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RELATIONS BETWEEN THE DECOMPOSITION OF PEAT AND SOC IN FENS OF NORTHEASTERN GERMANY

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SUMMARY

Organic soils play a significant role in the climate system. In this study fen soils from Northeastern Germany were investigated concerning aspects of the soil carbon balance. Due to clarity reasons this paper is separated into two parts.

(A) Relations between the decomposition of radicell peat (von-Post-method) and contents of soil organic matter (SOM) and soil organic carbon (SOC) were identified and quantified. High negative correlations between the degree of decomposition and SOM and SOC contents were proved.

(B) Conversion factors from SOC to SOM were investigated referring to different levels of SOM and SOC contents. The calculated values ranged between 1.7 and 2.1.

KEY WORDS: SOM, SOC, degree of decomposition, conversion factor, radicell peat

INTRODUCTION (A)

The assessment of “degrees of decomposition” of peat by von Post (1922) is an approved and commonly used field method. It is established in Europe and some regions of Canada. The results of the von-Post-method were not less accurate than laboratory methods for that purpose (Stanek and Silc, 1977; Malterer et al., 1992). Some studies analyzed relations between the degrees of decomposition (scale H 1 – H 10) and some physical soil properties of peat materials (fiber content; bulk density; hydraulic conductivity) from different regions. A comprehensive review is given by Verry et al. (2011). The decrease of SOM content at a rising degree of decomposition was described by a case study on agricultural peat soils in England (Kechavarzi et al., 2010) but the relation was not quantified. The objective of this study was to investigate the relations between the degrees of decomposition and contents of SOM and SOC using adapted datasets of radicell peat (composed of roots and rhizomes of sedges and other vascular plants) from Northeastern Germany. Advancing losses of SOM and SOC as CO_2–emissions caused by microbial respiration in line with the peat decomposition process (Kamal and Varmer, 2008) were supposed. That assumption would comprise a relative accumulation of mineral peat compounds.

METHODS (A)

Soil mapping and soil sampling were done in 1965 and 2010 in a typical fen region near by the Lake Müritz / Mecklenburg-Vorpommern in Northeastern Germany. All peat samples were dried and powdered for laboratory analyses. The SOM content was detected by the loss-on-ignition method (550°C; dataset 1965; Fig. 1); the SOC content was measured with the "vario max C" element analyser (Elementar GmbH, Hanau; dataset 2010; Fig. 2). Statistical methods used were the correlation analysis and the linear regression model (PASW Statistics 18). To minimize the disturbing factors of allochthonous mineral input and site-dependent high contents of calcium carbonate the datasets had previously been prepared to eliminate unusable values by definition of a cutoff for the SOM content. The limit value of 80% SOM content was derived from the biochemical constitution of pedogenetic less modified radicell peat (Tab. 1). That reflects the origin constitution of undisturbed pure radicell peat.

Tab. 1: SOM content of sedge peat and fen peat (Central Europe) according to different authors to define a cutoff limit value of undisturbed pure radicell peat. Peats below the top soil (subsurface) are less influenced by anthropogenic material input caused by wind and water erosion.

Author (year) / region	**Peat type**	**Degree of decomposition (von Post)**	**Important peat or soil properties**	**SOM content [%]**
Härtel and Schmidt (1965/66) / Germany	sedge peat	for the most part H 4 – H 5	subsurface / less top soil	86.5 (s = 5.04)
Sillanpää (1972) / Finland	*Carex* peat	-	subsurface	94.5
Grosse-Brauckmann (1990) / Germany	fen peat	-	without allochthonous material input	85 – 95
Schäfer (2002) / Germany	fen peat	for the most part H 5 – H 7	subsurface	80 – 95
All authors				**80 - 95**

RESULTS (A)

Between SOM content and the degree of decomposition a high negative correlation was identified (Fig. 1); the same relation was found between the SOC contents and the degree of decomposition (Fig. 2). Both contents of SOM and SOC decreased at 1.25% [CI (95%) = -0.97; -1.54] and at 0.66% [CI (95%) = -0.42; -0.9] per von Post scale unit. SOM and SOC contents declined on the von Post scale from H 1 to H 10 about 92% to 80% (77-82%) and 54 to 48% (45-50%) respectively.

CONCLUSION AND DISCUSSION (A)

The hypothesis of increasing SOM and SOC losses at rising degrees of decomposition could be verified.

