Ecosystem Service	**Chemical composition of atmosphere and oceans**
CICES class name	Regulation of chemical composition of atmosphere and oceans
CICES Section	Regulation & Maintenance (Biotic)
CICES Class code	2.2.6.1

Sample Indicators

Indicator values from			
Experiment or direct measurement		Survey	
Expert assessment		Statistical- or census data	
Model or GIS		Literature values	
Stakeholder participation		Not provided	

Table 1: Field Scale

Indicator	**Unit**	**Indicator values from**
[29] Long term carbon stabilization: Carbon content in microaggregate-within-macroaggregate fraction (c.f. Six & Paustian, 2014. DOI: 10.1016/j.soilbio.2013.06.014)	Not provided	
[42] Soil organic carbon content (0–10 cm)	Not provided	
[55] Soil organic carbon (SOC) stock (0-20cm)	Mg * ha^{-1}	,
[14] Carbon stock in soil (0-30 cm)	Mg * ha^{-1}	
[24] Soil organic carbon (0–30 cm) after 20 years of management	Mg * ha^{-1}	
[25] Soil organic carbon (0–30 cm) after 20 years of management	Mg * ha^{-1}	
[14] Carbon in trees (dbh≥10 cm) and bushes (dbh <10 cm, height >2 m)	Mg * ha^{-1}	
[37] Carbon stored in aboveground woody biomass; carbon stored in topsoil (0–20 cm)	Mg * ha^{-1}	
[38] Carbon storage in aboveground biomass (sum of herbaceous and tree components) and soils (upper 20 cm)	Mg * ha^{-1}	
[44] Amounts of carbon fixed in the soil and in the annual organs of orchard trees	kg * ha^{-1} * yr^{-1}	
[33] Carbon sequestered in soil and orchard-trees	kg * ha^{-1} * unit $time^{-1}$	
[51] Climate regulation: annual net ecosystem exchange (NEE) of carbon	Mg C * ha^{-1}	

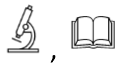
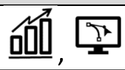
[44] Prevention of N denitrification: yearly amount of denitrified nitrogen	kg N_2O-N * ha^{-1} * yr^{-1}	
[33] Greenhouse gas mitigation: Cumulative denitrified nitrogen	kg N_2O-N * ha^{-1} * unit $time^{-1}$	
[54] Greenhouse gas emissions	CO2 equ. * ha^{-1}	
[23] Net global warming impact of soil carbon sequestration, agronomic N fertilizer application, lime application, fuel usage, nitrous oxide (N2O) emissions, and methane (CH4) oxidation	g CO_2e * m^{-2} * yr^{-1}	
[33] Greenhouse gas mitigation: Cumulative amounts of CO_2 emitted by agricultural operations	kg C * ha^{-1} * unit $time^{-1}$	
[38] Emissions of GHG (CO_2, CH_4, N_2O) measured by static chamber techniques in the field	$CO_{2\ equ.}$	
[43] Emissions of CO_2 and N_2O	Not provided	
[41] Indicator value calculated as: $$I=\frac{\sum\lvert\log(\frac{i}{i_{max}})\rvert}{n}$$ With: i – variable i measured, i_{max} – maximum ecologic potential of variable i in benchmark reference, n – number of variables. Where performance is considered better than in the benchmark and deviation, therefore, has a positive effect, $\lvert\log(\frac{i}{i_{max}})\rvert$ is subtracted from the sum instead of added. For this ecosystem service, variables were: -Soil organic matter [% dw] -Bacterial biomass [mg C /g dw] -pH in KCl -Physiological diversity bacteria [biolog. CLPP: Hill's slope]	-	

Table 2: Farm Scale

Indicator	**Unit**	**Indicator values from**
[34] Climate regulation: Vegetation cover [%], expressed as a four-level index	poor-fair-good-excellent]	
[53] Vegetation carbon stock: Above ground dry biomass of trees, bushes, and herbaceous plants	Mg C * ha^{-1}	
[53] Topsoil carbon stock: calculated from bulk density and total C content at 0–10, 10–20, and 20–30 cm depths	Mg C * ha^{-1}	

Table 3: Regional Scale

Indicator	**Unit**	**Indicator values from**
[1] Carbon sequestration	kg * ha^{-1} * yr^{-1}	

