

**FOR THE DEVELOPMENT TO THE SELECTION OF SOIL BIOINDICATORS FOR SOIL PROTECTION**

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Soil can be considered as a non-renewable resource that must be protected because it is essential to our economic activities (it provides us with food, drinking water, biomass and raw materials) and its degradation is accelerating (erosion, contamination, compaction). Protecting and managing soils will require a set of indicators able to inform about degradation and/or remediation of their properties and functions. Considering the lack of biological indicators (bioindicators) to describe the quality of soil, a national research programme has been set up to develop such indicators. The main objectives were to (i) develop methods for measuring soil biodiversity and soil functions, (ii) use soil bioindicators to monitor soil quality and (iii) identify relevant bioindicators or endpoints for ecological risk assessment of soil contamination. Research within this programme was organized in 2 steps. The first one, finished in 2008, had to develop and to test several bioindicators based on the following biological organisms:

- Bacteria and fungi (indicators based on the diversity and the activity),
- Collembola and Nematodes (indicators based on the diversity),
- Earthworms and total macrofauna (indicators based on the diversity, the activity, bioaccumulation and physiological biomarkers),
- Snails (indicators based on the bioaccumulation),
- Birds and micromammals (indicators based on bioaccumulation and morphological or physiological biomarkers)
- Plants (indicators based on the diversity, bioaccumulation and physiological biomarkers).

During this first step of the programme, these indicators were individually tested by independent sub-programmes studying their specific bioindicators and applying their specific sampling and analysis methods. Therefore, it was not possible to compare the indicators and to test their relevance. The objective of the 2<sup>nd</sup> step was to focus on some selected indicators and selected sites. The aim was to test the same bioindicators on the same sites and at the same moment, and to validate their use according to specific situations. Therefore, based on the results obtained by each sub-programmes and on a multivariate analysis, 47 relevant bioindicators were selected. These bioindicators covered microorganisms, fauna and flora indicators.

The 2<sup>nd</sup> step started in 2009 has to calibrate (variability caused by soil use, by contamination or caused by climate change ..), to validate (studies on sensitivity) and to compare the selected bioindicators with the others. The 47 bioindicators were tested in 47 situations combining different soil types, land uses and practices: forest soils, organic farming, pastures, contaminated sites, remediated soils. Consequently, a national soil sampling campaign was realised in similar conditions on common pilot sites (standardised sampling protocols were used). A data base was created and a working group was defined to propose the relevant data mining applied by all partners in order to insure the quality of the data treatment. Based on the results obtained by all research teams and on a multivariate analysis it will be possible to select indicators relevant for our main objectives (i.e soil monitoring and ecological risk assessment of contaminants). This programme, which implicates the collaboration of 22 research teams (i.e., 70 members), will also initiate the development of a national reference database. In parallel, this program will provide a better understanding of soil biodiversity and related ecosystem services.