12-2001

Volumes and Areas of Early Weichselian Ice Dammed Lakes in Northern Russia

Martin Jakobsson
University of New Hampshire, Durham

Jan Mangerud
University of Bergen

Valery Astakov
Petersburg University, St. Petersburg, Russia

John Inge Svendsen
University of Bergen

Volumes and areas of Early Weichselian ice dammed lakes in Northern Russia

Martin Jakobsson[a], Jan Mangerud[b], Valery Astakov[c] and John Inge Svendsen[d]

[a]Center for Coastal and Ocean Mapping, University of New Hampshire, Durham, NH 03824, USA. [martin.jakobsson@unh.edu]
[b]University of Bergen, Department of Geology, Allégt. 41, N-5007 Bergen, Norway. [jan.mangerud@geol.uib.no]
[c]St. Petersburg University, Geological Faculty, Universitetskaya 7/9, St. Petersburg 199034, Russian Federation. [valery@NB1466.spb.edu]
[d]University of Bergen, Centre for Studies of the Environment and Resources, Høyteknologisenteret, N-5020 Bergen, Norway. [john.svendsen@smr.uib.no]

Early Weichselian ice dammed lakes in Northern Russia

Legend

- Early Weicselian Ice sheet limit (90-100 ka). Modified from Eurasian Ice Sheet project (Svendsen et al., 2001)
- Ice sheet limit used to dam the proglacial lakes
- Ice dammed lakes
- Hydrology from the Digital Chart of the World. Only water bodies larger than 20km² are shown.

Map sources

The maps are compiled by Martin Jakobsson using the Intergraph GIS softwares Geomedia Professional and MGE.

Projection: Lamberts Equal Area
Datum: WGS 84
Bathymetry: International Bathymetric Chart of the Arctic Ocean (Jakobsson et. al. 2000) and Predicted topography (Smith & Sandwell, 1992)
Coastline: World Vector Shoreline
Land topo.: US Geological Survey GTOPO30 and GLOBE

0 300 600 900 1200 1500 km
Scale

Abstract

The early Weichselian Ice Sheet on the continental shelves of the Barents and Kara seas advanced onto the Northern Russian mainland and blocked the paths of the north-flowing rivers to the Arctic Ocean. As a consequence huge proglacial lakes were dammed between the ice margin in the north and the continental drainage divides in the south. The lake in the Pechora lowland, named Lake Komi, is the best mapped (Astakhov et al. 1999; Mangerud et al. in press). The damming of the rivers Yenisei and Ob caused an overflow to the Aral Sea with further drainage to the Caspian and Black seas. Volumes and areas of these Early Weichselian ice dammed lakes were estimated using modern topography, elevations of the former lake surfaces and the geographic position of the damming ice margin. In addition, estimations have been made of the volumes of additional water in the Aral and Caspian Seas respectively; if they were to be filled from today's levels up to their overflow passes. Calculated volumes and areas are summarized in Table 1.

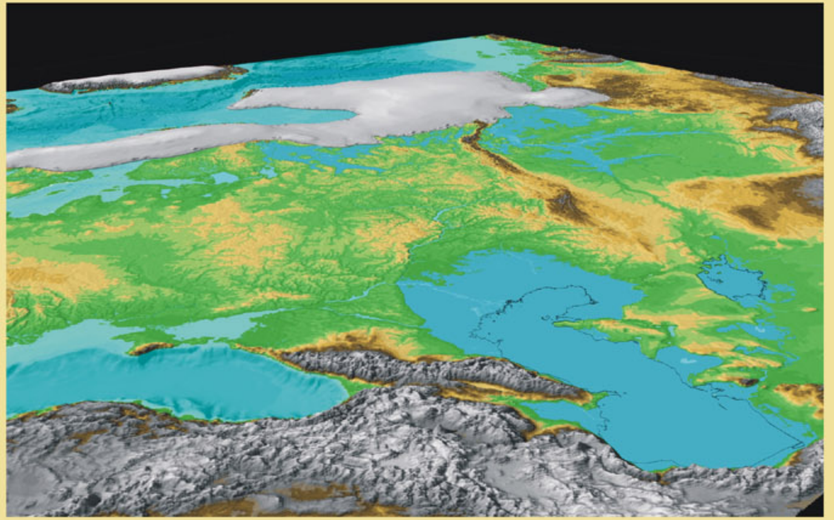
The use of modern topography for the volume and area estimation does not consider sediment deposition or erosion in the lake's basins that took place since the time of the paleo-lake's phases considered. The topography was derived from the Global Land One-Kilometer Base Elevation (GLOBE) Digital Elevation Model (GLOBE Task Team et al., 1999) and the bathymetry from the International Bathymetric Chart of the Arctic Ocean (IBCAO) grid model (Jakobsson et al. 2000), with a horizontal resolution of 2500 m. The GLOBE and IBCAO grids were projected to Lamberts Equal Area projection, resampled to a grid spacing of 1000 m, and combined using Intergraph's Modular GIS Environment (MGE) software modules were the calculations were performed.