[15] Carbon sequestration rate (above and belowground)	Mg * ha^{-1}* yr^{-1}	
[36, 47] Carbon sequestration rate: sum of above and below ground crop and tree biomass and soil organic carbon (SOC)	t * ha^{-1} * yr^{-1}	
[5] Carbon sequestration: annual change in above- & below ground biomass. Values are monetarized based on an estimated social cost of carbon of $43/ton.	$ * ha^{-1} * yr^{-1}	
[4] Carbon sequestration in soil & biomass	kg C *ha^{-1}	
[9] Organic carbon stored in soils and above- and belowground biomass, divided by area	kg * m-2	
[3] Carbon sequestered in above- and belowground biomass of woody species	t CO2 eq. * ha^{-1} * yr^{-1}	
[16] Carbon sequestration: Amount of carbon that is sequestered from land use, land use change and forestry	C * km^{-2} * yr^{-1}	
[52] Above- and belowground carbon stored in living plant material.	t C * ha^{-1} * yr^{-1}	
[31] Carbon sequestration: identification of areas with peat soils or carbon-rich semi-terrestrial areas	Not provided	
[21] Carbon sequestration: Values based on land use by assigning a country-specific, land use type specific emission factor to each land use type. The emission factor also considers forest age and soil carbon stock.	Not provided	
[49] Soil organic carbon stock, values for CORINE land cover classes	t C * ha^{-1}	, ,
[26] Carbon stock of above- and below ground phytomass within different land cover classes	Mg C * ha^{-1}	,
[35] Carbon storage: Carbon stored in aboveground biomass, belowground biomass, and soils; calculated by combining the InVEST model with wood production figures.	Mg * ha^{-1}	,
[36] Carbon stock: sum of above and below ground crop and tree biomass and soil organic carbon (SOC)	t C * ha^{-1}	
[21] Carbon stocks in soil and vegetation. Based on land use by assigning a region-specific, age-specific biomass carbon stock to the land use types "forest" and "(semi-)natural vegetation"	Not provided	
[40] Carbon stored in soil and biomass. Values were normalized [0-1] using benchmark values where available and observed values otherwise.	t C * ha^{-1}	
[46] Carbon stock in living biomass, deadwood, litter, and soils	t C * ha^{-1}	
[47] Annual carbon stock: above and below ground biomass, soil organic carbon	t C * ha^{-1}	
[45] Carbon stored in aboveground biomass, belowground biomass, soil and dead organic matter (calculated with InVEST's Carbon Storage and Sequestration model). Values for all pools per land-use class were taken from Japans National Greenhouse Gas Inventory Report.	t * ha^{-1} * grid $cell^{-1}$	
[49] Total carbon stock for CORINE land cover classes, calculated as the sum of aboveground biomass, belowground biomass, litter and soil organic carbon	t C * ha^{-1}	, ,

