Scientific report ESF Molter Exchange Visit Dr. S. De Baets at BIOEMCO (Grigon, Paris)

1. Purpose of the visit

The purpose of this collaboration and visit was to determine the differences in lignin content in SOC along a land use and topographical gradient in order to get an insight into the stability of this sub-reservoir and into the large-scale ecological dynamics resulting from soil and vegetation degradation in semi-arid environments.
It was hypothesized that when differences in total C stocks due to soil degradation are not well pronounced because of the low SOC amounts, this effect might be seen faster/easier in the decomposition of some chemical compounds such as lignin.

2. Description of work

After collecting field samples in SE Spain (Sierra de Los Filabres) on abandoned fields, 9 field locations, differing in topography and land use, were selected for lignin analysis. Three depositions locations, three positions on the hillslope and three eroded zones on top of the hillslope were selected on croplands and fields that were abandoned since 10 and 50 years respectively. For each location topsoil (0-10 cm) and deeper soil (10-20 and 20-30 if soil deph > 20 cm), as well and root and litter samples were analyzed. In total, for 12 series of 9 samples, lignin phenols were extracted.
This was done using the CuO oxidation method (developed by Hedges and Ertel (1982) and modified by Kögel and Bochter (1985) in Bahri et al., 2008). Briefly, the CuO oxidation of dried and ground samples was performed under alkaline conditions at high temperature. The CuO oxidation products were purified and extracted using a C18 reversed phase column. They were subsequently quantified as trimethylsilyl derivatives by gas chromatography (GC) with a HP gas chromatograph (HP GC 6890). Derivatizing lignin phenols lasts 2 days for 9 samples.
CuO oxidation yields a suite of phenolic oxidation products (vanillyl-, syringyl-, and p-coumaryl-units). The lignin component in the sample is represented by the sum of those units (V + S + C), hereafter noted as VSC lignin. The concentration of V-type phenols was calculated as the sum of the concentrations of vanillin, acetovanillone and vanillic acid. The concentration of S-type phenols was the sum of syringaldehyde, acetosyringone and syringic acid. C-type phenols were estimated as the sum of ferulic and p-coumaric acids (Bahri et al., 2008). Additionally, Ad-to-Al (Acid-to-Aldehyde) of V and S units and C- and S-to-V ratios were calculated. Whereas the VSC sum is generally considered as a quantitative measure of soil lignin, the Ad-to-Al ratios are good indicators for the state of lignin in soils. With increasing decomposition VSC is decreasing, whereas the ratios are increasing. C- and S-to-V ratios are used as source indicators (Thevenot et al., 2010). According to Tareq et al. (2004) a lignin phenol vegetation index (LPVI) was calculated as well to investigate whether soil lignin comes from the current type of vegetation (non-woody) or is a remnant from a previous (woody) vegetation.

3. <u>Main results obtained</u>

More lignin is found in soil from abandoned fields (Fig.1). Lignin input from litter is highest for 50y abandoned fields. Whereas litter lignin input is not remarkably lower for croplands as compared to fields abandoned for 10 years, soil lignin degrades faster under cropland. This may be related to the higher root lignin input on 10 year abandoned fields, as root lignin is known to be more stable than litter lignin. For fields that were abandoned since 50 years, total lignin content (VSC sum) is highest for the deposition location and decreases along the hillslope to the lowest values for the most eroded zones on top of the hillslope. For cropland, there are hardly any differences in lignin content according to topographical position (Fig.1). For fields that were abandoned since 10 years, the deposition position has the highest lignin content, whereas the slope position reports the lowest sum of lignin products (Fig.1). Differences in soil lignin are most remarkable for the topsoil (0-10 cm). For deeper soil differences are less pronounced, but follow the same trend and was reported for the topsoil (Fig.2). However, no differences were evident when we look at lignin contribution to SOC (total mg lignin phenols/g SOC). For deposition positions lignin is more degraded in cropland, followed by 10y and 50y abandoned fields respectively (seen in the Ac/Al: Fig.3 and C/V ratios: Fig.4). For hillslope positions this tendency can be observed as well in the Ac/Al_S ratio (Fig.3).
The LPVI index doesn't differ much, but values are in the range of 'angiosperms from non-woody vegetation', so lignin doesn't come from woody input of previous forest cover, but from current shrubs and crops.

