# Dataset of indicators for the Assessment of Ecosystem Services Affected by Agricultural Soil Management

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## List of Factsheets



* CICES: Common International Classification of Ecosystem Services; shortened class names taken from Paul et al., 2019 (DOI: 10.1111/ejss.13022)

| | |
|---|---|
| **Short name** | **Cultivated terrestrial plants for nutrition** |
| **CICES class name** | Cultivated terrestrial plants (including fungi, algae) grown for nutritional purposes |
| **CICES Section** | Provisioning (Biotic) |
| **CICES Class code** | 1.1.1.1 |

## 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 |
|---|---|---|
| [35, 48] Yield | Not provided |  ,  |
| [49] Yield | $Mg * ha^{-1}$ |  |
| [13] Yield | $kg * ha^{-1} * yr^{-1}$ |  |
| [26, 27] Yield | $Mg * ha^{-1}$ |  |
| [1, 23] Grain yield | $Mg * ha^{-1} * yr^{-1}$ |  |
| [38] Yield (maize, beans) | $kg * ha^{-1} * harvest^{-1}$ |  |
| [59] Annual total crop yield (corn, soybean, wheat) | $bushel * acre^{-1}$ |  |
| [37] Production of food | $kg\ fresh\ weigh * m^{-2} * yr^{-1}$ |  |
| [1] Average grain yield over the last 50 years, applying a factor to account for changes in technology over time | $t * ha^{-1}$ |  |

| | | |
|---|---|---|
| [62] Total grass yield | t * ha$^{-1}$ | |
| [47] Forage: herbaceous biomass production | Not provided | |
| [47] Forage: herbaceous biomass cover | Not provided | |
| [59] Annual total forage crops and perennial grass yield (alfalfa, hay, pasture) | kg * ha$^{-1}$ | |
| [13] Production value of crop-pasture sequence | $ * ha$^{-1}$ * yr$^{-1}$ | |
| [45] Yield potential: Effect of organic and conventional farming are accounted for by using residuals of crop yields (after fitting farming system (conventional or organic) to yield quantities in t ha−1, instead of reported yields. | t * ha$^{-1}$ | |
| [61] Biotic production | kg * m$^{-2}$ * yr$^{-1}$ | |
| [24] Plant dry biomass per experimental pot | g | |
| [61] Net primary production (NPP) | kg dm * m$^{-2}$ * yr$^{-1}$ | |
| [35] Land equivalent ratio | Not provided | , |
| [33] Fruit yield | Mg * ha$^{-1}$ | , |
| [38] Fruit yield | # * ha$^{-1}$ * harvest$^{-1}$ | |
| [2] Coffee: number of fruiting nodes per hectare | # * ha$^{-1}$ | |
| [46] Grape yield: bunches per vine | # | |
| [46] Grape yield: bunch weight | g | |
| [46] Grape yield: yield per vine | kg | |
| [46] Grape yield: 100 berries weight | g | |
| [35] Quality: Level of mycotoxins in crops | Not provided | , |
| [37] Concentration of trace metal elements relative to food quality standards | mg * kg of fresh matter$^{-1}$ | |

| | | |
|---|---|---|
| [35] Percentage of polyunsaturated fatty acids in milk from cows (for fodder quality) | Not provided | |
| [62] Total crude protein in yield | t * $ha^{-1}$ | |
| [1] Grain protein content (winter wheat) | % | |
| [62] Crude protein concentration in grass yield (first cut, re-growth) | % | |
| [33] Fruit quality: Fruit mass | g | |
| [33] Fruit quality: Fruit size | mm | |
| [33] Fruit quality: Fruit colour grade | Not provided | |
| [33] Fruit quality: Titratable acidity | % of malic acid | |
| [33] Fruit quality: Soluble solids concentration | % | |
| [33] Fruit quality: Firmness | Newton or<br>kg * $cm^{-2}$ | |
| [46] Grape quality: total soluble solids (sugar) | °Bx | |
| [46] Grape quality: titratable acidity | g * $l^{-1}$ | |
| [46] Grape quality | pH [-] | |
| [49] Mean individual fresh fruit mass (quality criterion for the market) | g * $fruit^{-1}$ | |
| [42] Combination of the following indicators to assess relative economic benefits of Forage Production:<br>Site quality: *animal units supported per month and hectare, scaled to [0 -1]*<br>Site opportunity: *distance to markets, scaled to [0 -1]*<br>Complimentary inputs: *availability of water sources, scaled to [0 -1]*<br>Reliability: *Risk of future service loss through urban development within a 3-mile radius, scaled to [0 -1]* | | |
| [45] Use of bundles of indicator species that indicate agricultural landscapes with high value for crop yields identified for a certain region. Species may belong to different taxonomic groups | Not provided | |

| | | |
|---|---|---|
| [67] Net primary productivity (NPP): average of total above and below ground dry mass at harvest over a 30-years simulation period | Mg / hectare * year) | |
| [68] Cropland yield | tons/hectare | |
| [68] 1000-grain weight | g | |

*Table 2: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [20] Index for average yield of common crops (e.g. corn, soy-bean and wheat). The index is calculated by dividing the ob-served value by a target value. Target values may be average or maximum values found in the region or empirical values from the literature. If the calculated index is higher than 1, it is set to one. | Index 0-1 | , |
| [20] Index for alternate income opportunities provided by speci-ality (food) products. The index is calculated by dividing the observed value by a target value. Target values may be aver-age or maximum values found in the region or empirical val-ues from the literature. If the calculated index is higher than 1, it is set to one. | Index 0-1 | , |
| [29] Accessibility: Share of land surface within 100 meters from road. Values were scaled [0-1] | % | |
| [29] Share of farmers with the expressed motivation of achiev-ing a high economic value of the farm that indicates their pro-duction intensity. Values were scaled to [0-1] | % | |
| [29] Crop yield | $t * ha^{-1} * yr^{-1}$ | |
| [45] Yield potential: Effect of organic and conventional farming are accounted for by using residuals of crop yields (after fit-ting farming system (conventional or organic) to yield quanti-ties in $t * ha^{-1}$, instead of reported yields. | $t * ha^{-1}$ | |
| [45] Use of bundles of indicator species that indicate agricul-tural landscapes with high value for crop yields identified for a certain region. Species may belong to different taxonomic groups. | Not provided | |

| | | |
|---|---|---|
| [56] Forage provision by pastures: calculated by a formula derived from expert assessment. Experts determined maximal DM yield, the selected up to 7 variables relevant for yield levels (soil pH, mean depth of a soil series, soil type, amount of phosphorous fertilizer applied, amount of lime applied, irrigation, altitude) and weighed them according to their importance. | t dm * $ha^{-1}$ *$a^{-1}$ | , |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] Production of edible crops | kg * $ha^{-1}$ * $yr^{-1}$ | , |
| [6] Food and fodder from plants | t * $ha^{-1}$ * $yr^{-1}$ | |
| [10] Food crops output per unit sown area | kg * $ha^{-1}$ | |
| [52] Average annual yield of all food crops in the region | t * $ha^{-1}$ | |
| [51] Food production value: expert based index for ES provision by land cover class [1-5] multiplied by the area of land cover class [$km^2$] and literature-based monetary value of ES | $ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [51] Food production: expert based index for ES provision by land cover class [1-5] multiplied by the area of land cover class [$km^2$] | Index 1-5 * $km^{-2}$ | , , |
| [55] Grain production: total yield of rice, wheat, corn and soy | t * $ha^{-1}$ | |
| [58] Grain output: total grain output from statistics, spatial allocation to grid cells of cultivated land based on the ratio of the cells' NDVI value relative to the NDVI of all cultivated land | t * $area^{-1}$ *$yr^{-1}$ | , |
| [59] Annual total crop yield (corn, soybean, wheat) | bushel * $acre^{-1}$ | |
| [5] Average yield | kg * $ha^{-1}$ | |
| [12] Yield | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [12] Agricultural harvest/yield | 100 kg grain equivalent unit (GEU) * $ha^{-1}$ *$yr^{-1}$ | |
| [43] Agricultural yields | t * $ha^{-1}$ | , , |

| | | |
|---|---|---|
| [41] Agricultural production; values were normalized [0-1] using benchmark values where available and observed values otherwise. | t * ha$^{-1}$ | |
| [60] Total crop production per area (including agricultural and non-agricultural areas) | t * ha$^{-1}$ * yr$^{-1}$ | |
| [28] Crop production: values assigned are based on the land cover class. The matrix defined by Burkhard et al., 2012 (DOI:10.1016/j.ecolind.2011.06.019) is adapted to the GlobCover dataset and used in this study. | Index 0-5 | |
| [29] Crop yield (autumn wheat). Values were scaled [0-1] | t * ha$^{-1}$ * yr$^{-1}$ | |
| [44] Winter wheat yields | t * ha$^{-1}$ | |
| [55] Oil crop production: oil yield | t * ha$^{-1}$ | |
| [25] Amount of forage | Mg dm * ha$^{-1}$ | |
| [59] Annual total forage crops and perennial grass yield (alfalfa, hay, pasture) | kg * ha$^{-1}$ | |
| [15] Feed: Percentage of the area used for grazing | % | |
| [28] Fodder production: values assigned are based on land cover class. The matrix defined by Burkhard et al., 2012 (DOI:10.1016/j.ecolind.2011.06.019) is adapted and used in this study. | Index 0-5 | |
| [40] Fodder quantity: Above-ground biomass in mown grasslands | Not specified | |
| [40] Fodder quantity: Sward height | Not specified | |
| [40] Fodder quality: Lower Leaf tensile strength (Feed quality) | Not specified | |
| [40] Fodder quality: Abundance of legumes | Not specified | |
| [40] Fodder quality: Leaf crude protein content | Not specified | |
| [11] Total biomass production on agricultural land | t DM | |
| [53] Annual biomass yield | t DM * ha$^{-1}$ * yr$^{-1}$ | |
| [53] Biomass stock in the landscape (crops and trees) at any one time | t DM * ha$^{-1}$ | |
| [14] Sum of arable land cells (GIS: 10m x 10m cells) within the two highest soil fertility classes | m$^2$ | |

| | | |
|---|---|---|
| [21] Share of arable land use within a region | % | |
| [43] Acreage of farmland | ha | , , |
| [50] Food production potential: total farmland area | ha * grid cell$^{-1}$ | |
| [31] Yield potential | 1: very low - 5: very high | |
| [45] Yield potential: Effect of organic and conventional farming are accounted for by using residuals of crop yields (after fitting farming system (conventional or organic) to yield quantities in t ha−1), instead of reported yields. | t * ha$^{-1}$ | |
| [36] Soil fertility of arable fields: index based on water holding capacity, soil moisture and carbonate content. | Index 1-5 | |
| [4] Area of agricultural ecosystems under sustainable management | Not provided | |
| [4] Organic farming | Not provided | |
| [7] Market value of products per hectare | $ * ha$^{-1}$ * yr$^{-1}$ | |
| [10] Gross farming output value per rural chemical fertilizer use | $ * kg$^{-1}$ | |
| [10] Agricultural labor productivity [monetary agricultural output value/ agricultural labourer] | $ * capita$^{-1}$ | |
| [19] Gross output of agricultural production (crops & livestock) | $ * ha$^{-1}$ * yr$^{-1}$ | , |
| [19] Net margin of agricultural production (including subsidies) | $ * ha$^{-1}$ * yr$^{-1}$ | , |
| [25] (Historical Analysis) Value of production: Sum of working hours needed to buy basic agric. commodities of 1 ha of land | h * ha-1 | , |
| [29] Accessibility: Share of land surface within 100 meters from road that affects the level of agricultural production intensity. Values were scaled [0-1] | % | |
| [16] "Energy" of harvested crops | solar equivalent J | |

| | | |
|---|---|---|
| [17] Biomass: Energy output from agricultural biomass | MJ * $ha^{-1}$ | |
| [18] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | Index 0-5 | |
| [29] Share of farmers with the expressed motivation of achieving a high economic value of the farm. Values were scaled to [0-1] | % | |
| [30] Direct goods provision (meat & grain): NPP x H x Qf x 1.5; where NPP: Net primary production (0-1000), H: Harvest index by men (0-1), Qf: quality factor of primary outputs | Not provided | |
| [45] Use of bundles of indicator species that indicate agricultural landscapes with high value for crop yields identified for a certain region. Species may belong to different taxonomic groups. | Not provided | |
| [54] Percentage of the products of a land use class that is consumed by households as food | % | |
| [54] Percentage of the products of a land use class that is used for animal feed | % | |
| [54] Rating of current service provision per land use class by expert-stakeholders | Rating 0-10 | |
| [54] Rating of increases/decreases of service provision in scenarios, relative to the status quo | % | |
| [64] Number of agricultural holdings | [#] | |
| [64] Utilised agricultural area | [not provided] | |
| [64] Area of arable land | [not provided] | |
| [64] Production quality: agricultural area of PDO and/or PGI farms | [not provided] | |
| [65] Mass of food crops/feed/livestock | tons/ ($km^2$ * year) | |

| | | |
|---|---|---|
| [65] Calorific value of food crops/feed/livestock | MJ / ($km^2$ * year) | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [11] Total biomass production on agricultural land | dm t | |
| [57] Yield | t * $district^{-1}$ or<br>t * $nation^{-1}$ | |
| [39] Yields of food and feed crops | t * $ha^{-1}$,<br>t dm * $ha^{-1}$,<br>MJ * $ha^{-1}$ | |
| [39] Grassland yields | t * $ha^{-1}$,<br>t dm * $ha^{-1}$,<br>MJ * $ha^{-1}$ | |
| [39] Food and feed crop area | ha | |
| [39] Grassland area | ha | |
| [21] Share of arable land use within a region | % | |
| [4] Area of agricultural ecosystems under sustainable management | Not provided | |
| [4] Organic farming | Not provided | |
| [8] Expert assessment for each land use, based on the indicators: yield/hectare; light, water, nutrient, warmth availability; disturbances, climate change (units not given) | very negative (−3) to very positive (+3) | |
| [9] Summed gross margin of production (area of crop multiplied by the gross margin per unit area) | $ | , |
| [34] Historical analysis: Production of "ecosystem service products" in a region: cereal crops, vegetables, hop, wine | Not provided | , |
| [34] Historical analysis: Occurrence of specific production areas in a region: orchards, orchard meadows, vineyards | Not provided | , |
| [34] Historical analysis: fodder or fodder used in a region: fodder-hay, fodder-oak | Not provided | , |

| | | |
|---|---|---|
| [34] Historical analysis: Occurrence of specific livestock feeding system in a region: grazing, grazing/fodder-hay | Not provided | , |
| [22] Maximum stocking rate supported by pastures | Livestock units * $ha^{-1}$ | |
| [57] Quality: alpha-diversity of agricultural goods calculated as Pielou's (1969) J-index (evenness index): J = (sum of (P_it * ln(p_it))/ ln (St); where St is the number of crops recorded during year t, while p_it refers to the relative abundance of crop i [based on the crop's yield (weight)] during year t | [-] | |
| [57] Quality: beta-diversity of agricultural goods calculated as Margalef's (1958) index of diversity (D): D= S-1 / ln(N); where S is the number of species, and N represents the total yield (weight) | [-] | |
| [57] Quality: gamma-diversity calculated from alpha- and beta diversity | [-] | |
| [63] Downscaled crop production: Arable land cover classes are identified from satellite images. National crop production data is then downscaled to the respective land use classes, adjusting for crop cultivation intensity by assigning a weight of 1.25 to intensive of 0.66 to extensive croplands. | $t/km^2$ | , |
| [63] Fodder production potential: Area of rainfed agricultural land [not provided] | Not provided | |

*Table 5: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [17] Biomass: Energy output from agricultural biomass | MJ * $ha^{-1}$ | |
| [32] Crops: values assigned are based on Corine land cover classes. The matrix defined by Burkhard et al. (2009; DOI: 10.3097/LO.200915) was used and modified for the context of riparian zones. | Index 0-5 | |
| [32] Fodder: Values assigned are based on Corine land cover classes. The matrix defined by Burkhard et al. (2009; DOI: 10.3097/LO.200915) was used and modified for the context of riparian zones. | Index 0-5 | |
| [21] Share of arable land use within a region | % | |
| [4] Area of agricultural ecosystems under sustainable management | Not provided | |
| [4] Organic farming | Not provided | |

*Table 6: Global Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [4] Area of agricultural ecosystems under sustainable management | Not provided | |
| [4] Organic farming | Not provided | |
| [66] Yield | ton/km$^2$ | |

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| **Ecosystem Service** | **Cultivated terrestrial plants for materials** |
|---|---|
| **CICES class name** | Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) |
| **CICES Section** | Provisioning (Biotic) |
| **CICES Class code** | 1.1.1.2 |

## 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** |
|---|---|---|
| [14] Yield | Not provided | |
| [19] Biotic production | kg * $m^{-2}$ * $yr^{-1}$ | |
| [19] Net primary production (NPP) | kg dm * $m^{-2}$ * $yr^{-1}$ | |
| [20] Net primary productivity (NPP): average of total above and below ground dry mass at harvest over a 30-years simulation period | Mg / (hectare * year) | |

*Table 2: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [6] Yield | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [17] Annual biomass yield | t dm * $ha^{-1}$ * $yr^{-1}$ | , , |

| | | |
|---|---|---|
| [3] Biomass for industrial use/processing | $t * ha^{-1} * yr^{-1}$ | |
| [12] Provisioning of material: Modelled biomass yield | $t\ dm * ha^{-1} * yr^{-1}$<br>$t\ dm * ha^{-1}$ | , , |
| [16] Timber production in the region | $m^3$ | |
| [8] Crop production: assigned value depends on the land cover class. 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 | |
| [8] Production of biochemicals and medicine: assigned value depends on the land cover class. 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 | |
| [15] Cultivated medicinal plants: expert-based index for ES provision by land cover class [1-5] multiplied by area of land cover class [km2] | $Index\ 1\text{-}5 * km^{-2}$ | , , |
| [15] Cultivated medicinal plants' value: expert-based index for ES provision by land cover class [1-5] multiplied by area of land cover class [km2] and literature-based monetary value of ES | $\$ * ha^{-1} * yr^{-1}$ | , , |
| [17] Biomass stock in the landscape (crops and trees) at any one time | $t\ dm * ha^{-1}$ | , , |
| [2] Annual growth rates of woody species representative for the land use type | $t\ db * ha^{-1}$ | |
| [9] Yield potential | very low 1 to very high 5 | |
| [7] Share of arable land use within each NUTS2 region | % | |
| [18] Percentage of the products of a land use class that is used for construction purposes (e.g., roofs, pillars) | % | |
| [1] Area of agricultural ecosystems under sustainable management | Not provided | |
| [1] Organic farming | Not provided | |
| [15] Agricultural inputs (e.g. materials, compost): expert based index for ES provision by land cover class [1-5] multiplied by area of land cover class [km2] | $Index\ 1\text{-}5 * km^{-2}$ | , , |

| | | |
|---|---|---|
| [15] Agricultural inputs' (Support for local production base e.g. materials for floating agricultural bed, compost and irrigation) value: expert based index for ES provision by land cover class [1-5] multiplied by area of land cover class [$km^2$] and literature-based monetary value of ES | $ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [18] Rating of current service provision per land use class by expert-stakeholders | 0-10 | |
| [18] Rating of increases/decreases of service provision in scenarios, relative to the status quo | % | |

*Table 3: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [5] Total biomass production on agricultural land | t dm | |
| [13] Yields of fibre crops | t * $ha^{-1}$<br>t dm * $ha^{-1}$<br>MJ * $ha^{-1}$ | |
| [13] Yields of crops used for medicinal and cosmetic purposes | t * $ha^{-1}$<br>t dm * $ha^{-1}$<br>MJ * $ha^{-1}$ | |
| [13] Fibre crop area | ha | |
| [13] Area of crops used for medicinal and cosmetic purposes | ha | |
| [1] Area of agricultural ecosystems under sustainable management | Not provided | |
| [1] Organic farming | Not provided | |
| [4] Summed gross margin of production (area of crop multiplied by the gross margin per unit area) | $ | , |
| [11] Historical analysis: materials used in (farmhouse) buildings in a region: carrier material (e.g., straw, bendable wood), insulation (e.g., e.g., moss), stable wood, timber, weatherproof wood, weather protection roofing (e.g., straw, reed), flowers, ropes (e.g., hemp), special wood used for handcrafts/ornamentation | Not provided | , |

| | | |
|---|---|---|
| [11] Historical analysis: materials used for agricultural purposes in a region: mulching, peat, plaggen, river sediments, hedges | Not provided | , |

*Table 4: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Area of agricultural ecosystems under sustainable management | Not provided | |
| [1] Organic farming | Not provided | |
| [7] Biomass: Energy output from agricultural biomass | MJ * ha$^{-1}$ | |
| [10] Crops: 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 | |
| [10] Biochemicals & medicines: 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 | |

*Table 5: Global Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Area of agricultural ecosystems under sustainable management | Not provided | |
| [1] Organic farming | Not provided | |

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[*] The impact area discussed on this factsheet is not a focus of the cited paper

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| Ecosystem Service | Cultivated terrestrial plants for energy |
|---|---|
| **CICES class name** | Cultivated plants (including fungi, algae) grown as a source of energy' |
| **CICES Section** | Provisioning (Biotic) |
| **CICES Class code** | 1.1.1.3 |

## 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 2: Field Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] Yield | kg * $ha^{-1}$ * $yr^{-1}$ | Literature values |
| [1] Biotic production | kg * $m^{-2}$ * $yr^{-1}$ | Literature values |
| [1] Net primary production (NPP) | kg dry matter * $m^{-2}$ * $yr^{-1}$ | Literature values |
| [2] Fuelwood production | volume * $ha^{-1}$ | Experiment or direct measurement |
| [23] Net primary productivity (NPP): average of total above and below ground dry mass at harvest over a 30-years simulation period [Mg / hectare * year)] | Mg / (hectare * year) | Model or GIS |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [6] Yield | kg * $ha^{-1}$ * $yr^{-1}$ | Model or GIS |

| | | |
|---|---|---|
| [10] Biomass yield | t dry matter * $ha^{-1}$ * $yr^{-1}$ | , , |
| [18] Total biomass production on agricultural land | t dry matter | |
| [8] Yield potential | 1: very low - 5: very high | |
| [4] Annual growth rates of woody species representative for a given land use type | t dry matter * $ha^{-1}$ | |
| [12] Share of arable land use within each NUTS2 region | % | |
| [9] Number of areas and total area covered by firewood species | #, ha | , , |
| [10] Biomass stock in the landscape (crops and trees) at any one time | t dry matter * $ha^{-1}$ | , , |
| [13] Energy output from agricultural biomass | MJ * $ha^{-1}$ | |
| [7] Energy (biomass): values are assigned to 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 | |
| [11] Percentage of the products of a land use class that is used for fuel | % | |
| [11] Rating of current service provision per land use class by expert-stakeholders | 0 - 10 | |
| [11] Rating of increases/decreases of service provision in scenarios, relative to the status quo | % | |
| [9] Number of households using biogas plants | # | , , |
| [21] Biomass: Energy output from agricultural biomass | MJ * $ha^{-1}$ | |
| [22] Fraction of the plant component (e.g. sugar content) used for biofuel production | kg / ($km^2$ * year) | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [19] Yields of energy crops | $t * ha^{-1}$, t dry matter * $ha^{-1}$, $MJ * ha^{-1}$ | |
| [18] Total biomass production on agricultural land | t dry matter | |
| [19] Yields of grassland for energy production | $t * ha^{-1}$, t dry matter * $ha^{-1}$, $MJ * ha^{-1}$ | |
| [19] Production of biofuel, biodiesel, bioethanol | ktoe | |
| [12] Share of arable land use within each NUTS2 region | % | |
| [19] Energy crop area | ha | |
| [19] Grassland for energy area | ha | |
| [17] Summed gross margin of production (area of crop multiplied by the gross margin per unit area) | $ | , |
| [16] Expert assessment for each land use class based on the indicators: yield/hectare; light, water, nutrient, warmth availability; disturbances, climate change [units not given] | very negative (−3) to very positive (+3) | |
| [15] Historical analysis: Production of "ecosystem service products" in a region: firewood-hedges, firewood-trees, fuel-peat | Not provided | , |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [13] Biomass: Energy output from agricultural biomass | $MJ * ha^{-1}$ | |
| [20] Crops: Values were assigned to 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 | |

| | | |
|---|---|---|
| [20] Wood fuel: Values were assigned to 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 | |
| [12] Share of arable land use within each NUTS2 region | % | |

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| **Ecosystem Service** | **Genetic material from plants for breeding** |
|---|---|
| **CICES class name** | Higher and lower plants (whole organisms) used to breed new strains or varieties |
| **CICES Section** | Provisioning (Biotic) |
| **CICES Class code** | 1.2.1.2 |

## 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 6: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Trends in genetic diversity of cultivated plants of major socioeconomic impact | Not provided | |

*Table 7: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Trends in genetic diversity of cultivated plants of major socioeconomic impact | Not provided | |

