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Quantitative tree cover reconstructions for northern Eurasia: method verification and application to late-Quaternary pollen data

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Accurate reconstruction of late-Quaternary vegetation cover is necessary for better understanding of past vegetation dynamics, the role of vegetation feedbacks in glacial-interglacial climate variations, and for validating vegetation and climate models. In this paper over 1700 surface-pollen spectra from the former Soviet Union, Mongolia, northern China, and northern Japan together with data from the Advanced Very High Resolution Radiometer (AVHRR) were used to calibrate modern-analogue method for quantitatively reconstructing past woody cover from fossil pollen data. The AVHRR-based estimates of woody cover percentages within a 21 by 21 km window around pollen sampling sites were attributed to the respective modern pollen spectra. Reconstructions of modern woody cover using the pollen data and best-modern-analogues (BMA) method matched well to the original AVHRR-based estimates, for both total woody cover (r2=0.77) and its fractions, including broad-leaved (r2=0.66), needle-leaved (r2=0.79), deciduous (r2=0.60) and evergreen (r2=0.76) woody cover. Discrepancies in the pollen-AVHRR cross-validation may be caused by long-distance transport of arboreal pollen, patchy forest distributions, under-representation of Larix and Populus in pollen records, and errors in the AVHRR classification. The generally

strong correlations encourage application of the modern analogue approach for reconstructing late-Quaternary variations in vegetation cover from northern Asian fossil pollen records. At the last glacial maximum (LGM: ca. 21,000 cal yr BP), areas presently occupied by boreal forest were much more open, suggesting a reduction in total woody cover to below 20% at most modern forest sites. Pollen records from northern and central Siberia suggest a rather quick spread of tree and shrub vegetation after 15,000 cal yr BP, presumably in response to increased summer insolation. Woody cover histories are spatially variable in the modern forest-steppe, where tree growth is largely controlled by the ratio of annual actual over potential evapotranspiration which serves as an index of moisture availability. In northwestern Mongolia, woody cover percentages decreased between 9000 and 5000 cal yr BP and again between 2000 and 1000 cal yr BP and may be linked to shifts in intensity of the Pacific monsoon. In contrast, pollen data from the Kazakhstan forest-steppe (where atmospheric precipitation is associated with the Atlantic westerly flow) suggest that woody cover density reached modern levels only during the last millennium.

Reference: Tarasov, P., Williams, J.W., Andreev, A., Nakagawa, T., Bezrukova, E., Herzschuh, U., Igarashi, Y., Müller, M., Werner, K., Zhuo, Z. (2007) Satellite- and pollen-based quantitative woody cover reconstructions for northern Asia: verification and application to late-Quaternary pollen data. Earth and Planetary Science Letters 264, 284-298.