User Manual – QGIS plugin of ENCA tool

17 October 2023 – v2.2

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1 Introduction

The Sys4ENCA tool, developed in the context of the PAPBio program, computes the ecosystem accounts for Area of Interests (AoI's) at three levels (Tier 1, Tier 2 and Tier 3) in a semi-automatic way. It consists of five sub-processors:

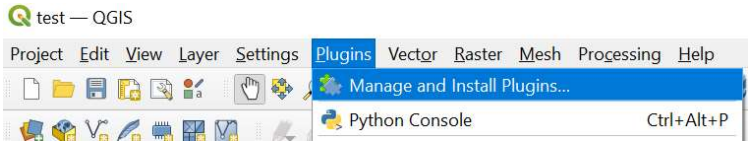
- Landcover processor
- Carbon processor
- Water processor
- Infrastructure processor
- Ecosystem capability processor (total)

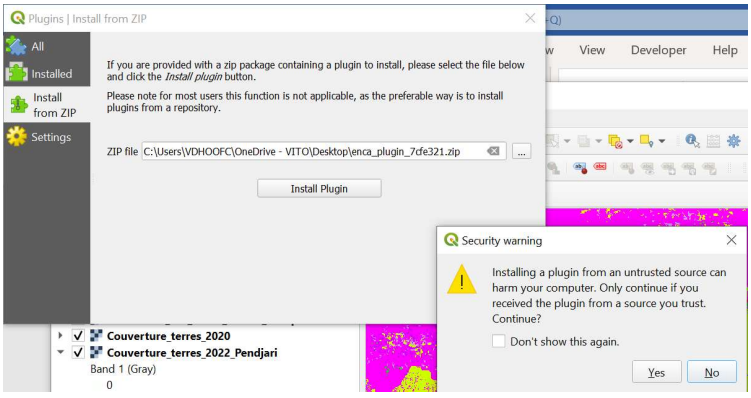
These different processors, encoded in Python, are embedded in a QGIS-plugin. The user of this QGIS-plugin is therefore expected to have basic knowledge of:

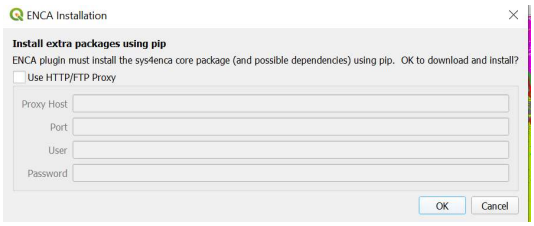
- ENCA accounting methodology, see http://www.ecosystemaccounting.net/?page_id=8
- QGIS3 package, see https://gisgeography.com/qgis-tutorial-how-to-use-qgis-3/

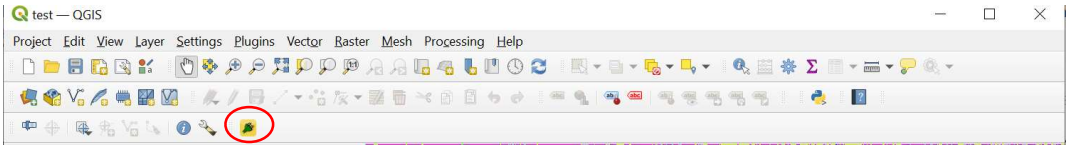
1.1 Installing the ENCA QGIS-plugin

- Download last version of the ENCA QGIS-plugin zip file and save on local drive
- Open QGIS 3.
- Go to 'Plugins', select 'Manage and Install Plugins', and then 'Install from ZIP'
- Select the ENCA QGIS-plugin zip file under location where it has been saved and click on 'Install Plugin'. Subsequently accept to continue, under the security warning.
- A window with following text might pop-up: 'ENCA installation' – 'Install extra packages using pip' -> click: 'OK', and restart QGIS when prompted to do
- Reopen QGIS and click on ENCA QGIS-plugin in top bar





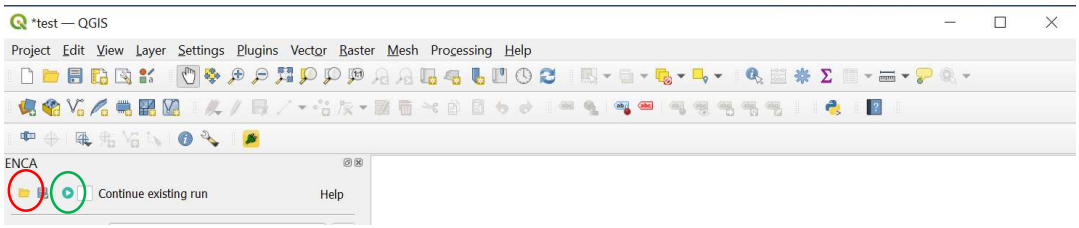




1.2 Creating accounts – consecutive steps

To compute accounts for a specific area of interest, the following steps need to be followed:

