

## Spatial and temporal air pollution patterns inferred from $\delta^{15}\text{N}$ in tree-rings (*Larix sibirica*) in Ulaanbaatar, Mongolia

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Since the transition to a market economy in 1990 rapid urbanization and land expansion has led to high pollution levels in the capital of Mongolia, Ulaanbaatar. The emissions mainly originate from households using local brown coal for cooking and heating during the long-lasting winter season, the coal powered thermoelectric power plants and vehicle exhaust. Environmental monitoring has a short history in Ulaanbaatar, making it difficult to understand the development of pollution in the city, especially since the growth of the city has been disorganized, which has led to an uneven distribution of pollution within the city. Trees uptake  $\text{NO}_x$  via leaves and roots and 'archive' it in the tree tissue, such as tree-rings and leaves. Therefore, in this study  $\delta^{15}\text{N}$  in tree-rings of the last 40 years were used as a proxy of air pollution. Tree-ring, needle and soil stable isotope of nitrogen in larch trees growing in different representative locations (control, city center, industrial, residential, summer house and ger area) in Ulaanbaatar were used to estimate temporal and spatial change in pollution for the period 1978-2016. The results of tree-rings showed for the city center, ger and industrial area increasing  $\delta^{15}\text{N}$  ratios for the last 20 years, where the highest concentration was found in the same areas. This increasing trend is linked to increasing use of coal and number of cars. From the  $\delta^{15}\text{N}$  values and the conditions in the ger and residential areas, it could be inferred that the main source of pollution was coal and vehicle exhaust respectively, while the city center and industrial area showed a combination of pollution sources. Thus, tree-ring  $\delta^{15}\text{N}$  proved its high potential to be used as a proxy for the temporal as well as micro-spatial pollution characteristics within cities, especially in areas where no information about past pollution is available.

Keywords:  $\delta^{15}\text{N}$ , air pollution,  $\text{NO}_x$  emission, *Larix sibirica*, tree-ring