*Table 8: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Trends in genetic diversity of cultivated plants of major socioeconomic impact | Not provided | |

*Table 9: Global Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Trends in genetic diversity of cultivated plants of major socioeconomic impact | Not provided | ⃠ |

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| No. | Citation |
|---|---|
| 1* | Feld CK, Sousa JP, da Silva PM, Dawson TP (2010) Indicators for biodiversity and ecosystem services: towards an improved framework for ecosystems assessment. Biodiversity and Conservation 19(10): 2895-2919. DOI: 10.1007/s10531-010-9875-0 |


* The impact area discussed on this factsheet is not a focus of the cited paper

| **Ecosystem Service** | **Biotic remediation of waste** |
|---|---|
| **CICES class name** | Bio-remediation by micro-organisms, algae, plants, and animals |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.1.1.1 |

## 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 10: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [2] Organic waste used | kg * $m^{-2}$ * $yr^{-1}$ | |
| [1] Natural attenuation/ clean groundwater:<br>Indicator value calculated as:<br>$I = \frac{\sum \lvert \log(\frac{i}{i_{max}}) \rvert}{n}$<br>With: I – Indicator value, i – variable i measured, $i_{max}$ – maximum ecologic potential of variable i in benchmark reference, n – number of variables.<br>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 ES, variables were:<br>-Soil organic matter [% dw]<br>-Bacterial biomass [mg C *(g dw)$^{-1}$ ]<br>-pH in KCl<br>-Physiological diversity bacteria [bBiolog. CLPP: Hill's slope]<br>-Water suluble P (Pw) [mg * $l^{-1}$] and extractable P (PAL) [mg * $kg^{-1}$] | - | , |

*Table 11: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Share of nitrogen retained during water passage between agricultural sub-catchment and sea. Values were scaled [0-1] | % | |
| [3] Share of farmers that express clearly a value and care for the health of the land. Values were scaled [0-1] | % | |

*Table 12: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [6] Nitrate leaching | kg * ha$^{-1}$ * yr$^{-1}$ | |
| [5] Risk of nitrate leaching: exchange frequency of the soil water in the root layer. Infiltration rate divided by field capacity | % | |
| [3] Share of nitrogen retained during water passage between agricultural sub-catchment and sea. Values were scaled [0-1] | % | |
| [3] Share of farmers that express clearly a value and care for the health of the land. Values were scaled to [0-1] | % | |
| [4] Nutrient regulation: assigned values depend on the land cover class. 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 | |
| [7] Share of riparian forest cover in 25 m buffer along rivers. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | % | |
| [7] Share of natural forest cover in municipality's surface. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | % | |
| [8] Water purification and provision, calculated as: $W = NPP * (1 - VCNPP) * IC_s * S_{cf}$ With: W – water purification and provision, NPP – Net Primary Production calculated from NDVI-values and expressed on a relative scale set to [0 – 1000], VCNPP – coefficient of variation of NPP [0 – 1], $IC_s$ – soil infiltration capacity [0 – 1], $S_{cf}$ – slope average correction factor of the study area [0 – 1] | n/a | |
| [8] Waste purification, calculated as: $W = NPP * (1 - VCNPP) * I_w * O_w * 1.75$ With: NPP – Net Primary Production calculated from NDVI-values and expressed on a relative scale set to [0 – 1000], | n/a | |

| | | |
|---|---|---|
| VCNPP – coefficient of variation of NPP [0 – 1], $I_w$ – water input to the system (calculated as rainfall * (1–runoff coefficient) and scaled to a range of [0 – 1]), $O_w$ – water bodies occupancy percentage and flat floodplain area [0 – 1] | | |
| [11] Volume of purified water | $m^3$ / ($km^2$ * year) | |
| [11] Mass of a specific nutrient retained | ton/ ($km^2$ * year) | |
| [12] Area of undisturbed creek banks that serve as buffers to pesticide and fertilizer runoff | n/a | |

*Table 13: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [9] "Recycling capacity" of external nutrients: Amount of phosphorus in pig manure that can be spread on tillage soils and P deficient grassland soils. | t P * $yr^{-1}$ | |

*Table 14: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [10] Nutrient regulation: Values were assigned to 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 - 1 | |

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* The impact area discussed on this factsheet is not a focus of the cited paper

| Ecosystem Service | **Biotic filtration, sequestration and storage of waste** |
|---|---|
| **CICES class name** | Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.1.1.2 |

## 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** |
|---|---|---|
| [1] Filtering and buffering:<br>-Soil organic carbon [%]<br>-Acetate esterase enzyme activity [not provided]<br>-Bulk density [g * $cm^{-3}$]<br>-Basal soil respiration [mg $CO_2$ * $g^{-1}$] | Not provided | |
| [3] Soil carbon (0-100cm) | kg C * $m^{-2}$ | |
| [2] Natural attenuation/ clean groundwater:<br>Indicator value calculated as:<br>$$I=\frac{\sum\lvert\log(\frac{i}{i_{max}})\rvert}{n}$$<br>With: I – Indicator value, i – variable i measured, $i_{max}$ – maximum ecologic potential of variable i in benchmark reference, n – number of variables<br>Where performance is considered better than in the benchmark and deviation, therefore, has a positive effect, $\lvert\log(\frac{i}{i_{max}})\rvert$ subtracted from the sum instead of added. For this ES, variables were:<br>-Soil organic matter [% dw]<br>-Bacterial biomass [mg C *g $dw^{-1}$] | - | , |

| | | |
|---|---|---|
| -pH in KCl<br>-Physiological diversity bacteria [bBiolog. CLPP: Hill's slope]<br>-Water suluble P (Pw) [mg * $l^{-1}$] and extractable P (PAL) [mg * $kg^{-1}$] | | |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [4] Share of nitrogen retained during water passage between agricultural sub-catchment and sea. Values were scaled [0-1] | % | |
| [4] Share of farmers that express clearly a value and care for the health of the land. Values were scaled to [0-1] | % | |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [10] Nitrate leaching | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [5] Nitrogen loss | kt N | |
| [8] Risk of nitrate leaching: exchange frequency of the soil water in the root layer. Infiltration rate divided by field capacity | % | |
| [4] Share of nitrogen retained during water passage between agricultural sub-catchment and sea. Values were scaled [0-1] | % | |
| [6] Mechanical filtration capacity: infiltration capacity, calculated as:<br>$C = soil_{perm} * (1 - s)$<br>With: C – mechanical filtration capacity, $soil_{perm}$ – soil permeability [cm * $d^{-1}$], s – share of anthropogenic surface sealing | cm * $d^{-1}$ | , |
| [6] Physicochemical filtration capacity, calculated as:<br>$C = CEC * (1 - s)$<br>With: C – physicochemical filtration capacity, CEC – effective cation exchange capacity [cmol(+) * kg $dm^{-1}$], s – share of anthropogenic surface sealing) | cmol(+) * kg $dm^{-1}$ | , |
| [9] Share of natural forest cover in municipality's surface. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | % | |
| [4] Share of farmers that express clearly a value and care for the health of the land. Values were scaled to [0-1] | % | |

| | | |
|---|---|---|
| [7] Nutrient regulation: Assigned values depend on the land cover class. 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 | |
| [11] Water purification and provision, calculated as: $$W = NPP * (1 - VCNPP) * IC_s * S_{cf}$$ With: W – water purification and provision, NPP – Net Primary Production calculated from NDVI-values and expressed on a relative scale set to [0 – 1000], VCNPP – coefficient of variation of NPP [0 – 1], $IC_s$ – soil infiltration capacity [0 – 1], $S_{cf}$ – slope average correction factor of the study area [0 – 1] | - | |
| [11] Waste purification, calculated as: $$W = NPP * (1 - VCNPP) * I_w * O_w * 1.75$$ With: NPP – Net Primary Production [0-1000], VCNPP – coefficient of variation of NPP [0–1], $I_w$ – water input to the system [0–1], $O_w$ – water bodies occupancy percentage and flat floodplain area [0–1] | - | |
| [13] Volume of purified water | $m^3$ / ($km^2$ * year) | |
| [13] Mass of a specific nutrient retained | ton/ ($km^2$ * year) | |
| [14] Area of undisturbed creek banks that serve as buffers to pesticide and fertilizer runoff | n/a | |

*Table 4: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [12] Nutrient regulation: Values were assigend 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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| **No.** | **Citation** |
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| 8 | Bastian O, Lupp G, Syrbe RU, Steinháußer R (2013) Ecosystem services and energy crops - Spatial differentiation of risks. Ekologia Bratislava 32(1): 13-29. DOI: 10.2478/eko-2013-0002 |
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| 10 | Kay S, Crous-Duran J, Ferreiro-Domínguez N, García de Jalón S, Graves A, Moreno G, Mosquera-Losada MR, Palma JHN, Roces-Díaz JV, Santiago-Freijanes JJ, Szerencsits E, Weibel R, Herzog F (2018) Spatial similarities between European agroforestry systems and ecosystem services at the landscape scale. Agroforestry Systems 92(4): 1075-1089. DOI: 10.1007/s10457-017-0132-3 |
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| 14 | Groot JCJ, Yalew SG, Rossing WAH (2018) Exploring ecosystem services trade-offs in agricultural landscapes with a multi-objective programming approach. Landscape and Urban Planning 172: 29-36. DOI: 10.1016/j.landurbplan.2017.12.008 |

| Ecosystem Service | Smell reduction |
|---|---|
| CICES class name | Smell reduction |
| CICES Section | Regulation & Maintenance (Biotic) |
| CICES Class code | 2.1.2.1 |

## 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 15: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Hedgerow length | Not specified | |

## References



| No. | Citation |
|---|---|
| 1 | Maes J, Liquete C, Teller A, Erhard M, Paracchini ML, Barredo JI, Grizzetti B, Cardoso A, Somma F, Petersen JE, Meiner A, Gelabert ER, Zal N, Kristensen P, Bastrup-Birk A, Biala K, Piroddi C, Egoh B, Degeorges P, Fiorina C, Santos-Martín F, Naruševičius V, Verboven J, Pereira HM, Bengtsson J, Gocheva K, Marta-Pedroso C, Snäll T, Estreguil C, San-Miguel-Ayanz J, Pérez-Soba M, Grêt-Regamey A, Lillebø AI, Malak DA, Condé S, Moen J, Czúcz B, Drakou EG, Zulian G, Lavalle C (2016) An indicator framework for assessing ecosystem services in support of the EU Biodiversity Strategy to 2020. Ecosystem Services 17: 14-23. DOI: 10.1016/j.ecoser.2015.10.023 |

| **Ecosystem Service** | **Noise attenuation** |
|---|---|
| **CICES class name** | Noise attenuation |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.1.2.2 |

## 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 16: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Hedgerow length | Not specified | ⃠ |

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| **No.** | **Citation** |
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| Ecosystem Service | Visual screening |
|---|---|
| **CICES class name** | Visual screening' |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.1.2.3 |

## 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 17: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Hedgerow length | Not specified | |

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| **Ecosystem Service** | **Erosion control** |
|---|---|
| **CICES class name** | Control of erosion rates |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.1.1 |

## 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 |
|---|---|---|
| [1] Sediment lost by erosion | $t * yr^{-1}$ |  |
| [8] Soil loss | Not provided |  |
| [9] Annual total sediment yield in runoff | $t * ha^{-1}$ |  |
| [2] Erosion regulation potential | $t * ha^{-1} * yr^{-1}$ |  |
| [5] Erosion by water | $t * ha^{-1} * yr^{-1}$ |  |
| [6] Erosion by water | $t * ha^{-1} * yr^{-1}$ |  |
| [5] Erosion by wind (measured with DIN 19706 method) | - |  |
| [6] Erosion by wind (measured with DIN 19706 method) | - |  |
| [3] Change in soil height, measured by means of pins hammered into the soil at the beginning of measurements | mm |  |
| [7] Bare soils | Not provided |  |
| [3] Soil mulch cover (non-living vegetative biomass) | $kg * ha^{-1}$ |  |
| [7] Litter cover | Not provided |  |

| | | |
|---|---|---|
| [7] Biological soil cover | Not provided | |
| [4] Drainage | mm * $yr^{-1}$ | |

*Table 2: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [11] Prevention of water erosion: rate of water infiltration into the soil | mm * $ha^{-1}$ | |
| [12] Bank stability: Share of irrigation channel bank considered stable (not vertical, un-vegetated or eroded), expressed as a four-level index | %, Index: poor-fair-good-excel-lent | |
| [12] Vegetation cover, expressed as a four-level index | %, Index: poor-fair-good-excel-lent | |
| [10] Index for share of fields with continuous living cover. The index is calculated by dividing the observed value by a target value. Target values may be average or maximum values found in region or empirical values from literature. If the cal-culated index is higher than 1, it is set to one. | Index 0 - 1 | , |
| [10] Index for share of farm fields protected by conservation structures such as field buffers. The index is calculated by di-viding the observed value by a target value. Target values may be average or maximum values found in region, or empirical values from literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | , |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [35] Annual average erosion | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [25] Erosion rate calculated by modified Universal-Soil-Loss-Equation (USLE) | t * $ha^{-1}$ * $yr^{-1}$ | |
| [31] Annual soil erosion, assessed using the Revised Universal Soil Loss Equation (RUSLE) | t soil * $ha^{-1}$ * $yr^{-1}$ | |
| [20] Modelled erosion, calculated with LANCA model (simplified Universal Soil Loss Equation (USLE)) and with Revised Univer-sal Soil Loss Equation (RUSLE) | t soil * $ha^{-1}$ * $yr^{-1}$ | |
| [32] Potential soil erosion level calculated with Revised Univer-sal Soil Loss Equation (RUSLE) | t * $ha^{-1}$ * $yr^{-1}$ | , |

| | | |
|---|---|---|
| [36] Soil erosion by water, calculated with Revised Universal Soil Loss Equation (RUSLE) | t soil * $ha^{-1}$ * $yr^{-1}$ | |
| [9] Annual total sediment yield in runoff | t * $ha^{-1}$ | |
| [35] Annual average sediment in rivers | t * $yr^{-1}$ | |
| [35] Annual average sediment retention | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [19] Sediment retention, calculated with InVEST model based on universal soil loss equation and the land use/land cover specific sediment removal efficiencies | Mg * $ha^{-1}$ | |
| [35] Annual sediment retention to reservoirs | kg * $yr^{-1}$ | |
| [27] Modelled rates of water caused erosion and accumulation for a 10-year rainfall event | t * $ha^{-1}$ | |
| [23] Erosion control: Difference between the calculated erosion (using the Universal Soil Loss Equation) for a situation of bares soils and the current situation (considering the factors C: land cover management and P: supporting practices) | kg * $m^{-2}$ | |
| [28] Erosion control: Difference between the calculated erosion (using the InVEST Model based on the Universal Soil Loss Equation) in a model run that accounts for land cover and land management and in one that does not | t * $ha^{-1}$ | |
| [33] Erosion control: Difference between the calculated erosion (using the InVEST Model based on the Revised Universal Soil Loss Equation) in a model run that accounts for land cover and land management and in one that does not | t * $ha^{-1}$ | |
| [15] Erosion control: Difference between the calculated erosion rates (using the Universal Soil Loss Equation) with- and without considering land cover | t soil * pixel $area^{-1}$ (e.g., 30 m * 30 m) | |
| [34] Soil conservation calculated by RUSLE equation: $$A = R * K * LS * (1 - C * P)$$ With: A – soil conservation, R – rainfall erosivity factor, K – soil erodibility factor, LS – slope length and steepness factor, C – cover and management factor, P – conservation practice factor | t * $ha^{-1}$ * $yr^{-1}$ | |
| [14] Soil erosion protection: C-factor in the Universal Soil Loss Equation (USLE) | - | |
| [17] Soil erosion protection: C-factor in the Universal Soil Loss Equation (USLE) | - | |
| [29] Soil formation and erosion prevention: expert-based index for ES provision by land cover class [1-5] multiplied by the area of land cover class | $km^2$ | , , |

| | | |
|---|---|---|
| [29] Soil formation and erosion prevention value: expert-based index for ES provision by land cover class [1-5] multiplied by the area of land cover class and a literature-based monetary value of ES | $km^2$, $ * $ha^{-1}$ * $yr^{-1}$ | |
| [30] Wind erosion: Expert-/stakeholder rating of how much of erosion control can be provided by a landscape (represented by a land use map), using a 6-point Lickert-scale | none - highest capacity | |
| [30] Wind erosion: Expert-/stak eholder rating based on pair-wise comparisons of landscapes (represented by land use maps) in an Analytical Hierarchical Process (AHP). Experts se-lect the landscape with higher capacity for providing erosion control and rate the difference between the two landscapes | 1: equal capacity - 9: absolute preference of one landscape | |
| [18] "Emergy" of topsoil loss, calculated as: $$E = L_{OM} * T_{OM} + L_N * T_N + L_P * T_P + L_K * T_K$$ With: E – Emergy, $L_{OM}$ – loss of topsoil organic matter, $T_{OM}$ – transformity of organic matter, $L_N$ – loss of topsoil nitrogen, $T_N$ – transformity of nitrogen, $L_P$ – loss of topsoil phosphorus, $T_P$ – transformity of phosphorus, $L_K$ – loss of topsoil potassium, $T_K$ – transformity of potassium | seJ | |
| [35] Number of prevented hazards | # * $yr^{-1}$ | |
| [26] Area affected by erosion | ha | |
| [24] Share of areas without erosion problems relative to munic-ipality's surface. Values were normalized [0-1] using bench-mark values where available and observed values otherwise. | % | |
| [13] Erosion control capacity: values are assigned for different land cover classes. Index values were taken from Burkhard et al. (2012, DOI:10.1016/j.ecolind.2011.06.019)). | Index 0 - 5 | |
| [21] Erosion regulation: values are assigned for different 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 | |
| [16] Relative erosion sensitivity (based on modified Universal Soil Loss Equation (USLE)), considering soil type, slope, land use and distance to water | - | |
| [22] Resistance to soil erosion from water, calculated using the Universal Soil Loss Equation (USLE): $\text{Resistance} = \text{USLE K\_factor (soil)} * \text{USLE S\_factor (slope)}$ | | |
| [22] Resistance to soil erosion from wind | 1: very low - 5: very high | |
| [32] Rating of current service provision per land use class by ex-pert-stakeholders | Rating 0 - 10 | |
| [32] Rating of increases/decreases of service provision in sce-narios, relative to the status quo | % | |

| | | |
|---|---|---|
| [37] Soil protection<br>$$SP = NPP * (1 - VC_{NPP}) * (1 - S_{cf}) * 1.5$$<br>With: 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], $S_{cf}$ – slope average correction factor of the study area [0 – 1]. | Not specified | |
| [38] Soil protection factor. Region-specific and land use specific protection factor. Only areas with erosion risk > 2 t * ha$^{-1}$ (calculated using the Universal Soil Loss Equation) are considered. | Not specified | , |
| [35] Natural barriers against floods (dunes, mangroves, wetlands, coral reefs) | ha | |
| [35] Vegetation cover | % | |
| [35] Conservation of river banks | km | |
| [43] Amount of retained soil per unit area | tons / (km$^2$ * year) | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [41] Calculated current water Erosion (using modified Universal Soil Loss Equation (USLE)) | t * ha$^{-1}$ * yr$^{-1}$ | , |
| [40] Soil erosion risk | Not specified | |
| [41] Avoided water Erosion: Difference in calculated erosion (modified Universal Soil Loss Equation (USLE)) between the real situation and a hypothetical situation without vegetative cover | t * ha$^{-1}$ * yr$^{-1}$ | , |
| [41] Water Erosion avoided due to small scale structures in arable land:<br>Difference in calculated erosion (modified Universal Soil Loss Equation (USLE)) between a situation without small scale structures and a a situation where erosive slope length is reduced by small scale structures | t * ha$^{-1}$ * yr$^{-1}$ | , |
| [40] Percentage of soil cover in cropland (conservation tillage (low tillage), zero tillage, winter crops, cover crop or intermediate crop, plant residues) | % | |
| [40] Density of hedgerows | Not specified | |
| [40] Percentage of grassland cover | % | |
| [41] Share of organic cultivation in a federal state's arable land | % | , |

| | | |
|---|---|---|
| [39] Expert assessment of erosion control for each land use class | very negative (−3) to very positive (+3) | |

*Table 5: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [42] Erosion regulation: values assigned 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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| **Ecosystem Service** | **Mass movement control** |
|---|---|
| **CICES class name** | Buffering and attenuation of mass movement |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.1.2 |

## 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 18: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Spring litter in un-mown plots (alpine grasslands; high amounts of litter increase risk of snow gliding) | Not specified | |
| [2] Number of landslide per year | # | , , |
| [2] Area affected by landslide | ha | |
| [3] Supply of landside regulation, based on:<br>1.) deriving a formula for calculating landslide risk by using an Analytic Hierarchy Process (AHP)<br>2.) creating an ES potential map (high risk= low potential, low risk = high potential)<br>(Expert assessment was used to assign discrete values for each class of variables in AHP process and mapping of ES potential). | Index 0 - 5 | |

*Table 19: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [4] Expert assessment for each land use class based on the indicators: soil cover; trees; landslides; flooding; debris flow (units not given) | very negative (−3) to very positive (+3) | |

| | | |
|---|---|---|
| [5] Density of hedgerows | Not specified | ⃠ |

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| **Ecosystem Service** | **Hydrological cycle and flood control** |
|---|---|
| **CICES class name** | Hydrological cycle and water flow regulation (Including flood control, and coastal protection) |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.1.3 |