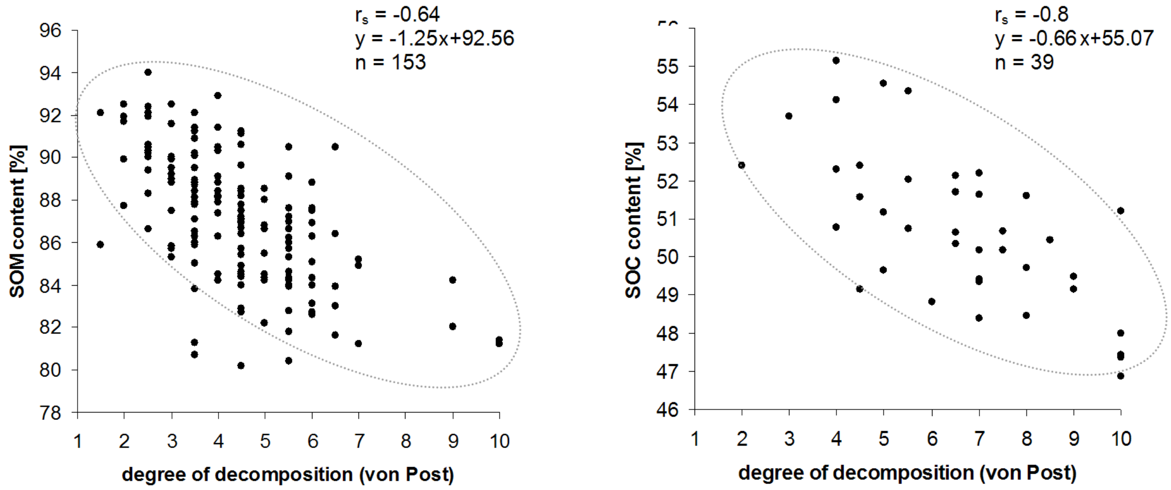


Fig. 1 / **Fig. 2:** Relation between SOM (1964, left) and SOC (2010, right) of radicell peats and the degree of decomposition according to von Post including intermediate levels such as H 5-6. The limit value of 80% SOM content was previously defined, that of the SOC content (46.2%) was calculated by the regression equation in Fig. 3 (x=80).

Due to the differences of the peats´ biochemical composition, which is the result of variant peat forming species (Rydin and Jeglum, 2006), the dispersion of values was comparatively high.

However, it is possible to describe and quantify the relation between SOM and SOC contents and the degree of decomposition (von Post), if the following conditions are met. The analyses should be done for each peat type and each mire region separately to minimize the differences in the primary biochemical composition of each peat type. Because of potential inputs of allochthonous mineral material and high contents of calcium carbonate, the datasets should be prepared by defining a limit value for the SOM content and to eliminate disturbing values. Advancing SOC losses due to mineralisation of amorphous peat (von Post level H 10) cannot be described by the degree of decomposition. Referring to the climate impact of fen soil degradation by CO_2–emissions, the H 10 von Post level is the most important one. Less and medium decomposed peats (H 1 – H 6) are considered to be a minimum source of greenhouse gases. They probably lost no more than 4% of their origin SOC contents. However, pathways of SOC losses were not identified and may be in parts DOC output of unknown height.

INTRODUCTION (B)

Since 1829 many research groups worldwide have estimated reciprocal conversion factors of SOC and SOM using different approaches and laboratory methods (Pribyl, 2010). The results were not consistent and the mean variations were very high in many cases. Thus, the factor of 1.724 published by Sprengel (1829), known as the „van Bemmelen factor", was used and never changed. The trend of all investigations with emphasis on mineral soils was up to the factor 2.0. Research studies on peatland soils or peat materials had a low number. Different authors considered the factor 1.724 as being too low for calculation of peats´ SOM. (Schmidt, 1988; Paepke, 1992). The values of Schmidt (1988) and Paepke (1992) were up to 1.98 (range: 1.79 - 2.18) and 1.93 (range: 1.92 – 1.94). Robinson et al. (1929) identified a factor of 1.88 (range: 1.86 - 1.95) and the factor determined by Succow and Joosten (2001) was up to