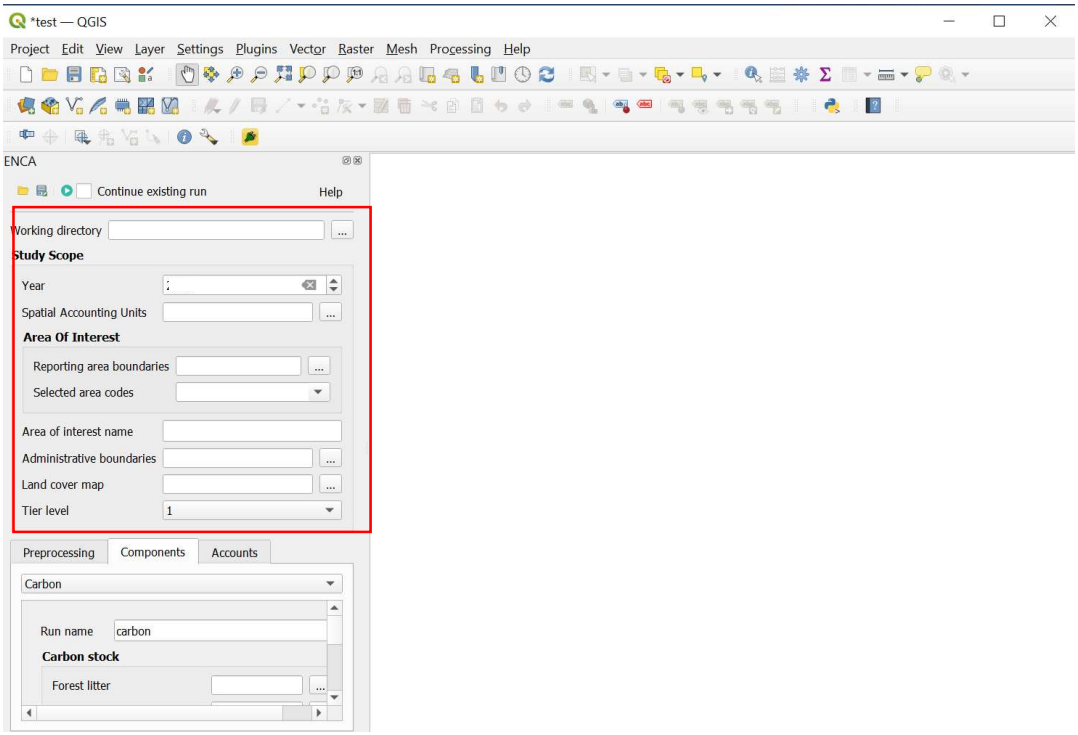
1. **Define study scope** and prepare general input data -> see section 2. Defining working directory and study scope
2. **Prepare input data** for each component (landcover, carbon water and infrastructure) -> go to sections 3.1 Carbon accounting, 4.1 Water accounting, 5.1. Landcover accounting and 6.1. Infrastructure accounting for more information.
3. **In case, pre-processing required** for input data of Carbon accounting and/or Water accounting, go to sections 3.2 Carbon pre-processing and 4.2 Water pre-processing for preparing input data of **pre-processing modules**.
4. Once all input files have been prepared and paths to these input files have been provided within the User Interface of specific module, **run** the (pre-processing) module by clicking on the white arrow within the red circle. In case you want to continue running an existing run, select this option. Each module is run independently and consecutively. For each run, a yaml file will be created under the working directory that you have defined. This yaml file contain the settings of the (pre-processing) module that was run.



For you to start, a set of **examples input data** (for the WAP complex) **and yaml** files are provided under each folder of respective (pre-processing) modules. To use the settings defined in these yaml files, click on the folder (in red circle) on the left just under 'ENCA', and select the appropriate yaml file.

2 Defining working directory and study scope

Before creating accounts, the working directory and the study scope need to be defined.



1. Working directory: directory where the output will be saved.
2. Year: year for which the accounts are computed.
3. Spatial accounting units: vector file mapping the smallest statistical units, so-called socio-ecological landscape units, SELU's, at which the accounts are computed; often catchment boundaries. These units need to cover the whole area of interest, within and intersecting the area. The following fields are mandatory:

HYBAS_ID	DLCT
<Hybas id_j>	
….	
<Hybas id_m>	

where 'HYBAS_ID' the unique string identifier per polygon and 'DLCT' the code of the dominant landcover type per statistical unit (if no data, can be set to any value e.g.1).

