

Impact assessment on ecosystem services

RECARE Task 7.1

CDE University of Bern; Gudrun Schwilch, Tatenda Lemann

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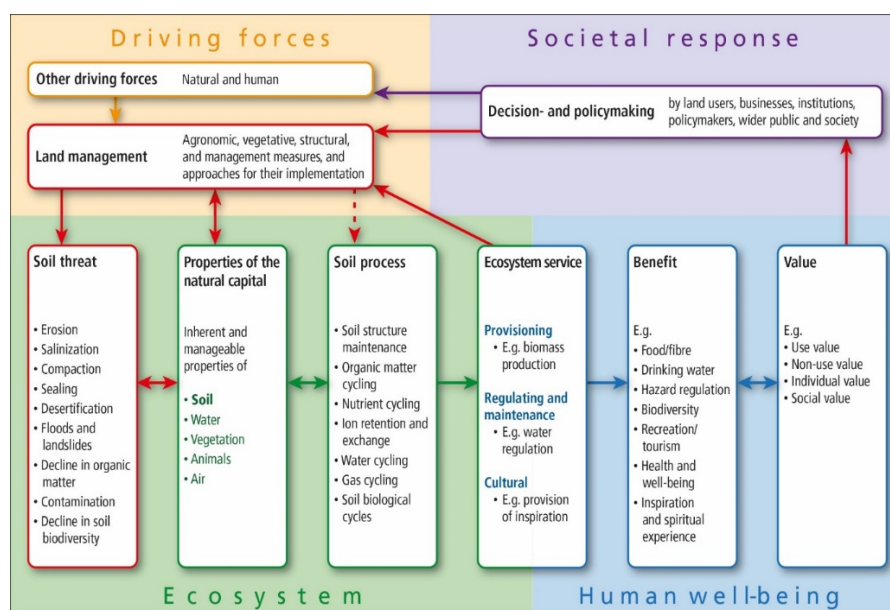


Manual to Excel Tool ES Assessment, version September 2017

(Tool_IndicatorsESAssessment_V10.xlsx)

Background

In Task 7.1, RECARE aims to assess how remediation measures affect ecosystem services (ES). The framework developed in WP2 provides the conceptual basis for this task (Schwilch et al., 2016).



The rationale is that changes in the natural capital's properties influence soil processes, which support the provision of ecosystem services. The benefits produced by these ecosystem services are explicitly or implicitly valued by individuals and society. This can influence decision- and policy making at different scales, potentially leading to a societal response, such as improved land management. The framework thus reflects the specific contributions soils make to ecosystem services and helps reveal changes in ecosystem services caused by land management and policies affecting soil.

The specific objectives of Task 7.1 are:

1. Identify properties and indicators to capture impacts of trialled measures on soil processes and provision of ES
2. Combine their relative influence in order to quantify changes in ES through trialled measures
3. At levels of field trial and case study

In September 2016, the case studies have identified the properties of the natural capital that are likely affected by the trialled measure and how these changes are assessed. It was also investigated which of the identified property changes have an impact on a specific soil process and how. Finally,

the case studies identified which ES are affected by the trialled measure and which indicators can be used to measure the change in ES directly.

With this Excel tool, we now move to the calculations of these impacts by using the identified properties and indicators and the quantified data from the field trials. The impact will be assessed for the **affected area** (plot level) and the **wider area** (WOCAT-mapping), each for the **SLM implementation period** (about 2 years) and a **10-year scenario**. This results in four different graphs, which will provide the **basis for the ES valuation together with stakeholders in Task 4.3**.

NEW: Additionally to the ES assessment, the case study researchers are asked to identify the benefits and drawbacks associated with these ES within Task 7.1. This will reduce the time requested from stakeholders during the 3rd workshop, as stakeholders will only be asked to complement the already identified benefits and drawbacks.

