National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

Methods for ecosystem service appraisal using data on soil characteristics and stakeholder participation

Ecosystem services (ES) play a central role in the transition from a hazard perspective towards sustainability in environmental management and spatial planning. With an extensive set of ES, all relevant beneficiaries can be involved in the participative multi stakeholder process.
The result will be a set of weighted ES relevant for a defined environmental unit (site, region), in this case for four arable farms on silt loam in the Hoeksche Waard, The Netherlands (Table). Professionals are then required for setting up indicators and calculation algorithms to quantify performance of ES, in current and future situation according to management schemes (scenario's).

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Nr	Ecosystem service indicator	score
1	First: rotation management	(116)
2	Soil organic matter content	(114)
4	Earthworm community, abundance	(93)
5	Pore volume (water and air)	(90)
7	pH	(90)
10	Earthworm community, diversity	(85)
12	Bulk density	(82)
13	Soil penetration resistance	(81)
18	Bacterial biomass	(78)
19	Nematode community, diversity	(77)
22	Bacteria, functional diversity	(74)
24	Micro arthropod community, diversity	(70)
26	Total P and water soluble P	(68)
28	Potential C mineralisation capacity	(65)
33	Potential N mineralisation capacity	(62)
45	Number of plant parasitic nematodes	(51)
50	Last not selected: metal concentration	(44)

$$\textbf{soil quality} = \Sigma\ \gamma_{(i)} \cdot ES_{soil(i)}$$

(weight factors $\gamma_{(i)}$ were determined in a multi-stakeholder process)

$$ES_{soil} = f\ (\text{biotics, abiotics, other})$$

1. Soil as a factor in production

1a. Nutrients: nutrients are needed for the growth of crops and ornamental plants. Retention and release of nutrients is mediated through the soil — **3.8**

1b. Soil structure: stable aggregates and large pores enable roots to penetrate the soil for healthy crops and water management — **3.2**

1c. Plant diseases and plagues: soil has a natural capacity to suppress plant diseases and plagues — **4.0**

2. Soil as a robust though flexible system

2a. Resilience and stress resistance: Climate change and intensive land management impose large pressures on soil. Healthy soils withstand these pressures and recover quickly — **2.6**

2b. Flexibility: different land uses have specific soil demands, and transients should be made possible. — **2.4**

3. Soil's regulation services

3a. Transition of organic matter: plant residues enter the system to serve as carbon and energy source and to produce stable organic matter for building the soil structure — **2.8**

3b. Natural attenuation capacity: Soil catalyzes degradation of harmful and nutritious compounds, both form natural and for anthropogenic origin. — **3.1**

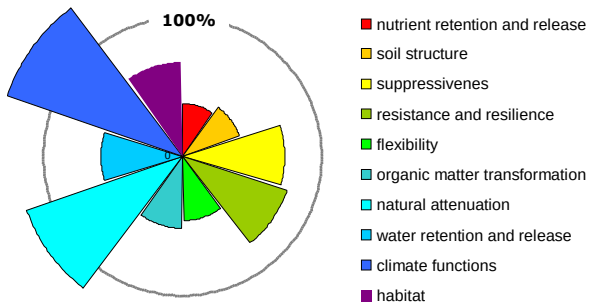
3c. Water retention: Soil is a sponge: it absorbs and releases water for transport to plants, aquifers and surface water. — **3.9**

3d. Climate regulation: The soil plays a role in regulation of local and global climate (humidity, temperature) and in climate change (green house gases). — **1.1**

4. Habitat for soil organisms

The soil provides a natural habitat for a vast amount of species and a large gene pool. Current and future generation profit from this habitat for educational, spiritual and esthetical values. — **3.3**

We developed indicative quantification schemes for ES of the soil system in agricultural and nature areas. For the assessment, a national database with soil chemical and soil biological data was used to develop a distance to target ruler. The target is a small set of most sustainable farms in the existing database within a category of soil type and land use, according to a multidisciplinary panel of soil professionals. Although many steps in the appraisal of ES still have to be improved, indicative values for ecosystem service performance determined at four farms in the Hoeksche Waard could be linked to management practice, i.e. organic, conventional and intensive arable farming on silt loam.



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