4. <u>Future collaboration with host institute</u>

Contact with the host institute will be maintained for further discussing the obtained results. This prospective study resulted in some interesting insights and confirmed our hypothesis that differences in soil lignin response can be detected along a land use and topographical gradient. As the current study shows some trends, some replicates will be analyzed in future to study whether the observed differences are significant or not.

5. <u>Projected publications resulting from the grant</u>

It is aimed to prepare a manuscript for publication in the next months, based on the above mentioned preliminary results and more detailed analysis:

De Baets, S., Baumann, K., Hamer, U., Van Oost, K., Dignac, M.F., Rumpel, C. Lignin characterization in response to land abandonment and erosion in luvisol of SE Spain, Geoderma, in preparation.

It is planned as well to present the data at the international SOM conference in 2011 in Leuven.

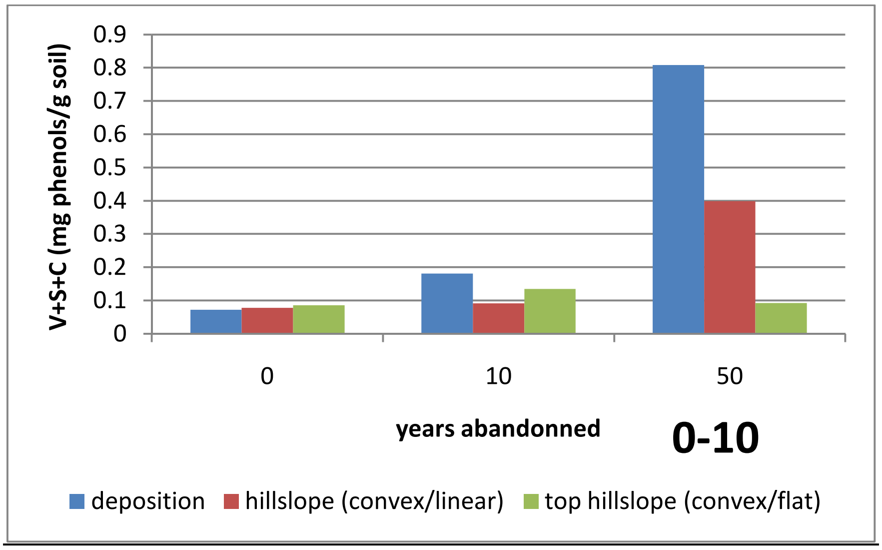

Figure 1: Sum of all lignin phenols (mg) per gram soil for the topsoil (0-10 cm) layer

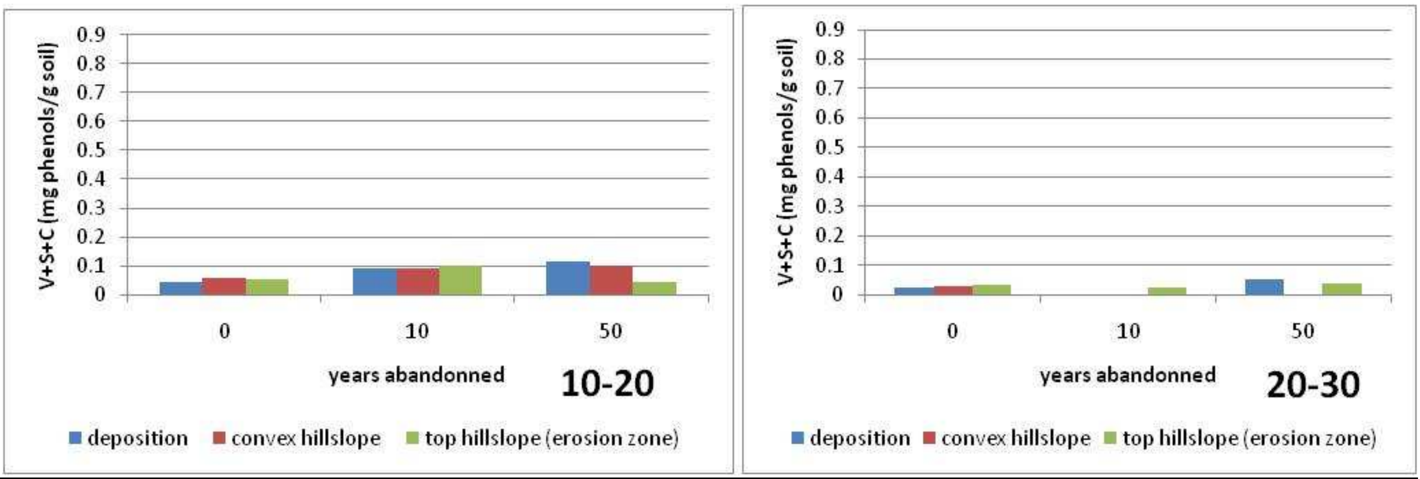

Figure 2: Sum of all lignin phenols (mg) per gram soil (10-20 and 20-30 layers)