The procedure includes the following **steps**:

1. Quantification of the observed **changes in properties** of the natural capital (soil, water, vegetation, etc.) before and after implementation of the trialled measure and appraisal of magnitude of the measured changes (strong increase to strong decrease) in the local context. This step is done for the plot level as well as the wider area separately.
2. Weighing of the **impact of the relevant properties on ecosystem services**. This step includes an estimation of the relative importance of each property change in contributing to the different ES by assigning a percentage of each, summing up to 100%.
3. **Measured impact on ecosystem services**. Complementation of assessed impact due to changed properties of the natural capital with directly measured ES indicators. Identification of benefits and drawbacks associated with the ES.
Visualisation of the calculated changes in ES due to the trialled measure, where 0 indicates no change in ES.
4. Estimation of expected long-term changes in ES at plot level and wider area for a 10-year **scenario** and visualisation of these. Identification of long-term benefits and drawbacks associated with the ES.

With your feedback from the first round in September 2015, we have defined 15 ecosystem services that are relevant for RECARE study sites. They are a combination of the division and group from the CICES classification and were all mentioned to be affected by the trialled measures in one or more case studies. See Annex for details and examples from CICES.

<p><u>Provisioning Services:</u></p> <ul style="list-style-type: none"> • Nutrition Biomass • Nutrition Water • Material Biomass • Material Water • Biomass-based energy sources 	<p><u>Regulating Services</u></p> <ul style="list-style-type: none"> • Mediation of waste, toxics and other nuisances • Mediation of flows (mass, liquid, air) • Lifecycle maintenance, habitat and gene pool protection • Pest and disease control • Soil formation and composition • Water conditions • Atmospheric composition and climate regulation 	<p><u>Cultural Services</u></p> <ul style="list-style-type: none"> • Physical and experiential interactions • Intellectual and representative interactions • Spiritual and symbolic interactions
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Step 1. Changes in properties

Changes of properties of the natural capital induced by trialled measure (**Bold = input required**)

- *Cells B10 and B11:* Name of case study and trialled measure. Note that for each trialled measure tested in the case study site, a separate Excel file needs to be filled in.
- *Column A-D:* The list of the properties of the natural capital consists of different sources. Most properties are copied from Dominati et al. (2004) and others were proposed by case study partners. Column D contains suggested units for each property (*comments welcome*).
- *Column E-F:* Responses of the respective case study to the question 'What is the impact of the SLM measure on the soil properties' (from first round in Sept 2016). This mainly includes the expected change in properties, which serves as a source of information for the current assessment, and can be adapted if necessary. "+/-" indicates that a change was expected, but with an unclear direction. Through the measurements, this should now be clarified and supported by data.
- **Column G-H:** Each case study will fill in the measured properties without and with trialled measure for the trialled measure implementation period. All rows of properties that were selected in the first round appear in white, meaning that data is expected here. If there are no measured numbers but there are important changes, the changes can also be explained with some words. These measurements are important to have quantitative data behind the estimated impact of the changes.
- *Column I-J:* Automatic calculation of the absolute and percentage changes – no input required.
- **Column K-L:** Case study partners estimate the magnitude of change (column I-J) and rate it in the local context from -3 (strong decrease) to 3 (strong increase). If possible, consider seasonality and velocity of changes. *E.g. is a decrease of the pH from 7 to 6.5 a strong (-3), a moderate (-2), or a small (-1) decrease in the local context? If you observed a change in a property, which was not measured, please estimate the magnitude of change. In any case, please use column L to explain/justify your estimation of the magnitude!*

Step 2. Impact of relevant properties on ecosystem services

Impact dependence and relative contribution of the changed properties on ecosystem services. It is helpful to have the CICES list (see annex in this document) at hand for explanations of the different ecosystem services. (**Bold = input required**)