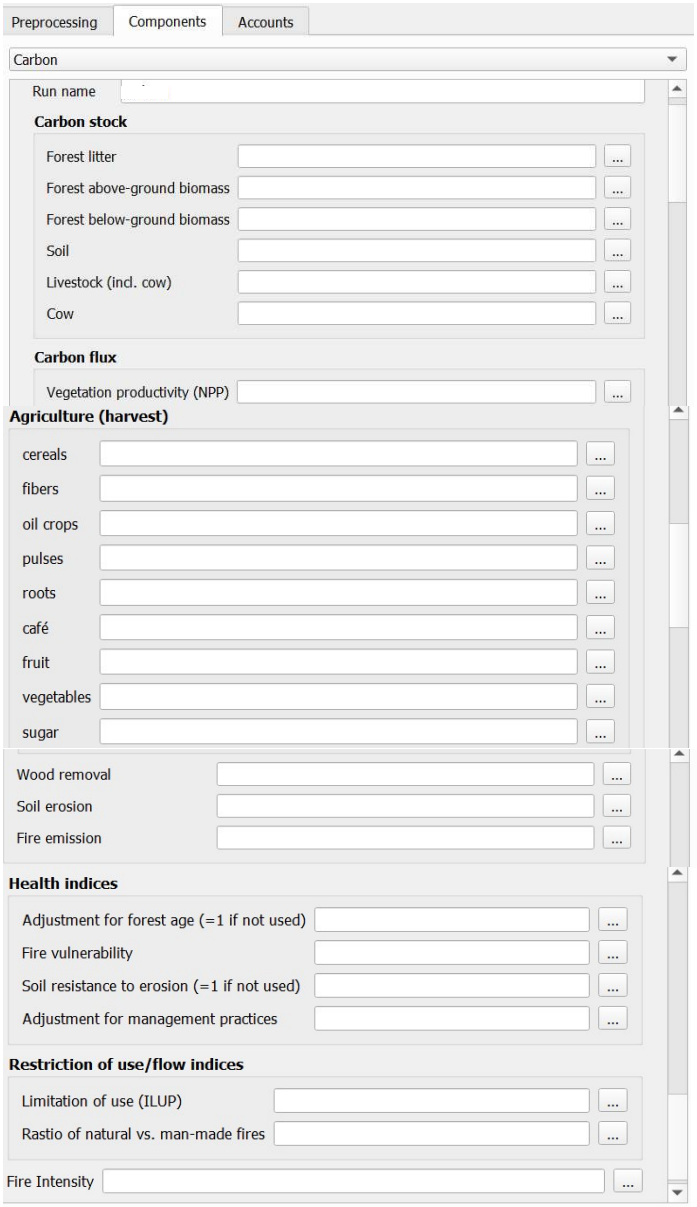
4. Reporting area boundaries: vector file mapping the boundaries of the polygons within the area of interests for which accounts should be reported. A field named "REP_ID", with unique string identifier per polygon, is mandatory.

5. Selected area codes: unique string identifier “REP_ID” of the polygons from the “Reporting area boundaries” vector file for which accounts should be reported.
6. Area of interest name: Given name to the area of interest. This name is used to create a folder within your working directory where output will be saved
7. Administrative boundaries: vector file of the administrative boundaries for which statistical data is available. A field named “ADMIN_ID”, with unique string identifier per administrative area, is mandatory.
8. Land cover map: land cover map in raster format covering the whole extent of the administrative boundaries of interest, including all spatial accounting units within and intersecting the area of interest, and representative for the selected ‘year’. Band 1 contains the code of the landcover classes for lookup table with legend. In addition to providing information on the landcover, this raster file is used as a reference regarding grid resolution and geolocation for accounting in Sys4ENCA plugin.
9. Tier level: tier level at which the accounts are computed. This is used to create a folder under the folder with the area of interest as given name.

3 Carbon module

3.1 Carbon accounting

The carbon module computes ecosystem carbon accounts for all SELU's within the Area of Interest (AoI). All input files for this module are rasters covering the full AoI, which includes all the polygons within the "Spatial accounting units" file.



