Geophysical Research Abstracts, Vol. 7, 00818, 2005
SRef-ID: 1607-7962/gra/EGU05-A-00818

Spatial patterns of the isotopic composition of soil and plant C and N in an urban ecosystem

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Urban ecosystems are characterized by a divers land use pattern, strongly influenced by anthropogenic activities. It is known that agriculture, traffic, construction activities, etc., affect the natural abundance of stable C and N isotopes. The aim of this study was to assess whether the spatial distribution of δ^{15}N and δ^{13}C signatures could be explained by patterns of urban land use. The study area (81.5 km^2) was the city of Ghent in Belgium and consisted of a historic city centre, residential areas, urban greens, agricultural areas, nature reserves, roads, highways, railways, waterways, industrial areas and a harbour. In the study area 200 sample locations were identified and the δ^{15}N and δ^{13}C signature of soil (0-5 cm) and grass samples has been measured. The spatial structure of the isotopic distribution has been investigated using simple kriging with land use as complete categorical secondary information.

The δ^{15}N$_{soil}$ and δ^{15}N$_{grass}$ data varied between –1.55‰ to 11.68‰ and –4.00 to 16.22‰, respectively. The δ^{13}C$_{soil}$ and δ^{13}C$_{grass}$ data varied between –30.76‰ to -12.02‰ and –33.78 to -19.93‰, respectively. Despite the overlapping standard deviations the average δ^{15}N$_{soil}$, δ^{15}N$_{grass}$, δ^{13}C$_{soil}$, δ^{13}C$_{grass}$ data showed a clear pattern for the following land use classes: grassland, arable land, historic centre and residential area, harbour and industrial area, and urban greens. The δ^{15}N$_{soil}$ values showed the highest continuity with land use. The agricultural areas showed the highest δ^{15}N$_{soil}$ data, which could be attributed to a more open N cycle and the loss of ^{15}N depleted N species or the use ^{15}N enriched of organic fertilizers. The wet grasslands of the nature reserves also showed higher δ^{15}N$_{soil}$ data, probably caused by enhanced denitrification losses. The urban greens showed the lowest δ^{15}N$_{soil}$ data, which could be explained by the absence of fertilizer input and the presence of N$_2$-fixing species (clover). The historic city centre and the residential areas showed average δ^{15}N$_{soil}$

data. The $\delta^{15}N_{grass}$ correspond very well to the $\delta^{15}N_{soil}$ data, but the $\delta^{15}N_{grass}$data were on average 1.3‰ depleted and showed a more random distribution. The $\delta^{13}C_{soil}$ data clearly indicated the introduction of maize (C4 plant) in agriculture, causing an increase of the $\delta^{13}C_{soil}$ values of the agricultural zone of the study area. The wet grasslands of the nature reserves showed the lowest C3-signals in $\delta^{13}C_{soil}$. The harbour area and the historic city centre and some isolated industrial sites showed the highest $\delta^{13}C_{soil}$ data. These high values can be explained through the introduction of carbonate-rich materials from e.g. constructions material, metallurgic activities and the use of carbonate rich soils for the construction of the harbour and the industrial areas. The $\delta^{13}C_{grass}$ values could be split up in more rural and urban areas. The urban areas gave enriched $\delta^{13}C_{grass}$ data, probably caused by increased growth stress of the grasses. In the neighbourhood of the most important roads the $\delta^{13}C_{grass}$ values were more depleted due to the exhaust of ^{13}C-depleted CO_2 from traffic.

It could be concluded that he stable isotopic composition of the topsoil and grass showed a moderate to strong relationship with land use of the studied urban ecosystem.