- **Column 'Impact dependence' N/Q/T/W etc:** For each property with an impact on the identified ecosystem service, we define the "impact dependence" (impact is positive +1 or negative -1) for the plot level and the wider area. These columns are predefined but can be adapted if necessary in a specific context and for properties with an optimum. *E.g. a decrease of the pH from 7 to 6.5 can be positive or negative, depending on the pH tolerance of the plants.*
- **Column 'weight %' O/R/U/X etc:** In a default setting, we weighted the impact of each property on the specified ecosystem service. The total impact of all properties with an impact on an ecosystem service is always 100%. The case study partners should check the distribution of weights and change them if necessary. *All relevant properties should be included in case you consider them important to explain the ES, independent whether measured/estimated data is*

available. The colour of the 100% cell (row 69) will turn from red to black as soon as the 100% are reached and the user has to adapt the weighing in case the sum is below or above 100%. If one of the changed properties is decisive for a certain ES, then it has to be assigned to 100% (e.g. high salinity is preventing plant growth). **Please comment your weights in row 70! This will help to understand your reasoning behind the differently assigned weights and may improve our overall understanding on the factors explaining changes in ES.**

For this part, we still welcome expert input from the RECARE partners to get the best rule setting as possible!

With the estimated impact of the measured change, the impact dependence and the weighting of the properties, we calculate two impact values between -3 and 3 (in yellow box) for each ecosystem service, one for the affected area (plot level) and one for the wider area. The calculation is done multiplying the “magnitude of change” and the “impact dependence” with the “weight”. Please note that this value may pretend a wrong accurateness. However, we decided to keep it for the moment, as restricting the final values to integers would probably level out any differences among ES.

Important: If a specific ES is not relevant for the case study, a N/A can be written directly into the yellow box.

Step 3. Measured impact on ecosystem services

Complementation of indirectly and directly measured indicators (**Bold = input required**).

Some of the ecosystem services can be measured directly, such as yield, or using other indicators than those related to a change in properties of the natural capital (such as number of visitors). The three sheets of step 3 (on provisioning, regulating and cultural services respectively) thus serve to complement the previously assessed impacts due to changed properties of the natural capital with directly measured ES indicators. This procedure is based on the assumption that these directly measured ES indicators do only explain part of the ES.

The three sheets are structured identically:

- *Column A-C:* Information on the defined ecosystem services. *No changes to be done by the case study partners.*
- *Column D-G:* Answers from the specific case study partner from the first round (Sept 2016). This includes the expected change in ES and their indicators, which serves as a source of information for the current assessment. *No changes to be done by the case study partners.*
- **Column H-I/ S-T:** Each case study fills in the measured indicators of the ecosystem services (if available) without and with the trialled measure (*e.g. crop yield, number of visitors*). These measurings are important to have quantitative data behind the estimated impact of the changes. For the cultural services, it would also be important to differentiate gender, i.e. indicate the number of men and women visitors / participants / stakeholders.
- *Column J-K/U-V:* Automatic calculation of the absolute and percentage changes – no input required.
- **Column L-M/ W-X:** Case study partners appraise the magnitude of the changes and rate it in the local context from -3 (strong decrease) to 3 (strong increase). *E.g. is a decrease of the potato harvest from 160 t/ha to 130 t/ha a strong (-3), a moderate (-2), or a small (-1) decrease in the local context?* **Please use column M and X to explain/justify your estimation of the magnitude!**

- *Column N and Y: ES change (calculated with properties) taken from the yellow field in sheet 1.*
- *Column O and Z: Average of the two previous columns which is the final change of the ecosystem services, due to the implementation of the trialled measure – from “-3” (strong decrease) to “3” (strong increase).*
- **Column P-R/ AA-AC:** List **benefits** (positive impacts, advantages) and **drawbacks** (losses, negative impacts, disadvantages) that the trialled measure may have for people and nature, i.e. increased yield, clean water, increased workload, etc. Separate the different benefits/drawbacks with comma and try to keep text short (this will be used in the Task 4.3 workshop for complementation and valuation by stakeholders). Please use column R and AC for further explanations or comments.
Try to think broadly, i.e. beyond yield, costs and the specific soil threat(s) addressed and identify benefits/drawbacks even if there is no change in the assessed ES in column O / Z!

