



Guest Editorial

Closing and exposing the gaps in knowledge: INTIMATE workshop on terrestrial records from central Eastern Europe for the Last Glacial–Interglacial transition



1. Introduction

INTIMATE (INTEgration of Ice-core, MARine and TERrestrial records) was initiated in the early 1990s as a core project of the INQUA Palaeoclimate Commission, aiming to “clarify the sequence, timing, nature and causes of abrupt environmental events at the Last Glacial–Interglacial transition” (Hoek et al., 2008). Between 2010 and 2014, INTIMATE was an EU-funded COST Action [<http://cost-es0907.geoenvi.org/>], aiming to reconstruct past climate changes in Europe between 60,000–8000 years ago, by integration of ice core, marine, and terrestrial palaeoclimate records and use of the combined proxy data and climate models to facilitate the understanding of mechanisms and impacts of these changes.

Within the EU-COST Action, INTIMATE organised a series of workshops, sessions, conferences and summer schools grouped in four working groups (WG): WG 1) Dating and chronological modelling, WG 2) Quantification of past climate, WG 3) Modelling mechanisms of past change, and WG 4) Climate impacts. The workshop held in March 2013 in Cluj Napoca (Romania) brought together palaeoclimatologists, palaeoecologists and geomorphologists from Central and Eastern Europe (CE Europe hereafter) with the aim to: i) examine the available palaeo-datasets covering the 60–8 ka time-interval in this region; ii) identify the best available high-resolution, well-dated palaeo-records, and compile these datasets in a standardised form; iii) discuss the potential of a series of syntheses as well as single-site articles in order to identify local to regional temporal patterns of climate variability and associated biotic response; iv) identify future critical areas and subjects of research and initiate future cooperation.

2. Outcome of the workshop

Three important scientific products resulted from this workshop. Firstly, the main outcome of the workshop was the publication of the first large geographical scale synthesis paper for the CE Europe (Feurdean et al., 2014). This paper compiles up to date, the best available quantitative and semi-quantitative climatic and vegetation records for the past 60–8 ka in CE Europe and describes the main patterns of climate variability and the timing and magnitude of vegetation response to changes in climate conditions. Secondly, most of the workshop presentations and discussions materialised into 12 articles published in this volume. Thirdly, some key issues arose during the workshop discussions and from the published papers. These are outlined below and may serve as

guidelines for future subjects of research and studies integrating various environmental records.

1) Filling gaps in palaeo datasets

A major gap in the temporal distribution of the palaeorecords is the absence of continuous records spanning the INTIMATE time frame (8–60 ka) in CE Europe. Most of the records cover the Late Glacial and Holocene, with only a few reaching beyond the Last Glacial Maximum (LGM). However, these pre-LGM records are fragmentary and have low temporal resolution; most of them are derived from the loess deposits that cover the central and southern part of CE Europe. Most post-LGM palaeo-records come from vegetation-based proxies from peat bogs and lakes, with a few speleothemes in the Carpathian Mts., thus posing a major challenge for disentangling between reconstructions of climatic conditions and of climate impacts on vegetation. Further, ice (in the northern part) and loess (in the southern part) covered most of the region before and during the LGM, so that terrestrial archives going back beyond the LGM are extremely rare.

2) Chronological control

A major challenge for palaeoenvironmental reconstructions in general, and those in CE Europe in particular, is the chronological control and identification of the leads, lags and synchronicity in the climate system as well as in the vegetation responses to climate changes. Much of interpretation of leads and lags in palaeo-records from this region is based on wiggle-matching with better-dated records from various Greenland ice cores. However, the use of tuning for chronological purposes can give an unrealistic picture of globally or regionally synchronous rapid climate changes. Proposed methods to better assess the leads, lags and synchronicity in palaeorecords across large spatial regions and to distinguish between climate forcing and local environmental changes, are high-resolution dating and particularly the use of tephra layers.

3) Creation of local calibration sets and transfer functions

Transfer function methods are used to quantify the relationship between physical and chemical properties of various sedimentary archives and ecological assemblage and climate. However, without exception, calibration sets used in CE Europe are generated mainly in the more humid, oceanic, climatic province of Europe (Moreno

et al., 2014). Given the present-day large climatic differences between various regions in Europe, these calibration sets could be biased towards conditions of these regions, thus local calibration sets for palaeoclimatic and palaeoecological analysis are one of the most stringent prerequisites for a better understanding of the rate of climatic changes and of biota response in CE Europe.

4) Improved quantification of the vegetation record

The vegetation records (pollen, plant macrofossil, charcoal) are the most abundant palaeoecological records in CE Europe. However, many of the vegetation records are described qualitatively. Improved quantification of the vegetation record should include: i) disentangling the effects of multiple factors on vegetation composition; ii) use of numerical methods for inter-site vegetation comparison and regional syntheses; iii) better understanding of pollen-vegetation relationship by testing the available pollen-vegetation models (e.g. Birks, 2012; Feurdean et al., 2015; Kunes et al., 2015).

