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A comparison of indexing methods to evaluate quality of soils subjected to different erosion: the role of soil microbiological properties.

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Soil quality assessment is needed to evaluate the soil conditions and sustainability of soil and crop management properties, and thus requires a systematic approach to select and interpret soil properties to be used as indicators. The aim of this work was to evaluate and compare different indexing methods to assess quality of an undisturbed grassland soil (UN), a degraded pasture soil (GL) and a no tilled soil (NT) with four different A horizon depths (25, 23, 19 and 14 cm) reflecting a diverse erosion. Twenty four soil properties were measured from 0 to10 (1) and 10 to 20 cm. (2) and a minimum data set was chosen by multivariate principal component analysis (PCA) considering all measured soil properties together (A), or according to their classification in physical, chemical or microbiological (B) properties. The measured soil properties involved either inexpensive or not laborious standard protocols, to be used in routine laboratory analysis (simple soil quality index – SSQI), or a more laborious, time consuming and expensive protocols to determine microbial diversity and microbial functionality by methyl ester fatty acids (PLFA) and catabolic response profiles (CRP), respectively (complex soil quality index - CSQI). The selected properties were linearly normalized and integrated by the weight additive method to calculate SSQI A, SSQI B, CSQI A and CSQI B indices. Two microbiological soil quality indices (MSQI) were also calculated: the MSQI 1 only considered microbiological properties according to the procedure used for calculating SQI; the MSQI 2 was calculated by considering microbial carbon biomass (MCB), microbial activity (Resp) and functional diversity determined by CPR (E). The soil quality indices were SSQI A = MCB 1 + Particulate Organic Carbon (POC)1 + Mean Weight Diameter (MWD)1; SSQI B = Saturated hydraulic conductivity (K) 1 + Total Organic Carbon (TOC) 1 + MCB 1; CSQI A = MCB 1 + POC 1 + MWD 1; CSQI B = K 1+ TOC 1+ 0.3 * (MCB 1+ i/a +POC 1) + 0,05 * (E + cy/pre), where i/a and cy/pre are the iso/anteiso and cyclopropyl/precursors ratios determined by PLFA; MSQI 1 (0,3 * (MCB 1+ i/a 1 +POC 1) + 0,05 * (E 1+ cy/pre 1)) and MSQI 2 (MCB 1+Resp 1+ E 1). All the calculated indices differentiated references plots (UN and GL), from those under no tillage (NT) system. Values were similar in NT plots with low erosion levels (NT 25 and 23) but higher than values of plots with high erosion (NT 19 and 14). Soil quality indices constructed by procedure B, (SSQI B and CSQI B) differentiated among the studied plots with the same or higher sensitivity than the other indices and allowed evaluating the impact of soil management practices and erosion on soil physical, chemical and microbiological properties. The lack of indicators representing all soil properties (physical, chemical and biological) in SQI constructed by procedure A could decrease the index sensitivity to changes in management; and the same may happen when physical, chemical and biological properties present different weights into the calculated SQI. The inclusion of CRP and PLFA data in the indices slightly increased or did not increase the index sensitivity (CSQI A and CSQI B). Generally microbiological indices (MSQI 1 and MSQI 2) were highly sensitive to soil erosion. However, we suggest that indices integrating physical, chemical and microbiological properties may give a more complete view of the soil quality than indices only based on measurement of a few microbiological properties.