Project name: **Postglacial palaeoclimatic and -botanical dynamics at the tundra-taiga borderzone of West Siberia, Russia**

Project acronym: PALSIB

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Sites of research: **Nymto park station** (Mukhrino field station), Russia
Duration of project: March 2014, 1.5 weeks (depends on weather and coring conditions); 50 mandays.
InterAct call for winter 2013/2014

Background:

The global climate change that is observed by modern scientists is nothing new for Earth. During the Last Glacial Maximum (LGM) at about 18–20,000 years ago the several kilometres thick ice sheets extended over Scandinavia, large areas in Great Britain, Ireland, the Baltic states, Belarus, Poland, large areas of the Barents and Kara Sea and NW Russia (Svendsen et al. 2004). The glacial-interglacial cycles affected landforms and biota not only in the directly glaciated region itself but the large ice-mass that formed during the merger of Scandinavian, Kara and Barents Ice Sheets influenced climate and water circulation on hemispheric scale (Rinterknecht et al. 2006). The deglaciation process lasted several thousand years with coolings and warmings; later in the Holocene, the modern biota started to form step-by-step.

One notable sign of region's climate change is the treeline location. Treeline is a major ecoclimatic feature that is sensitive to environmental change as well reflects the interaction of climate, physiography and species' ecology and physiology (Prentice et al. 1992). The large-scale climate changes have been and will affect remarkably the position of boreal treeline – the action has been recorded throughout the postglacial period by palaeoecological studies and it is going on in present days (Petit et al. 2008). The series of sediment multi-proxy studies from NE European Russia (e.g. Salonen et al. 2011) demonstrate the notable changes in palaeotemperatures during the Holocene and the fluctuations of the treeline.

The previous research of the current team has been carried out in eastern Baltic area, thousands of kilometres westwards. This region was covered by the ice of the last glaciation and deglaciated step-by-step between 14500 – 11600 cal y BP (Amon et al. 2012, Veski et al. 2012). During the Late-glacial period, the northern treeline fluctuated over the eastern Baltic region. Based on series of studies, it can be suggested that the maximum limit of Late-glacial treeline in eastern Baltic area did not exceed 57,5 °N (Amon et al., in prep.).

The proposed study area in West Siberia, Russia was not glaciated during the LGM but was influenced by huge Barents-Kara Ice Sheet that was formed north from the mainland, in the present-day sea (Svendsen et al. 2004). The hemispheric climate changes during the deglaciation and in Holocene played role in the vegetation development such as migration of species and probable shifts in forest limit. These changes are preserved in lake sediments and could give interesting insight into the past climate and vegetation dynamics of the area.

Research objectives:

* to reconstruct the temporal and spatial fluctuations of an important environmental indicator, the tundra-taiga borderzone and Northern forest limit in the poorly studied area, West Siberia, in Russia;
* to determine the hemispheric postglacial palaeoclimatic signals (e.g. LGM, GS-1 cooling, 8.2k event, Holocene thermal maximum) using multi-proxy approach to lake sediment archive;
* to reconstruct the botanical and sedimentological changes in a selected lake and its surrounding to define forcing factors for these changes;
* to build a chronological background to the environmental shifts reflected by palaeobotanical and sedimentological analyses and to estimate the speed of changes (e.g. species migration).

The most suitable station for fieldworks that would best achieve the listed goals, is Nymto park station in Russia. The station is suitably situated near to modern tundra-taiga zone that is a good basis for comparison with past plant communities. During the LGM the area was not directly covered by Barents-Kara Ice Sheet but could have been influenced by this former vast ice mass. There are some recent multi-proxy palaeoecological studies from the NE European Russia region (e.g Pechora Lowland, Timan Ridge), but internationally available studies from the eastern side of the Ural Mountains, the West Siberian Plain are lacking (Leshchinskiy et al. 2006). The Khanty-Mansiisk area is rich in lakes and recently several hundreds of them were just searched for mineral resources (E. Lapshina, pers.comm). New palaeoecological multi-proxy data from this area would add information to understand the possible effects of (past) climate change to plant communities and species migration.

