Quaternary International 386 (2015) 70–82

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Vegetation pattern and sedimentation changes in the context of the Lateglacial climatic events: Case study of Staroje Lake (Eastern Belarus)

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ARTICLE INFO

Article history:
Available online 13 July 2014

Keywords:
Palaeobotany
Stable isotope
Palaeoenvironmental changes
Lateglacial
Belarus

ABSTRACT

A lake sediment core collected from the Staroje Lake, southeastern Belarus, reveals significant changes of the terrestrial and limnic environmental during the Lateglacial and Early Holocene in the periglacial zone of the Late Weichselian Glaciation. The combination of lithological (loss-on-ignition), palaeobotanical (pollen, non-pollen palynomorphs, diatoms) and isotopic ($\delta^{18}O$, $\delta^{13}C$, ^{14}C) proxy parameters was applied for the reconstruction of the vegetation pattern and sedimentation regime. The Lateglacial pre-Interstadial (GS-2) vegetation was dominated by mineral-soil pioneers with scattered occurrence of *Pinus* and *Betula*; an Interstadial (GI-1) dominated by *Pinus* forest with increasing representation of open-ground species since approximately 13,500 cal BP; and Lateglacial Stadial (GS-1) with recurring opening of the vegetation pattern with scattered tree patches including those of *Picea*. Presence of *Pinus* stomata confirms the local origin of this plant since the pre-Interstadial. Starting from the Holocene, birch, later accompanied by other deciduous species (*Ulmus*, *Alnus*, *Quercus*, *Corylus*), took over in the local vegetation structure.

Isotopic records ($\delta^{18}O$, $\delta^{13}C$) obtained on bulk carbonates as well as diatom data exhibit several shifts reflecting variations both in terrestrial and limnic environment. Distinct negative excursion of $\delta^{18}O$ curve recorded during the first half of the GI-1 event suggests intensive groundwater discharge accompanied by active transportation of detrital carbon in to the basin. Limited basin productivity is also indicated by lithological and diatom records. Since approximately 13,700 cal BP, sedimentation regime in the lake stabilised and productivity of the basin started to increase in positive correlation with LOI data. A considerable decrease in $\delta^{18}O$ values punctuated by a rapid jump in the middle of the interval was recorded during the GS-1 Stadial and could be associated with the deterioration of the environmental regime and degradation of the soil layer, increasing erosion activity alongside the rising input of detrital carbonates into the basin. The water table was low, as indicated by diatom data. Recovery of the environmental regime preceded the GS-1/Holocene boundary, as is seen in lithostratigraphical and isotopic data. During the early Holocene, stable isotopes show several episodes with altered levels suggesting instability of the environmental regime, most probably related with the global climatic alterations.

1. Introduction

The Last Glacial Termination was characterized by numerous environmental oscillations recorded in terrestrial, glacial, and marine proxy records collected from around the North Atlantic realm. At the same time, the wide climatic instability (Walker, 1995; von Grafenstein et al., 1999; Lowe et al., 2008; Brooks and Birks, 2000a,b) related to the changes of thermohaline circulation and solar activity among other factors have been confirmed. Insights into the pattern of these changes are crucial to predicting future environmental and climatic regimes.

While numerous studies have revealed and characterised Lateglacial vegetation and sedimentation dynamics (Starkel, 2002;

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http://dx.doi.org/10.1016/j.quaint.2014.06.045
1040-6182/