The Northern Russian and Western Siberian Early Weichselian ice dammed lakes were comparable in size to the largest stage, Upper Campbell beach level, of the North American ice dammed lake Agassiz that formed ca 9400 ^{14}C yr B.P (Leverington et al., 2000).

The lakes changed the hydrology of much of the continent, the fresh water supply to the Arctic Ocean, and even to the Caspian and Black seas, possibly also the Mediterranean. A catastrophic tapping of the ice dammed lakes into the Arctic Ocean probably took place during the final stage of the Early Weichselian when the ice sheet retreated.

Table 1. Estimates of volumes and areas of Early Wechselian ice dammed lakes in Northern Russia and Western Siberia and additional water that would fill the Caspian and Aral seas respectively, if they were filled up to their overflow passes shown on the main map..

Ice dammed lakes and additional water in the Caspian and Aral Seas	Topographic level of watersurface (m)	Area (1000 km²)	Volume (1000 km³)	Average Depth (m)
Lake west of the Timan Ridge	100	218	15.1	69
Lake Komi between Timan Ridge and Urals	100	78.1	2.35	30
Lake between the Urals and the Central Sibirian Highland	70	760	21.4	28
Caspian Sea between 28 m b.s.l. and 26 m a.s.l. (area in brackets is the total area at 26 m a.s.l.)	-28 to 26	424 [830]	34.3	
Aral Sea between 40 m a.s.l. and 57 m a.s.l. (area in brackets is the total area at 57 m. a.s.l.)	40 to 57	[121]	1.48	
Lake Agassiz, Upper Campbell beach level formed 9.4 ^{14}C ka B.P. [Leverington et al., 2000]		263	22.7	86



3D-visualization of the Early Weichselian ice dammed lakes and the higher levels of the Caspian and Aral Seas as shown in the main 2D-map and Table 1. Shorelines of the Caspian and Aral Seas are plotted in black for comparison using the World Vector Shoreline Plus database. The visualization was made using the software Fledermaus from IVS (www.ivs.unb.ca).

References

Astakhov, V. I., Svendsen, J. I., Matiouchkov, A., Mangerud, J., Maslenikova, O., and Tveranger, J., Marginal formations of the last Kara and Barents ice sheets in northern European Russia. Boreas. v. 28, p. 23-45, 1999.

GLOBE Task Team and others (Hastings, D. A., Dunbar, P. K., Elphingstone, G. M., Bootz, M., Murakami, H., Maruyama, H., Masaharu, H., Holland, P., Payne, J., Bryant, N. A., Logan, T. L., Muller, J. P., Schreier, G., and MacDonald, J. S), eds.,The Global Land One-kilometer Base Elevation (GLOBE) Digital Elevation Model, Version1.0: National Oceanic and Atmospheric Administration, National Geophysical Data Center, CD-ROM, 1999.

Jakobsson, M., Cherkis, N., Woodward, J., Coakley, B., and Macnab, R., A new grid of Arctic bathymetry: A significant resource for scientists and mapmakers, EOS Trans. v. 81, p. 89, 93, 96., 2000.

Leverington, D., Mann, J., and Teller, J., Changes in bathymetry and volume of glacial Lake Agassiz between 11,000 and 9300 ^{14}C yr B.P. Quaternary Research, v. 54, p. 174-181, 2000.

Smith, W. H. F., and Sandwel, D. T., Global seafloor topography from satellite altimetry and ship depth soundings, Science, v. 277, p. 1957-1962, 1992.

Mangerud, J., Astakhov, V. I.,Murray, A., and Svendsen, J. I., The chronology of a large ice-dammed lake and the Barents-Kara Ice Sheet advances, Northern Russia, Global and Planetary Change, in press.