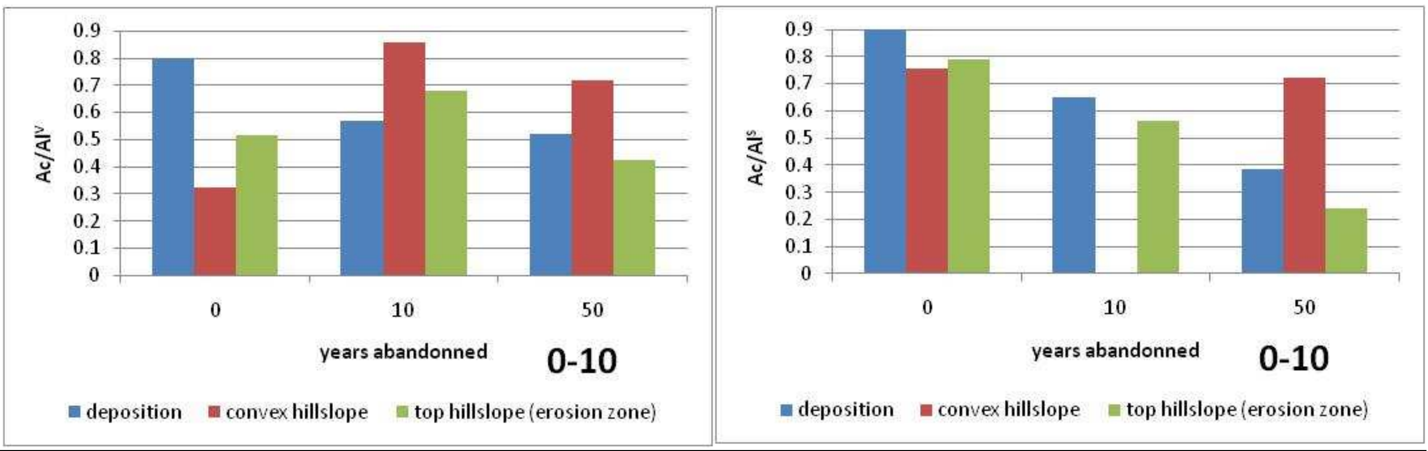

Figure 3: Acid to aldehyde ratios for V and S lignin phenols respectively for topsoils (0-10 cm).

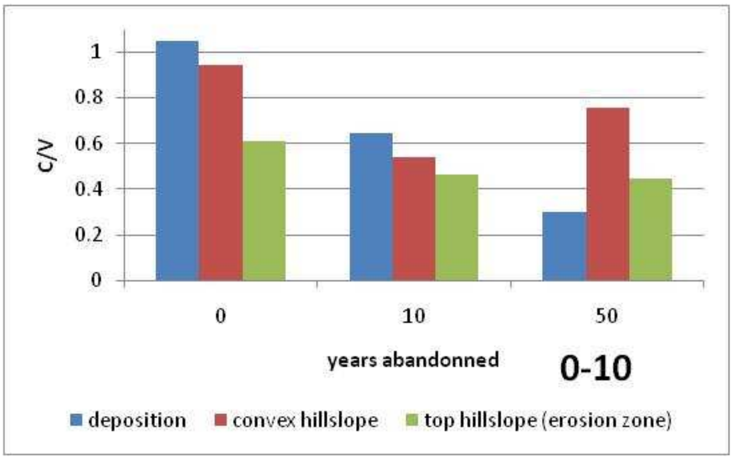

Figure 4: C phenols to V phenols ratio for topsoils (0-10 cm)

References

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Tareq, S.M., Tanaka, N., Ohta, K. 2004. Biomarker signature in tropical wetland: lignin phenol vegetation index (LPVI) and its implications for reconstructing the paleoenvironement. Science of the Total Environment, 324: 91-103.

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