## 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** |
|---|---|---|
| [1] Water (in)filtration capacity | $m^3 * m^{-2} * yr^{-1}$, $mol * m^{-2}$ |  |
| [7] Infiltration: unsaturated hydraulic conductivity | $mm * h^{-1}$ |  ,  |
| [5] Water infiltration into the soil (using Beerkan test) | $mm * h^{-1}$ |  |
| [7] Deep percolation | mm |  ,  |
| [4] Drainage below the bottom of the root zone (in the dryland context; low drainage is desirable to avoid salinization) | $mm * yr^{-1}$ |  |
| [6] Water drainage | $mm * yr^{-1}$ |  ,  |
| [10] Modelled drainage | $mm * yr^{-1}$ |  ,  |
| [15] Water drainage | $mm * yr^{-1}$ |  |

| | | |
|---|---|---|
| [14] Water loss through drainage and runoff | mm * $yr^{-1}$ | |
| [7] Hortonian runoff | mm during growing season | , |
| [18] Flood regulation: annual number of days with runoff>10mm | # | |
| [17] Quantity: Share of rain water that evapotranspirates on site (without creating runoff) (urban agriculture) | % | |
| [2] Water movement and availability:<br>-Soil porosity [%]<br>-Water-filled pore space [%]<br>-Electrical conductivity [µS $cm^{-1}$]<br>-pH [-] | | |
| [2] Accommodate water entry:<br>-Stable aggregate index [not provided]<br>-Bulk density [g * $cm^{-3}$]<br>-Earthworms [not provided] | | |
| [5] Soil macroporosity (0 - 10 cm) | Cm | |
| [3] Soil water holding capacity (0-20 cm), calculated by sample drying & rewetting | g $H_2O$ * g $soil^{-1}$ | |
| [11,12] WHC water holding capacity in topsoil (0-20cm) | % | |
| [16] Water holding capacity | % | |
| [13] Available Water Capacity (AWC); the amount of water held between conventional field capacity and wilting point, estimated according to texture and organic matter up to the rooting depth, excluding stones | % | |
| [6] Mean water content in different soil depths | g $H_2O$ * 100 g dry $soil^{-1}$ | , |
| [14] Soil moisture in topsoil (0-5 cm) and at rooting depth (5-60 cm) | cm * $cm^{-3}$, % | |
| [10] Soil water content on a specific date (July, the most water-limited part of the growing season) | g $H_2O$ * g $soil^{-1}$ | , |
| [15] Mean soil humidity in topsoil (0-30cm) during observation period | % dm | |
| [5] Plant-available soil water (0 - 10 cm) | cm | |
| [7] Water stress | prop. of days | , |

| | | |
|---|---|---|
| [13] Soil Aridity Index (SAI); average number of days with dry soil in the upper soil layer where roots accumulate | d * $yr^{-1}$ | |
| [17] Water Quality: Weighted average concentration of TOC, TIC, $NO^{-3}$, and $NH^{+4}$ in leachate (Retention of elements and molecules, leaching, biodegradation) | mg * $l^{-1}$ | |
| [8] Soil hydrological functions indicator based on a principal component analysis (PCA) of 12 variables assessed at 0-10 cm and 10-20 cm. Variables included:<br>-Volumetric and gravimetric moisture content<br>-Micro (<0.03 µm), meso (0.03–3 µm) and macro (>3 µm) porosity<br>-Plant available water retained between water holding capacity and wilting point<br>-Aggregate stability, bulk density, resistance to vertical penetration, shear strength resistance,<br><br>Variables with significant contribution (>50 % of the maximum value) to either of the first two principal component axes were selected. Their contribution to PCA axes 1 and 2 multiplied by the overall variability explained by each PCA axis. These weighted factors were summed up and scaled to a range of 0.1 - 1.0. | - | |
| [9] Indicator value calculated as:<br>$I=\frac{\sum \lvert \log(\frac{i}{i_{max}}) \rvert}{n}$<br>With: I – indicator value, 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 ES, variables were:<br><br>-Soil organic matter [% dw]<br>-Earthworm abundance [# * $m^{-2}$]<br>-Bacterial biomass [mg C * g $dw^{-1}$]<br>-Number of earthworm taxa [-] | - | , |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [20] Rate of water infiltration into the soil | mm * $ha^{-1}$ | |
| [19] Four-level index based on the number of days streamflow is extended through seepage losses in channel irrigation systems (which recharge groundwater aquifers). | Index poor-fair-good-excellent | |

| | | |
|---|---|---|
| [19] Flood protection: Four-level index based on share of water lost through seepage in open channel irrigation [%]. The higher the value, the better. | Index poor-fair-good-excellent | |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [21] Water holding capacity | $m^3 * ha^{-1}$ | , |
| [22] Water retention capacity | $m^3 * ha^{-1}$ | |
| [30] Soil water storage capacity. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | mm | |
| [22] Runoff coefficient | - | |
| [23] Mitigated runoff: difference between total input precipitation by storm event and runoff | mm, $m^3 * km^{-2}$ | |
| [23] Mitigated runoff: percentage of mitigated flood water (intercepted, absorbed, or detained flood water, divided by total precipitation) multiplied by the number of beneficiaries at risk of flooding | - | |
| [23] Mitigated runoff: runoff Curve Number (CN). The CN determines the approximate amount of direct runoff from a rainfall event in a particular area. | Range 30 - 100 | |
| [18] Inverse indicator. Flood regulation: annual number of days with runoff>10mm | # | |
| [24] Flood regulation: (runoff) curve number | - | |
| [36] Number of extreme (runoff) events | $\# * yr^{-1}$ | |
| [22] Groundwater recharge | $m^3 * ha^{-1}$ | |
| [35] Baseflow regulation, calculated using InVEST model | Not provided | |
| [22] Evapotranspiration | mm | |
| [22] Share of sealed soils | % | |
| [30] Soil water infiltration capacity. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | $cm * h^{-1}$ | |

| | | |
|---|---|---|
| [37] Water infiltration: annual subsurface water flow | mm * $y^{-1}$ | |
| [31] Water yield: rainfall - actual annual evapotranspiration (using InVEST's Hydropower Water Yield model) | $m^3$ * $yr^{-1}$ * grid $cell^{-1}$ | |
| [25] Moderation of extreme events: Percentage of the total area of the region that contains native vegetation | % | |
| [27] Water regulation index. The index is based on soil physical characteristics, including volumetric and gravimetric moisture content, porosity, plant available water (based on water retention curves), aggregate stability, bulk density, penetration resistance and shear strength resistance. | Index 0.1 - 1 | |
| [32] Water flow management: expert-based index for ES provision by land cover class [1-5], multiplied by the area of the land cover class | $km^2$ | , , |
| [32] Water flow management value: expert-based index for ES provision by land cover class [1-5], multiplied by the area of the land cover class and a literature-based monetary value of the ecosystem service | $km^2$, \$ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [27] Bio-indicator: Presence of specific ant species is used as an indicator for high, medium or low provision of this ecosystem service. Suitable indicator species must first be identified by correlation between presence of species and ecosystem service provision. | - | |
| [26] Flood regulation score: preventative and mitigation functions of vegetation and soils. Score calculated after Nedkov and Burkhard (2012), using the parameters: interception, infiltration, surface runoff and peak flow. | Score 0 - 100 | , |
| [28] Flood protection: Values are assigned 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 | |
| [29] Reduction of flash flood risk: total area of flooded buildings (relative to total catchment area) in a 100-year rainfall event. | % | , |
| [32] Flood control: expert-based index for ES provision by land cover class [1-5] multiplied by the area of the land cover class | $km^2$ | , , |
| [32] Flood control value: expert-based index for ES provision by land cover class [1-5], multiplied by the area of the land cover class and a literature-based monetary value of the ecosystem service | $km^2$, \$ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [33] Flood regulation: Expert-/stakeholder rating of how much of this ES can be provided by a landscape (represented by a land use map), using a 6-point Lickert-scale | Scale none - highest capacity | |

| | | |
|---|---|---|
| [33] Flood regulation: Expert-/stakeholder rating based on pair-wise comparisons of landscapes (represented by land use maps) in an Analytical Hierarchical Process (AHP). Experts select the landscape with higher capacity for providing this ES and rate the difference between the two landscapes | Rating 1: equal capacity - 9: absolute preference of one landscape | |
| [34] Flood regulation, calculated as: maximum number of annual flood events in time series - average number of annual flood events during time series. Only events where damages exceed a certain cost are counted. | # | |
| [38] Flood regulation supply Indicator: normalized total river discharge within five days after a modelled precipitation event. Calculated with the hydrological model STREAM | Index 0 - 1 | |
| [40] Flood risk: expected cost of temporary disruption of transport infrastructure | $ * $ha^{-1}$ * $yr^{-1}$ | , |
| [40] Flood risk: expected cost damages to residential properties | $ * $ha^{-1}$ * $yr^{-1}$ | , |
| [39] Disturbance control, calculated as: $$DC = I_W * O_W * 1.25$$ With: DC – Disturbance control, $I_w$ – water input to the system, calculated as rainfall * (1–runoff coefficient) and scaled to a range of [0 – 1000], $O_w$ – water bodies occupancy percentage and flat floodplain area [0 – 1] | - | |
| [41] Flood regulation supply: continuous index, based on the variability of the peak discharge at the outlet of a catchment in dependence of land use and soil distribution | - | |
| [40] Floodplain capacity to store water: time to fill storage capacity (T) [days], calculated as: $$T = \frac{S}{86400 * Q_{med}}$$ With: T – Index of flood storage [d], S – Storage volume [$m^3$], $Q_{med}$ – Median annual flood [$m^3$ * $s^{-1}$] | d | , |
| [40] Space for water (in floodplains): theoretical proportion of floodplain area flooded annually, calculated by dividing the area of the indicative floodplain by the total area of the floodplain, and multiplying by the annual flood probability. | - | , |
| [42] Flood regulation supply index. The index represents the capacity of catchments to retain precipitation as a function of a catchments' topography and hydrology, water holding capacity of the soil, and land use. | 0 - 1 | |

| | | |
|---|---|---|
| [45] Volume of irrigation water | n/a | |
| [45] Volume of surface water used for irrigation | n/a | |
| [45] Volume of groundwater used for irrigation and in restoration consortiums | n/a | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [43] Water quantity: Expert assessment for each land use class, based on the indicator: above-ground runoff [not provided] | very negative (−3) to very positive (+3) | |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [43] Flood regulation supply: continuous index, based on the variability of the peak discharge at the outlet of a catchment in dependence of land use and soil distribution | 0 - 1 | |
| [44] Flood protection: Values are assigned to 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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| **Ecosystem Service** | **Wind protection** |
|---|---|
| **CICES class name** | Wind protection |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.1.4 |

## 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: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Storm protection: expert-based index for ES provision by land cover class [1-5] multiplied by the area of the land cover class [km2] | Index 1-5 * $km^{-2}$ | , , |
| [3] Storm protection value: expert-based index for ecosystem service provision by land cover class [1-5], multiplied by the area of the land cover class [km2] and a literature-based, monetary value of the ecosystem service | $ * $ha^{-1}$ * $yr^{-1}$ | , , |

*Table 2: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Historical analysis: storm protection in a region: occurrence of trees and hedges planted around houses as storm protection | Not provided | , |
| [2] Storm protection: Density of hedgerows | Not specified | |

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| No. | Citation |
|---|---|
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| | |
|---|---|
| **Short name** | **Fire protection** |
| **CICES class name** | Fire protection |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.1.5 |

## 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** |
|---|---|---|
| [1] Property loss due to fires, calculated as a combination of:<br>• Site quality: population within 3 mile radius [0 - 1]<br>• Site opportunity: value of property at risk [0 - 1]<br>• Compelamentary inputs: is the site within or adjacent to a major urban area [0 - 1]<br>• Reliability: Risk of future service loss through urban development within 3 mile radius [0 - 1] | Index [0 - 1] | , |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [2] Fire risk index. The index is based on the vegetations vul-nerability to wildfires, climatic conditions, and topography. | Index [-] | |

*Table 4: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] (Historical analysis) Protection against fires from lightning strikes: occurrence of big trees near houses that were able to attract lightning and thereby protect the houses | [not provided] | , |

*Table 5: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Fire risk index. The index is based on the vegetations vulnerability to wildfires, climatic conditions, and topography. | Index [-] | |

## References


| No. | Citation |
|---|---|
| 1 | Wainger LA, King DM, Mack RN, Price EW, Maslin T (2010) Can the concept of ecosystem services be practically applied to improve natural resource management decisions? Ecological Economics 69(5): 978-987. DOI: 10.1016/j.ecolecon.2009.12.011 |
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| **Ecosystem Service** | **Pollination** |
|---|---|
| **CICES class name** | Pollination (or 'gamete' dispersal in a marine context) |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.2.1 |

## 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** |
|---|---|---|
| [1] Pollen transported by pollinators | $kg * yr^{-1}$ | |
| [11] Abundance and diversity of pollinators | Not provided | , |
| [15] Abundance of bumblebees | Not provided | |
| [15] Plant Simpson diversity as an indicator for bumblebee abundance. | Not provided | |
| [11] Number of seeds per fruit | # | , |
| [11] Share of fruit set pollinated | % | , |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [8] Share of cropland area less than 100m from a non-cropland edge other than water or impervious surfaces.  Values were scaled to [0-1] | % | |

| | | |
|---|---|---|
| [8] Share of farmers that consider open landscapes a valued landscape feature. Values were scaled to [0-1] | % | |
| [12] Vegetation diversity: four-level index based on the number of plant species | Index [poor-fair-good-excellent] | |
| [19] Richness of pollinators: Total number of Sphingidae collected | # | |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [2] Area of potential nesting sites for wild bees | $m^2$ | |
| [2] Distance between potential nesting sites for wild bees and nearest arable land cell (GIS 10x10 m cells) | m | |
| [2] Number of visitations from wild bees to arable fields, calculated as the sum of visitation probabilities based on proximity between potential nesting sites and arable fields | - | |
| [3] Relative pollination potential: continuous index, based on the availability of floral resources, bee flight ranges and the availability of nesting sites | - | |
| [5] Share of land cover suitable as pollinator habitat in the direct vicinity of cropland | % | |
| [8] Share of cropland area less than 100m from a non-cropland edge other than water or impervious surfaces. Values were scaled to [0-1] | % | |
| [13] Share of area reachable by cavity and ground-nesting pollinator species, assuming 100 and 350 m flight and foraging distances, calculated using the equations by (Lonsdorf et al., 2009) | % | |
| [8] Share of farmers that consider open landscapes a valued landscape feature. Values were scaled to [0-1] | % | |
| [6] Pollination contribution by ecosystems (index): For each cropland, a) the crop pollination dependency ratio was calculated based on the specific crop type, b) the pollinator visitation probability was calculated as a regression between distance to natural habitat and visitation rate. The sum of a) and b) was then assigned to the closest natural ecosystem. | - | |
| [7] Pollination: Values are assigned based on land cover class. 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 | |

| | | |
|---|---|---|
| [10] Habitat scores: number of bee species and medicinal plant species found in a specific land use class divided by benchmark value (number of species in land use class with the highest absolute number of species) | % | , |
| [16] Number of bird & bee pollinators per hectare | # * $ha^{-1}$ | , , |
| [16] Yield of pollinated crops | t * $ha^{-1}$ | , , |
| [17] Abundance of pollinators | Not provided | |
| [17] Richness of pollinators | Not provided | |
| [17] Diversity of pollinators | Not provided | |
| [17] Effects of pollinators | Not provided | |
| [18] Area pollination indicators (Lonsdorf et al., 2009), calculated for different assumptions regarding the distances that pollinators can cover (100 m, 350 m, 500 m):<br>- Area providing flowering [ha]<br>- Area suitable for nesting of wild bees and bumblebees<br>- Share of flowering sites reachable from nesting sites | [ha]<br>[ha]<br>[%] | |
| [21] Seed weight of pollinated plants | tons / ($km^2$ * year) | |

*Table 4: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [4] Resilience of pollination service: number of pollinators morphospecies in the (primarily) pollinator taxa: Lepidoptera, Cerambycidae, Buprestidae and Aculeata. Two or more specimens are considered the same morphospecies if an entomologically trained person (but non-specialist for the respective species groups) can not see external morphological differences. To save costs, only seven weeks where maximum catches are expected were sampled, only the four weeks with the highest catches were identified. | # | |
| [5] Share of land cover suitable as pollinator habitat in the direct vicinity of cropland | % | |
| [14] Pollination potential | Not specified | |
| [14] Pollinators distribution | Not specified | |
| [14] Pollinators species richness | Not specified | |

| | | |
|---|---|---|
| [14] Number of beehives | Not specified | |
| [14] Areal coverage of vegetation features supporting pollination (hedgerows, flower strips, High Nature Value Farmland etc.) | Not specified | |
| [20] Pollinator visitation probability: Land use classes providing wild bee habitats are identified, with grassland/steppe; garrigue and woodland considered full habitats (100%) and arable land and orchards considered partial habitats (50%). Visitation Probability is then calculated as: Visitation Probability = $e^{(-0.00104 \times \text{Distance\_to\_habitat})}$. | [-] | |

*Table 5: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] Relative pollination potential: continuous index, based on the availability of floral resources, bee flight ranges and the availability of nesting sites | [-] | |
| [9] Pollination: 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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| No. | Citation |
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| **Ecosystem Service** | **Nursery populations and habitats** |
|---|---|
| **CICES class name** | Maintaining nursery populations and habitats (Including gene pool protection) |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.2.3 |

## 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** |
|---|---|---|
| [1] Biodiversity & habitats: Earthworms | Not provided |  |
| [2] Species richness of birds | # |  |
| [2] Species richness of farmland birds | # |  |
| [2] Species richness of birds listed as vulnerable or threatened in Annex I of the EU Birds Directive | # |  |
| [6] Overall species richness of flowers relevant to pollinators | # |  |
| [6] Overall species richness of flowers | # |  |
| [15] Herbaceous species richness | # |  |
| [9] Ant species richness as a predictor of overall bird species richness and abundance. | # |  |
| [7] Aboveground biodiversity: number of trees species with DBH≥ 1 cm | # per plot |  |
| [16] Number of carabid- and plant species (alpha diversity) | # |  ,  |

| | | |
|---|---|---|
| [16] Number of red listed species | # | , |
| [7] Aboveground biodiversity: Shannon index of trees species with DBH≥ 1 cm in the plot | - | |
| [12] Diversity of plant community (calculated from species richness and structural diversity) | Dimensionless | |
| [13] Diversity of plant community (calculated from species richness and structural diversity) | Dimensionless | |
| [14] Abundances of soil microathropods (Acari: Oribatida, Acari: Mesostigmata and Collembola) | Not provided | |
| [7] Belowground biodiversity: Number of arthropods per soil pit (25 cm x 25 cm x 30 cm) | # | |
| [7] Belowground biodiversity: Number of earthworms per soil pit (25 cm x 25 cm x 30 cm) | # | |
| [7] Belowground biodiversity: macrofauna richness per soil pit (25 cm x 25 cm x 30 cm) | # of species | |
| [7] Belowground biodiversity: macrofauna diversity per soil pit (25 cm x 25 cm x 30 cm) calculated as Shannon index | - | |
| [1] Biodiversity & habitats: Microarthropod-based soil quality index | Not provided | |
| [1] Biodiversity & habitats: dsDNA content (Fornasier et al., 2014, DOI:10.1016/j.ecolind.2014.03.028) | µg dsDNA * $g^{-1}$ soil | |
| [2] Connectivity. Weighted Euclidean distance between smaller patches of natural habitat and the nearest large habitat patch (i.e.>25 $km^2$). Distances were weighted by the resistance values of land use types in between areas of natural habitat. Resistance values were expert-based, and no distinction was made for species-specific dispersal capacities. In summary, built-up areas were assigned a high resistance value (10), cropland and open water were assigned intermediate resistance values (4), and other land use types, including pasture and recently abandoned farmland, were assigned low resistance values (1 or 2). | Not provided | |
| [3] Distance-to-Nature-Potential (DNP) | Index 0 - 1 | |
| [9] Plant species richness as a predictor of butterfly abundance and species richness | # | |
| [6] Colour richness of flowers relevant for pollinators | # of colour groups visible to pollinators: green, white, yellow, purple, violet, UV | |
| [11] Habitat for arthropods: total number of plant species | # | |

| | | |
|---|---|---|
| [9] Plant Simpson diversity as a predictor of bee and beetle abundance. | Index 0 - 1 | |
| [9] Floristic Quality Assessment (FQA) as a predictor of butter-fly species richness and abundance. FQA is the sum of the products of a species' "coefficient of conservatism" and its percentage of cover (or presence/absence data), calculated over all species. | - | |
| [17] Share of semi-natural habitats | % | |
| [11] Habitat for soil microbes and invertebrates: Soil carbon (0-100cm) | kg C * $m^{-2}$ | |
| [12] Share of years within management period in which protec-tion plant products were used | % | |
| [13] Share of years within management period in which protec-tion plant products were used | % | |
| [5] Groundcover: annual mean daily value expressed as a frac-tion | % | |
| [3] Relative reduction in species richness | % | |
| [3] Relative reduction in species functional diversity | % | |
| [3] Number of species lost regionally and globally | # * $m^{-2}$ | |
| [6] Functional stability: Average species richness of flowers within colour groups during the flowering season (of flowers relevant for pollinators) | # of species | |
| [6] Functional intensity: Average size of flowers or discernible sub-sets of inflorescences that are relevant for pollinators | cm | |
| [17] Carabidae diversity and traits | Not provided | |
| [16] Difference among carabid- and plant species compositions under different management types (beta diversity) | - | , |
| [14] Biodiversity indices for microbial communities (Shannon, Pielou, Evenness); based on genetic fingerprinting of micro-bial communities in DNA extracted from bulk soil, rhizo-sphere soil, and roots. | Not provided | |

| | | |
|---|---|---|
| [9] AntQA index as a predictor of abundance of grassland bird and butterfly species. AntQa is the sum of the products of an ant species' "coefficient of conservatism" and its percentage of presence/absence in an area, calculated over all species. | | |
| [10] EPX (ecosystem-service performance index)<br>Indicator value calculated as:<br>$\mathrm{I}=\frac{\sum \lvert \log(\frac{i}{i_{max}})\rvert}{n}$<br>With: I – Indicator value, 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:<br><br>-pH in KCl<br>-Number of earthworm taxa [-]<br>-Number of nematode taxa [-]<br>-Number of micro-athropode taxa [-]<br>-Physiological diversity bacteria [biolog. CLPP: Hill's slope] | - | , |
| [8] Soil biodiversity indicator) based on a principal component analysis (PCA) of soil macro invertebrate data. Variables included:<br>-Abundance of soil macro invertebrate communities (endogeic earthworms, epigeic earthworms, termites, ants, coleoptera, myriapoda, other litter invertebrate) [individuals * $m^2$]<br>-Taxonomic richness of soil macro invertebrates [not provided]<br>-Sum of soil macro invertebrate collected at each plot [individuals * $m^2$]<br><br>Variables with significant contribution (>50% of the maximum value) to either of the first two principal components, axes were selected and their contribution to PCA axes 1 and 2 multiplied by the overall variability explained by each PCA axis. These weighted factors were summed up and scaled to a range of 0.1 - 1.0. | - | |
| [4] Coffee plantations: 5 level shade index | Index 5 (unshaded monoculture) - 1 (leguminous trees and other plants) | |
| [57] Cumulative avian species richness: number of species and number of breeding pairs observed during 4 site visits, walking at a slow pace and thoroughly surveying the entire site. | n/a | |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [18] Vegetation richness: Number of planted crop species<br><br>The index is calculated by dividing the observed value with a target value. Target values may be average or maximum values found in region or empirical values from the literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | |
| [18] Number of different land cover types<br><br>The index is calculated by dividing the observed value with a target value. Target values may be average or maximum values found in region or empirical values from the literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | |
| [18] Share of the farmland in non-crop vegetation (percent of non-crop)<br><br>The index is calculated by dividing the observed value with a target value. Target values may be average or maximum values found in region or empirical values from the literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | |
| [18] Share of the farmland covered by rare landscape elements (e.g. wetlands, riparian areas, primary forest and prairie)<br><br>The index is calculated by dividing the observed value with a target value. Target values may be average or maximum values found in region or empirical values from the literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | |
| [18] Birds: observed of indicator species<br><br>The index is calculated by dividing the observed value with a target value. Target values may be average or maximum values found in region or empirical values from the literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | |
| [18] Native to total bird species ratio: Index based on observation of indicator species<br><br>The index is calculated by dividing the observed value with a target value. Target values may be average or maximum values found in region or empirical values from the literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | |
| [19] Structural vegetation diversity: four-level index based on the number of different vegetation height classes that occur together (grass, shrubs, trees) | Index poor-fair-good-excellent | |
| [21] Number of plant species observed during surveys within 1000 m from a farmhouse. Values were scaled [0-1]. | # | , |
| [17] Carabidae diversity and traits | Not provided | |

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|---|---|---|
| [20] Biodiversity index based on number of moths, birds, bees, fruit flies, spiders, ants, soil macrofauna, termites, earth-worms, and small, medium, and tall plants | Index 0.1 - 1 | |
| [21] Number of bird species observed during surveys within 300 m from farmhouse. Values were scaled [0-1]. | # | , |
| [22] Red-list biodiversity potential: weighted sum of red-listed species; number of red-listed species across all sampled taxonomic groups in each landscape, weighted by the respective IUCN category in the Swedish national red list. Multiplicators were: near threatened (1), vulnerable (2), endangered (3), regionally extinct (4). | # | |
| [22] Use of bundles of indicator species identified for a certain region. Species may belong to different taxonomic groups | Not provided | |
| [19] Wildlife diversity: four-level index based on the number of species occurring | Index poor-fair-good-excellent | |
| [17] Share of semi-natural habitats | % | |
| [21] Landscape variation: length of land cover "edges" per hectare land surface. Values were scaled [0-1]. | km * $ha^{-1}$ | , |
| [21] Share of farmers surveyed that consider open landscapes valuable landscape elements. Values were scaled [0-1]. | % | , |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [21] Number of plant species observed during surveys within 1000 m from farmhouse. Values were scaled [0-1]. | # | , |
| [23] Biodiversity of plant species: number of species | # | , |
| [23] Biodiversity of plant species: total abundance (i.e. species cover) | Not provided | , |
| [23] Biodiversity of plant species: true species diversity (i.e. exponential of Shannon entropy) | - | , |
| [25] Richness of wild higher plants | # | |
| [37] Plant diversity: Plants Simpson's biodiversity index | Index 0 - 1 | |
| [41] Number of weed species on arable land per relevé (method of Braun-Blanquet, 1964) | # | |
| [17] Carabidae diversity and traits | Not provided | |

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|---|---|---|
| [21] Number of bird species observed during surveys within 300 m from farmhouse. Values were scaled [0-1]. | # | , |
| [25] Richness of wild higher animals | # | |
| [29] Terrestrial vertebrate species richness, calculated with the GAP Analysis program from the U.S. Geological Survey | # of species * $ha^{-1}$ | |
| [31] Biodiversity & biological activity index: The index is based on the collection and sorting of soil macrofauna (including ants) into 16 taxonomic groups (e.g., Oligochaeta, Isoptera, Coleoptera) largely separated by order. | Index 0.1 - 1 | |
| [31] Bio-indicator: Presence of specific ant species is used as an indicator for high, medium or low provision of this ecosystem service. Suitable indicator species must first be identified by a correlation between the presence of species and ecosystem service provision. | | |
| [46] Number of endangered species of vertebrates, invertebrates and plants | # * $km^{-2}$ | |
| [22] Red-list biodiversity potential: weighted sum of red-listed species; number of red-listed species across all sampled taxonomic groups in each landscape, weighted by the respective IUCN category in national red list. Multiplicators were: near threatened (1), vulnerable (2), endangered (3), regionally extinct (4). | # | |
| [22] Use of bundles of indicator species identified for a certain region. Species may belong to different taxonomic groups | Not provided | |
| [24] Biological diversity: composition of flora and fauna communities in relation to the potential natural communities | Not provided | |
| [25] Number of endemic species | # | |
| [28] Wetland habitats: Number of unique species in wetlands and floodplains | # | |
| [34] Bioscore index based on national biodiversity map. Scores are calculated as sum of scores for the distribution of endangered species (1-9), and from scores based on selected species and habitat indicators (1-11). All intensively cultivated fields are assigned a score of 0 by default. | Index 0 - 20 | |
| [35] Alpha, beta and gamma diversity of bird species and woody species. Bird species values based on point measurements, recording all birds seen or heard up to a 30 m radius within a 10 min period (except flyover birds). Woody species values based on determining all woody plants with diameter at breast height > 5 cm. | - | |