3. Contents of the special issue

This special issue contains papers presented at the 2013 Cluj Napoca INTIMATE Workshop, as well as some derived from the discussions that emerged during and after the meeting. The content clearly reflects the points highlighted above, with most of the paper focusing on the impact of climate changes on vegetation cover, with limited reconstructions of climate changes based on quantifiable proxies.

Veski et al. (2015), present a comprehensive quantitative climate reconstruction based on pollen and chironomids from the Baltic area during the Lateglacial and the early Holocene. They found that the magnitude of temperatures change was larger in northern part of Baltic area than in the south. However, winter temperature reached modern values earlier (10 ka BP) in southern Baltic area than in the north (9000 cal BP).

Novenko and Olchev (2015) show that during the early Holocene, the East European Plain experienced a colder and wetter climate across a transect from the northern taiga through the southern deciduous forest zone. Further, the 9.1 and 8.2 ka cooling episodes supposedly caused by melt-water pulses in the Northern Atlantic region seem to have extended well inside the Eurasian Plain, although dating uncertainties hinder the recognition of a possible lag in the eastward transfer of the climatic signal.

Gałka et al. (2015) and Kolaček et al. (2015-a) used biotic records (plant macrofossils, pollen and diatoms) to infer lake level changes and terrestrial and aquatic vegetation responses to the Lateglacial and Holocene climatic fluctuations in Poland. They show that both aquatic and terrestrial vegetation responded sensitively to the climate warming at the Late Glacial–Holocene transitions. Several high and low lake level stands were also noted during the entire period indicating marked fluctuations in the lake level.

Kolaček et al. (2015-b) use a combination of isotopic ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$), geochemical (TOC, TN, C/N) and palaeobotanical proxies to track environmental changes at the Last Glacial–Holocene transitions, to which botanical proxies seem to be less sensitive.

Słowiński et al. (2015) present a case of the interplay between melting of buried ice, geomorphological development and hydrological changes in Northern Poland. Melting of a buried (dead) ice block in the early Holocene led to the rapid development of a lake that was subsequently filled-in and transformed into an alluvial plain. Pollen trapped in the lake indicates a rapid development of the forest at the valley floor, in the still cold and dry climate of the Early Holocene.

Further south, Grindean et al. (2015) reconstruct the vegetation response to climatic changes in the Romanian Carpathian Mts., from the Late Glacial through the early to mid-Holocene. Their results show that most tree taxa responded even to small-amplitude temperature and precipitation changes of the Holocene. Importantly, the absence of *Fagus sylvatica* and *Carpinus betulus* pollen in the early Holocene seems to contradict previous suggestions of potential survival of these two species in local glacial refugia in this region.

Lascu et al. (2015) use a multiproxy analysis of sediment composition and texture, mineral magnetism, organic macrofossils of a sediment profile from northern Transylvania, Romania. The reconstructed palaeo-environmental evolution at the site captures the warm and humid climate during the Lateglacial interstadial (GI-1), and cooling at the onset of the Younger Dryas (GS-1). Interestingly, they found that the Late Glacial climatic events are well expressed also in lowland regions where climatic effects were expected to be more muted.

The following three papers deal with the impact of climatic and vegetation changes on the dynamics of fluvial systems in CEE, across a latitudinal and altitudinal transect from the Baltic through the Black Sea through the Carpathians Mts. Starkel et al. (2015) summarise the succession of fluvial phases between 60,000 and 8000 years ago, showing that although climate changes played the major role in shaping the timing and style of fluvial activity, vegetation and geology modulated this role, and in some places (e.g., NW Romania) were even overriding it. In the mountain regions, vertical shifts in the vegetation belts as well as changes from oceanic to continental climate conditions (with associated hydrological changes) were the main players influencing timing and rates of fluvial erosion (Gębica et al., 2015). In the Great Hungarian Plain, tectonic processes interplayed with climatic and vegetation changes to shape a complex fluvial system (Kiss et al., 2015). Local subsidence led to shifts of the valleys for more than 80 km, and a subsequent transition from dominance of fluvial to aeolian processes within these regions. Generally, all these studies revealed that during colder periods (either the entire glacial and/or the shorter GS-1), braided rivers shaped the landscape, while the warmer Holocene and associated forest development led to fixation of slope deposits and shifts towards meandering rivers.

Gheorghiu et al. (2015) present new data on the deglaciation of the Carpathians, evidencing the survival of cirque glaciers throughout the Late Glacial, with final melting well into the Holocene (10.2 ka). The ice retreat was synchronous with similar cirque glaciers in the Alps, Balkans and Anatolia, but given the dating uncertainties up to 1 kyr, it is still debatable whether the drier climate of the Carpathians (as compared with the more westerly located Alps and sea-side Balkans) favoured the delay in final melting of the glaciers.

Timar-Gabor et al. (2015) set to resolve the disagreement among the ages obtained on fine (4–11 μm) and coarse (63–90 μm) grains found in the Romanian loess by applying time-resolved optically stimulated luminescence (TR-OSL) on quartz, in samples from the Orlovat loess paleosol section (Vojvodina, Serbia). They show an age discrepancy between the two grain sizes from this profile, which confirms previously findings in the Romanian loess, and conclude that this pattern might be more widespread than previously thought.

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