MONITORING SOIL QUALITY

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Abstract

As far as soil quality is concerned, because of the features on which depends the state of health of the living beings, literature often equals soil quality and soil health. The confusion is due also to the different meanings of the word "quality": degree of suitability, global value (e.g., excellent quality lands), or an attribute referring to a certain feature (e.g., land or soil with a very good water holding capacity, land with good or moderate fertility, etc.). The confusion is also enhanced by the parallel circulation of the term "quality" as in "land quality" as a criterion of assessment of the land based on a complex of features (attributes) that confers it a certain behaviour, among which, obviously, soil features (which allows the classification of soils into quality classes): van Diepen et al. (1991, in van Ranst, 1996) considers that the term in not properly defined and Sys (1993) makes a similar commentary redefining it by adding that soil assessment should be done for a certain type of use.

Key words: sustainable development, project, management

INTRODUCTION

The crucial importance of soil resides in the fact that, used properly, it contributes to ensuring food safety: it is the main factor on which depend the quantity and quality of the products necessary to all living beings (including humans). To this, we should add the essential role soil plays in accomplishing certain functions and services necessary to live.

The term "soil quality", introduced relatively recently and increasingly used, it is much debated in literature because, due to its many connotations, it confuses quite often (Rositer, 1996; Ranst, 1996; Bouma, 1996). It seems that this term is used in analogy with such terms as "water quality", "air quality", "life quality": the notion of quality involves an ensemble of features that define subjective-objective relationships considered anthropocentric, regarding the state of meeting (fulfilling) or the degree in which it meets specific demands (being good or bad).

MATERIAL AND METHOD

Soil Quality Assessment Methods

There is no global assessment methodology for soil quality valid under any condition and for all uses; it cannot be developed since soil quality is estimated depending on the soil use or functions that are extremely varied. Soil quality assessment is also done for each soil use or soil function apart starting either directly from the soil features (soil science indices) or soil functions which, in their turn, are estimated through soil science indices, as well.

As a principle, the methodology (Metodologia elaborarii studiilor pedologice, ICPA, 1987, Florea, 2003) consists in:

- choosing the best indices regarding the features showing a close correlation with the function or use of the soil considered and that reflects it the best, followed by the classification of the values of the indices into size classes;
- establishing the measure in which the values of the indices (or size classes) are favourable or not for the function or use to be assessed meet the requirements, thus producing the quality level of the feature for the function or use considered;
- attributing a quality index (numerical) taking into account the measure in which different indices have been or not favourable (their quality level under the circumstances).

Practical application varies very much in the establishment of assessment criteria (indices) starting from simple observations in the field and quick measurements in the field made by a specialist (such as shown in the card attached) to detailed soil studies containing morpho-genetic, physical, chemical, biochemical, biological data on the environment or site, completed with varied laboratory analyses (as those in the Metodologia elaborarii studiilor pedologice, ICPA, 1987).

For a global assessment of soil quality, they had the idea of calculating a quality number-index as simple or ponderated mean of the numerical indices corresponding to the five main soil features.

In the same order of ideas, one can imagine the establishment of global soil quality classes and subclasses by defining the class (I, II, III, IV, V) depending on the best function or functions and the subclasses (a, b, c, d, e) depending on the nature of 1-2 best ranked functions by noting their class with figures (1, 2, 3, 4, 5) as, for instance, in the symbol IIb, 3c, 4a meaning 2nd quality soil for the function b, 3rd class for the function c, and 4th class for the function.

RESULTS AND DISSCUSIONS

Soil Quality Indices. Soil quality is determined by a series of physical, chemical and biological processes and by the intensity of their development (e.g., alteration, levigation, humification, substance exchange, erosion, etc.). Because it is impossible to measure these processes, they use a series of soil features that are significant to these processes. The features measured (or assessed from a demi-qualitative perspective) are a set of indices on which relies the assessment of the quality. Most indices are physical, chemical, and biological. The most use is (according to Brady and Weil, 2000):

Physical indices:

- texture and structure, which influence water and substance retention and transport;
- soil depth and rooting, which influence fertility potential, soil erosion, relief stability;
- infiltration and apparent density, which influence erosion potential, porosity and productivity;
- water holding capacity, which is correlated with water retention and transport, with hydric erodability, with workability and traffickability, etc.

Chemical indices:

- total content of organic matter, which defines the storage of C, potential fertility and structural stability;
- content of active organic matter, which defines structural stability and food for microorganisms;
- pH, which defines the thresholds (steps) of chemical and biological activity;
- electric conductivity, which defines the thresholds of microbial and plant activity;
- extractable N, P, K, which define nutrient availability for the plants and N loss potential, and that are indices of fertility and environment quality.

