Soil Transformation of European Catchments (SoilTrEC)- Project Fact Sheet (www.soiltec.eu)

SUSTAINABILITY INDICATORS FOR SOIL (SIFS)

Sustainability assessment provides an integrated understanding of social, economic and ecological conditions that are critical for strategic and coordinated action for sustainable development. Sustainability assessment is a tool to help decision– and policy–makers to decide which actions should or should not be taken in an attempt to make society more sustainable, and thereby contribute to sustainable development. Indicators are important tools of sustainability assessment. An indicator demonstrates in what direction a system is heading, and in the context of sustainable development towards or away from sustainability. By visualizing phenomena and highlighting trends, indicators simplify, quantify, analyze and communicate otherwise complex and complicated information.

Framework for the development of sustainability indicators for soil

Sustainable use of soil is defined as "the temporal and/or spatial harmonisation of the uses of all soil functions, excluding or minimising irreversible ones, where the goal is to maintain and provide multiple soil functions for the wellbeing of humans and the environment, in the present as well as in the future" . The EU´s Soil Thematic Strategy recognised seven main functions: (1) Biomass production; (2) Storing filtering and transforming nutrients, substances and water; (3) Biodiversity pool; (4) Acting as carbon pool; (5) Physical and cultural environment for humans; (6) Source of raw material; and (7) Archive of geological and archaeological heritage. Soil indicators for sustainability should indicate if soil functions are maintained and alert if functions are being degraded.

The SoilTrEC project has developed SIFS that rely on a theme based development approach and the DPSIR causal framework . The SIFS indicators can be used by decision-makers at various levels of decision-making, and were developed with extensive stakeholder participation.

The indicator development process consisted of the following steps: 1) Defining the goal(s) of the indicator set; 2) Defining the sustainability dimensions; 3) Defining the sustainability themes and subthemes; 4) Identifying an initial, all inclusive set of sustainability indicators based on an extensive literature search; 5) Eliminating unsuitable indicators based on OECD indicator criteria; 6) Identifying important and unsuitable indicators through a survey based stakeholder participation based on a Delphi Survey; and 7) Assessment of indicators.

The Bellagio principles were applied at every stage in the development process.

Soil indicators for sustainability. The indicator set for soil sustainability developed by the SoilTrEC project consist of 30 indicators, that then are broken to core indicators and optional indicators by stakeholder group. The table below illustrates all the indicators developed and included in the indicator set. Those marked with a star (*) are justified by all stakeholder groups and are referred to as SoilTrECs justified SIFS.

Theme	Sub-theme	Number	Indicator	Metrics
Atmosphere	*Atmosphere*	**N–1**	Net carbon sequestration in soil*	C equivalent gC/m2/yr.
		N–2	Extreme weather events	Days/season, quantity/intensity.
Biodiversity	*Biodiversity*	**N–3**	Pedodiversit*	Number of soil classes within an area.
Soil Properties	*Physical*	**N–4**	Aggregate diversity*	Mean weight Diameter of various aggregates, and aggregate diversity measured with the Shannon-Wiener index.
		N–5	Bulk density*	g/cm3.
		N–6	Topsoil depth	cm.
		N–7	Soil sealing*	% of total land area, excluding land under water and ice.
		N–8	Soil erosion*	µg/m3 of particulate
	Chemical	**N–9**	Change in cation exchange capacity (CEC)	Milli-equivalents /100 g.
		N–10	Soil contamination	Concentrations in topsoil.
		N–11	Change in topsoil pH*	pH.
	Biological	**N–12**	Changes in microbial biomass	C (mg kg–1).
		N–13	Change in and absolute level of net N mineralization*	mg/kg soil.
		N–14	Soil protective cover	% per season.
		N–15	Changes in flora diversity above ground*	Shannon's index and Simpson's index.
		N–16	Changes in fauna diversity above ground*	Shannon's index and Simpson's index.
		N–17	Change in total soil organic matter (TSOM)*	%.
Economic value of soil ecosystem services	*Economic value of soil ecosystem services*	**E–1**	Economic value of soil ecosystem services.	€.
Consumption patterns	*Land use*	**E–2**	Changes in land use diversity	% of land cover
Industry specific indicators for agriculture and forestry	*Productivity*	**E–3**	Yield, given no change in fertilization*	Tonnes/ha.
	Input intensity	**E–4**	Chemical fertilizer use intensity	Kg/ha per yield (kg) by crop type/ha.
		E–5	Pesticide use intensity.*	Kg/ha per yield (kg) by type/ha
		E-6	Soil salinity due to irrigation	g/kg (Na, K, Ca, Mg salts).
Institutional framework and capacity	*Governance*	**S-1**	Government policies	Existence of soil related policies.
	Science, technology and education	**S-2**	Expenditure on soil related research and development	% of overall research expenditure.
Awareness and public participation	*Awareness and public participation*	**S-3**	Education on sustainability	%
		S-4	Public awareness of the value of soil*	% of population, with survey.
		S-5	Public participation	% of population, measured by survey.
Health	*Heath*	**S-6**	Bioavailability of essential major and trace elements	Mg/kg.
Demographics	*Demographics*	**S-7**	Population growth	%.

For more information visit SoilTrEC website: www.soiltrec.eu

Authors: Jón Örvar Geirsson Jónsson, Brynhildur Davidsdottir, Eydis Mary Jonsdottir, Sigrún Maria Kristinsdóttir and Kristin Vala Ragnarsdottir. Contact us: Prof. Steven Banwart, SoilTrEC Project Coordinator, University of Sheffield. Email: S.A. banwart@sheffield.ac.uk