Visualisation of step 3

The graph in Excel is a temporary version. To get the final graph, R-Studio needs to be installed and a script run. Instructions see below.

The values on the axes of each ES indicate the change in the ES compared to the situation without the trialled measure, which are caused by the changes in properties of the natural capital over the period of monitoring. The grey circle of ‘no change’ reflects the supply of the ES before the implementation of the trialled measure.

Step 4. 10-year scenario and visualisation

(Bold = input required)

- *Column C/ I:* Results from Step 3. To order to estimate changes in ES due to the trialled measure practice in 10 years, the values from the short-term assessment need to be reviewed.
- **Column D-E/ J-K:** For each ES, it should be assessed whether the assigned short-term value will still be the same in 10 years, or whether the changes in ES will increase or decrease (plot level and wider area). For example, nutrition biomass (yield) may decrease in the first two years after implementation, but will increase within 10 years. This could mean that an initial negative change (e.g. -1) would turn into a positive (e.g. +2). Or SOM would initially only change little (e.g. 0 or +1 and then increase much more over 10 years (e.g. +3). If the change will be the same in short- and long-term, the same value needs to be entered. Please use column E/ K for explanations and comments on your estimation of the long-term change!
- **Column F-H/ L-N:** Benefits and drawbacks need also to be identified for the 10-year scenario (column F-G/ L-M). Some benefits/drawbacks may only emerge after the long term. If the benefits/drawbacks remain the same, please list them here again. Separate the different benefits/drawbacks with comma and try to keep text short (this will be used in the Task 4.3 workshop for complementation and valuation by stakeholders). Please use column H and N for further explanations or comments.

If measured data from long-term trials are available, we recommend copying the short-term file and filling in all the sheets again with the long-term data (i.e. with the details of the changes in properties of the natural capital).

Visualisation of step 4

Two additional graphs will result from column D and J containing the resulting ES change. *No changes to be done.* To get the final graph, R-Studio needs to be installed and a script run. Instructions see below.

Summary of benefits and drawbacks from step 3 and 4

Here all benefits and drawbacks are listed for plot level and wider area and for present and future. *This list will be used for the preparations of your stakeholder workshop 3 (WP 4.3): Stakeholder valuation of ecosystem services.*

Visualisation in R

To run the visualisation in R, please follow these steps. **If you don't feel comfortable in doing this, you can also send the file to us and we run it for you!**

STEP 1 -- Download and install R

Download R if it is not on your computer (latest version 3.3.3) <https://cran.rstudio.com/>

STEP 2 -- Download and install RStudio

Download R-Studio if it is not on your computer (Open Source License for free):
<https://www.rstudio.com/products/rstudio/download/>