Biological indices:

- C and N of microbial mass, which reflect the microbial catalytic potential and early warning on the effect of management practice on organic matter;
- potential mineralisable N, which reflects the N supply potential and soil fertility (productivity);
- specific respiration, which reflect microbiological activity per unit of microbial biomass;
- number of macro organisms, which reflect the activity of organisms in the soil particularly earth worms.

Of course, other indices can also be used.

From a practical point of view, it is useful to systematise soil science indices depending on the degree of influence and on how they change depending on soil management practice. From this point of view, we can distinguish between three categories of indices (Brady and Weil, 2000) that reflect different categories of features, as follows:

- relatively stable features, that do not change through management practice or that change a little: soil texture, soil skeletal feature, soil inorganic layer mineralogy, soil thickness, soil restrictive horizons, and land slope;
- labile features, features that can alter quickly, from one day to another, as a result of meteorological conditions or of current management practices: soil water content, soil apparent density, N, P, Z soil content, soil pH, soil salinity, soil air composition, etc.;
- intermediary features that can change under the influence of management practices (medium- or long-term): soil organic matter content, soil content of active organic C, soil microbial biomass, soil structure, soil specific respiration, etc.

Of all these features (and, indirectly, indices), literature has paid special attention to the last ones because, once deteriorated, their recovery is difficult and it asks much time; good management practices can increase their level which, once reached, tends to maintain for longer periods of time.

Assessing soil quality is based on the examination of indices referring to stable or intermediary features that determine soil functional capacity for a certain purpose. The nature and number of indices depend on the assessment scale (field, farm, landscape, region) and, also, on the goal of the assessment (function or service of different soil uses).

The indices chosen for the assessment should be sensitive to alterations of the features, safe, reflect the situation properly, be easy to get or determine, and able to detect even the slightest changes in the processes, features and interrelations in the soil; they need to be measured quantitatively or, at least, assessed demi-quantitatively. In some cases, we can get them through soil transfer functions (mathematical relationships between two or more soil features that show high level statistic confidence).

Restrictions (Limitations) and Degradations

In assessing soil quality, we frequently use the term limitation or restriction (or even limitative or restrictive factor) that should not be equalled with soil degradation or deterioration state.

Limitation (or restriction) refers to a native soil (land) feature that limits its use for a certain purpose or certain crop. For instance, a serious slope, the strong skeletal feature of the soil, intense salinisation, very low soil thermal regime, etc. are conditions or factors that exclude the use of soil as arable land. Other features such as high acidity, texture, thermal regime, etc. limit the range of crops that can be practiced successfully.

In the case of the lands with limiting factors, we need to adapt the use of the land and the crop by taking into account, if the case, the nature of the limiting factor or factors and the intensity of their manifestation if we cannot change them. From this point of view, restrictive (limiting) factors can be absolute or non-correctible (e.g., low temperature, serious slope, rocky soil, etc.) and limiting factors that can be corrected, modified or improved through different treatments or works (soil acidity, soil salinisation, soil water excess, etc.).

Soil degradation, unlike limiting (restricting) is induced by man who uses soil improperly, generating deterioration or even destruction. Sometimes, such restrictions as native salinisation or swamping are taken for degradation; we should not take an unproductive or a low productive land for degraded (anthropic) land that has diminished its productive potential.

There are also cases when the decrease of the productive potential of a land has natural causes of recent nature such as the lands affected by land glides, clogging through flooding with infertile sediments, lands covered by lava o volcanic ashes, etc.

Soil Quality Monitoring. Soil quality monitoring is the operation of monitoring the trends in the alteration of the soil functional capacity or in the soil quantitative indices aiming at assessing the result of a management practice and, if the case, at making the best decisions for the correction or completion of the management practices. Soil quality monitoring is done through a systematic quantitative data collection referring some indices, their analysis and interpretation. The operation is repeated in time in the same locations after a certain time (biannually, annually, etc.), as a rule, in the same season. Optimum time and sites (locations) and indices to be monitored depend on the goal of the monitoring:

- inventory data of the soil resource quality to justify decisions regarding soil use and valorisation;
- data on the influence of management practice on soil quality in different locations (sites) to establish the best valorisation (including the improvement of management practice);
- information that detect a negative evolution of soil quality (with the accompanying early warning allowing timely measures);
- identifying areas with degradation risks and the nature of these risks allowing making the proper decisions.

As for the indices, besides relatively stable ones, they pay particular attention to intermediary indices that change depending on the type of management practice. In interpreting the values obtained, they are compared with reference data that can be initial values or the values of a soil used and managed in similar conditions.