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|---|---|---|
| [36] Habitat scores: number of species found in a specific land use class divided by benchmark value (number of species in land use class with the highest absolute number of species). | % | , |
| [36] Habitat scores for endangered species: number of endangered species found in a specific land use class divided by benchmark value (number of endangered species in land use class with the highest absolute number of endangered species). | % | , |
| [45] Number and identity of selected species in rivers or lakes | # | |
| [45] Biodiversity value (e.g., species richness, species composition) | Not provided | |
| [49] Mean species value per hectare: score based on the habitat suitability for all vertebrate and vascular plant species listed in the UK Biodiversity Action Plan, each rated [0 – 1] multiplied by their respective colonization potential, each [0 – 1]. The scores are weighted so that each species contributes equally, regardless of how many habitat types it occurs in. | - | |
| [40] Genetic Resources: Number and varieties of species | # | , , |
| [17] Share of semi-natural habitats | % | |
| [44] Share of semi-natural habitat | % | , |
| [44] Number of the semi-natural habitat types | # | , |
| [21] Landscape variation: length of land cover "edges" per hectare land surface. Values were scaled [0-1]. | km * $ha^{-1}$ | , |
| [25] Diversity of ecosystem types | # | |
| [25] Proportion of woodland, garden and grassland area in total | % | |
| [26] Area of "*ecological compensation areas*" | ha | |
| [38] Share of special protection area relative to municipality's surface area. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | % | |
| [38] Share of habitats of community interest relative to municipality's surface area. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | % | |
| [39] Designated Natura 2000 areas | ha | |

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|---|---|---|
| [27] Indicator for ecological integrity, based on:<br>-Naturalness: Hemeroby index [not provided]<br>-Land use diversity: Number of plant species [not provided]<br>-Landscape fragmentation (landscape metrics): Effective mesh size [not provided],<br>-Core area index [not provided]<br>-Landscape diversity: Shannon diversity index [-]<br>-Patch density [not provided]<br>-Shape index [not provided]<br>-Habitat connectivity: Cost distance analysis [not provided] | Index 1 - 100 | |
| [32] Habitat index from InVEST model | Index 0 - 1 | |
| [33] Size and distribution of strictly protected areas (nature reserves, biosphere reserve, Natura 2000) | Not provided | |
| [42] Landscape heterogeneity: Satoyama index, calculated as Simpson's diversity index for land uses multiplied by the proportion "non-urban, non-agricultural" land use classes. | Index 0 - 1 | |
| [43] Providing nurseries, habitat for species and conserving genetic diversities: expert-based index for ecosystem service provision by each land cover class [1-5], multiplied by the area of the land cover class | $km^2$ | , , |
| [43] Providing nurseries, habitat for species and conserving genetic diversities value: expert-based index for ecosystem service provision by each land cover class [1-5], multiplied by the area of the land cover class and literature-based monetary value of the ecosystem service | $km^2$, $ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [44] Structural diversity measured by the Simpson diversity index | - | |
| [45] Ecological-morphological status | preferences, e.g., good, neutral, bad | |
| [45] Floodplain area | ha | |
| [23] Floodplains: Riparian Quality Index (RQI). The index considers (i) average width of riparian corridor; (ii) longitudinal continuity, coverage and distribution pattern of riparian corridor (woody vegetation); (iii) composition and structure of riparian vegetation; (iv) age diversity and natural regeneration of woody species; (v) bank conditions; (vi) floods and lateral connectivity; and (vii) substratum and vertical connectivity | Index 0 - 100 | , |
| [46] Number of ecosystem types per area (based on classification in national ecosystem assessment) | # * $area^{-1}$ | |
| [47] Habitat richness based on landscape metrics: Simpson diversity index | - | |

| | | |
|---|---|---|
| [47] Habitat richness based on landscape metrics: Share of seminatural habitat | % | |
| [47] Habitat richness based on landscape metrics: Number of seminatural habitat types | # | |
| [48] Biodiversity conservation, calculated as: $$BC = NPP * (1 - VC_{NNP}) * I_W * N_f$$ With: BC – Biodiversity conservation, 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], $I_W$ – water input to the system, calculated as *rainfall* * (1–runoff coefficient) and scaled to a range of [0 -1], $N_f$ – naturalness factor considering naturalness and structural complexity of the ecosystem [0 – 1] | - | |
| [49] Habitat conservation score, based on conservation priorities and significance of habitats. Conservation priorities were derived from the policy document, while significance was determined by calculating the proportion of the national and regional resource that occurred for each habitat type at each site, and particular site-specific features. | - | , |
| [21] Share of farmers surveyed that consider open landscapes valuable landscape elements. Values were scaled [0-1]. | % | , |
| [30] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | - | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [53] Area weighted mean species richness of vascular plants | # of species | |
| [50] Diversity of breeding bird species (Simpson-index) | - | |
| [50] Number of farmland bird species | # | |
| [51] Species diversity: Expert assessment for each land use class, based on the indicators: species number; endangered species; invasive species (units not given) | very negative (−3) to very positive (+3) | |
| [52] Species of conservation concern: based on species listed in U.K. Biodiversity Action Plan and recorded in a grid cell (further specification lacking) | not provided | , |

| | | |
|---|---|---|
| [51] Genetic diversity: Expert assessment for each land use class, based on the indicator: crop variety (units not given) | very negative (−3) to very positive (+3) |  |
| [51] Habitat diversity: Expert assessment for each land use class, based on the indicators: intensive agriculture; homogeneity; fragmentation; extensive/organic agriculture (units not given) | very negative (−3) to very positive (+3) |  |
| [53] Degree of naturalness: 7-point scale indicator | 1 (natural) - 7 (artificial) |  |
| [54] Area of high nature value farmland | ha |  |
| [55] Share of high nature value farmland | % |  |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [56] Biodiversity: Values assigned 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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| **Ecosystem Service** | **Pest control (including invasive species)** |
|---|---|
| **CICES class name** | Pest control (including invasive species) |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.3.1 |

## 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 20: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Injuries by root-lesion nematodes: Number of root-lesion nematode in 100 g of roots | # * $100g^{-1}$ | |
| [1] Injuries by root-knot nematodes: Number of root-knot nematode in 100 g of roots | # * $100g^{-1}$ | |
| [7] Level of injury severity, fruit loss, leaf loss, LAI loss | % | , |
| [9] Damage from pests six weeks after planting. Based on visual inspection of 40 randomly selected plants. | Index 1-3 | |
| [5] Biological control: total number of plant species | # | |
| [15] Nematode abundance | Not provided | |
| [9] Weed cover | kg * $ha^{-1}$ | |
| [15] Weed biomass | Not provided | |
| [15] Weed density | Not provided | |
| [7] Rates of predation by natural enemies, rates of parasitism by parasitoids | Not provided | , |
| [7] Indicators or models to assess the impact of pesticides | Not provided | , |

| | | |
|---|---|---|
| [11] Abundance of ladybird beetles (natural enemies of aphids and other sap-sucking pest species) | Not provided | |
| [11] Plant Simpson diversity as predictor of beetle abundance | Not specified | |
| [11] Abundance of birds from species that are known insectivores in agricultural fields | Not provided | |
| [11] Ant species richness as predictor of the abundance of birds, including those from species that are known insectivores. | Not provided | |
| [12] 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:<br>-Soil organic matter [% dw]<br>-pH in KCl<br>-Number of nematode taxa [-]<br>-Number of micro-arthropod taxa [-]<br>-Density of nematode plant-parasites [number per 100 g soil] | - | , |
| [14] Aphid biocontrol index; based on pairwise pot experiment introducing and exposing twenty-four aphids over a five-day period. The number of pests in an open treatment was divided by the number of pests in a caged treatment that excluded ground-dwelling and flying natural enemies. Values were standardized to a maximum value of 1. | Index 0-1 | |
| [14] Use of bundles of indicator species identified for a certain region. Species may belong to different taxonomic groups | Not provided | |
| [21] Carabid activity density | - | |
| [21] Number of carabid species caught in pitfall traps | # | |
| [21] Spider activity density | - | |
| [21] Rove beetle activity density | - | |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [6] Share of cropland area less than 100m from a non-cropland edge other than water or impervious surfaces. Values were scaled to [0-1] | % | , |
| [6] Share of farmers surveyed that clearly expresses a value and care for the health of the land. Values were scaled to [0-1] | % | , |
| [8] Vegetation diversity: four-level index based on the number of plant species | Index [poor-fair-good-excellent] | |
| [14] Aphid biocontrol index; based on pairwise pot experiment introducing and exposing twenty-four aphids over a five-day period. The number of pests in an open treatment was divided by the number of pests in a caged treatment that excluded ground-dwelling and flying natural enemies. Values were standardized to a maximum value of 1. | Index 0-1 | |
| [14] Use of bundles of indicator species identified for a certain region. Species may belong to different taxonomic groups | Not provided | |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [16] Pest abundance | Not provided | |
| [16] Pest richness | Not provided | |
| [16] Pest damage | Not provided | |
| [16] Natural enemy abundance | Not provided | |
| [16] Natural enemy richness | Not provided | |
| [16] Natural enemy diversity | Not provided | |
| [16] Direct natural enemy effects on pest reduction | Not provided | |
| [2] Capacity for biological regulation: number of habitats for pest control species | Not provided | |
| [3] Number of species providing natural control of invertebrate and rodent pest species | # | |
| [14] Aphid biocontrol index; based on pairwise pot experiment introducing and exposing twenty-four aphids over a five-day period. The number of pests in an open treatment was divided by the number of pests in a caged treatment that excluded ground-dwelling and flying natural enemies. Values were standardized to a maximum value of 1. | Index 0-1 | |

| | | |
|---|---|---|
| [13] Number of cases of reduced pest infestation in the locality | # | , , |
| [6] Share of cropland area less than 100m from a non-cropland edge other than water or impervious surfaces. Values were scaled to [0-1] | % | , |
| [6] Share of farmers surveyed that clearly expresses a value and care for the health of the land. Values were scaled to [0-1] | % | , |
| [14] Use of bundles of indicator species identified for a certain region. Species may belong to different taxonomic groups | Not provided | |
| [17] Expert-/stakeholder rating of how much of this ES can be provided by a landscape (represented by a land use map) | 6-point Lickert-scale (none – highest capacity) | |
| [17] Expert-/stakeholder rating based on pairwise comparisons of landscapes (represented by land use maps) in an Analytical Hierarchical Process (AHP). Experts select the landscape with higher capacity for providing this ES and rate the difference between the two landscapes | 1 (equal capacity) – 9 (absolute preference of one landscape) | |
| [18] Area used for organic agriculture | n/a | |
| [19] Pests' natural enemy biomass | n/a | |
| [19] Pests' egg predation | n/a | |
| [19] For plants with insecticidal properties: amount of active ingredient | kg/ km$^{-2}$ | |
| [19] Amount of insecticide used per unit | tons / km$^{-2}$ | |
| [20] Area of flower strips suitable for natural enemies of agricultural pests | n/a | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [4] Resilience of pest control service: number of arthropod morphospecies from (primarily) carnivorous taxa divided by number of morphospecies from (primarily) herbivorous taxa. Two or more specimens are considered the same morphospecies if an entomologically trained person (but non-specialist for the respective species groups) cannot see external morphological differences | [-] | |
| [10] Density of hedgerows | m * ha$^{-1}$ | |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Number of species providing natural control of invertebrate and rodent pest species | # | |

## References



| No. | Citation |
|---|---|
| 1 | Allinne C, Savary S, Avelino J (2016) Delicate balance between pest and disease injuries, yield performance, and other ecosystem services in the complex coffee-based systems of Costa Rica. Agriculture Ecosystems & Environment 222: 1-12. DOI: 10.1016/j.agee.2016.02.001 |
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* The impact area discussed on this factsheet is not a focus of the cited paper

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|---|---|
| 12 | Rutgers M, van Wijnen HJ, Schouten AJ, Mulder C, Kuiten AMP, Brussaard L, Breure AM (2012) A method to assess ecosystem services developed from soil attributes with stake-holders and data of four arable farms. Science of the Total Environment 415: 39-48. DOI: 10.1016/j.scitotenv.2011.04.041 |
| 13 | Adhikari S, Baral H, Nitschke CR (2018) Identification, Prioritization and Mapping of Ecosys-tem Services in the Panchase Mountain Ecological Region of Western Nepal. Forests 9(9): 554. DOI: 10.3390/f9090554 |
| 14 | Birkhofer K, Rusch A, Andersson GKS, Bommarco R, Dänhardt J, Ekbom B, Jönsson A, Lind-borg R, Olsson O, Rader R, Stjernman M, Williams A, Hedlund K, Smith HG (2018) A frame-work to identify indicator species for ecosystem services in agricultural landscapes. Ecologi-cal Indicators 91: 278-286. DOI: 10.1016/j.ecolind.2018.04.018 |
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| **Ecosystem Service** | **Disease control** |
|---|---|
| **CICES class name** | Disease control |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.3.2 |

## 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 21: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Leaf damages: Maximal percentage of young leaves in-fected in the year | % | |
| [1] Plant damages: Dieback. Percentage of (coffee) plants in-fected in the plot | % | |
| [3] Damage from diseases six weeks after planting. Based on visual inspection of 40 randomly selected plants. | Index 1 - 3 | |
| [1] Fruit Damages: Incidence of Ceratocystis canker. Maximal percentage of fruits infected in the year | % | |
| [2] Level of injury severity, fruit loss, leaf loss, LAI loss | % | , |
| [2] Indicators or models to assess the impact of pesticides | Not provided | , |
| [4] Indicator value calculated as: $$I=\frac{\sum\lvert\log(\frac{i}{i_{max}})\rvert}{n}$$ With: i – variable i measured, $i_{max}$ – maximum ecologic po-tential 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 ef-fect, $\lvert\log(\frac{i}{i_{max}})\rvert$ is subtracted from the sum instead of | - | , |

| | | |
|---|---|---|
| added. For this ecosystem service, variables were:<br>-Soil organic matter [% dw]<br>-pH in KCl<br>-Number of nematode taxa [-]<br>-Number of micro-arthropod taxa [-]<br>-Density of nematode plant-parasites [number per 100 g soil] | | |

*Table 22: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [6] Disease prevalence | Not provided |  |
| [6] Host and vector abundances | Not provided |  |
| [6] Infection levels | Not provided |  |
| [7] Expert-/stakeholder rating of how much of this ecosystem service can be provided by a landscape (represented by a land use map) | 6-point Likert-scale (none - highest capacity) |  |
| [7] Expert-/stakeholder rating based on pairwise comparisons of landscapes (represented by land use maps) in an Analytical Hierarchical Process (AHP). Experts select the landscape with higher capacity for providing this ecosystem service and rate the difference between the two landscapes | 1 (equal capacity) - 9 (absolute preference of one landscape) |  |
| [5] Human diseases: number of diseases and effects among local inhabitants | # | , ,  |
| [9] Area used for organic agriculture | n/a |  |

*Table 23: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [8] Density of hedgerows | m * $ha^{-1}$ |  |

## References


| No. | Citation |
|---|---|
| 1 | Allinne C, Savary S, Avelino J (2016) Delicate balance between pest and disease injuries, yield performance, and other ecosystem services in the complex coffee-based systems of Costa Rica. Agriculture Ecosystems & Environment 222: 1-12. DOI: 10.1016/j.agee.2016.02.001 |
| 2 | Demestihas C, Plénet D, Génard M, Raynal C, Lescourret F (2017) Ecosystem services in orchards. A review. Agronomy for Sustainable Development 37(2): 12. DOI: 10.1007/s13593-017-0422-1 |
| 3 | Kearney SP, Fonte SJ, García E, Siles P, Chan KMA, Smukler SM (2019) Evaluating ecosystem service trade-offs and synergies from slash-and-mulch agroforestry systems in El Salvador. Ecological Indicators 105: 264-278. DOI: 10.1016/j.ecolind.2017.08.032 |
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| 8 | Maes J, Liquete C, Teller A, Erhard M, Paracchini ML, Barredo JI, Grizzetti B, Cardoso A, Somma F, Petersen JE, Meiner A, Gelabert ER, Zal N, Kristensen P, Bastrup-Birk A, Biala K, Piroddi C, Egoh B, Degeorges P, Fiorina C, Santos-Martín F, Naruševičius V, Verboven J, Pereira HM, Bengtsson J, Gocheva K, Marta-Pedroso C, Snäll T, Estreguil C, San-Miguel-Ayanz J, Pérez-Soba M, Grêt-Regamey A, Lillebø AI, Malak DA, Condé S, Moen J, Czúcz B, Drakou EG, Zulian G, Lavalle C (2016) An indicator framework for assessing ecosystem services in support of the EU Biodiversity Strategy to 2020. Ecosystem Services 17: 14-23. DOI: 10.1016/j.ecoser.2015.10.023 |
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| **Ecosystem Service** | **Soil quality by weathering processes** |
|---|---|
| **CICES class name** | Weathering processes and their effect on soil quality |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.4.1 |

## 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 24: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Net annual prevention of soil erosion through soil formation | t * $ha^{-1}$ * $yr^{-1}$ | , , |
| [2] Soil formation and erosion prevention: expert-based index for ecosystem service provision by land cover class [1-5], multiplied by the area of the land cover class | $km^2$ | , , |
| [2] Soil formation and erosion prevention value: expert-based index for ecosystem service provision by land cover class [1-5], multiplied by the area of the land cover class and a literature-based monetary value of the ecosystem service | $ * $yr^{-1}$ | , , |

*Table 25: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Share of organic farming | % | |
| [3] Soil organic matter content | % | |
| [3] pH of topsoil | - | |

| | | |
|---|---|---|
| [3] Cation exchange capacity | cmol(+) * $kg^{-1}$ | |

## References


| No. | Citation |
|---|---|
| 1 | Adhikari S, Baral H, Nitschke CR (2018) Identification, Prioritization and Mapping of Ecosystem Services in the Panchase Mountain Ecological Region of Western Nepal. Forests 9(9): 554. DOI: 10.3390/f9090554 |
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| **Ecosystem Service** | **Soil quality by decomposition and fixing processes** |
|---|---|
| **CICES class name** | Decomposition and fixing processes and their effect on soil quality |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.4.2 |

## 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** |
|---|---|---|
| [1] Nutrient cycling:<br>-pH<br>-Cation exchange capacity<br>-Water-filled pore space | Not provided | |
| [1] C cycling:<br>-Soil organic carbon<br>-$KMnO_4$ oxidizable C<br>-Beta-glucosidase activity<br>-Metabolic $CO_2$ quotient | Not provided | |
| [2] Soil organic carbon depletion | kg C * $ha^{-1}$ * $yr^{-1}$ | |
| [1] N cycle:<br>-Total nitrogen<br>-Potentially mineralizable nitrogen<br>-Leucine aminopeptidase activity<br>-N-acetyl glucosamine activity | Not provided | |
| [3] Biological nitrogen fixation | kg N * $ha^{-1}$ * $yr^{-1}$ | - |
| [1] P cycle:<br>-Available inorganic P<br>-Alkaline phosphomonoesterase activity<br>-Phosphodiesterase activity | Not provided | |

| | | |
|---|---|---|
| [4, 20] Soil organic carbon in topsoil (0-20cm) | g * $kg^{-1}$ | |
| [6] Soil organic carbon (0-20 cm), calculated from loss on ignition | % | |
| [5] Carbon stocks in soil biomass (0-30 cm) | Mg * $ha^{-1}$ | |
| [7] Soil organic carbon stock over a 2.5 m deep soil profile | kg * $ha^{-1}$ | |
| [12] Total soil organic carbon (0-20 cm, 20-60 cm) | g * $kg^{-1}$ | |
| [12] Soil carbon stock in 0 -20 and 20 – 60 cm depth | Mg * $ha^{-1}$ | |
| [14] Soil organic carbon concentration in top soil (0-5 cm) and rooting layer (5-60 cm) | %, g * $g^{-1}$ | |
| [14] Soil organic carbon stock in top soil (0-5 cm) and rooting layer (5-60 cm) | kg * $ha^{-1}$ | |
| [17] Soil carbon (0-100cm) | kg C * $m^{-2}$ | |
| [18] Carbon stock in soil: organic C contained in topsoil (0–30 cm) after 20 years of management | t * $ha^{-1}$ | |
| [19] Carbon stock in soil: organic C contained in topsoil (0–30 cm) after 20 years of management | t * $ha^{-1}$ | |
| [21] $C_{tot}$: Total carbon content in soil sample (0-7.5 cm), measured as weight loss on ignition | % | |
| [21] $C_{org}$: Organic carbon content in soil sample (0-7.5 cm,) measured by wet combustion ($Cr_2O_7$ oxidation) and colorimetric analysis | % | |
| [21] $C_{labile}$: Labile carbon content in soil sample (0-7.5 cm), measured by oxidation with 333 mM $KMnO_4$ and spectral analysis at 565 nm | % | |
| [21] CMI: Carbon management index, calculated as: $$CMI = \frac{C_{totagr}}{C_{totnat}} * \frac{C_{labileagr}}{C_{non-labileagr}} * \frac{100}{\frac{C_{labilenat}}{C_{non-labilenat}}}$$ With: $C_{totagr}$ – $C_{tot}$ in agricultural site, $C_{totnat}$ – $C_{tot}$ under native vegetation, $C_{labileagr}$ – $C_{labile}$ inagricultural site, $C_{non-labileagr}$ – $C_{non-labile}$ in agricultural site, $C_{labilenat}$ – $C_{labile}$ under native vegetation, $C_{non-labilenat}$ – $C_{non-labile}$ under native vegetation | Index 0 - 100 | |
| [21] LCMI: Landscape carbon management index, calculated as: | - | |

| | | |
|---|---|---|
| $LCMI = CMI_{nat} * S_{nat} + CMI_{grass} * S_{grass} + CMI_{crop} * S_{crop}$ With: $CMI_{nat}$ – CMI (native vegetation), $S_{nat}$ – share of native vegetation in landscape, $CMI_{grass}$ – CMI (grassland), $S_{grass}$ – share of grassland in the landscape, $CMI_{crop}$ – CMI (cropland), $S_{crop}$ – share of cropland in the landscape | | |
| [13] Litter cover | cm | |
| [13] Biological soil cover | cm | |
| [12] Soil carbon/nitrogen ratio (0-20cm) | - | |
| [17] C/N ratio in soil (0-100 cm) | - | |
| [4] TN - total nitrogen in topsoil (0-20cm) | $g * kg^{-1}$ | |
| [4] Net N mineralisation | $mg * kg^{-1}$ | |
| [6] Total N content in soil samples (0-20 cm), calculated from dry combustion data | % | |
| [7] Nitrogen mineralization | $kg\ TN * ha^{-1} * yr^{-1}$ | |
| [20] Net N mineralisation | $mg * kg^{-1}$ | |
| [8] Soil nitrogen availability: Soil organic nitrogen variation | $kg\ N * ha^{-1} * yr^{-1}$ | , |
| [8] Soil nitrogen availability: Mean, maximal and minimal soil nitrate concentration over a time period | $mg\ NO_3\text{-}N * kg$ dry $soil^{-1}$ | , |
| [12] Total nitrogen in soil (0-20 cm, 20-60 cm) | $g * kg^{-1}$ | |
| [14] Soil total nitrogen concentration in top soil (0-5 cm) and rooting layer (5-60 cm) | %, $g * g^{-1}$ | |
| [14] Soil total nitrogen stock in top soil (0-5 cm) and rooting layer (5-60 cm) | $kg * ha^{-1}$ | |

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|---|---|---|
| [15] Amount of organic nitrogen stocked or destocked within the soil | kg N * $ha^{-1}$ * $yr^{-1}$ | |
| [15] Mean nitrate concentration in topsoil (0–30 cm) | mg $NO_3^-$N * kg $dm^{-1}$ | |
| [17] Nitrate leaching | kg $NO_3^-$N * $ha^{-1}$ * $yr^{-1}$ | |
| [19] Nitrate concentration in seepage water | mg * $l^{-1}$ * $yr^{-1}$ | |
| [18] Nutrient use efficiency (N): Total harvested biomass in dry matter (DM) produced per unit of nutrient assimilated | kg * kg $biomass^{-1}$ | |
| [20] TN - total nitrogen in topsoil (0-20cm) | g * $kg^{-1}$ | |
| [4] Plant available phosphorus in topsoil (0-20cm): Bray P | mg * $kg^{-1}$ | |
| [6] Soil phosphorous content (0-20 cm), calculated from acetate extraction & ICP data | mg P * kg $soil^{-1}$ | |
| [14] Soil total phosphorus concentration in top soil (0-5 cm) and rooting layer (5-60 cm) | %, g * $g^{-1}$ | |
| [14] Soil total phosphorus stock in top soil (0-5 cm) and rooting layer (5-60 cm) | kg * $ha^{-1}$ | |
| [18] Nutrient use efficiency (P): Total harvested biomass in dry matter (DM) produced per unit of nutrient assimilated | kg * kg $biomass^{-1}$ | |
| [19] Nutrient use efficiency (N & P): Total harvested biomass in dry matter (DM) produced per unit of nutrient assimilated | kg * kg $biomass^{-1}$ | |
| [19] Phosphorus loss - particulate | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [20] Plant available phosphorus in topsoil (0-20cm): Bray P | mg * $kg^{-1}$ | |
| [6] Soil potassium content (0-20 cm), calculated from acetate extraction & ICP data | mg P * kg $soil^{-1}$ | |
| [12] Soil cation exchange capacity (CEC) | cmol * $kg^{-1}$ | |
| [12] Exchangeable Ca, Mg, K and Na | cmol * $kg^{-1}$ | |