STEP 3 -- Prepare the data

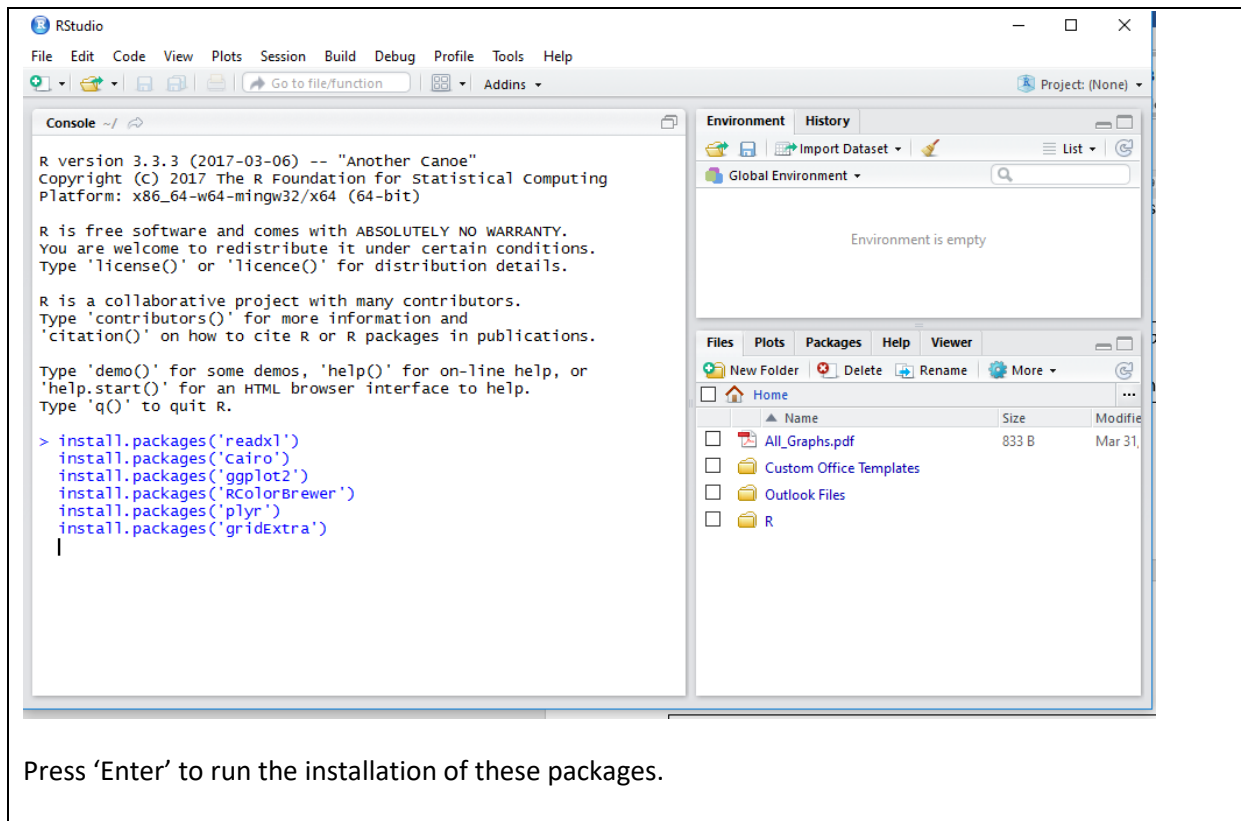
Uncompress the "_RTool_IndicatorsESAssesment.zip" file in your desired working directory. Copy the excel file of your study site "XXX_Tool_IndicatorsESAssesment_v9.xlsx" (when complete) into the same folder.