Method and material:

For current study, lake sediment cores for multi-proxy (minerological, geochemical and palaeobiological) analyses will be collected by coring on ice with Russian-type corer or Uwitec piston corer. Laboratory analyses and additional methods for fulfilling the proposed aims are following:

- radiocarbon (^{14}C) dating method - it is the basis to build a realistic chronological background to past environmental changes;
- sediment structure and sedimentological proxies - lithology, granulometry, mineralogy, magnetic susceptibility;
- sediment composition and geochemistry - basic composition (water, organic matter, carbonates, biogenic silica, terrigenous matter), organic matter elemental composition (C,H,N,O,S), nutrients (P, N), organic C and N isotope ratios, mineral matter chemical composition. The listed features characterise the influence of the lake catchment to sediment formation, different weathering and erosional processes, transport and deposition conditions, lake past trophic state etc., all linked to environmental changes and climatic variability.
- palaeobotanical/palaeobiological methods - pollen analysis, plant macrofossil analysis, diatom analysis. Pollen analysis is the most widespread palaeobotanical method to reconstruct the vegetation development in regional scale. Plant macrofossil analysis provides basis for local vegetation reconstruction. This method is especially useful in treeless arctic landscapes or in study locations with past tundra conditions and fluctuating boreal treeline. Diatom analysis describes the past lake water environment conditions but also past climate changes.

Permits: We are aware that certain permits are needed to transport the sediment samples out of Russian Federation. We hope to rely on assistance by local station manager, prof. Elena Lapshina who already draw the outlines of possible solutions. Our group has also connection to Russian scientists (prof. D. Subetto from Dept. of Geography, Herzen State University, St. Petersburg) who can provide advice.
Alternative plans and critical points: There are no obvious alternatives to the study plan as the main interest, to study the forest limit fluctuations and possible former ice sheet influence, could be best observed and compared near modern tundra-taiga borderline. Mukhrino field station is listed as an alternative because it is further away from the modern tundra-taiga borderline but could display some changes in vegetation dynamics caused by past hemispheric climatic fluctuations. The other Russian stations are only partially available during the winter but our equipment and experience are tested on coring on ice. The Khanty-Mansiysk area is rich in lakes, many of them are of thermokarstic origin or have very thin sediment layer but during the fieldwork when searching possible coring sites we would follow the instructions from Russian colleagues (E. Lapshina, pers.comm) and unpublished overviews. We would core over 10 lakes and select the best for our research goals.

Implementation:
Timetable of the project:

- March 2014: fieldworks
- April-May 2014: laboratory procedures e.g. sediment description, sediment structure analyses, preparation of palaeobotanical samples, preparation of samples for radiocarbon analyses (^{14}C analysis will be outsourced).
- June-October 2014: geochemical and palaeobotanical analyses
- November 2014: processing of the available data, discussions and refining the results, reconstructions etc. Preparing the reports.
- December 2014: compilation and submission of an article.

Mandays for fieldworks in Nymto park station:

Name	Position	Days
Tiiu Alliksaar	Senior researcher	10
Leeli Amon	Researcher	10
Atko Heinsalu	Senior researcher	10
Normunds Stivrins	PhD student	10
Siim Veski	Senior researcher	10

Note: the dates cannot be specified at the moment as they depend on the winter ice conditions.

Travel and logistics:

Item	pcs/days	Estimated cost in EUR
Visas	5 pers.	a 75 EUR; 5x75=**375 EUR**
Tallinn-Surgut, return flight	5 pers.	1 person 600 EUR **;**5x600=**3000 EUR**
Special luggage costs (coring equipment)		1 kg extra =10 EUR; second piece 50 EUR **~ 600 EUR**
Hotel in Surgut, both ways – in arrival and in departure	5 pers.	a 40 EUR; 5x40* 2 =**400 EUR**
4 WD Car rental + fuel (snow scooter? – depends on snow condition)	10 days	Estimated total km ~ 2200 km Fuel cons. 15 l / 100 km, ~0.9 EUR/l; in total **~ 300** EUR

		Rental car: ~80 EUR/day, in total ~**800 EUR**
		Sum ~5475 EUR

Specific features:

- Russian visas
- Permits to transport the coring equipment and sediment samples

Expected results:

The main expected output of the project would be new high-resolution multi-proxy palaeoenvironmental data linking palaeoecology and climate as well proxy inferring past temperature estimations. The project is a classical palaeoecological case study but the main novelty is the research area. The study will improve our knowledge of the poorly studied region's vegetation dynamics and responses to climate variables. The understanding of long-term fluctuations of natural systems is a basis to predict their response to future environmental changes.

The acquired data will be publicly available and published in internationally refereed journals as well presented on international conferences and workshops. We also will communicate the past and future climate issues to schoolchildren during the monthly lectures in our institute and university students within special courses about Quaternary geology.

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