[27] Total carbon stored in landscape, calculated with InVEST model	Mg	
[12] Carbon storage capacity	t C * ha^{-1}	
[17] Carbon flow change: Carbon stock in vegetation (above- and belowground) + soil organic carbon stock (1 m). Values are compared to values for a reference situation.	t C * ha^{-1}	,
[10] Greenhouse gas emissions	1000 t CO2eq.	
[19] Greenhouse gas balance of entire agricultural production system, including emissions from soils and fabrication of fertilizers and machinery	CO2 eq. * ha^{-1} * yr^{-1}	,
[8] Climate change mitigation: Annual carbon sequestration and GHG emissions, using the methodology for the LULUCF sector in Finland's National Inventory of greenhouse gases	CO2 equ. * km^{-2}	,
[49] Annual Gross Primary Production, based on "Moderate Resolution Imaging Spectroradiometer (MODIS) 17" satellite datasets	t C * ha^{-1} * yr^{-1}	, ,
[49] Annual total Net Primary Production, based on "Moderate Resolution Imaging Spectroradiometer (MODIS) 17" satellite datasets	t C * ha^{-1} * yr^{-1}	, ,
[18] Carbon capture: NPP × (1−VC_{NNP}) × (1−Ow); where NPP: Net Primary Production calculated from NDVI-values and expressed on a relative scale set to (0 - 1000), VC_{NPP}: coefficient of variation of NPP (0 - 1), Ow: water bodies occupancy percentage and flat floodplain area (0 - 1). Ow is used to reflect that water cover is negatively correlated with plant cover and therefore by proxy with carbon capture	-	
[50] Carbon sequestration and oxygen production: net primary productivity	t C * $area^{-1}$ * yr^{-1}	
[51] Climate regulation: annual net ecosystem exchange (NEE) of carbon	Mg C * ha^{-1}	
[52] Net ecosystem productivity	t C * ha^{-1} * yr^{-1}	
[48] Carbon sequestration: net primary productivity (NPP) using CASA (Carnegie-Ames-Stanford Approach) ecosystem model	gC * ha^{-1}	
[8] Airborne nutrient input: Exceedance of empirical critical loads of nitrogen in Natura 2000 sites	mg N * m^{-2}	,
[13] "Emergy" of O_2 release by crops (derived from yield and a dollar price for O_2) and "emergy" of CO_2 absorption soils (based on organic matter accumulation)	solar equivalent Joules	
[20] Index based on: a) Carbon storage: aboveground carbon in living biomass and soil carbon in the surface layer (0–20 cm) [tons C/ha] b) Greenhouse gas emissions: Emissions of CO_2, CH_4, and N_2O measured at monthly intervals [CO2 equ. flux] Both a and b were scaled to a range of 0.1-1 (whereby 0.1 denotes the highest GHG emissions) and averaged.	-	
[20] Bio-indicator: Presence of specific ant species is used as an indicator for high, medium or low provision of this ES. Suitable	low-medium-high	

indicator species must first be identified by a correlation between the presence of species and ES provision.		
[28] Global climate regulation: values for ecosystem service supply based on land cover classes. The matrix defined by Burkhard et al., 2012 (DOI:10.1016/j.ecolind.2011.06.019) was adapted and used in this study.	Index 0-5	
[49] Global climate regulation service, expert-based index values for CORINE land cover classes published by Burkhard et al. (2014, DOI: 10.3097/LO.201434).	Index 0-5	
[1] NO_2 dry deposition velocity	mm * s^{-1} * ha^{-1}	

Table 4: National Scale

Indicator	**Unit**	**Indicator values from**
[2] GHG emissions: methane (CH_4) from livestock (both through the production of manure and enteric fermentation); nitrous oxide (N_2O) from the application of inorganic fertilizers; and carbon dioxide (CO_2) associated with changes in carbon stocks in above and below ground biomass (making allowance for soil type) and from the burning of fossil fuels to power agricultural machinery and production of fertilizers and pesticides	CO_2 equ. * $area^{-1}$ * yr^{-1}	
[2] GHG emissions: as above, valuation based on UK official non traded carbon value	Money * $area^{-1}$ * yr^{-1}	
[11] GHG emissions from agriculture	t CO_2 eq.	
[21] Carbon sequestration. Based on land use by assigning a country-specific, land use type specific emission factor to each land use type. The emission factor also considers forest age and soil carbon stock.	Not provided	
[22] Carbon sequestration by farm afforestation	t CO_2 eq. * ha^{-1} * yr^{-1}	
[39] Carbon sequestered by permanent crops and grassland	Not specified	
[7] Carbon stored in vegetation and soils	kg C * m^{-2}	
[21] Carbon stocks in soil and vegetation. Based on land use by assigning a region-specific, age-specific biomass carbon stock to the land use types "forest" and "(semi-)natural vegetation"	Not provided	
[6] Global climate: Expert assessment for each land use class based on the indicators: CO_2, CH_4, N_2O, NO, and soot emissions	very negative (−3) to very positive (+3)	

[6] Air quality: Expert assessment for each land use class based on the indicators: nitrous oxide, ammonia, and soot emissions; trees	very negative (−3) to very positive (+3)	

Table 5: Multinational Scale

Indicator	**Unit**	**Indicator values from**
[16] Carbon sequestration: Amount of carbon that is sequestered from land use, land use change and forestry	C * km^{-2} * yr^{-1}	
[32] Global climate regulation: values for Corine land cover classes, based on values published by Burkhard et al. (2009; DOI: 10.3097/LO.200915) and modified for the context of riparian zones.	Index 0-5	

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