Deliverable D2 action B4: Soil quality indices

Introduction: soil quality definition

During the last decades, the Scientific Community is increasingly drawing the attention on soil. Soil is not yet considered simply a sort of substrate for fiber and food production, but a fundamental component of the biosphere involved in the maintenance of environmental quality at local, regional and global scale. In this context, the necessity of defining criteria for (i) determining the health of soils and (ii) developing indexes for soil quality comparisons in time and space is becoming one of the main topics of soil research. In order to reach these objectives, it necessary to develop a flexible procedure for indexing able to be easily modified according to the different soil types (Andrews et al., 2002). Moreover, it should be able to classify the different categories of dynamic quality, evaluate their evolution in time and finally use results to quantify long term effects of different soil use (Andrews et al., 2002).

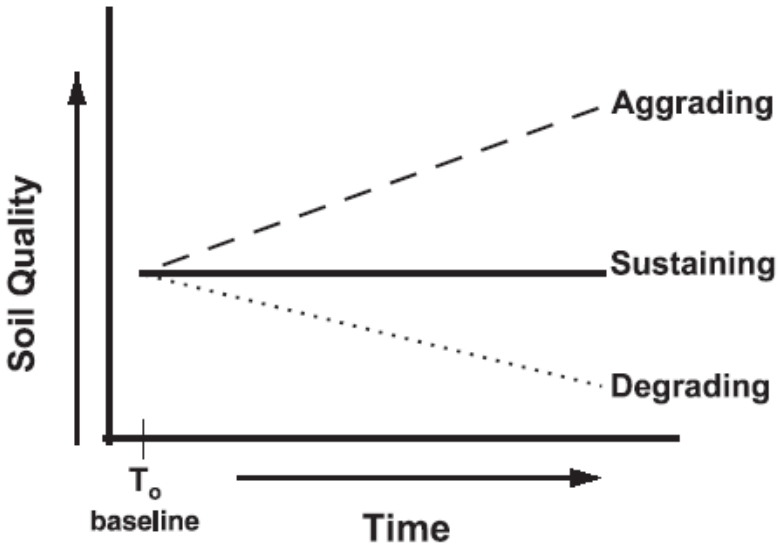
Soil quality can be defined in terms of agricultural productivity, environmental quality or land use applications, further definitions include "fitness for use" and "the capacity of a soil to function". Combining these, soil quality is the ability of a soil to perform the functions necessary for its intended use.

Soil functions include:

- Sustaining biological diversity, activity, and productivity
- Regulating water and solute flow
- Filtering, buffering, degrading organic and inorganic materials
- Storing and cycling nutrients and carbon
- Providing physical stability and support

Since the soil functions are very difficult to be measured, the soil quality approach consider soil parameters as indicators of the function analysed.
In particular, dynamic soil properties, that are soil characteristics susceptible of significant changes in a single year or growing season, are considered.
In order to assess the soil dynamic properties, biological, physical and chemical soil parameters are considered as indicator and measured.
An indicator to be effective in the evaluation of soil quality, must meet the following requirements (Doran and Parkin, 1996; Doran and Zeiss, 2000):

1. Sensitivity to changes in soil management. "An indicator should be sensitive enough to reflect the influence of different types of management and climate changes on long-term soil quality (Doran and Parkin, 1996). Soil organisms (biological indicators), in particular, have this requirement, being able to respond significantly to human activity (Pankhurst et al., 1997; Wolters and Schafer, 1994).
2. To be well correlated with the positive functions of soil.
3. Be helpful to explain ecosystem processes. Indicators should explain why the soil "work" or "will not work" as expected by providing guidance on how to act if necessary to return to the original situation.
4. Be understandable and useful to decision makers.
5. Be easy and cheap to measure. The indicators of the quality of the soil should be accessible both in economic terms (Pankhurst et al., 1997 Ndiaye et al., 2000) that the time required for their determination, and being of easy execution (Dick et al., 1996).



A common strategy for evaluating soil quality consists in selecting a minimum data set of soil quality indicators (MDS) and condensing it in a synthetic index (IQ).
In detail, the indexing of the dynamic quality of the soil takes place through three steps:
• selection of appropriate indicators to represent the soil functions that you want to monitor;
• transformation of the indicator value in a normalized score;
• Integration of the data of the indicators normalized to obtain an index value of soil quality (IQ).

Working methodology for LIFE DOP Project

During LIFE DOP the following working steps will be implemented to assess the changes in soil quality caused by different management practices (Dynamic or management dependent features).

Soil sampling:

Representative samples of each experimental plot will be collected according to standard procedure.
Soil will be collected from a depth of 40 cm by randomized sampling at the beginning of the trial (before treatment, time 0) and at the end of the experimental plan (time f).

Definition of Synthetic Soil Quality Index (IQ)

The following biological, physical and chemical indicators selected basing on expert opinions as significant soil functions will be measured and employed to construct the Minimum Data Set in order to describe soil quality.

In particular, the following parameters will be measured:

- Organic Carbon
- Organic Matter
- Total Nitrogen
- pH
- C/N ratio
- Texture
- CEC (Cation Exchange Capacity)
- Available Phosphorus
- Exchangeable cations: Ca, Mg, Na, K
- Soil respiration
- WHC (Water Holding Capacity)
- PLFA (Phospholipid Fatty Acid)

To define if and how the use of the tested fertilizers is able to affect soil quality, previous parameters will be used to calculate the quality indexes (IQ).

Soil parameters will be grouped in soil functions (i.e. nutritional, biological etc..). Afterwards, the kind of variation ("*more is better*","*less is better*","*optimum*") and the relative theoric range of variation will be identify depending on for each indicator of the MDS.
Each indicator will be normalized and weighed depending on the function considered. In this way it will be possible to calculate a synthetic index of quality, varying from 0 to 1, which will be able to define the effects of the practice applied to the soils. The synthetic index (of quality IQ) will include all the parameters measurement on soil, giving a better manageability of numbers and their meaning.

References

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