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|---|---|---|
| [4,20] pH in topsoil (0-20cm) | - | |
| [6] Soil pH (water) | - | |
| [12] pH (soil:water = 1:5) | - | |
| [12] Total equivalent $CaCO_3$ | % | |
| [12] Electrical conductivity (soil:water = 1:5) | $mS * cm^{-1}$ | |
| [5] Indicator of chemical soil quality in topsoil (0-10 cm), based on pH $H_2O$; CEC; exchangeable $K^+$, $Ca^{2+}$, $Mg^{2+}$, $Al^{3+}$ & $NH_4^+$ and extractable phosphorus concentrations | 0.1 - 1 | |
| [13] Soil nutrients (0–10 cm) | $kg * ha^{-1}$ | |
| [9] Soil composition:<br>-pH (in $H_2O$)<br>-total soil organic matter (SOM) [%]<br>-available phosphorus (P) [$mg * kg^{-1}$]<br>-potassium (K) [$mg * kg^{-1}$]<br>-calcium (Ca) [$cmolc * kg^{-1}$]<br>-magnesium (Mg) [$cmolc * kg^{-1}$] using the Mehlich-3 method<br>-bulk density [$g * cm^{-3}$] | - | |
| [10] Chemical soil fertility indicator based on a principal component analysis (PCA) of 20 variables evaluated at 0–10 cm and 10–20 cm. Variables included:<br>-C and N contents<br>-Cation exchange capacity (CEC)<br>-Al saturation<br>-Concentrations of Ca, K, Mg, P Bray II, Al, B, Fe, Mn, Cu, Zn<br>-Soil pH measured in 2:1 water solution<br><br>Variables with significant contribution (>50 % of the maximum value) to either of the first two principal component axes were selected and their contribution to PCA axes 1 and 2 multiplied by the overall variability explained by each PCA axis. These weighted factors were summed up and scaled to a range of 0.1 - 1.0. | Index 0.1 - 1.0 | |
| [12] Decomposition rate of commercially available tea bags (weight loss) | $g * d^{-1}$ | |
| [12] Decomposition rate of commercially available tea bags (stabilization factor); factor associated with labile compounds that become recalcitrant and do not decompose. | Range 0 - 1 | |

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|---|---|---|
| [4] Microbial biomass of bacteria and fungi in topsoil (0-20cm), based on characterization by extracted phospholipid fatty acids (PLFAs) | mg C * $g^{-1}$ | |
| [6] Biomass of bacteria, saprophytic fungi and arbuscular mycorrhizal fungi (0-20 cm), calculated from phospho- and neutral lipid fatty acid analysis data (PLFA, NLFA) data | nmol * g $soil^{-1}$ | |
| [20] Microbial biomass of bacteria and fungi in topsoil (0-20cm), based on characterization by extracted phospholipid fatty acids (PLFAs) | mg C * $g^{-1}$ | |
| [12] Enzyme activity: soil analysis for<br>-N-acetyl-β-glucosaminidase (NAG)<br>-β-glucosidase (β-G)<br>-butyrate esterase (BUT)<br>-acid phosphatase (AP)<br>-arylsulphatase (ARYL)<br>-β-xylosidase (XYL)<br>-cellulose (CELL)<br>-acetate esterase (AC) activity | kat | |
| [12] Sum of soil enzyme activity: sum of the percentage of the maximum value found for a specific enzymatic response across all enzymes investigated | - | |
| [11] Indicator value calculated as:<br>$$\mathrm{I}=\frac{\sum \lvert \log(\frac{i}{i_{max}}) \rvert}{n}$$<br>With: i – variable I measured, $i_{max}$ – maximum ecological 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.<br>a) with a focus on "nutrient retention and release", variables for this ecosystem service were:<br>-Soil organic matter [% dw]<br>-Earthworm abundance [number * $m^{-2}$]<br>-pH in KCl<br>-Potential C mineralization [mg C * kg $soil^{-1}$ * $week^{-1}$]<br>-Potential N mineralization [mg N * kg $soil^{-1}$ * $week^{-1}$]<br>-Water-soluble P (Pw) and extractable P (PAL)<br>b) with a focus on "fragmentation and mineralization of soil organic matter ", variables for this ecosystem service were:<br>-Soil organic matter [% dw]<br>-Earthworm abundance [# * $m^{-1}$]<br>-Bacterial biomass [mg C * g $dw^{-1}$]<br>-Physiological diversity bacteria [biolog. CLPP: Hill's slope] | | , |

| | | |
|---|---|---|
| -Potential C mineralization [mg C * kg soil$^{-1}$ * week$^{-1}$]<br>-Potential N mineralization [mg N * kg soil$^{-1}$ *week$^{-1}$] | | |
| [16] Soil fertility, indicated by high organic matter, low bulk density, high soil nutrient contents:<br>-Soil organic matter [%]<br>-Bulk density [g * cm$^{-3}$]<br>-Percent weight of C [%]<br>-Percent weight of N [%]<br>-C:N Ratio [-] | | |
| [42] SOC in top soil (0–20 cm) at the end of a 30-year simulation period | Mg of carbon / hectare | |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [22] Topsoil carbon stock: calculated from bulk density and total C content at 0–10, 10–20, and 20–30 cm depths | Mg C * ha$^{-1}$ | |
| [22] Soil chemical quality index based on exchangeable $Ca^{2+}$, $Mg^{2+}$,$K^{+}$, $Al^{3+}$ and $NH_4^{+}$, and extractable P contents at a 0–10 cm depth | 0.1 - 1 | |
| [24] Index of soil quality BISQ (richness; structure; function) | Not provided | |
| [23] Vegetation diversity: four-level index based on the number of plant species | poor-fair-good-excellent | |
| [24] Earthworm biomass and diversity | g * m$^{-2}$, species # * m$^{-2}$ | |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [26] Soil organic carbon stock (30 cm) | t C * ha$^{-1}$ | |
| [28] Soil organic carbon content (0-30 cm) | % | , |
| [30] Soil organic carbon stock | t C * ha$^{-1}$ | |
| [35] Soil organic carbon content | g * kg$^{-1}$ | |
| [27] Organic matter layer thickness in topsoil (0-10cm) | cm | |

| | | |
|---|---|---|
| [27] Organic matter content in topsoil (0-10 cm) | % Weight | |
| [33] Topsoil organic carbon content | % | |
| [36] Carbon storage in aboveground, belowground, soil, and dead organic carbon, calculated with InVEST model based on land use/land cover information | Mg * $ha^{-1}$ | |
| [37] Soil carbon stock | kg C * $ha^{-1}$ | |
| [23] $C_{tot}$: Total carbon content in soil sample (0-7.5 cm), measured as weight loss on ignition | % | |
| [23] $C_{org}$: Organic carbon content in soil sample (0-7.5 cm,) measured by wet combustion ($Cr_2O_7$ oxidation) and colorimetric analysis | % | |
| [23] $C_{labile}$: Labile carbon content in soil sample (0-7.5 cm), measured by oxidation with 333 mM $KMnO_4$ and spectral analysis at 565 nm | % | |
| [23] CMI: Carbon management index, calculated as: $$CMI = \frac{C_{totagr}}{C_{totnat}} * \frac{C_{labileagr}}{C_{non-labileagr}} * \frac{100}{\frac{C_{labilenat}}{C_{non-labilenat}}}$$ With: $C_{totagr}$ – $C_{tot}$ in agricultural site, $C_{totnat}$ – $C_{tot}$ under native vegetation, $C_{labileagr}$ – $C_{labile}$ inagricultural site, $C_{non\text{-}labileagr}$ – $C_{non\text{-}labile}$ in agricultural site, $C_{labilenat}$ – $C_{labile}$ under native vegetation, $C_{non\text{-}labilenat}$ – $C_{non\text{-}labile}$ under native vegetation | | |
| [23] LCMI: Landscape carbon management index, calculated as: $$LCMI = CMI_{nat} * S_{nat} + CMI_{grass} * S_{grass} + CMI_{crop} * S_{crop}$$ With: $CMI_{nat}$ – CMI (native vegetation), $S_{nat}$ – share of native vegetation in landscape, $CMI_{grass}$ – CMI (grassland), $S_{grass}$ – share of grassland in the landscape, $CMI_{crop}$ – CMI (cropland), $S_{crop}$ – share of cropland in the landscape | | |
| [34] Nitrogen loss | kt N | |
| [35] Total nitrogen content | g * $kg^{-1}$ | |
| [35] Total phosphorus content | mg * $g^{-1}$ | |

| | | |
|---|---|---|
| [25] Total "Emergy" of the amounts of nitrogen, potassium and phosphorus in the soil | seJ | |
| [35] pH | - | |
| [29] Soil chemical fertility index. The index is based on the parameters: pH, SOM, total N, available P, Al saturation, cation exchange capacity, and macronutrient concentrations at the 0–10 cm and 10–20 cm depths. | 0.1 - 1 | |
| [32] Maintenance of soil fertility: expert based index for ecosystem service provision by land cover class [1-5], multiplied by the area of the land cover class | $km^2$ | , , |
| [32] Maintenance of soil fertility value: expert based index for ecosystem service provision by land cover class [1-5]. multiplied by the area of the land cover class and a literature-based monetary value of the ecosystem service | $ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [24] Index of soil quality BISQ (richness; structure; function) | Not provided | |
| [31] Natural soil production capacity: (for historic analyses in Germany) Prussian Taxation soil production capacity index | 1 - 8 | , |
| [31] Natural soil production capacity: (for Germany) German soil inventory production potential index (for historical analyses); index value represents the percentage of potential yield relative to most productive soils in Germany. | 1 - 100 | , |
| [29] Bio-indicator: Presence of specific ant species is used as an indicator for high, medium or low provision of this ES. Suitable indicator species must first be identified by a correlation between presence of species and ecosystem service provision. | low-medium-high | |
| [24] Earthworm biomass and diversity | g * $m^{-2}$, species # * $m^{-2}$ | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [39] Soil organic carbon in topsoil layer | t | |
| [38] Soil fertility: Expert assessment for each land use class based on chemical (e.g., N, P, K, Ca), physical (e.g., aggregate stability; bulk density; percolation stability), and biological (e.g., mycorrhizae; microbial biomass; earthworm biomass) indicators | very negative (−3) to very positive (+3) | |

| | | |
|---|---|---|
| [40] Area of N fixing crops | ha, $m^2$ | |
| [24] Index of soil quality BISQ (richness; structure; function) | Not provided | |
| [24] Earthworm biomass and diversity | $g * m^{-2}$, species # $* m^{-2}$ | |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [41] Nutrient regulation: Index 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 | |
| [24] Index of soil quality BISQ (richness; structure; function) | Not provided | |
| [24] Earthworm biomass and diversity | $g * m^{-2}$, species # $* m^{-2}$ | |

*Table 6: Global Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [24] Index of soil quality BISQ (richness; structure; function) | Not provided | |
| [24] Earthworm biomass and diversity | $g * m^{-2}$, species # $* m^{-2}$ | |

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| **Ecosystem Service** | **Chemical condition of freshwaters** |
|---|---|
| **CICES class name** | Regulation of the chemical condition of freshwaters by living processes |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.5.1 |

## 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 26: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [5] Seepage rate - amount of water that leaves the rooting zone toward the groundwater table | $mm * yr^{-1}$ |  |
| [6] Seepage rate - amount of water that leaves the rooting zone toward the groundwater table | $mm * yr^{-1}$ |  |
| [2] Concentration of nitrates in drained water | $mg\ NO_3^- * l^{-1}$ |  |
| [5] Nitrate concentration in seepage water | $mg * l^{-1}$ |  |
| [6] Nitrate concentration in seepage water | $mg * l^{-1} * yr^{-1}$ |  |
| [10] Soil mineral nitrogen content at the end of summer (0-90 cm, measured between October 1st and November 15th) | $kg * ha^{-1}$ |  ,  |
| [4] Nitrate leaching | $kg\ NO_3^-N * ha^{-1} * yr^{-1}$ |  |
| [9] Nitrate leaching prevention: nitrate concentration in drained water | $mg\ NO_3^- * l^{-1}$ |  |
| [8] $NO_3^-$ loss through leaching and runoff, following cover crop or fallow period | $kg * ha^{-1}$ |  |

| | | |
|---|---|---|
| [11] Groundwater: annual total nitrate ($NO_3$-N) leached at the bottom of the soil profile | kg * $ha^{-1}$ | |
| [1] Nitrogen mineralization | kg $N_{tot}$ * $ha^{-1}$ * $yr^{-1}$ | |
| [11] Surface water: annual total phosphorus yield in runoff | kg * $ha^{-1}$ | |
| [8] Dissolved P loss through leaching and runoff, following cover crop or fallow period | kg * $ha^{-1}$ | |
| [7] Total P leached from experimental pot 1 day after applying phosphorus solution | µg | |
| [5] Phosphorus loss (particulate phosphorus removed by water erosion) | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [6] Phosphorus loss (particulate phosphorus removed by water erosion) | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [6] Erosion by water | t * $ha^{-1}$ | |
| [2] Concentration of pesticides in drained water | µg * $l^{-1}$ | , |
| [6] Share of years within management period in which protection plant products were used | % | |
| [42] Mineral nitrogen content in soils (0–90 cm), calculated as the sum of $NO_3^+$-N and $NH_4^-$-N | kg/ha | |
| [42] Soil phosphorus extractable in calcium-chloride (0–10 cm) | p.p.m. | |
| [42] Soil phosphorus (0–10 cm) measured as Olsen-P | p.p.m. | |
| [3] Natural attenuation/ clean groundwater:<br>Indicator value calculated as:<br>$I=\frac{\sum \lvert \log(\frac{i}{i_{max}}) \rvert}{n}$<br>With: I – indicator value, 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:<br>-Soil organic matter [% dw]<br>-Bacterial biomass [mg C * g $dw^{-1}$]<br>-pH in KCl<br>-Physiological diversity bacteria [bBiolog. CLPP: Hill's slope]<br>-Water-soluble P (Pw) and extractable P (PAL) | | , |

*Table 27: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [14] Share of nitrogen retained during water passage between agricultural sub-catchment and sea | % | |
| [12] Share of waterways protected by buffers. The index is calculated by dividing the observed value with a target value. Target values may be average or maximum values found in region, or empirical values from literature. If the calculated index is higher than 1, it is set to one. | Index 0 - 1 | |
| [13] Macroinvertebrates: index based on number of aquatic macroinvertebrates species | poor - fair - good - excellent | |
| [13] Turbidity: index based on the turbidity of water in the stream channel | poor - fair - good - excellent | |
| [14] Share of farmers that express clearly a value and care for the health of the land | % | |

*Table 28: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [20] Freshwater supply: Annual groundwater recharge | cm * $yr^{-1}$ | , |
| [15] N export with seepage water | kg N * $ha^{-1}$ | |
| [28] Nitrogen leaching | kg N * $ha^{-1}$ * $yr^{-1}$ | |
| [31] Nitrate leaching | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [11] Groundwater: annual total nitrate ($NO_3$-N) leached at the bottom of the soil profile | kg * $ha^{-1}$ | |
| [33] Potential nitrate leaching, estimated from agricultural productivity and associated inputs | kg $NO_3^-$ * $ha^{-1}$ * $yr^{-1}$ | |
| [23] Risk of nitrate leaching: exchange frequency of the soil water in the root layer. Infiltration rate divided by field capacity | % | |
| [14] Share of nitrogen retained during water passage between agricultural sub-catchment and sea | % | |
| [35] Water purification: Nitrogen retention | g N * $yr^{-1}$ * $m^{-2}$ | |

| | | |
|---|---|---|
| [21] Groundwater quality: Probability of groundwater nitrate concentration <3.0 mg per litre | 0 - 1 | |
| [26] Nitrogen retention at watershed level calculated with In-VEST's Nutrient Retention Model. Calculation based on nitrogen loading and vegetation filtering value for different land-use classes. | t N * yr$^{-1}$ * grid cell$^{-1}$ | |
| [29] Total nitrogen export that reaches the nearest stream, calculated with InVEST model | t * ha$^{-1}$ | |
| [11] Surface water: annual total phosphorus yield in runoff | kg * ha$^{-1}$ | |
| [20, 21] Surface-water quality: Annual phosphorus loading, calculated using the InVest model | kg * ha$^{-1}$ | |
| [29] Total phosphorus export that reaches the nearest stream, calculated with InVEST model | t * ha$^{-1}$ | |
| [15] P export with seepage water | kg N * ha$^{-1}$ | |
| [28] Phosphorus loss | kg P * ha$^{-1}$ * yr$^{-1}$ | |
| [18] Phosphorus retention, calculated with InVEST model | kg * ha$^{-1}$ | |
| [16] Total N and P loading in lakes | t * yr$^{-1}$ | |
| [16] Outflow N and P loading in lakes | t * yr$^{-1}$ | |
| [16] N and P retention in lakes | t * yr$^{-1}$ | |
| [16] N and P concentration in lakes | mg * l$^{-1}$ | |
| [25] Water quality: concentrations of nitrogen, phosphorus, and sediments (including suspended solids and turbidity) | mg * l$^{-1}$ | |
| [30] Leakage of nutrients | kg * ha$^{-1}$ * yr$^{-1}$ | |
| [30] Turnover rates of nutrients, e.g., N, P | kg * yr$^{-1}$ | |
| [30] Total dissolved solids | mg * l$^{-1}$ | |
| [30] Decomposition rate of organic matter | kg * ha$^{-1}$ | |
| [34] Water quality of freshwater ecosystems | Not provided | |

| | | |
|---|---|---|
| [30] Area occupied by riparian forests | ha | |
| [24] Share of natural forest cover in municipality's surface. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | % | |
| [17] Area of buffer strips alongside rivers. Buffer strips are defined as areas connected to the river system and belonging to the land use classes: pasture, open space/heathland, woodland/single tree, tree hedgerow/hedgerow, arable field boundaries, grassland boundaries, deciduous tree dominated forest, coniferous tree dominated forest, or peatland | $m^2$ | |
| [17] Arable land uphill from buffer strips alongside rivers | $m^2$ | |
| [17] Arable land on slopes steeper than 3% uphill from buffer strips alongside rivers | $m^2$ | |
| [17] Potential erosion from buffer strips and the area uphill from them (using RUSLE equation) | $t * yr^{-1}$ | |
| [19] Mechanical filtration capacity: infiltration capacity, calculated as: $IC = s_p * (1 - s)$ With: IC – infiltration capacity, $s_p$ – soil permeability [cm/day], s – share of anthropogenic surface sealing) | $cm * d^{-1}$ | , |
| [19] Physicochemical filtration capacity, calculated as: $C = CEC_{eff} * (1 - s)$ With: C – physicochemical filtration capacity, $CEC_{eff}$ – effective cation exchange capacity, s – share of anthropogenic surface sealing | cmol(+) * kg $dm^{-1}$ | , |
| [22] Water purification: values for 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 | |
| [27] Mediation of water pollution such as excess nitrogen removal: expert based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class | $km^2$ | , , |
| [27] Mediation of water pollution such as excess nitrogen removal value: expert based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class and a literature-based monetary value of the ecosystem service | $\$ * ha^{-1} * yr^{-1}$ | , , |

| | | |
|---|---|---|
| [32] Water purification and provision, calculated as: $$W = NPP * (1 - VCNPP) * IC_s * S_{cf} * 1.75$$ With: W – water purification and provision, NPP – Net Primary Production calculated from NDVI-values and expressed on a relative scale set to [0 – 1000], VCNPP – coefficient of variation of NPP [0 – 1], $IC_s$ – soil infiltration capacity [0 – 1], $S_{cf}$ – slope average correction factor of the study area [0 – 1] | - | |
| [32] Waste purification, calculated as: $$W = NPP * (1 - VCNPP) * I_w * O_w * 1.75$$ With: W – waste purification, NPP – Net Primary Production [0 - 1000], VCNPP – coefficient of variation of NPP [0 – 1], $I_w$ – water input to the system [0 – 1], $O_w$ – water bodies occupancy percentage and flat floodplain area [0 – 1] | - | |
| [14] Share of farmers that express clearly a value and care for the health of the land. Values were scaled to [0-1] | % | |
| [40] Volume of purified water | $m^3/(km^2 * year)$ | |
| [40] Mass of a specific nutrient retained | $ton/ (km^2 * year)$ | |
| [41] Area of undisturbed creek banks that serve as buffers to pesticide and fertilizer runoff | n/a | |

*Table 29: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [37] Denitrification capacity | $kg\ N * ha^{-1} * yr^{-1}$ | |
| [37] Phosphorus sorption capacity | $kg\ P * ha^{-1} * yr^{-1}$ | |
| [38] Chemical status | Not provided | |
| [38] Ecological status | Not provided | |
| [34] Water quality of freshwater ecosystems | - | |
| [36] Water quality: Expert assessment for each land use class, based on the indicators: nutrient efficiency; pesticides (units not given) | very negative (−3) to very positive (+3) | |
| [38] Groundwater: Indicators of groundwater quality | Not specified | |
| [38] Wetlands: Potential of water purification of wetlands | Not specified | |

*Table 30: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [34] Water quality of freshwater ecosystems | - | |
| [35] Water purification: Nitrogen retention | g N * $yr^{-1}$ * $m^{-2}$ | |
| [39] Water purification: 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 | |

*Table 31: Global Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [34] Water quality of freshwater ecosystems | - | |

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| | |
|---|---|
| **Ecosystem Service** | **Chemical condition of salt waters** |
| **CICES class name** | Regulation of the chemical condition of salt waters by living processes |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.5.2 |

## 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 32: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [7] $NO_3$– loss through leaching and runoff, following cover crop or fallow period | Not provided | |
| [7] Dissolved P loss through leaching and runoff, following cover crop or fallow period | Not provided | |
| [8] Nitrate leaching prevention: nitrate concentration in drained water | mg $NO_3$ * liter of drained water $^{-1}$ | |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Share of nitrogen retained during water passage between agricultural sub-catchment and sea. | % | |
| [3] Share of farmers that express clearly a value and care for the health of the land. | % | |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Phosphorus retention, calculated with InVEST model | kg * ha$^{-1}$ | |
| [6] Costal nitrogen load per agricultural area in the watershed: amount of nitrogen leached from soils (and not retained) that reaches the coast, divided by the agricultural area | t * ha$^{-2}$ * yr$^{-1}$ | , |

| | | |
|---|---|---|
| [9] Nitrogen retention at watershed level calculated with InVEST's Nutrient Retention Model. Calculation based on nitrogen loading and vegetation filtering value for different land-use classes | t N * $yr^{-1}$ * grid $cell^{-1}$ | |
| [11] Leakage of nutrients | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [11] Turnover rates of nutrients, e.g., N, P | kg * $yr^{-1}$ | |
| [11] Total dissolved solids | mg * $l^{-1}$ | |
| [11] Decomposition rate of organic matter | kg * $ha^{-1}$ | |
| [2] Water purification: ecosystem service supply depends on the land cover class. The matrix defined by Burkhard et al., 2012 (DOI:10.1016/j.ecolind.2011.06.019) was and used in this study. | Index 0-5 | |
| [3] Share of nitrogen retained during water passage between agricultural sub-catchment and sea. | % | |
| [3] Share of farmers that express clearly a value and care for the health of the land. | % | |
| [10] Mediation of water pollution such as excess nitrogen removal: expert based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [$km^2$] | Index 1-5 * $km^{-2}$ | , , |
| [10] Mediation of water pollution such as excess nitrogen removal value: expert based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [$km^2$] and a literature-based monetary value of the ecosystem service | $ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [11] Area occupied by riparian forests | ha | |
| [12] Mass of a specific nutrient retained | ton/ ($km^2$ * year) | |
| [12] Volume of purified water | $m^3$/($km^2$ *year) | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [5] Indicators of groundwater quality | Not specified | |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [4] Water purification: 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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| **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 $CO_2$e * $m^{-2}$ * $yr^{-1}$ | , |
| [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:<br>$I=\frac{\sum \lvert \log(\frac{i}{i_{max}}) \rvert}{n}$<br>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:<br><br>-Soil organic matter [% dw]<br>-Bacterial biomass [mg C /g dw]<br>-pH in KCl<br>-Physiological diversity bacteria [biolog. CLPP: Hill's slope] | - | , |
| [58] SOC in top soil (0–20 cm) at the end of a 30-year simulation period | Mg of carbon / hectare | |
| [59] SOC in top soil (0–20 cm) | tons / hectare | |