As a rule, the density of monitoring locations is increased in areas with degradation risk and in degraded areas with considerable recovery or restoration potential.

In general, the idea of soil quality varies in different people depending on their concerns:

- for agriculturists, it is a productive land easy to exploit, highly profitable and that maintains its fertility;
- for naturalists, it is a soil harmoniously integrated in the geographical landscape;
- for those who are concerned with soil, it is a soil that accomplishes its functions in the ecosystem or geosystem at the level of its potential or that maintains soil biodiversity, soil water quality, soil air quality, soil nutrient cycle, soil quantity of biomass, and soil quality of biomass, etc.

Assessing Soil Quality

Establishing soil quality or assessing soil quality from the perspective of the definition given above is an issue that still waits to be solved though its evolution in time is very important in the establishment of the effect of management practices in soil. They are carrying out studies for the development of proper methodologies. At the same time, they are developing a new integrating concept of soil quality through scientific debates with a double goal: on the one hand, to publicly extend and acknowledge its importance in the harmonious and healthy functioning of the ecosystems and, on the other hand, to consider and use it as an effective tool in the choice of the best agricultural practices or of the best measures or technical improvement soil works or land management practices depending on the land use.

We need to mention that this global feature of the soil, quality, cannot be measured directly (like soil fertility); it can be indirectly assessed through a series of quality and quantity indices taking into account that they reflect the composition and making up of the soil, varied physical, chemical and biological features and processes that interact within a dynamic living body or system.

Establishing or assessing soil quality can be considered a global feature of soil closely related to the first meaning of quality, i.e. "the totality of essential features and aspects depending on which a thing is what it is and it differentiates from other things" (DEX, 1998), no matter how good or bad they are. They have suggested calling this global feature <u>absolute soil quality</u> in order to differentiate it from <u>relative soil quality</u> which, by definition, corresponds to the second meaning of quality, i.e. be good or bad at different degrees. Specific absolute soil quality corresponds, therefore, to the totality of soil features considered objectively and not anthropocentrically, defined through sizes and indices in themselves without assessing how good or bad they are. In everything that follows, the term soil quality is used to designate relative soil quality.

The complex character of soil assessment derives from the concept itself because, by definition, it refers to both natural and anthropic ecosystems. As such, we need to make a difference between native (natural) soil quality developed under the influence of environmental factors and the processes generated by them, practically with no influence from the humans (inherent soil quality) and anthropically modified soil quality (dynamic soil quality) referring to soil quality as resulted from the soil features modified by the different land uses in agricultural practice, land improvement, etc.

Assessing soil quality supposes the existence of a reference term with which to compare soil functional capacity (reference soil condition). As a rule, the comparison is with a widely spread soil that is representative for a territory and has a special significance from an agricultural, forestry, engineering, etc. point of view (benchmark soil); we can also compare it with the initial soil features (baseline) as in soil science monitoring or with the features of a similar soil with native vegetation (not disturbed) or with similar management practices.

Assessing soil quality (or one of its features) needs also to have a precise goal or soil functioning conditions because that soil feature can be good for a certain use, plant or management practice, bad for other use, plant or management practice, or indifferent in other situations. Assessing quality is done, therefore, depending on the concrete soil use situations. It is, sometimes, necessary to mention the conditions in which the soil is – mainly topographic ones (on the upper or lower side of a slope, slope degree and exposition, floodable character and frequency of flooding, etc.) in order to have a proper assessment.

We need to also note the subjective character of the assessment of different features of the soil because of their interpretation if we take into account how useful they are to man (anthropocentric character).

CONCLUSIONS

Soil is one of the most complex systems on the Earth and has a fundamental importance in life support. Soil or, to be more specific, soil layer, is a very important natural resource of the planet, a means of production in agriculture and forestry, an object of man’s activity and the main source of agro-alimentary produce, which makes it an irreplaceable asset of nature and society. Soil makes up a huge system at planet level, a subsystem of continental geosystems and terrestrial ecosystems which, together with the planetary ocean system, influence the entire biosphere and atmosphere and is influenced, in its turn, by them. It participates actively in all the cycles of substances and energy in nature and it contributes to the regulation of the composition of the atmospheric air and of water on the surface of the Earth. It consists in numerous ecosystems and geographical landscapes closely connected in the space and coherently linked to the lithosphere, biosphere (higher vegetation, animals, microorganisms), atmosphere, climate conditions, and topography for which it is an interface, intermediating substance and energy exchanges as well as the varied geochemical and biochemical processes on the surface of the Earth.

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