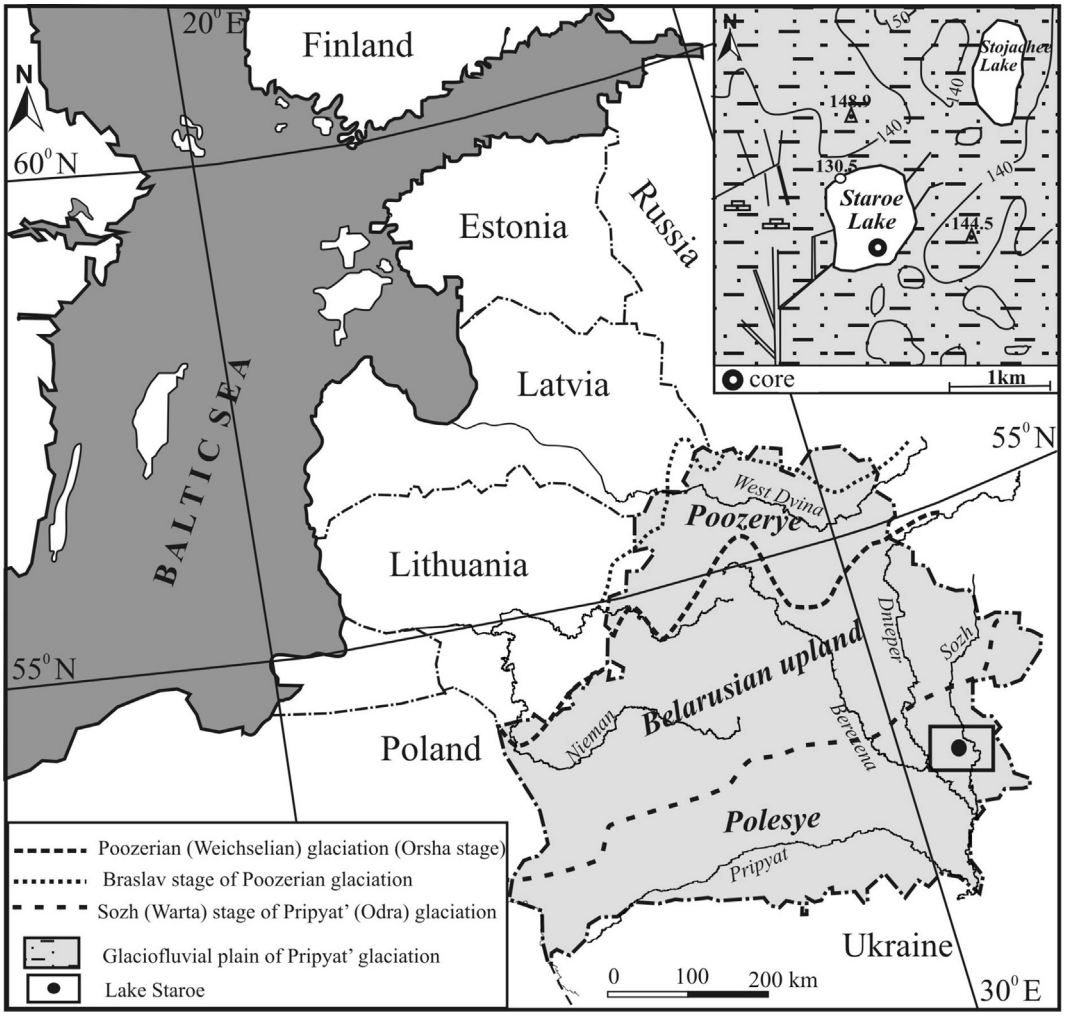

Fig. 1. Situational map of the Belarus territory showing the position of Staroje Lake and location of the ice marginal zones.

Birks and Birks, 2004; Willis and van Andel, 2004; Giesecke, 2005a,b; Latałowa and van der Knaap, 2006; Margielewski, 2006; Birks and Willis, 2008; Binney et al., 2009) in northern, northwestern and central Europe fewer sedimentary records exist for the eastern part of the continent including western and northwestern Russia, Belarus and Ukraine (Zernitskaya et al., 2001; Makhnach et al., 2004; Wohlfarth et al., 2006; Novenko et al., 2009; Väliranta et al., 2011). The existing data sets suggest a high synchronicity of the main climatic events and the associated environmental response *circum* North Atlantic (Lowe et al., 2008), while some alterations, such as the delay of the early Holocene warming and the subsequent environmental shifts were fixed in the north-eastern part of the European continent (Wohlfarth et al., 1999, 2002, 2004, 2006, 2007; Subetto et al., 2002; Stančikaitė et al., 2008, 2009).

Discussing the different aspects of the Lateglacial environmental pattern, the Eastern European territories situated outside the maximum extent of the Scandinavian Ice sheet are of crucial importance, as numerous processes, including forestation of the newly deglaciated areas, started from the periglacial zone. As the major part of the Belarusian territory was free of ice during the Last Glacial maximum, this region provides exceptional opportunities for multi-proxy palaeoenvironmental and palaeoclimatic reconstructions, filling the gap between the western and eastern European databases. According to existing information, the processes of the lacustrine sedimentation started before 12.8 ka BP (Matveyev et al., 1993; Zernitskaya et al., 2001; Zernitskaya and Mikhailov, 2009) in Belarus. However, the main Lateglacial sites are located in central, western, and southwestern parts of the country. Late Glacial deposits of Eastern Belarus are poorly studied and have been restricted to palynological stratigraphy. In the present study, we attempt to achieve more detailed knowledge on the Late Glacial and Early Holocene establishment of the plant cover, development of the sedimentary environment, and changes of climatic regime in this poorly studied region in southeastern Belarus. This study investigated regional climatic changes in the context of supra-regional climatic events, documented in the GISP2 Greenland ice core (Stuiver et al., 1995). Increasing the number of chronologically well-supported high-resolution multi-proxy archives representing areas where the number of similar investigations is still low may aid in improving the understanding of the Lateglacial climatic evolution and the ecosystem reaction in the Northern Hemisphere.

2. Site description

Lake Staroje (52°51′N, 30°58′E, 130.5 m a.s.l., Chechersk district, Gomel oblast) situated in southeastern Belarus (Fig. 1) lies in the glacial meltwater channel (depth 15–20 m) formed during the Pripyat' Glaciation (Dnieper stage or Saale II). In the northern and