*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 | t * $ha^{-1}$ * grid $cell^{-1}$ | |

| | | |
|---|---|---|
| per land-use class were taken from Japans National Greenhouse Gas Inventory Report. | | |
| [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:<br>a) Carbon storage: aboveground carbon in living biomass and soil carbon in the surface layer (0–20 cm) [tons C/ha]<br>b) Greenhouse gas emissions: Emissions of $CO_2$, $CH_4$, and $N_2O$ | - | |

| | | |
|---|---|---|
| measured at monthly intervals [CO2 equ. flux]<br>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 indicator species must first be identified by a correlation between the presence of species and ES provision. | low-medium-high | |
| [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 * $s^{-1}$ * $ha^{-1}$ | , |
| [57] Amount of carbon stored in the above/below ground biomass and soil over a specified amount of time (e.g. 20-years) | ton / $km^2$ | |

*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) | |
| [56] $NO_2$ deposition velocity: calculated as as a linear function of wind speed at 10m height and land cover type. | mm/s | |
| [56] $NO_2$ removal flux calculated as the product of modelled $NO_2$ concentration and deposition velocity. Deposition velocity is calculated as as a linear function of wind speed at 10m height and land cover type. | t/(ha*year) | |

*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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|---|---|
| **Ecosystem Service** | **Local regulation of air temperature and humidity** |
| **CICES class name** | Regulation of temperature and humidity, including ventilation and transpiration |
| **CICES Section** | Regulation & Maintenance (Biotic) |
| **CICES Class code** | 2.2.6.2 |

## 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 33: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [7] 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:<br><br>-Soil organic matter [% dw]<br>-Bacterial biomass [mg C /g dw]<br>-pH in KCl<br>-Physiological diversity of bacteria [biolog. CLPP: Hill's slope] | - | , |

*Table 2: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [4] Canopy shading: four-level index based on the degree of canopy shading | poor-fair-good-excellent | |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Cool air production | $m^3 * ha^{-1} * h^{-1}$ | |
| [1] Leaf area index | - | |
| [1] Albedo | % | |
| [6] Evapotranspiration (local climate regulation). Values were normalized [0-1] using benchmark values where available and observed values otherwise. | mm | |
| [2] Local climate regulation: values for ecosystem service supply based on the land cover class. 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 | |
| [8] Local climate regulation: expert-based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [$km^2$] | Index 1-5 * $km^{-2}$ | , , |
| [8] Local climate regulation value: expert-based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [$km^2$] and a literature-based monetary value of the ecosystem service | $ * $ha^{-1} * yr^{-1}$ | , , |
| [9] Expert-/stakeholder rating of how much of this ecosystem service can be supplied by a landscape (represented by a land use map) | 6-point Lickert-scale (none - highest capacity) | |
| [9] Expert-/stakeholder rating based on pairwise comparisons of landscapes (represented by land use maps) in an Analytical Hierarchical Process (AHP). Experts select the landscape with higher capacity for supplied this ecosystem service and rate the difference between the two landscapes | 1 (equal capacity) - 9 (absolute preference of one land-scape) | |

*Table 4: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [5] Amount of biomass | Not specified | |

*Table 5: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] Local 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 | |
| [3] Air quality 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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| **Ecosystem Service** | **Recreation through activities in nature** |
|---|---|
| **CICES class name** | Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through active or immersive interactions |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.1.1.1 |

## 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** |
|---|---|---|
| [13] Capacity for nature-based recreation: The indicator is based on the vicinity of water, land relief, accessibility from urban areas, presence of HNV farmland and variation in land cover. | - | |
| [23] Abundance of birds with hunting value | Not provided | |
| [23] Ant species richness as the predictor of the abundance of birds, including those with hunting value. | Not provided | |
| [25] Recreational hunting. Values are based on the following indicators:<br>- Site quality: habitat suitability for prey [low, medium, high]<br>- Site opportunity: population within 1.5 ha travel distance, scaled to [0 -1]<br>- Complementary inputs: availability of campsites in the area [0 -1]<br>- Scarcity: Existence of alternative sites with same quality within the same travel distance [0 -1]<br>- Reliability: Risk of future service loss through urban development within a 3-mile radius [0 -1] | Not provided | , |

*Table 2: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [30] Recreation opportunities: Indicator calculated by a formula derived from survey and expert assessment. Up to five attributes were considered: singular natural resources, scenic beauty, accessibility, tourism attraction capacity, and tourism use aptitude.<br>Results were corrected by carrying capacity of land use types, considering factors such as flora and fauna factor, perimeter area ratio and slope factor. | persons * $ha^{-1}$ | , , |

*Table 2: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [4] Tourism: Ratio of tourism income to GDP | % | |
| [7] Potential number of visitors calculated from population statistics and assuming travel distance of 80 km for daily trips and 8 km for short trips | # | , , |
| [7] Actual number of visits from surveys or statistics | # | , , |
| [24] Density of rural tourism establishments. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | # * $km^{-2}$<br>Y | |
| [26] Number of visitors | # * $yr^{-1}$ | , , |
| [14] Zone of visual influence: share of the site that is visible by different user groups (pedestrians, cyclists, small vehicle users, train users) due to the layout of footpaths, roads and rail-networks | % | |
| [14] Visual quality index (VQI), based on 19 parameters (terrain ruggedness, presence of: waterfalls, wells and springs, area of standing water, length of flowing water, presence of the coast, habitat richness, area of woodland, presence of single large trees, number of plant species, hedgerow length, number of vegetation colours, area of human-influenced land, number of spot utilities/quarries, building area, road length, dry-stone walls length, presence of scheduled ancient monuments, presence of designated historic parks or gardens, presence of listed buildings) | Index 0-1 | |
| [29] Forest recreation: share of land that is forested | % | |
| [5] Area of natural or semi-natural habitats not affected by roadside noise louder than 55dB(A) | $m^2$ | |
| [5] Area of natural or semi-natural habitats not affected by roadside noise louder than 55dB(A) and accessible from the nearest city within a given time constraint | $m^2$ | |

| | | |
|---|---|---|
| [15] (Designated) recreational trails | km | |
| [26] Area covered by recreational landscape | ha | , , |
| [6] Total number of recreational areas | # | |
| [9] Recreation & ecotourism potential, calculated based on:<br>*Distance to singular natural resources (e.g., diverse forests, presence of water bodies) [0 -100]<br>*Scenic beauty (viewsheds) [0-100]<br>*Accessibility (gaussian distance to roads) [km]<br>*Tourism attraction capacity (distance to natural attractions concentration [1-100], variety of natural attractions [1-100], distance to tourism services [km])<br>*Tourism use aptitude [1-100] (based on land cover)<br>Selection and weighing of factors based on expert assessment | Index 0 - 100 | |
| [9] Recreation & ecotourism opportunities, calculated as: (Recreation & ecotourism potential /100) * ((physical carrying capacity of an area) * (erodibility of the area) * (correction factor for account for fauna) * (perimeter/area ratio)) | persons * $ha^{-1}$ | |
| [1] Recreational potential: calculated by a composite model that considers the degree of naturalness, nature protection, and presence of water. | Index 0–1 | |
| [8] Recreation potential: continuous index, based on presence of certain ecosystems (i.e., forest, coastline), certain ecosystem characteristics (i.e., naturalness) and their accessibility | - | |
| [12] Recreational potential, calculated as the sum of scores for density of public rights of way (footpaths, bridleways), the cultural heritage value of land use and proximity of similar alternative sites, each (1-5), multiplied by the score for the population living within 3 km travel distance of any part of the site (1-5) | - | , |
| [17] Recreation & aesthetic values: values are assigned to different land cover classes. The matrix by Burkhard et al., 2012 (DOI: 10.1016/j.ecolind.2011.06.019) was adapted the and used in this study. | Index 0-5 | |
| [16] Recreational surface per capita, calculated as recreational areas (forests, abandoned land, water courses and grassland areas) within a distance of 5 km to settlements divided by the number of residents | ha * $capita^{-1}$ | |
| [19] Recreational potential: the following indicators were normalized, and the average was calculated:<br>- Degree of naturalness: hemeroby index based on the land cover type [1 (natural/ without actual human impact) - 7 (artificial)]<br>- Protected areas: occurrence of protected areas [not provided]<br>- Attractiveness of water bodies: Distance to the nearest stagnant surface water body or water courses of the first or second order | Not provided | |

| | | |
|---|---|---|
| [22] Recreation potential: (modelled utility value of recreational nature areas (considering both quality of the area and distance to a person) divided by population density) | [0-1] | , |
| [27] Recreation: expert-based index for ecosystem service supply by land cover class [1-5] multiplied by the area of the land cover class [$km^2$] | Index 1-5 * $km^{-2}$ | , , |
| [27] Recreation value: expert-based index for ecosystem service supply by land cover class [1-5] multiplied by the area of the land cover class [$km^2$] and a literature-based monetary value of the ecosystem service | $ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [11] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | Index 0-5 | |
| [32] Index based on:<br>-naturalness (based on Corine Landcover Class),<br>-level of conservation (based on presence of protected areas)<br>- accessibility to human population (based on distance from areas with high population density) | - | , , |
| [18] Roadside variation: number of "land use patches" intersected by or adjacent to all roads and paths, except motorways and railways, divided by total road length. Values were scaled [0-1] | $km^{-1}$ | , |
| [18] Accessibility: Share of the land surface within 100 meters from a road. Values were scaled [0-1] | % | , |
| [31] (Water activities): Turnover from tourism | $ * $ha^{-1}$ | |
| [31] (Water activities): Status of fish population | ka * $ha^{-1}$ | |
| [31] (Water activities): Status of fish population | [species and age structure] | |
| [31] (Water activities): Median water clarity as a measure of swimming suitability | m | |
| [31] (Water activities): Number of sites with excellent bathing quality | # | |
| [31] (Water activities): Number of visitors or facilities (e.g., hotels or restaurants | # | |
| [33] Number of visitors arrivals | # | |
| [33] Number of domestic visitors arrivals | # | |
| [33] Number of foreign visitors arrivals | # | |
| [33] Number of active enterprises in the area | # | |
| [33] Number of active enterprises in agriculture (crop production, support activities to agriculture) | # | |
| [33] Number of active enterprises in accommodation and food services activities | # | |

| | | |
|---|---|---|
| [33] Number of farms with other gainful activities (agritourism, recreational and social activities) | # | |
| [33] Number accommodation establishments | # | |
| [33] Number of hotels and similar establishments | # | |
| [33] Number of holiday- and other short-stay accommodations, camping grounds, recreational vehicle parks and trailer parks | # | |
| [34] For services that can be monetized: value of cultural services | USD / $km^2$ * year) | |
| [34] For services that can not be monetized: qualitative value assessment using Likert-scales | - | |
| [35] Visibility of creeks from cycle paths | n/a | |

*Table 4: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Number of visits per year | # * $area^{-1}$ * $yr^{-1}$ | |
| [2] Valuation: Number of visits per year multiplied by value indicator. The value indicator depends on the habitat mix for that location | $ * $area^{-1}$ * $yr^{-1}$ | |
| [3] Number of "day leisure visits" (any round trip of less than one day in duration made from home or a holiday destination for leisure purposes) | # * grid $cell^{-1}$ | |
| [7] Potential number of visitors calculated from population statistics and assuming travel distance of 80 km for daily trips and 8 km for short trips | # | , , |
| [7] Actual number of visits from surveys or statistics | # | , , |
| [10] Number of visitors per year | # | |
| [21] Number of visitors in agricultural areas | Not specified | |
| [21] Number of rural enterprises offering tourism-related services | Not specified | |
| [21] Number of hunting licences | Not specified | |
| [20] Modelled probability of visitation by recreationists/tourists (0-1), based on land cover class, mean elevation, distance from nearest major road, path density, county and population. | - | , |
| [21] Farm tourism | Not specified | |

| | | |
|---|---|---|
| [21] Walking and biking trails | Not specified | ⃠ |

*Table 5: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [8] Recreation potential: continuous index, based on presence of certain ecosystems (i.e., forest, coastline), certain ecosystem characteristics (i.e., naturalness) and their accessibility | - | |

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| **Ecosystem Service** | **Recreation through observation of nature** |
|---|---|
| **CICES class name** | Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.1.1.2 |

## 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** |
|---|---|---|
| [17] Capacity for nature-based recreation indicator. The indicator is based on the vicinity of water, land relief, accessibility from urban areas, presence of HNV farmland and variation in land cover. | [-] | |
| [3] Hedges between agriculture and other use | Not provided | |
| [3] Number of elements and land cover types in a viewshed | # | |
| [3] Diversity of land cover/ land use types (calculated by adapting Shannon Index 'H', Gini index, or Simpson's Diversity Index' D') | [-] | |
| [28] Abundance of large butterflies (species with median wingspan>5.4 cm) | Not provided | |
| [28] Abundance of birds that are either: colourful species, species that people attract to their homes with feeders or species with hunting value | Not provided | |
| [28] Ant species richness as a predictor of the abundance of birds, including those described above | Not provided | |

*Table 2: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] Hedges between agriculture and other use | Not provided | |
| [3] Number of elements and land cover types in the viewshed | # | |
| [3] Diversity of land cover/ land use types (calculated by adapting Shannon Index 'H', Gini index, or Simpson's Diversity Index' D') | - | |
| [23] Four-level index based on the provision of walking trails/ecotourism/environmental education | poor-fair-good-excellent | |
| [33] Recreation opportunities: Indicator calculated by a formula derived from survey and expert assessment. Up to five attributes were considered: singular natural resources, scenic beauty, accessibility, tourism attraction capacity, and tourism use aptitude. Results were corrected by carrying capacity of land use types, considering factors such as flora and fauna factor, perimeter area ratio and slope factor. | persons * $ha^{-1}$ | |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [7] Tourism: Ratio of tourism income to GDP | % | |
| [18] Average travel cost of tourists | $ * $yr^{-1}$ | |
| [11] Potential number of visitors calculated from population statistics and assuming travel distance of 80 km for daily trips and 8 km for short trips | # | |
| [11] Actual number of visits from surveys or statistics | # | |
| [29] Density of rural tourism establishments. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | # * $km^{-2}$ | |
| [30] Number of visitors | # * $yr^{-1}$ | |
| [32] Forest recreation: share of land that is forested | % | |
| [9] Area of natural or semi-natural habitats not affected by roadside noise louder than 55dB(A) | $m^2$ | |
| [9] Area of natural or semi-natural habitats not affected by roadside noise louder than 55dB(A) and accessible from the nearest city within a given time constraint | $m^2$ | |

| | | |
|---|---|---|
| [19] (Designated) recreational trails | km | |
| [30] Area covered by recreational landscape | ha | |
| [10] Total number of recreational areas | # | |
| [4] Number of areas used for social amenity (e.g., picnic areas) in the area | # | |
| [13] Recreation & ecotourism potential, calculated based on:<br>*Distance to singular natural resources (e.g., diverse forests, presence of water bodies) [0 -100]<br>*Scenic beauty (viewsheds) [0-100]<br>*Accessibility (gaussian distance to roads) [km]<br>*Tourism attraction capacity (distance to natural attractions concentration [1-100], variety of natural attractions [1-100], distance to tourism services [km])<br>*Tourism use aptitude [1-100] (based on land cover)<br>Selection and weighing of factors based on expert assessment | Index 0 - 100 | |
| [13] Recreation & ecotourism opportunities, calculated as: (Recreation & ecotourism potential /100) * ((physical carrying capacity of an area) * (erodibility of the area) * (correction factor for account for fauna) * (perimeter/area ratio)) | persons * $ha^{-1}$ | |
| [1] Recreational potential calculated by a composite model that considers the degree of naturalness, nature protection, and presence of water. Dimensionless index | Index 0-1 | |
| [12] Recreation potential: continuous index, based on presence of certain ecosystems (i.e., forest, coastline), certain ecosystem characteristics (i.e., naturalness) and their accessibility | - | |
| [16] Recreational potential, calculated as the sum of scores for density of public rights of way (footpaths, bridleways), the cultural heritage value of land use and proximity of similar alternative sites, each (1-5), multiplied by the score for the population living within 3 km travel distance of any part of the site (1-5) | - | |
| [21] Recreation & aesthetic values: values are assigned to different land cover classes. The matrix by Burkhard et al., 2012 (DOI: 10.1016/j.ecolind.2011.06.019) was adapted the and used in this study. | Index 0-5 | |
| [20] Recreational surface per capita, calculated as recreational areas (forests, abandoned land, water courses and grassland areas) within a distance of 5 km to settlements divided by the number of residents | ha * $capita^{-1}$ | |
| [24] Recreational potential: the following indicators were normalized, and the average was calculated:<br>- Degree of naturalness: hemeroby index based on the land cover type [1 (natural/ without actual human impact) - 7 (artificial)]<br>- Protected areas: occurrence of protected areas [not provided] | Not provided | |

| | | |
|---|---|---|
| - Attractiveness of water bodies: Distance to the nearest stagnant surface water body or water courses of the first or second order | | |
| [27] Recreation potential: (1- (modelled utility value of recreational nature areas (considering both qualities of the area and distance to a person) divided by population density)) | 0-1 | , |
| [31] Recreation: expert-based index for ES provision by land cover class [1-5] multiplied by the area of land cover class [$km^2$] | Index 1-5 * $km^{-2}$ | , , |
| [31] Recreation value: expert-based index for ecosystem service supply by land cover class [1-5] multiplied by the area of the land cover class [$km^2$] and a literature-based monetary value of the ecosystem service | \$ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [15] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | Index 0-5 | |
| [35] Index based on naturalness (based on Corine Landcover Class), level of conservation (based on presence of protected areas) and accessibility to the human population (based on distance from areas with high population density) | - | , |
| [22] Roadside variation: number of "land use patches" intersected by or adjacent to all roads and paths, except motorways and railways, divided by total road length. Values were scaled [0-1] | $km^{-1}$ | |
| [22] Accessibility: Share of the land surface within 100 meters from the road. Values were scaled [0-1] | % | |
| [34] (Water activities): Numer of river watching sites | # | |
| [34] (Water activities): Number of visitors or facilities (e.g. hotels or restaurants | # | |
| [34] (Water activities): Length of walkway or cycleway | km | |
| [34] (Water activities): Turnover from tourism | \$ * $ha^{-1}$ | |
| [8] Open landscapes: Share of land under agricultural cultivation (keeping landscapes open through agriculture is seen as increasing aesthetic value) | % | |
| [3] Hedges between agriculture and other use | Not provided | |
| [3] Diversity of land cover/ land use types (calculated by adapting Shannon Index 'H', Gini index, or Simpson's Diversity Index' D') | [-] | |
| [8] Diversity of landscapes: Shannon index of land use | [-] | |

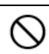
| | | |
|---|---|---|
| [3] Number of elements and land cover types in a viewshed | # | |
| [34] Proximity to urban areas of scenic rivers or lakes | km | |
| [18] WTP - willingness to pay for landscape preservation considering likely landscape changes | $ | |
| [37] Number of visitors arrivals | # | |
| [37] Number of domestic visitors arrivals | # | |
| [37] Number of foreign visitors arrivals | # | |
| [37] Number of active enterprises in the area | # | |
| [37] Number of active enterprises in agriculture (crop production, support activities to agriculture) | # | |
| [37] Number of active enterprises in accommodation and food services activities | # | |
| [37] Number of farms with other gainful activities (agritourism, recreational and social activities) | # | |
| [37] Number accommodation establishments | # | |
| [37] Number of hotels and similar establishments | # | |
| [37] Number of holiday- and other short-stay accommodations, camping grounds, recreational vehicle parks and trailer parks | # | |
| [38] For services that can be monetized: value of cultural services | USD / $km^2$ * year) | |
| [38] For services that can not be monetized: qualitative value assessment using Likert-scales | - | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [2] Number of visits per year | # * $area^{-1}$ * $yr^{-1}$ | |
| [2] Valuation: Number of visits per year multiplied by value indicator. The value indicator depends on the habitat mix for that location | $ * $area^{-1}$ * $yr^{-1}$ | |
| [6] Number of "day leisure visits" (any round trip of less than one day in duration made from home or a holiday destination for leisure purposes) | # * grid $cell^{-1}$ | |
| [11] Potential number of visitors calculated from population statistics and assuming travel distance of 80 km for daily trips and 8 km for short trips | # | , , |

| | | |
|---|---|---|
| [11] Actual number of visits from surveys or statistics | # | , ,  |
| [14] Number of visitors per year | # |  |
| [26] Number of visitors in agricultural areas | Not specified |  |
| [26] Number of rural enterprises offering tourism-related services | Not specified |  |
| [26] Number of birdwatchers | Not specified |  |
| [26] Farm tourism | Not specified |  |
| [25] Modelled probability of visitation by recreationists/tourists, based on land cover class, mean elevation, distance from a nearest major road, path density, county and population. | 0-1 | ,  |
| [26] Walking and biking trails | Not specified |  |
| [3] Number of elements and land cover types in a viewshed | # |  |
| [3] Hedges between agriculture and other use | Not provided |  |
| [3] Diversity of land cover/ land use types (calculated by adapting Shannon Index 'H', Gini index, or Simpson's Diversity Index' D') | - |  |
| [36] Opportunities for experiential uses of landscapes number of habitats protected in Annex 1 of the EC Habitats Directive (Council Directive 92/43/EEC). Point values are interpolated using inverse distance weighting. | - |  |
| [36] Frequency data of preferences: respondents of a questionnaire are asked to identify 3 places and landscapes that they have visited and are of high aesthetic value, the predominant land use/cover of each site, and the recreational activities they normally carry out at these locations. Frequency data from this preference assessment is then mapped for the identified sites. | n/a |  |
| [36] Frequency of responses associating land use/cover with aesthetic values are asked to identify 3 places and landscapes that they have visited and are of high aesthetic value, the predominant land use/cover of each site, and the recreational activities they normally carry out at these locations. Frequency data from this preference assessment was then mapped for the identified sites. | n/a |  |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Hedges between agriculture and other use | Not provided |  |
| [3] Number of elements and land cover types in a viewshed | # |  |
| [3] Diversity of land cover/ land use types (calculated by adapting Shannon Index 'H', Gini index, or Simpson's Diversity Index' D') | - |  |

| | | |
|---|---|---|
| [12] Recreation potential: continuous index, based on presence of certain ecosystems (i.e., forest, coastline), certain ecosystem characteristics (i.e., naturalness) and their accessibility | - | |

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| **Ecosystem Service** | **Scientific interactions with nature** |
|---|---|
| **CICES class name** | Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.1.2.1 |

## 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 34: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | Index 0-5 |  |
| [2] Number of studies conducted in the area | # | ,  |
| [3] Number of monitoring sites (by scientists) | # |  |

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| 2 | Adhikari S, Baral H, Nitschke CR (2018) Identification, Prioritization and Mapping of Ecosystem Services in the Panchase Mountain Ecological Region of Western Nepal. Forests 9(9): 554. DOI: 10.3390/f9090554 |

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[*] The impact area discussed on this factsheet is not a focus of the cited paper

| **Ecosystem Service** | **Education and training interactions with nature** |
|---|---|
| **CICES class name** | Characteristics of living systems that enable education and training |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.1.2.2 |

## 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 |  |

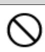
*Table 35: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Four-level index based on the provision of walking trails/ecotourism/environmental education | Index poor-fair-good-excellent |  |

*Table 36: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Number of educative panels in the area | # |  |
| [4] Number of environmental-education related facilities | # * ha$^{-1}$ |  |
| [3] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | Index 0-5 |  |
| [6] For services that can be monetized: value of cultural services | USD / km$^2$ * year |  |
| [6] For services that can not be monetized: qualitative value assessment using Likert-scales | - |  |

*Table 37: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [5] Number of didactic farms | # |  |

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* The impact area discussed on this factsheet is not a focus of the cited paper

| **Ecosystem Service** | **Culture or heritage from interactions with nature** |
|---|---|
| **CICES class name** | Characteristics of living systems that are resonant in terms of culture or heritage |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.1.2.3 |

## 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 38: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Quality and number of man-made structures (hedges, stone walls) | Not provided, # | |
| [11] Index [not provided]: Panoramic photographs are created on site that show the 'best representation' of the landscape. In a questionnaire, respondents from the same region are asked if they perceive the landscape as "traditional". | n/a | , |

*Table 39: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Quality and number of man-made structures (hedges, stone walls) | Not provided, # | |