STEP 4 -- Open RStudio

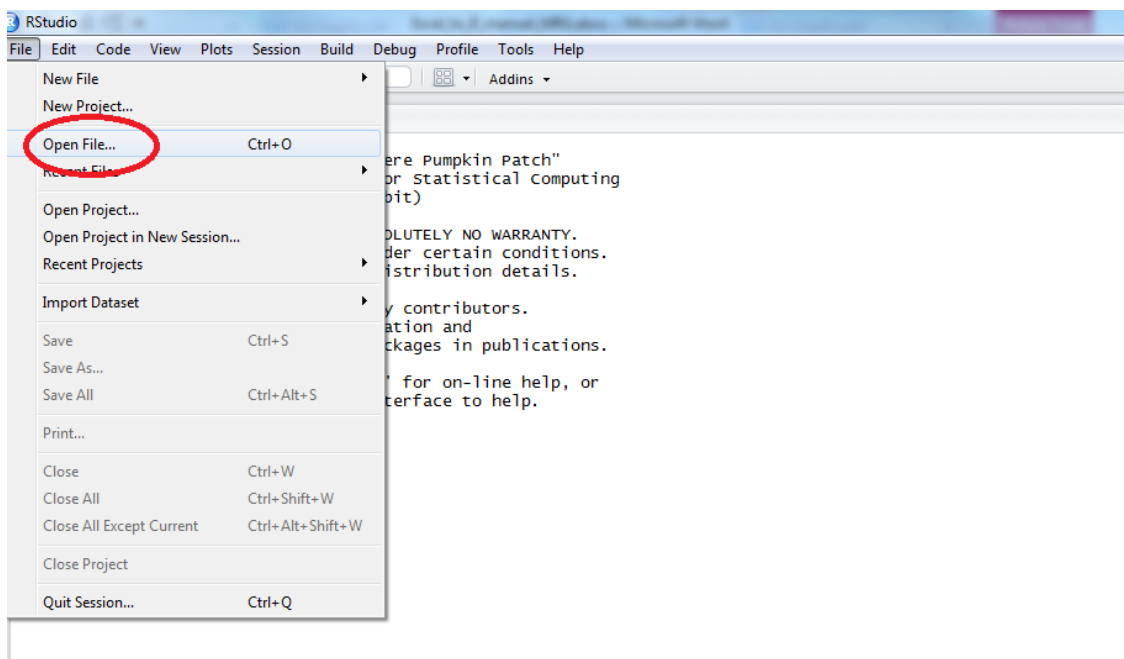
Just installed it? Then first install the packages needed. You have to install the packages only once.

For this, you can just copy the following lines into the console:

```
install.packages('readxl')
install.packages('Cairo')
install.packages('ggplot2')
install.packages('RColorBrewer')
install.packages('plyr')
install.packages('gridExtra')
install.packages('dplyr')
```



With "Open File..." you can open the R script "_applyTool.R" (see below).



STEP 5 -- Adapt and run the script

There are some adaptations needed in the script to run it for each case study. You can easily find the action required with "@_requiresACTION".

1. Adjust the directory path in line 37 of the script:

```
workingPath = "E:/_RTool_IndicatorsESAssesment"
with the path where you store the tool files, e.g.
```

```
workingPath = "D:/RECARE/WP7/ESAssessment"
```

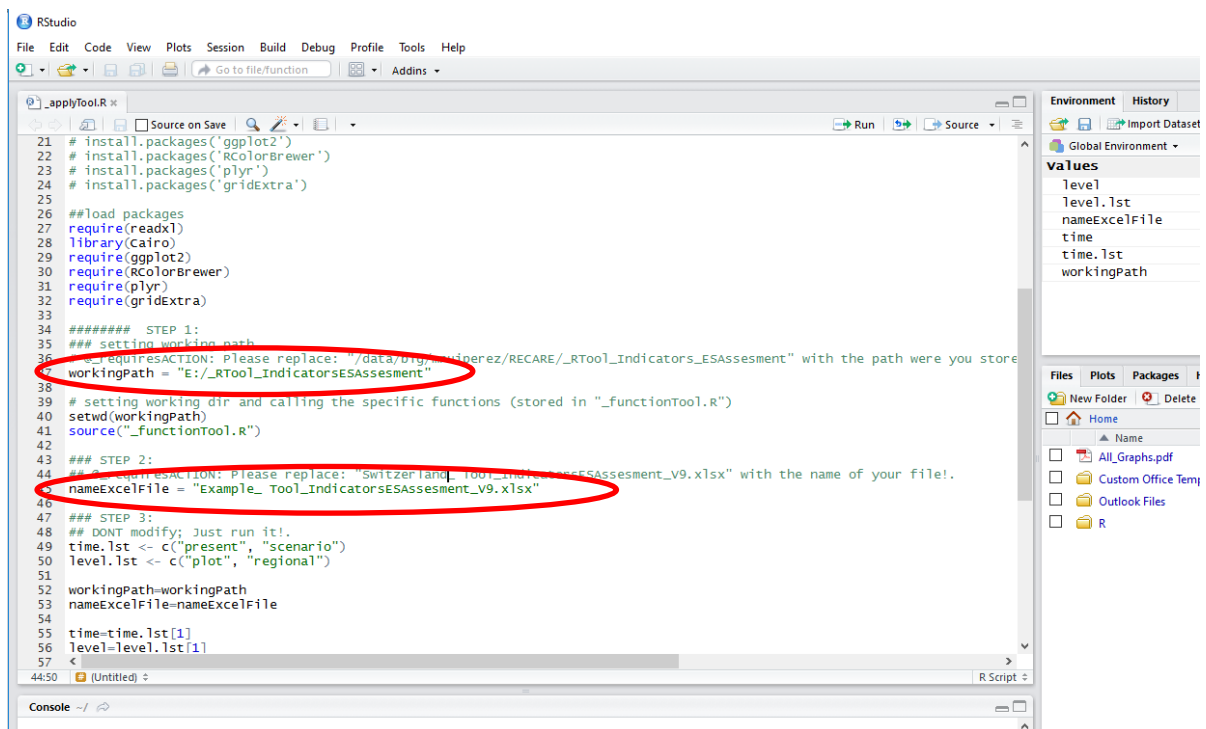
2. Replace in line 45 "Example_ Tool_IndicatorsESAssesment_V9.xlsx" with the name of your file, e.g.:

```
nameExcelFile = "Portugal_Tool_IndicatorsESAssesment_V9.xlsx"
```