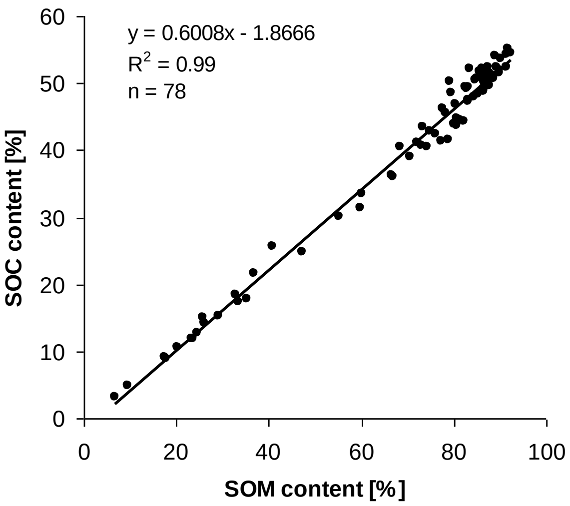
1.73 for peat that were characterized by a high SOM content of 70-90%. The objective of this study was to identify conversion factors for different levels of SOM which represents different states of peat decomposition. Thus, a dataset of radicell peat (≥30% SOM), half fen (≥15 -<30% SOM) and humic substrates (<15% SOM) from Northeastern Germany was evaluated. Expected results were different conversion factors for different levels of SOM and SOC contents. For peat substrates of a higher SOM contents a conversion factor of 1.73 and for substrates of lower SOM contents conversion factors near 1.9 to 2.0 were supposed.

METHODS (B)

The soil mapping and soil sampling were done in 2010 in a typical fen region near Lake Müritz / Mecklenburg-Vorpommern in Northeastern Germany. All peat samples were dried and powdered for laboratory analyses. The SOM content was detected by the loss-on-ignition method (550°C) and the SOC was measured with the "vario max C" element analyser (Elementar GmbH, Hanau). Statistical analysis used was the linear regression model (PASW Statistics 18). The conversion factor was calculated by division of x and y using the regression equation (Fig. 3).

RESULTS (B)

A high correlation is found between contents of SOM and SOC (R^2=0.99) of radicell peat from Northeastern Germany (Fig. 3). The calculated conversion factors have a range from 1,722 to 2,065 between the highest measured value of SOM content (92.2%) and the recommended limit value (15%) for using the regression. Below the limit value of 15% the regression does not reflect the measured values because of a rising influence of the regression constant. The mean value was 1,771 (1.58-2.06; s=0.103; n=78).



SOM content [%]	SOC content [%]	Conversion factor SOM/SOC
x	y	x/y
15	7.145	2.065
20	10.149	1.970
30	16.157	1.856
45	25.169	1.788
60	34.181	1.755
75	43.193	1.736
90	52.205	1.724

Fig. 3: Linear regression of SOM and SOC content for radicell peat, half fen and humic substrates from Northeastern Germany.

Tab. 2: Exemplary conversion factors SOM/SOC calculated by the use of the regression equation in Fig. 3 for radicell peat, half fen and humic substrates from Northeastern Germany. The shaded lines are limit values for the SOM content of histic horizons according to WRB (2007).

CONCLUSION AND DISCUSSION (B)

The results of this study are close to the data given by former publications. Further, it is possible to derive more accurate estimations of conversion factors for fen soils relating to the level of SOM and SOC contents (Tab. 2). The information of Succow and Joosten (2001) to the conversion factor SOM/SOC for peat substrates with higher SOM contents (70-90%) of 1.73 can be approved (80% SOM = 1.731). The substrates with lower SOM contents range near by the assumption of 1.9-2.0 but the calculated level is a little lower, for example 30% SOM = 1.856 or 20% SOM = 1.97 (Tab. 2). The relative low level of the average conversion factor (1.77) depends on the relative high level of the mean SOM content of 69.6%. Beside the logical tight relation between SOM and SOC content, the very high linear relationship (R^2=0.99) is caused by the suitability of methods and an accurate laboratory work.
The IUSS Working Group WRB (2007) defined the cut off of histic horizons to different horizons by limit values of 18% SOC (30% SOM) and 12% SOC (20% SOM) respectively. That conversion factor of 1.666 used by IUSS Working Group WRB (2007) is not in agreement with the studies´ results of 1.856 (30% SOM) and 1.97 (20% SOM). The resulting differences for 20% und 30% SOM are shown in table 2. Concerning the great role of peat soils in the climate system advancing research in carbon stocks and carbon balances of organic soils is needed. Particularly the knowledge about differences in substrate properties is an important field of investigation.

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