*Table 40: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Quality and number of man-made structures (hedges, stone walls) | Not provided, # | |

| | | |
|---|---|---|
| [2] Total area with outstanding historical or cultural significance | ha | |
| [9] Heritage: Participatory mapping. Respondents in an online survey mark on a map area in their region where different cultural ecosystem services are supplied. Then, the proportion of markings in each of the investigated land cover classes is calculated. After that, values are calculated for sub-regions. The proportions are multiplied with the area extent of the respective land cover classes in the sub-region and result for all land cover classes are summed up. | ha | |
| [5] Share of open land classified as semi-natural grassland (within a 5 km radius around farmhouse) | % | |
| [3] Agricultural heritage index: heritage value of the cultivation of native potato varieties, calculated based on the heritage value of the potato species, the systems of knowledge and social networks:<br><br>The heritage value of the species is represented by:<br>-Number of native potato varieties cultivated by the farmer<br>-Type of native potato varieties cultivated by the farmer<br>-Exchange of native potato seed<br>-Quantity of native potato for self-consumption/quantity harvested<br>-Quantity of native potato cultivated/quantity of commercial potato cultivated<br>-Storage and use of own native potato seed<br><br>Systems of knowledge are represented by:<br>-Cultivation practices used to come from inheritance<br>-Cultivation practices were learned by working at the farm<br>-Main reason to grow native potato is a tradition across generations<br>-Soil fertilization is made with farm-made products (organic fertilizers, algae)<br><br>Social networks are represented by:<br>-Exchange of native potato seed<br>-Number of know farmers that integrate your network of seed exchange<br>-The farmer participates in "minga", a traditional labour sharing custom between farms<br>-The farmer uses a mix of family and hired labour<br><br>The selection and weighing of sub-indicators are based on expert assessment. Indicators are spatially mapped based on distance from the service provider (traditional farmer). | Index 1 - 100 | , , |
| [3] Agricultural heritage benefit, based on willingness to pay (WTP) value for the preservation of the traditional potato cultivation and mapped by distributing the total amount in dollar (WTP population share of traditional potato cultivators that | $ * ha$^{-1}$ | , , |

| | | |
|---|---|---|
| live in the region) between all agricultural fields in the region, using "Agricultural heritage index" as weighing factor. | | |
| [7] WTP - willingness to pay for landscape preservation considering likely landscape changes | € | |
| [4] Landscape value, based on conformity of land use and land use changes with nationally defined landscape character for the respective region | - | , |
| [5] Share of farmers surveyed that state that their farm should look well-tended for | % | |
| [5] Share of farmers surveyed that attach value to cultural heritage elements, such as stone walls, hedgerows, etc. | % | |
| [5] Share of farmers surveyed that enjoy keeping animals | % | |
| [6] Negative indicator: Spring litter in un-mown plots (alpine grasslands: this is considered lack of "stewardship" which may diminish cultural heritage value) | Not specified | |
| [7] Average travel cost of tourists | € * $yr^{-1}$ | |
| [8] Sense of place: Number of people acknowledging the ecosystem as relevant for their identity, value and the place of their origin | # | , , |

*Table 41: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Quality and number of man-made structures (hedges, stone walls) | Not provided, # | |
| [10] Number of monuments in agricultural areas | # | |
| [10] Number of certified products that require traditional landscape management | # | |

*Table 42: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Quality and number of man-made structures (hedges, stone walls) | Not provided, # | |

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| | |
|---|---|
| **Ecosystem Service** | **Aesthetics from interactions with nature** |
| **CICES class name** | Characteristics of living systems that enable aesthetic experiences |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.1.2.4 |

## 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** |
|---|---|---|
| [2] Presence of water bodies | Not provided | Not provided |
| [2] Presence of sublime features, e.g., mountains | Not provided | Not provided |
| [3] Functional diversity: Colour richness of flowers | # of colour groups visible to humans: white, yellow, purple, violet | Experiment or direct measurement |
| [3] Functional intensity: Average size of flowers or discernible sub-sets of inflorescences (of colour groups visible to humans) | cm | Experiment or direct measurement |
| [3] Functional stability: Average species richness of flowers within groups visible to humans during the flowering season | # of species | Experiment or direct measurement |
| [3] Overall species richness of flowers in colour groups visible to humans | # of species | Experiment or direct measurement |
| [3] Overall species richness of flowers | # of species | Experiment or direct measurement |

| | | |
|---|---|---|
| [4] Abundance of large butterflies (species with median wing-span >5.4 cm) | Not provided | |
| [4] Abundance of birds that are either: colourful species or species that people attract to their homes with feeders | Not provided | |
| [4] Ant species richness as predictor of the abundance of birds, including those described above. | Not provided | |
| [26] Rating score [1 - 10]: Panoramic photographs are created on site that show the 'best representation' of the landscape. In a questionnaire, respondents are asked to rate them based purely on aesthetic criteria. The median score across all questionnaires is used. | n/a | , |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [2] Presence of water bodies | Not provided | |
| [2] Presence of sublime features, e.g., mountains | Not provided | |
| [5] Aesthetic landscape enhancement by a specific feature | poor-fair-good-excellent | |
| [6] Roadside variation: number of "land use patches" inter-sected by or adjacent to all roads and paths, except motor-ways and railways, divided by total road length | $km^{-1}$ | , |
| [6] Landscape variation: length of land cover "edges" per hec-tare land surface | $km * ha^{-1}$ | , |
| [6] Share of farmers surveyed that state that their farm should look well-tended | % | , |
| [6] Share of farmers surveyed that consider open landscapes valuable landscape elements | % | , |

*Table 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Complexity:<br><br>-Number of independently perceived visual elements in the scene<br>-Visual richness, the degree of scene intricateness and "how much is going on."<br>-The amount of information or the number of elements in | not provided | |

| | | |
|---|---|---|
| the immediate environment<br>-The promise of more information if one has more time to observe from the specific point<br>-The degree of simplicity versus complexity in the spatial structure<br>-Presence of multiple elements with diverse forms elements at a given resolution<br>-Diversity, richness and interspersion of landscape<br>-The amount of diversity or variety in a scene, the engaging amount of information<br>-The perceived degree of landscape variety (from not varied to varied)<br>-Composition, distribution, organization and variation of landscape elements contributing to visual richness and diversity | | |
| [1] Diversity:<br><br>-The degree of perceived visual variation among landscape elements<br>-Visual diversity; the number and degree of image elements or different features<br>-The diversity of landscape components "as the expression of vertical relationships between land use and abiotic features."<br>-"Simply describes differences in nature, quality or aspect", also "the nature and relative size of the fields within the farm."<br>-Composition, diversity, and relative abundance (evenness) of landscape cover types and land uses | not provided | 🛇 |
| [1] Heterogeneity: grain size, visual compartmentalization and versatility within the landscape | not provided | 🛇 |
| [1] Biodiversity: diversity of plants, insects or specific ecological groups relevant to scenic properties | not provided | 🛇 |
| [1] Texture: The attribute of visual quality evaluated as smooth, medium or rough, or proportion of the landscape area covered by it | not provided | 🛇 |
| [1] Pattern: presence of regularly repeated elements or clear patterns | not provided | 🛇 |
| [1] Variety:<br><br>-Scene as being varied or diverse in overall content; "diversity of colors, textures, shapes and masses, forms and spaces or other visible attributes that add a diversity or mixture of visual experiences." | not provided | 🛇 |
| [1] Color diversity and contrast: | not provided | 🛇 |

| | | |
|---|---|---|
| -Variety of colors, chromatic diversity, visual contrast among available colors | | |
| [1] 3D complexity:<br><br>-Heterogeneity in tree height and vertical vegetation layers<br>-Visual grouping, density and structuring of vegetation, thinning intensity (managed ecosystems)<br>-Presence of specific structural vegetation forms such as a tree, bush<br>-Presence/absence & diversity of man-made elements, either overall or as a modification to the landscape, sometimes as an undesirable factor | not provided | |
| [1] Edge:<br><br>-Presence, amount or density of distinct borders between areas<br>-Presence of linear edge features such as hedgerows, walls, tree lines; visual properties of field margins<br>-Edge condition | not provided | |
| [1] Relief:<br><br>-Topographic heterogeneity, variability in relief, non-uniform geomorphology, the contrast between flat and sloping | not provided | |
| [1] Ephemera and seasonality:<br><br>-Presence of elements and types of land use that change with seasons or overtime<br>-Perception of seasonal change | not provided | |
| [1] Time depth:<br><br>-Visual evidence of historical continuity and diversity, sometimes as architectural variety and presence of landmarks<br>-Level of succession (in woodlands) | not provided | |
| [2] Presence of water bodies | Not provided | |
| [2] Presence of sublime features, e.g., mountains | Not provided | |
| [6] Roadside variation: number of land use patches intersected by or adjacent to all roads and paths, except motorways and railways, divided by total road length | $km^{-1}$ | , |
| [6] Landscape variation: length of land cover "edges" per hectare land surface | $km * ha^{-1}$ | , |
| [6] Share of farmers surveyed that state that their farm should look well-tended | % | , |

| | | |
|---|---|---|
| [6] Share of farmers surveyed that consider open landscapes valuable landscape elements | % | , |
| [7] Natural-aesthetical value: expert opinion/regional preferences | Not provided | |
| [7] Recreation potential: number of visitors | # | |
| [18] Average travel cost of tourists | € * $yr^{-1}$ | |
| [8] Visibility of particularly beautiful spots (e.g., mountains, open water, forests, heterogeneous landscapes) | Index 0 - 100 | |
| [14] Occurrence of protected areas, large forests, water bodies | Not provided | |
| [9] Open landscapes: Share of land under agricultural cultivation (keeping landscapes open through agriculture is seen as increasing aesthetic value) | % | |
| [9] Diversity of landscapes: Shannon index of land use | - | |
| [10] Number of residential properties in the direct vicinity of major rivers (number of properties is seen here as an indicator for aesthetic appreciation and inspiration) | # | |
| [11] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively | Index 0 - 5 | |
| [12] Modelled landscape aesthetic value for a viewpoint: 360° panoramic photos of representative landscapes are created and assigned aesthetic scores [1-10] by stakeholders. The response is used to calibrate a regression model that relates landscape elements within the photos with the assigned aesthetic score. The following features are considered in the model:<br>- Landscape metrics (area-weighted mean patch area distribution [$m^2$]<br>- median radius of gyration distribution [$m^2$]<br>-modified Simpson's evenness index [-]<br>- number of patches [#]<br>- patch richness [-] | - | , |

| | | |
|---|---|---|
| - range perimeter–area ratio distribution [-]<br>- coefficient of variation of shape index distribution [-]<br>- median of shape index distribution [-]).<br>- Land use classes (Settlement [0/1], Road [0/1], Forest [0/1], Water [0/1])<br>- Viewshed in three distance zones (near zone 0–1.5 km, middle zone 1.5–10 km, far zone 10–50 km) [$m^2$] | | |
| [13] Recreation & aesthetic values: values for land cover classes. The matrix by Burkhard et al., 2012 (DOI: 10.1016/j.ecolind.2011.06.019) was adapted and used in this study. | Index 0-5 |  |
| [15] Flower diversity: Plants Simpson's biodiversity index | Not specified |  |
| [16] Visual quality index (VQI), based on 19 parameters (terrain ruggedness, presence of: waterfalls, wells and springs, area of standing water, length of flowing water, presence of the coast, habitat richness, area of woodland, presence of single large trees, number of plant species, hedgerow length, number of vegetation colours, area of human-influenced land, number of spot utilities/quarries, building area, road length, dry-stone walls length, presence of scheduled ancient monuments, presence of designated historic parks or gardens, presence of listed buildings) | Index 0 - 1 |  ,  |
| [17] Utility sum based on the following indicators:<br>-Level of the presence of linear landscape elements within a grid cell [1 - 3]: hedgerows, tree rows, tree alleys and windbreaks<br>-Level of the presence of point landscape elements within a grid cell [1 - 3]: hedgerows, tree rows, tree alleys and windbreaks<br>-Level of presence of livestock within a grid cell [0 - 1]: occurrence of grasslands used as a proxy<br>-Level of the diversity of crop production within a grid cell [1 - 3]: average plot size within field blocks used as a proxy | - |  |
| [19] Landscape beauty index; Values per land use class based on:<br>- a questionnaire-based photo survey on alpine landscapes<br>- topographical visibility analysis (from DEM)<br>- Shannon index of landscape diversity (Shannon index)<br>Each of the three components was weighted equally. | Not provided |  ,  |
| [20] Area providing an aesthetic and inspiring environment | ha |  ,  ,  |

| | | |
|---|---|---|
| [21] Aesthetic value of landscapes: values from landscape preference studies | Not provided | |
| [22] Cumulative viewshed: visibility of green areas (such as farmland and forest) from residential land (using the visibility function in ArcGIS's Spatial Analyst) | # | |
| [23] Landscape aesthetics and landmark: Participatory mapping. Respondents in an online survey mark on map areas in their region where different cultural ecosystem services are supplied. Then, the proportion of markings in each of the investigated land cover classes is calculated. After that, values are calculated for subregions. The proportions are multiplied with the area extent of the respective land cover classes in the sub-region, and result for all land cover classes are summed up. | ha | |
| [18] Willingness to pay (WTP) for landscape preservation considering likely landscape changes | € | |

*Table 4: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Presence of water bodies | Not provided | |
| [2] Presence of sublime features, e.g., mountains | Not provided | |
| [24] Shannon Diversity Index of landscapes | - | |
| [25] Number of visitors in agricultural areas | # | |
| [27] Frequency of responses associating land use/cover with aesthetic values are asked to identify 3 places and landscapes that they have visited and are of high aesthetic value and the predominant land use/cover of each site. Frequency data from this preference assessment was then mapped for the identified sites. | Not provided | |

*Table 5: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Presence of water bodies | Not provided | |
| [2] Presence of sublime features, e.g., mountains | Not provided | |

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[*] The impact area discussed on this factsheet is not a focus of the cited paper

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| **Ecosystem Service** | **Symbolic meaning of nature** |
|---|---|
| **CICES class name** | Elements of living systems that have symbolic meaning |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.2.1.1 |

## 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: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | Index 0-5 | |
| [2] Willingness to pay (WTP) for landscape preservation, considering likely landscape changes | € | |
| [2] Average travel cost of tourists | € * $yr^{-1}$ | |
| [4] Inspiration, spiritual and religious values: Participatory mapping. Respondents in an online survey mark on a map the areas in their region where different cultural ecosystem services are supplied. Then, the proportion of markings in each of the investigated land cover classes is calculated. After that, values are calculated for subregions. The proportions are multiplied with the area extent of the respective land cover classes in the sub-region, and results for all land cover classes are summed up. | ha | |
| [5] Number of spiritual facilities per landscape | # * $ha^{-1}$ | |
| [6] Qualitative value assessment using Likert-scales | - | |

*Table 2: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] Symbolic species | Not specified | ⃠ |

## References


| No. | Citation |
|---|---|
| 1 | Palomo I, Martin-Lopez B, Zorrilla-Miras P, Del Amo DG, Montes C (2014) Deliberative mapping of ecosystem services within and around Donana National Park (SW Spain) in relation to land use change. Regional Environmental Change 14(1): 237-251. DOI: 10.1007/s10113-013-0488-5 |
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* The impact area discussed on this factsheet is not a focus of the cited paper

| | |
|---|---|
| **Short name** | **Spritual meaning of nature** |
| **CICES class name** | Spritual meaning of nature |
| **CICES Section** | Cultural (biotic) |
| **CICES Class code** | 3.2.1.2 |

## 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 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Participatory mapping of inspiration, spiritual and religious values: Respondents in an online survey mark on a map areas in their region where different cultural ES are provided. Then, the proportion of markings in each of the investigated land cover classes is calculated and multiplied with the area extent of the respective land cover classes in the sub region. Finally, the result for all land cover classes are summed up. | [ha] | Survey |
| [2] For services that can be monetized: value of cultural services | [$ * km$^{-2}$ * yr$^{-1}$] | Not provided |
| [2] For services that can not be monetized: qualitative value assessment using Likert-scales | [-] | Not provided |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Religious monuments | [not specified] | Not provided |
| [3] Pilgrim paths in agro-ecosystems | [not specified] | Not provided |

## References

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| | |
|---|---|
| **Ecosystem Service** | **Existence value of nature** |
| **CICES class name** | Characteristics or features of living systems that have an existence value |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.2.2.1 |

## 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 43: Field Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Combination of the following indicators:<br>Existence value of a target species. Site quality: habitat suitability for prey (low, medium, high)<br>Existence value of a target species. Site opportunity: local level of habitat fragmentation, scaled to [0 -1]<br>Existence value of a target species. Scarcity: Risk of species population falling below viable population size, scaled to [0 - 1]<br>Existence value of a target species. Reliability: Risk of future service loss through urban development within a 3-mile radius, scaled to [0 -1] | - | , |

*Table 44: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Intrinsic value of biodiversity: values for land cover classes. The matrix by Burkhard et al., 2012 (DOI: 10.1016/j.ecolind.2011.06.019) was and used in this study. | Index 0 - 5 | |
| [3] Existence value: Participatory mapping. Respondents in an online survey mark on a map the areas in their region where | ha | |

| | | |
|---|---|---|
| different cultural ecosystem services are supplied. Then, the proportion of markings in each of the investigated land cover classes is calculated. After that, values are calculated for sub-regions. The proportions are multiplied with the area extent of the respective land cover classes in the sub-region, and results for all land cover classes are summed up | | |
| [4] Number of spiritual facilities per landscape | $\# * ha^{-1}$ | |
| [4] Number of national parks | # | |

*Table 45: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [5] Diversity of breeding bird species (Simpson-Index) | - | |
| [5] Number of farmland bird species | # | |
| [6] Species of conservation concern: based on species listed in U.K. Biodiversity Action Plan and recorded in a grid cell | Not provided | , |
| [7] Cropland or grassland in protected agricultural areas (e.g., Natura2000, Biosphere reserves, IUCN category V areas, World Heritage UNESCO sites related to agricultural landscape, landscape conservation areas) | ha | |

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| No. | Citation |
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| 4* | Pham HV, Torresan S, Critto A, Marcomini A (2019) Alteration of freshwater ecosystem services under global change - A review focusing on the Po River basin (Italy) and the Red River |


* The impact area discussed on this factsheet is not a focus of the cited paper

| No. | Citation |
|---|---|
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| **Ecosystem Service** | **Option or bequest value of nature** |
|---|---|
| **CICES class name** | Characteristics or features of living systems that have an option or bequest value |
| **CICES Section** | Cultural (Biotic) |
| **CICES Class code** | 3.2.2.2 |

## 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 46: Field Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Adaptability/ flexibility of soils as an option for land use change. Indicator value calculated as: $$I=\frac{\sum \mid \log(\frac{i}{i_{max}})\mid}{n}$$ With: I – Indicator value, 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, $\mid \log(\frac{i}{i_{max}})\mid$ is subtracted from the sum instead of added. For this ecosystem service, variables were:<br>-Soil organic matter [% dw]<br>-Earthworm abundance [number*m$^{-2}$]<br>-Number of earthworm taxa [-]<br>-Number of nematode taxa [-]<br>-Number of micro-arthropods taxa [-]<br>-Physiological diversity bacteria [biolog. CLPP: Hill's slope] | - | , |

*Table 47: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Intrinsic value of biodiversity: values for land cover classes. The matrix by Burkhard et al., 2012 (DOI: 10.1016/j.ecolind.2011.06.019) was dataset and used in this study. | Index 0 - 5 | |

*Table 48: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [3] Cropland or grassland in protected agricultural areas (e.g., Natura2000, Biosphere reserves, IUCN category V areas, World Heritage UNESCO sites related to agricultural land-scape, landscape conservation areas) | # | |

## References


| No. | Citation |
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| 2* | Zhang ZM, Gao JF, Fan XY, Lan Y, Zhao MS (2017) Response of ecosystem services to socioeconomic development in the Yangtze River Basin, China. Ecological Indicators 72: 481-493. DOI: 10.1016/j.ecolind.2016.08.035 |
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* The impact area discussed on this factsheet is not a focus of the cited paper

| | |
|---|---|
| **Ecosystem Service** | **Surface water for drinking** |
| **CICES class name** | Surface water for drinking |
| **CICES Section** | Provisioning (Abiotic) |
| **CICES Class code** | 4.2.1.1 |

## 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 49: Field Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Annual total drainage | mm | |

*Table 50: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [2] Mean annual water flow | $m^3 * s^{-1} * ha^{-1}$ | |
| [3] Streamflow calculated by SWAT model | $m^3 * time^{-1}$ | |
| [3] Surface runoff calculated by application of ECOSER protocol (www.eco-ser.com.ar) | $m^3 * ha^{-1}$ | |

*Table 51: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Annual total drainage | mm | |
| [5, 12] Precipitation – evapotranspiration, calculated with In-VEST model) | $m^3 * ha^{-1} * yr^{-1}$ | |
| [7] Surface water yield: mean annual precipitation - mean annual evapotranspiration; calculated with InVEST model. | mm | |

| | | |
|---|---|---|
| [13] Water yield: calculated as annual precipitation - evapotranspiration | $m^3 * area^{-1} * yr^{-1}$ | |
| [11] Potential water yield, calculated as precipitation - evapotranspiration | mm | , |
| [16] Provisioning of water: Groundwater recharge rate calculated from water balance | mm | |
| [14] Annual average water yield | $mm * yr^{-1}$ | |
| [14] Annual sectoral water yield (e.g., domestic, agriculture and industry | $mm * yr^{-1}$ | |
| [8] Runoff: renewable water supply. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | mm | |
| [14] Annual river runoff | $m^3 * yr^{-1}$ | |
| [15] Annual water flow that is available from surface waters | $mm * yr^{-1}$, $m^3 * yr^{-1}$ | |
| [14] Water level | m | |
| [14] Number of extreme (runoff) events | $\# * yr^{-1}$ | |
| [14] Annual average sediment in rivers | $t * yr^{-1}$ | |
| [14] Total dissolved solids | $mg * l^{-1}$ | |
| [14] Leakage of nutrients | $kg * ha^{-1} * yr^{-1}$ | |
| [9] Surface area of water bodies | ha | , , |
| [9] Number of traditional water sources | # | , , |
| [6] Freshwater supply: values for land cover classes. The matrix by Burkhard et al., 2012 (DOI:10.1016/j.ecolind.2011.06.019) was adapted and used in this study. | Index 0 - 5 | |
| [10] Water for drinking and non-drinking uses: expert-based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class | $km^2$ | , , |
| [10] Water for drinking and non-drinking uses' value: expert-based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class and a literature-based monetary value of ES | $km^2$, $\$ * ha^{-1} * yr^{-1}$ | , , |
| [11] Rating of current service supply per land use class by expert-stakeholders | Rating 0 - 10 | , |
| [11] Rating of increases/decreases of service provision in scenarios, relative to the status quo | % | , |
| [17] Water purification and provision: $$W = NPP * (1 - VCNPP) * IC_s * S_{cf} * 1.75$$ With: W – water purification and provision, NPP – Net Primary Production [0-1000], VCNPP – coefficient of variation of NPP [0–1], $IC_s$ – soil infiltration capacity [0–1], $S_{cf}$ – "slope average" correction factor of the study area [0–1] | | |
| [21] Freshwater recharge from the entire landscape | $m^3$/ ($km^2$ * year) | |

*Table 52: National Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [18] Supply and demand of drinking water, calculated by multiplying modelled average surface water runoff by the number of people living downstream and the average estimated domestic water use | $m^3 * yr^{-1}$ |  |
| [19] High Nature Value farmland | Not specified |  |

*Table 53: Multinational Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [20] Freshwater:  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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|---|---|
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| **Ecosystem Service** | **Surface water for non-drinking purposes** |
|---|---|
| **CICES class name** | Surface water used as a material (non-drinking purposes) |
| **CICES Section** | Provisioning (Abiotic) |
| **CICES Class code** | 4.2.1.2 |

## 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 |  |

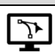
*Table 54: Field Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Annual total drainage | mm |  |

*Table 55: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [2] Mean annual water flow | $m^3 * s^{-1} * ha^{-1}$ |  |
| [3] Streamflow calculated by SWAT model | $m^3 * time^{-1}$ |  |
| [3] Surface runoff calculated using the ECOSER protocol (www.eco-ser.com.ar) | $m^3 * ha^{-1}$ |  |