3. Run this script by:

- Select all by Press Control +A
- Press Ctrl + Enter to run the script.

All the outputs will be stored in the same working directory.



Good luck!

In case of problems, please contact Gudrun Schwilch and/or Tatenda Lemann:

gudrun.schwilch@cde.unibe.ch

tatenda.lemann@cde.unibe.ch

Annex

Adapted CICES list of ecosystem services with examples

Provisioning services

RECARE ES (combination of CICES division & group)	Class	Examples
Nutrition biomass	Cultivated crops	Cereals (e.g. wheat, rye, barely), vegetables, fruits etc.
	Reared animals and their outputs	Meat, dairy products (milk, cheese, yoghurt), honey etc.
	Wild plants, algae and their outputs	Wild berries, fruits, mushrooms, water cress, salicornia (saltwort or samphire); seaweed (e.g. <i>Palmaria palmata</i> = dulse, dillisk) for food
	Wild animals and their outputs	Game, freshwater fish (trout, eel etc.), marine fish (plaice, sea bass etc.) and shellfish (i.e. crustaceans, molluscs), as well as equinoderms or honey harvested from wild populations; Includes commercial and subsistence fishing and hunting for food
Nutrition water	Surface water for drinking	Collected precipitation, abstracted surface water from rivers, lakes and other open water bodies for drinking
	Ground water for drinking	Freshwater abstracted from (non-fossil) groundwater layers or via ground water desalination for drinking
Material biomass	Fibres and other materials from plants, algae and animals for direct use or processing	Fibres, wood, timber, flowers, skin, bones, sponges and other products, which are not further processed; material for production e.g. industrial products such as cellulose for paper, cotton for clothes, packaging material; chemicals extracted or synthesised from algae, plants and animals such as turpentine, rubber, flax, oil, wax, resin, soap (from bones), natural remedies and medicines (e.g. chondritin from sharks), dyes and colours, ambergris (from sperm whales used in perfumes); Includes consumptive ornamental uses.
	Materials from plants, algae and animals for agricultural use	Plant, algae and animal material (e.g. grass) for fodder and fertilizer in agriculture and aquaculture;
Material water	Ground water for non-drinking purposes	Freshwater abstracted from (non-fossil) groundwater layers or via ground water desalination for domestic use (washing, cleaning and other non-drinking use), irrigation, livestock consumption, industrial use (consumption and cooling) etc.
Biomass-based energy sources	Plant-based resources	Wood fuel, straw, energy plants, crops and algae for burning and energy production
	Animal-based resources	Dung, fat, oils, cadavers from land, water and marine animals for burning and energy production

