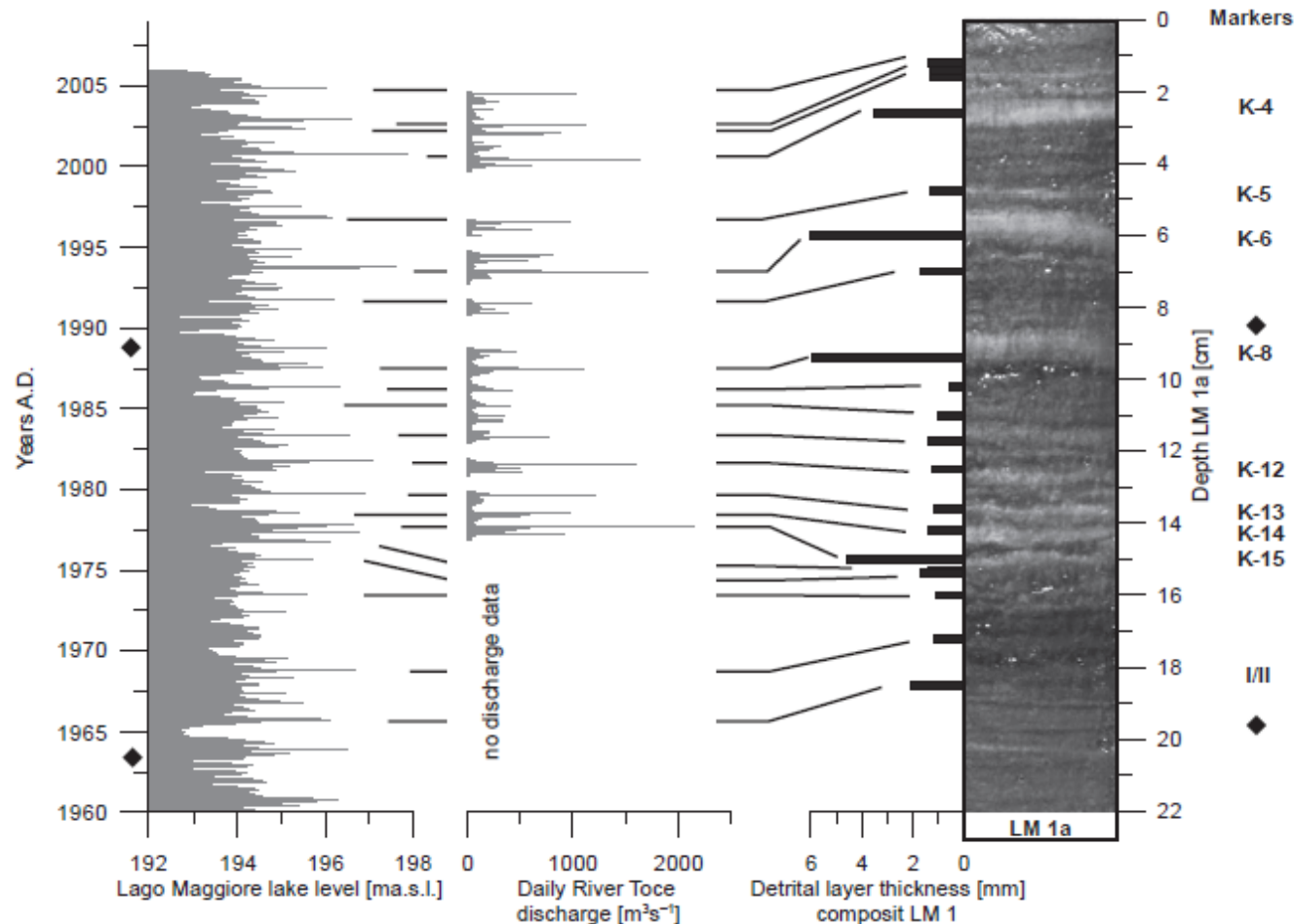


Fig. 7 Alignment of the composite record of detrital layers in core sequences LM 1a+b (dark bars, right) with daily Lago Maggiore lake level and River Toce discharge data (light bars, left). The photograph shows core LM 1a with the position of the 11 lithological markers used for dating the core sequences. Diamonds mark two distinct shifts in diatom composition documented in Marchetto *et al.*, 2004 and Guilizzoni *et al.*, 2012.

Lago Lugano 2010

Varese, Comabbio, Monate, Pusiano, 2010-2011

Tovel, 2001

Lago Maggiore 1998-2010

Colbricon, 2010

Lago di Avigliana 2008

Ledro, 2012

Garda 2011

Bolsena
Bracciano,
Albano
Nemi
(Paliclas 1994)

Monticchio 2006



NEXTDATA – Special project: lake archives

Local human perturbations increase lakes vulnerability to climate changes - A pan-European test

- 1 . comparing the responses of pelagic biological communities to climate change between the 15 lakes and quantifying the synchronicity or in contrast the idiosyncrasy in pelagic responses to CC
- 2 . To assess whether and to what extent the variability of responses depend on geomorphological characteristics and intensity of local human pressures of lakes.



WELCOME TO THE



WEBSITE

Perturbations Impacts on Lake food webs : a paleo-ecological approach



... take-home messages

- paleolimnology relies on interdisciplinary approaches to compensate for information loss, and to resolve the complexity of differential interpretations about ecosystem changes and driving forces. (Withmore Jlimnol 2014)
- morphologically comparable ecosystems under similar climate forcing are not evenly sensitive and these differences in vulnerability to climate warming depend on local stressors.
- Contribute to the debate about the predictability of the impacts of climate change on ecosystems
- understanding the role of local vs global forcing when extrapolating from one site to another.

people



P. Guilizzoni



A. Marchetto



S. Musazzi



S. Gerli

with contribution of



R. Piscia



M. Manca

CNR-Istituto per lo Studio degli Ecosistemi (ISE)



M. Tolotti

Limnology and Fresh Water Ecology research group
Fondazione Edmund Mach, S. Michele (TN)



W. Finsinger

Centre de Bio-Archeologie et d'Ecologie (CBAE)



M.E. Perga

IPER-RETRO - Impact des perturbations sur les réseaux trophiques en lacs : approche paléo-écologique

Laurent Millet - UMR 6249 Chrono-environnement Besançon, France



Zofia E. Taranu

McGill University
Canada

C. Barbante J. Gabrielli



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Thanks for your attention !