*Table 56: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Annual total drainage | mm |  |
| [6, 13] Precipitation – Evapotranspiration, calculated with In-VEST model | $m^3 * ha^{-1} * yr^{-1}$ |  |
| [8] Surface water yield: mean annual precipitation - mean annual evapotranspiration, calculated with InVEST model | mm |  |
| [14] Water yield: calculated as annual precipitation - evapotranspiration | $m^3 * area^{-1} * yr^{-1}$ |  |

| | | |
|---|---|---|
| [12] Potential water yield, calculated as precipitation - evapotranspiration | mm | |
| [17] Provisioning of water: Groundwater recharge rate based calculated from water balance | mm | |
| [15] Annual average water yield | mm * $yr^{-1}$ | |
| [15] Annual sectoral water yield (e.g., domestic, agriculture and industry | mm * $yr^{-1}$ | |
| [9] Runoff: renewable water supply. Values were normalized [0-1] using benchmark values where available and observed values otherwise. | mm | |
| [15] Annual river runoff | $m^3$ * $yr^{-1}$ | |
| [16] Annual water flow that is available from surface waters | mm * $yr^{-1}$, $m^3$ * $yr^{-1}$ | |
| [15] Water level | m | |
| [15] Number of extreme (runoff) events | # * $yr^{-1}$ | |
| [15] Annual average sediment in rivers | t * $yr^{-1}$ | |
| [15] Total dissolved solids | mg * $l^{-1}$ | |
| [15] Leakage of nutrients | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [10] Surface area of water bodies | ha | |
| [10] Number of traditional water sources | # | |
| [7] Freshwater supply: values for land cover classes. The matrix by Burkhard et al., 2012 (DOI:10.1016/j.ecolind.2011.06.019) was adapted and used in this study. | Index 0 - 5 | |
| [11] Water for drinking and non-drinking uses: expert-based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class | $km^2$ | |
| [11] Water for drinking and non-drinking uses' value: expert-based index for ecosystem service supply by land cover class [1-5] multiplied by the area of the land cover class and a literature-based monetary value of the ecosystem service | $km^2$, $ * $ha^{-1}$ * $yr^{-1}$ | |
| [12] Rating of current service provision per land use class by expert-stakeholders | 0 - 10 | |
| [12] Rating of increases/decreases of service supply in scenarios, relative to the status quo | % | |
| [18] Water purification and provision, calculated as: $W = NPP * (1 - VCNPP) * IC_s * S_{cf} * 1.75$ With: NPP – Net Primary Production [0-1000], VCNPP – coefficient of variation of NPP [0–1], $IC_s$ – soil infiltration capacity [0–1], $S_{cf}$ – “slope average" correction factor of the study area [0–1] | - | |
| [4] Agricultural water use for irrigation: Average irrigation water use over three years | GL * $a^{-1}$ | |
| [5] Spatial mapping by stakeholders: stakeholders could place green stickers on a map to mark the supply hotspots of this ecosystem service. Red stickers were used to mark locations | Index 0 - 5 | |

| | | |
|---|---|---|
| where the supply of this service is declining. Two different sizes of stickers were used to represent a radius of 0.75 km or 1 km, respectively. | | |
| [22] Irrigated area | Not provided | |
| [22] Area irrigated using surface water | Not provided | |
| [23] Freshwater recharge from the entire landscape | $m^3$/ ($km^2$ * year) | |

*Table 57: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [20] Surface water availability | $m^3$ * $person^{-1}$ * $yr^{-1}$ | |
| [20] Water abstracted | $km^3$ * $yr^{-1}$ | |
| [19] Supply and demand of irrigation water, calculated by multiplying average modelled surface water runoff [not provided] by the downstream areas of irrigable agriculture [not provided] and estimated annual water demand per hectare per year [not provided]. Water demand per hectare was adjusted for the amount of annual rainfall. | l * $d^{-1}$ | |
| [19] Supply and demand of water for hydropower dams, calculated by multiplying average modelled surface water runoff [not provided] by the water demand for hydropower dams using electrical production as proxy [MWh] | l * $d^{-1}$ | |
| [20] Water use per sector | % | |
| [20] Wetlands: the surface of flood-prone areas | ha | |

*Table 58: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [21] Freshwater supply: 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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| No. | Citation |
|---|---|
| 3 | Nahuelhual L, Benra F, Laterra P, Marin S, Arriagada R, Jullian C (2018) Patterns of ecosystem services supply across farm properties: Implications for ecosystem services-based policy incentives. Science of the Total Environment 634: 941-950. DOI: 10.1016/j.scitotenv.2018.04.042 |
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| 14 | Peng J, Tian L, Liu Y, Zhao M, Hu Y, Wu J (2017) Ecosystem services response to urbanization in metropolitan areas: Thresholds identification. Science of the Total Environment 607-608: 706-714. DOI: 10.1016/j.scitotenv.2017.06.218 |
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| 19 | Neugarten RA, Honzak M, Carret P, Koenig K, Andriamaro L, Cano CA, Grantham HS, Hole D, Juhn D, McKinnon M, Rasolohery A, Steininger M, Wright TM, Turner WR (2016) Rapid Assessment of Ecosystem Service Co-Benefits of Biodiversity Priority Areas in Madagascar. PLoS One 11(12): e0168575. DOI: 10.1371/journal.pone.0168575 |
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| Ecosystem Service | Groundwater for drinking |
|---|---|
| **CICES class name** | Ground (and subsurface) water for drinking |
| **CICES Section** | Provisioning (Abiotic) |
| **CICES Class code** | 4.2.2.1 |

## 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 | |

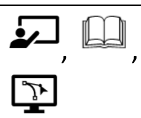
*Table 1: Field Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [23] Groundwater replenishment | $m^3 * m^{-2} * yr^{-1}$ | |
| [5, 22] Annual total drainage | $mm * yr^{-1}$ | |
| [6] Seepage rate: the amount of water that leaves the rooting zone toward the groundwater table | $mm * yr^{-1}$ | |
| [7] Seepage rate: the amount of water that leaves the rooting zone toward the groundwater table | $mm * yr^{-1}$ | |

*Table 2: Farm Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [14] Aquifer recharge from irrigation channels: Four-level index based on the share of water lost through seepage in open channel irrigation [%]. The higher the value, the higher the re-charge | poor-fair-good-excellent | |
| [14] Aquifer recharge from irrigation channels: Four-level index based on the share of irrigation channels that are unlined [%]. The higher the value, the higher the recharge | poor-fair-good-excellent | |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Groundwater recharge, calculated with the soil-water balance model (SWBM) by the U.S. Geological Survey | mm |  |
| [15] Provisioning of water: Groundwater recharge rate calculated from water balance | mm |  |
| [2] Groundwater recharge, calculated as: (Precipitation - Evapotranspiration) * (1 - Share of anthropogenic surface sealing) / (Discharge factor). Discharge factor [-] is determined based on distance from the surface to groundwater and slope. | mm * $yr^{-1}$ |  |
| [12] Groundwater recharge: mean annual infiltration rate | l * $m^{-2}$ |  |
| [19] Groundwater recharge: Share of precipitation not used by evapotranspiration or surface-runoff | % |  |
| [4, 16] Freshwater supply: Annual groundwater recharge | cm * $yr^{-1}$ |  |
| [21] Groundwater recharge rate | mm * $ha^{-1}$ * $yr^{-1}$ |  |
| [10] Groundwater recharge: values for 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 |  |
| [20] Water yield: calculated as annual precipitation - evapotranspiration | $m^3$ * $area^{-1}$ * $yr^{-1}$ |  |
| [9] Precipitation – Evapotranspiration, calculated with InVEST model | 1000 $m^3$ |  |
| [21] Annual average water yield | mm * $yr^{-1}$ |  |
| [21] Annual sectoral water yield (e.g., domestic, agriculture and industry | mm * $yr^{-1}$ |  |
| [22] Annual total drainage | mm |  |
| [10] Freshwater supply: values for 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 |  |
| [18] Water for drinking and non-drinking uses: expert based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [$km^2$] | Index 1-5 * $km^2$ |  |
| [18] Water for drinking and non-drinking uses' value: expert based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [$km^2$] and a literature-based monetary value of the ecosystem service | $ * $ha^{-1}$ * $yr^{-1}$ |  |
| [3] Water purification and provision: NPP × (1−VCNNP) × ICs × Scf; where NPP: Net Primary Production calculated from NDVI-values and expressed on a relative scale set to (0 - | - |  |

| | | |
|---|---|---|
| 1000), VCNPP: coefficient of variation of NPP (0 - 1), ICs: soil infiltration capacity (0 - 1), Scf: slope average correction factor of the study area (0 - 1) | | |
| [21] Leakage of nutrients | kg * ha$^{-1}$ * yr$^{-1}$ | |
| [21] Total dissolved solids | mg * l$^{-1}$ | |
| [8] Designated drinking water protection areas | ha | |
| [17] Runoff: renewable water supply. Values were normalized [0-1] using benchmark values where available and observed values otherwise | mm | |
| [24] Freshwater recharge from the entire landscape | m$^3$/ (km$^2$ * year) | |

*Table 4: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [13] Groundwater recharge: 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 | |
| [13] Freshwater: 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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| **No.** | **Citation** |
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| 2 | Nordborg M, Sasu-Boakye Y, Cederberg C, Berndes G (2017) Challenges in developing region-alized characterization factors in land use impact assessment: impacts on ecosystem services in case studies of animal protein production in Sweden. International Journal of Life Cycle Assessment 22(3): 328-345. DOI: 10.1007/s11367-016-1158-x |
| 3 | Barral MP, Oscar MN (2012) Land-use planning based on ecosystem service assessment: A case study in the Southeast Pampas of Argentina. Agriculture Ecosystems & Environment 154: 34-43. DOI: 10.1016/j.agee.2011.07.010 |
| 4 | Qiu JX, Turner MG (2015) Importance of landscape heterogeneity in sustaining hydrologic ecosystem services in an agricultural watershed. Ecosphere 6(11): 229. DOI: 10.1890/es15-00312.1 |
| 5 | Syswerda SP, Robertson GP (2014) Ecosystem services along a management gradient in Michigan (USA) cropping systems. Agriculture Ecosystems & Environment 189: 28-35. DOI: 10.1016/j.agee.2014.03.006 |

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| 6* | Tsonkova P, Bohm C, Quinkenstein A, Freese D (2015) Application of partial order ranking to identify enhancement potentials for the provision of selected ecosystem services by different land use strategies. Agricultural Systems 135: 112-121. DOI: 10.1016/j.agsy.2015.01.002 |
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| 8* | Vejre H, Vesterager JP, Andersen PS, Olafsson AS, Brandt J, Dalgaard T (2015) Does cadastral division of area-based ecosystem services obstruct comprehensive management? Ecological Modelling 295: 176-187. DOI: 10.1016/j.ecolmodel.2014.09.027 |
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| 13 | Clerici N, Paracchini ML, Maes J (2014) Land-cover change dynamics and insights into ecosystem services in European stream riparian zones. Ecohydrology and Hydrobiology 14(2): 107-120. DOI: 10.1016/j.ecohyd.2014.01.002 |
| 14 | Fleming WM, Rivera JA, Miller A, Piccarello M (2014) Ecosystem services of traditional irrigation systems in northern New Mexico, USA. International Journal of Biodiversity Science, Ecosystem Services and Management 10(4): 343-350. DOI: 10.1080/21513732.2014.977953 |
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| 16 | Qiu J, Wardropper CB, Rissman AR, Turner MG (2017) Spatial fit between water quality policies and hydrologic ecosystem services in an urbanizing agricultural landscape. Landscape Ecology 32(1): 59-75. DOI: 10.1007/s10980-016-0428-0 |
| 17 | Rodríguez-Loinaz G, Alday JG, Onaindia M (2014) Multiple ecosystem services landscape index: A tool for multifunctional landscapes conservation. Journal of Environmental Management 147: 152-163. DOI: 10.1016/j.jenvman.2014.09.001 |
| 18 | Huq N, Bruns A, Ribbe L (2019) Interactions between freshwater ecosystem services and land cover changes in southern Bangladesh: A perspective from short-term (seasonal) and long-term (1973-2014) scale. Science of the Total Environment 650: 132-143. DOI: 10.1016/j.scitotenv.2018.08.430 |
| 19 | Kay S, Crous-Duran J, García de Jalón S, Graves A, Palma JHN, Roces-Díaz JV, Szerencsits E, Weibel R, Herzog F (2018) Landscape-scale modelling of agroforestry ecosystems services in |


* The impact area discussed on this factsheet is not a focus of the cited paper

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| 20 | Peng J, Tian L, Liu Y, Zhao M, Hu Y, Wu J (2017) Ecosystem services response to urbanization in metropolitan areas: Thresholds identification. Science of the Total Environment 607-608: 706-714. DOI: 10.1016/j.scitotenv.2017.06.218 |
| 21 | Phama HV, Torresan S, Critto A, Marcomini A (2019) Alteration of freshwater ecosystem services under global change - A review focusing on the Po River basin (Italy) and the Red River basin (Vietnam). Science of the Total Environment 652: 1347-1365. DOI: 10.1016/j.scitotenv.2018.10.303 |
| 22 | Qiu JX, Carpenter SR, Booth EG, Motew M, Zipper SC, Kucharik CJ, Loheide SP, Turner AG (2018) Understanding relationships among ecosystem services across spatial scales and over time. Environmental Research Letters 13(5): 054020. DOI: 10.1088/1748-9326/aabb87 |
| 23* | Tang LL, Hayashi K, Kohyama K, Leon A (2018) Reconciling Life Cycle Environmental Impacts with Ecosystem Services: A Management Perspective on Agricultural Land Use. Sustainability 10(3): 630. DOI: 10.3390/su10030630 |
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| **Ecosystem Service** | **Groundwater for non-drinking purposes** |
|---|---|
| **CICES class name** | Groundwater (and subsurface) used as a material (non-drinking purposes) |
| **CICES Section** | Provisioning (Abiotic) |
| **CICES Class code** | 4.2.2.2 |

## 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** |
|---|---|---|
| [23] Groundwater replenishment | $m^3 * m^{-2} * yr^{-1}$ | |
| [5, 22] Annual total drainage | $mm * yr^{-1}$ | |
| [6] Seepage rate: the amount of water that leaves the rooting zone toward the groundwater table | $mm * yr^{-1}$ | |
| [7] Seepage rate: the amount of water that leaves the rooting zone toward the groundwater table | $mm * yr^{-1}$ | |

*Table 2: Farm Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [13] Aquifer recharge from irrigation channels: Four-level index based on the share of water lost through seepage in open channel irrigation [%]. The higher the value, the higher the re-charge | poor-fair-good-excellent | |
| [13] Aquifer recharge from irrigation channels: Four-level index based on the share of unlined irrigation channels [%]. The higher the value, the higher the recharge | poor-fair-good-excellent | |

*Table 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Groundwater recharge, calculated with the soil-water balance model (SWBM) by the U.S. Geological Survey | mm | |
| [14] Provisioning of water: Groundwater recharge rate calculated from water balance | mm | |
| [2] Groundwater recharge, calculated as: (Precipitation - Evapotranspiration) * (1 - Share of anthropogenic surface sealing) / (Discharge factor). Discharge factor [-] is determined based on distance from the surface to groundwater and slope | mm * yr$^{-1}$ | |
| [11] Groundwater recharge: mean annual infiltration rate | l * m$^{-2}$ | |
| [19] Groundwater recharge: Share of precipitation not used by evapotranspiration or surface-runoff | % | |
| [4, 16] Freshwater supply: Annual groundwater recharge | cm * yr$^{-1}$ | |
| [21] Groundwater recharge rate | mm * ha$^{-1}$ * yr$^{-1}$ | |
| [9] Groundwater recharge: values for 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 | |
| [20] Water yield: calculated as annual precipitation - evapotranspiration | m$^3$ * area$^{-1}$ * yr$^{-1}$ | |
| [8] Precipitation - Evapotranspiration calculated with InVEST model | 1000 m$^3$ | |
| [21] Annual average water yield | mm * yr$^{-1}$ | |
| [21] Annual sectoral water yield (e.g., domestic, agriculture and industry | mm * yr$^{-1}$ | |
| [22] Annual total drainage | mm | |
| [9] Freshwater supply: values for 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 | |
| [18] Water for drinking and non-drinking uses: expert-based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [km$^2$] | Index 1-5 * km$^2$ | , , |

| | | |
|---|---|---|
| [18] Water for drinking and non-drinking uses' value: expert-based index for ecosystem service supply by land cover class [1-5], multiplied by the area of the land cover class [$km^2$] and a literature-based monetary value of the ecosystem service | $ * $ha^{-1}$ * $yr^{-1}$ | , , |
| [3] Water purification and provision: NPP × (1–VCNNP) × ICs × Scf; where NPP: Net Primary Production calculated from NDVI-values and expressed on a relative scale set to (0 - 1000), VCNPP: coefficient of variation of NPP (0 - 1), ICs: soil infiltration capacity (0 - 1), Scf: slope average correction factor of the study area (0 - 1) | - | |
| [21] Leakage of nutrients | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [21] Total dissolved solids | mg * $l^{-1}$ | |
| [17] Runoff: renewable water supply. Values were normalized [0-1] using benchmark values where available and observed values otherwise | mm | |
| [24] Irrigated area | Not provided | |
| [24] Area irrigated using groundwater | Not provided | |
| [25] Freshwater recharge from the entire landscape | $m^3$/ ($km^2$ * year) | |

*Table 4: National Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [15] Groundwater bodies | Not specified | |
| [15] Groundwater abstraction | Not specified | |

*Table 5: Multinational Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [12] Groundwater recharge: 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 | |
| [12] Freshwater: 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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* The impact area discussed on this factsheet is not a focus of the cited paper

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| | services at the landscape scale. Agroforestry Systems 92(4): 1075-1089. DOI: 10.1007/s10457-017-0132-3 |
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| 17 | Rodríguez-Loinaz G, Alday JG, Onaindia M (2014) Multiple ecosystem services landscape index: A tool for multifunctional landscapes conservation. Journal of Environmental Management 147: 152-163. DOI: 10.1016/j.jenvman.2014.09.001 |
| 18 | Huq N, Bruns A, Ribbe L (2019) Interactions between freshwater ecosystem services and land cover changes in southern Bangladesh: A perspective from short-term (seasonal) and long-term (1973-2014) scale. Science of the Total Environment 650: 132-143. DOI: 10.1016/j.scitotenv.2018.08.430 |
| 19 | Kay S, Crous-Duran J, García de Jalón S, Graves A, Palma JHN, Roces-Díaz JV, Szerencsits E, Weibel R, Herzog F (2018) Landscape-scale modelling of agroforestry ecosystems services in Swiss orchards: a methodological approach. Landscape Ecology 33(9): 1633-1644. DOI: 10.1007/s10980-018-0691-3 |
| 20 | Peng J, Tian L, Liu Y, Zhao M, Hu Y, Wu J (2017) Ecosystem services response to urbanization in metropolitan areas: Thresholds identification. Science of the Total Environment 607-608: 706-714. DOI: 10.1016/j.scitotenv.2017.06.218 |
| 21 | Phama HV, Torresan S, Critto A, Marcomini A (2019) Alteration of freshwater ecosystem services under global change - A review focusing on the Po River basin (Italy) and the Red River basin (Vietnam). Science of the Total Environment 652: 1347-1365. DOI: 10.1016/j.scitotenv.2018.10.303 |
| 22 | Qiu JX, Carpenter SR, Booth EG, Motew M, Zipper SC, Kucharik CJ, Loheide SP, Turner AG (2018) Understanding relationships among ecosystem services across spatial scales and over time. Environmental Research Letters 13(5): 054020. DOI: 10.1088/1748-9326/aabb87 |
| 23* | Tang LL, Hayashi K, Kohyama K, Leon A (2018) Reconciling Life Cycle Environmental Impacts with Ecosystem Services: A Management Perspective on Agricultural Land Use. Sustainability 10(3): 630. DOI: 10.3390/su10030630 |
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| **Ecosystem Service** | **Abiotic filtration, sequestration and storage of waste** |
|---|---|
| **CICES class name** | Mediation by other chemical or physical means (e.g., via filtration, sequestration, storage or accumulation) |
| **CICES Section** | Regulation & Maintenance (Abiotic) |
| **CICES Class code** | 5.1.1.3 |

## 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 59: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [3] Nitrate leaching | kg * $ha^{-1}$ * $yr^{-1}$ | |
| [2] Risk of nitrate leaching: exchange frequency of the soil water in the root layer. Infiltration rate divided by field capacity | % | |
| [1] Mechanical filtration capacity: infiltration capacity, calculated as: $$IC = Perm_{Soil} * (1 - s)$$ With: IC – infiltration capacity, $Perm_{Soil}$ – soil permeability [cm*$d^{-1}$], s – share of anthropogenic surface sealing | cm * $d^{-1}$ | , |
| [1] Physicochemical filtration capacity, calculated as: $$IC_{physicochem} = CEC_{eff} * (1 - s)$$ With: $IC_{physicochem}$ – physicochemical filtration capacity, $CEC_{eff}$ – effective cation exchange capacity, s – share of anthropogenic surface sealing) | cmol(+) * kg $dm^{-1}$ | , |
| [4] Volume of purified water | $m^3$/ ($km^2$ *year) | |
| [4] Mass of a specific nutrient retained | ton/ ($km^2$ * year) | |
| [5] Area of undisturbed creek banks that serve as buffers to pesticide and fertilizer runoff | Not provided | |

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| No. | Citation |
|---|---|
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| 2 | Bastian O, Lupp G, Syrbe RU, Steinháußer R (2013) Ecosystem services and energy crops - Spatial differentiation of risks. Ekologia Bratislava 32(1): 13-29. DOI: 10.2478/eko-2013-0002 |
| 3 | Kay S, Crous-Duran J, Ferreiro-Domínguez N, García de Jalón S, Graves A, Moreno G, Mosquera-Losada MR, Palma JHN, Roces-Díaz JV, Santiago-Freijanes JJ, Szerencsits E, Weibel R, Herzog F (2018) Spatial similarities between European agroforestry systems and ecosystem services at the landscape scale. Agroforestry Systems 92(4): 1075-1089. DOI: 10.1007/s10457-017-0132-3 |
| 4 | Gasparatos A, Romeu-Dalmau C, von Maltitz GP, Johnson FX, Shackleton C, Jarzebski MP, Jumbe C, Ochieng C, Mudombi S, Nyambane A, Willis K (2018) Mechanisms and indicators for assessing the impact of biofuel feedstock production on ecosystem services. Biomass & Bioenergy 114: 157-173. DOI: 10.1016/j.biombioe.2018.01.024 |
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| Short name | **Recreational interactions with abiotic nature** |
|---|---|
| **CICES class name** | Recreational interactions with abiotic nature |
| **CICES Section** | Cultural (biotic) |
| **CICES Class code** | 6.1.1.1 |

## 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 3: Regional Scale*

| Indicator | Unit | Indicator values from |
|---|---|---|
| [1] Participatory mapping of outdoor activities: Respondents in an online survey mark on a map areas in their region where different cultural ES are provided. Then, the proportion of markings in each of the investigated land cover classes is calculated and multiplied with the area extent of the respective land cover classes in the sub region. Finally, the result for all land cover classes are summed up. | [ha] | |

## References


| No. | Citation |
|---|---|
| 1 | Jaligot R, Chenal J, Bosch M, Hasler S (2019) Historical dynamics of ecosystem services and land management policies in Switzerland. Ecological Indicators 101: 81-90. DOI: 10.1016/j.ecolind.2019.01.007 |

| **Short name** | **Intellectual interactions with abiotic nature** |
|---|---|
| **CICES class name** | Intellectual interactions with abiotic nature |
| **CICES Section** | Cultural (biotic) |
| **CICES Class code** | 6.1.2.1 |

## 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 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Participatory mapping of inspiration, spiritual and religious values: Respondents in an online survey mark on a map areas in their region where different cultural ES are provided. Then, the proportion of markings in each of the investigated land cover classes is calculated and multiplied with the area extent of the respective land cover classes in the sub region. Finally, the result for all land cover classes are summed up. | [ha] | |

## References



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|---|---|
| 1 | Jaligot R, Chenal J, Bosch M, Hasler S (2019) Historical dynamics of ecosystem services and land management policies in Switzerland. Ecological Indicators 101: 81-90. DOI: 10.1016/j.ecolind.2019.01.007 |

| | |
|---|---|
| **Short name** | **Symbolic and spiritual meaning of abiotic nature** |
| **CICES class name** | Symbolic and spiritual meaning of abiotic nature |
| **CICES Section** | Cultural (biotic) |
| **CICES Class code** | 6.2.1.1 |

## 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 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Participatory mapping of inspiration, spiritual and religious values: Respondents in an online survey mark on a map areas in their region where different cultural ES are provided. Then, the proportion of markings in each of the investigated land cover classes is calculated and multiplied with the area extent of the respective land cover classes in the sub region. Finally, the result for all land cover classes are summed up. | [ha] | |

## References



| **No.** | **Citation** |
|---|---|
| 1 | Jaligot R, Chenal J, Bosch M, Hasler S (2019) Historical dynamics of ecosystem services and land management policies in Switzerland. Ecological Indicators 101: 81-90. DOI: 10.1016/j.ecolind.2019.01.007 |

| **Short name** | **Non-use value of abiotic nature** |
|---|---|
| **CICES class name** | Non-use value of abiotic nature |
| **CICES Section** | Cultural (biotic) |
| **CICES Class code** | 6.2.2.1 |

## 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 3: Regional Scale*

| **Indicator** | **Unit** | **Indicator values from** |
|---|---|---|
| [1] Participatory mapping of existence value: Respondents in an online survey mark on a map areas in their region where different cultural ES are provided. Then, the proportion of markings in each of the investigated land cover classes is calculated and multiplied with the area extent of the respective land cover classes in the sub region. Finally, the result for all land cover classes are summed up. | [ha] | |

## References


| **No.** | **Citation** |
|---|---|
| 1 | Jaligot R, Chenal J, Bosch M, Hasler S (2019) Historical dynamics of ecosystem services and land management policies in Switzerland. Ecological Indicators 101: 81-90. DOI: 10.1016/j.ecolind.2019.01.007 |