Regulating services

RECARE ES (combination of CICES division & group)	Class	Example
Mediation of waste, toxics and other nuisances	Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	Biological filtration/sequestration/storage/accumulation of pollutants in land/soil, freshwater and marine biota, adsorption and binding of heavy metals and organic compounds in biota
	Filtration/sequestration/storage/accumulation by ecosystems	Bio-physicochemical filtration/sequestration/storage/accumulation of pollutants in land/soil, freshwater and marine ecosystems, including sediments; adsorption and binding of heavy metals and organic compounds in ecosystems (combination of biotic and abiotic factors)
Mediation of flows (mass, liquid, air)	Mass stabilisation and control of erosion rates	Erosion / landslide / gravity flow protection; vegetation cover protecting/stabilising terrestrial, coastal and marine ecosystems, coastal wetlands, dunes; vegetation on slopes also preventing avalanches (snow, rock), erosion protection of coasts and sediments by mangroves, sea grass, macroalgae, etc.
	Buffering and attenuation of mass flows	Transport and storage of sediment by rivers, lakes, sea
	Hydrological cycle and water flow maintenance	Capacity of maintaining baseline flows for water supply and discharge; e.g. fostering groundwater; recharge by appropriate land coverage that captures effective rainfall; includes drought and water scarcity aspects.
	Flood protection	Flood protection by appropriate land coverage; coastal flood prevention by mangroves, sea grass, macroalgae, etc. (supplementary to coastal protection by wetlands, dunes)
	Storm protection	Natural or planted vegetation that serves as shelter belts
Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	Pollination by bees and other insects; seed dispersal by insects, birds and other animals
Pest and disease control	Pest control	Pest and disease control including invasive alien species
	Disease control	In cultivated and natural ecosystems and human populations
Soil formation and composition	Weathering processes	Maintenance of bio-geochemical conditions of soils including fertility, nutrient storage, or soil structure; includes biological, chemical, physical weathering and pedogenesis
	Decomposition and fixing processes	Maintenance of bio-geochemical conditions of soils by decomposition/mineralisation of dead organic material, nitrification, denitrification etc.), N-fixing and other bio-geochemical processes;
Water conditions	Chemical condition of freshwaters	Maintenance / buffering of chemical composition of freshwater column and sediment to ensure favourable living conditions for biota e.g. by denitrification, re-mobilisation/re-mineralisation of phosphorous, etc.
Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	Global climate regulation by greenhouse gas/carbon sequestration by terrestrial ecosystems, water columns and sediments and their biota; transport of carbon into oceans (DOCs) etc.
	Micro and regional climate regulation	Modifying temperature, humidity, wind fields; maintenance of rural and urban climate and air quality and regional precipitation/temperature patterns

Cultural services

RECAP ES (combination of CICES division & group)	Class	Example
Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings	In-situ bird and wildlife watching, landscape experience, etc.
	Physical use of land-/seascapes in different environmental settings	Walking, hiking, climbing, boating, leisure fishing (angling) and leisure hunting
Intellectual and representative interactions	Scientific	Subject matter for research both on location and via other media
	Educational	Subject matter of education both on location and via other media
	Heritage, cultural	Historic records, cultural heritage e.g. preserved in water bodies and soils
	Entertainment	Ex-situ viewing/experience of natural world through different media
	Aesthetic	Sense of place, artistic representations of nature
Spiritual and symbolic interactions	Sacred and/or religious	Spiritual, ritual identity e.g. 'dream paths' of native Australians, holy places; sacred plants and animals and their parts
	Existence	Enjoyment provided by wild species, wilderness, ecosystems, land-/seascapes
	Bequest	Willingness to preserve plants, animals, ecosystems, land-/seascapes for the experience and use of future generations; moral/ethical perspective or belief