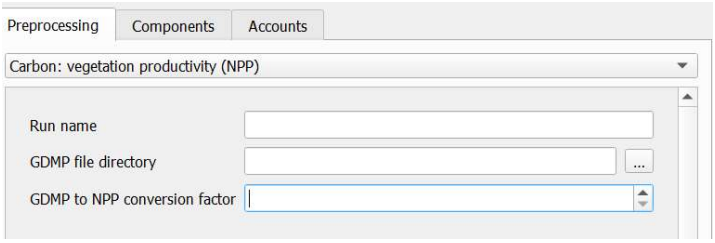
1. Run name: name that will be assigned to the folder within your working directory where output of the carbon processor will be saved
2. Forest litter: raster map of the carbon stock (ton C) per grid within the forest litter for the given accounting year -> see pre-processing
3. Forest above-ground biomass: raster map of the carbon stock (ton C) per grid within the forest above-ground biomass for the given accounting year -> see pre-processing
4. Forest below-ground biomass: raster map of the carbon stock (ton C) per grid within the forest below-ground biomass for the given accounting year -> see pre-processing
5. Soil: raster map of the carbon stock (ton C) per grid within the soil up to 1m depth for the given accounting year -> see pre-processing
6. Livestock (incl. cow): raster map of livestock, incl. cattle, biocarbon (ton C) per grid for the given accounting year -> see pre-processing
7. Cow: raster map of cattle only biocarbon (ton C) per grid for the given accounting year -> see pre-processing
8. Vegetation productivity (NPP): raster map of the Net Ecosystem Productivity (ton C) per grid for the given accounting year -> see pre-processing
9. cereals -> sugar: raster map of the carbon flow (ton C/year) due to crop harvest per grid for the given accounting year, per crop type; i.e. cereals…. sugar -> see pre-processing
10. Wood removal: raster map of the forest wood removal (ton C/year) per grid for the given accounting year -> see pre-processing
11. Soil erosion: raster map of the soil carbon loss (ton C/year) due to erosion per grid for the given accounting year -> see pre-processing
12. Fire emission: raster map of the carbon emission (ton C/year) due to fire per grid for the given accounting year -> see pre-processing
13. Adjustment for forest age: raster map of values between 0 and 1 based on the age of the forest, with a value of 1 for old growth forests (such as climax) and 0 for very young forests. per grid for the given accounting year. If no file provided, the values are all set to 1.
14. Fire vulnerability: raster map of values between 0 and 1 based on the vulnerability of the ecosystem to fire, with a value of 1 for low vulnerability (good health) and 0 for high vulnerability (poor heath), per grid for the given accounting year -> see pre-processing
15. Soil resistance to erosion: raster map of values between 0 and 1 based on the vulnerability to soil erosion, with a value of 1 for low vulnerability and 0 for very young forests, per grid for the given accounting year. If no file provided, the values are all set 1.
16. Adjustment for management practices: raster map of values between 0 and 1 based on the protection status of the ecosystem, with a value of 1 for strict ecosystem protection practices and 0 for no management practices, per grid for the given accounting year
17. Limitation of use: raster map of values between 0 and 1, with a value of 1 for strong limitations of use of ecosystem goods and 0 for no limitation of use, per grid for the given accounting year
18. Ratio of natural vs. man-made fires: raster map of values between 0 and 1 based on the ratio between natural and man-made induced fires, with a value of 1 in case all fires within the grid were naturally induced, and 0 in case all fires are man-made, per grid for the given accounting year
19. Fire intensity: raster map of values between 0 and 1, with a value of 1 for fires with a strong intensity, and 0 for those with low intensity, per grid for the given accounting year. If no file provided, the values are all set 1.

3.2 Carbon pre-processing

In this section, the pre-processing carbon modules to create the input data for the carbon module are described.

3.2.1 Carbon: vegetation productivity (NPP)

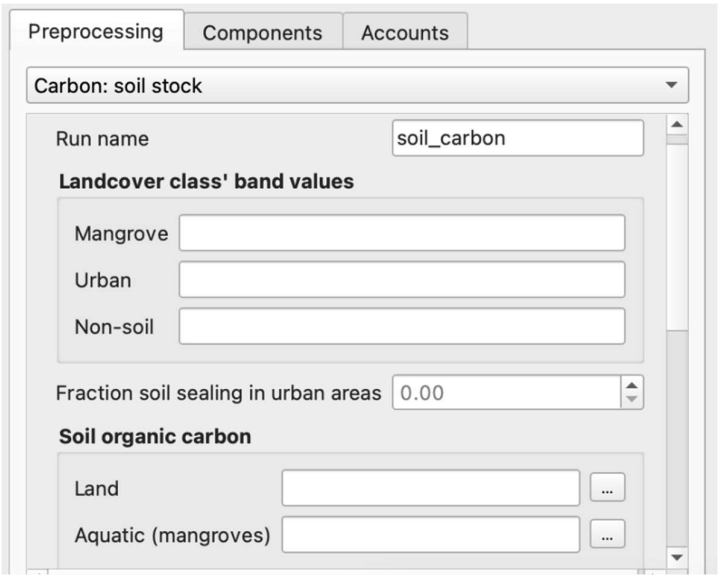
Objective: create raster map of account year of the Net Ecosystem Productivity (ton C) of vegetation, with values for each raster cell (within AoI).



1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: vegetation productivity (NPP) pre-processor will be saved.
2. GDMP file directory: directory with raster maps of 10-day averages of vegetation gross dry matter in kg/ha/day for specific accounting year. The gross dry matter productivity datasets provided by the Copernicus Global Land Services can be used as data source: https://land.copernicus.eu/global/products/dmp.
3. GDMP to NPP conversion factor: value used to convert GDMP into NPP.

3.2.2 Carbon: soil stock

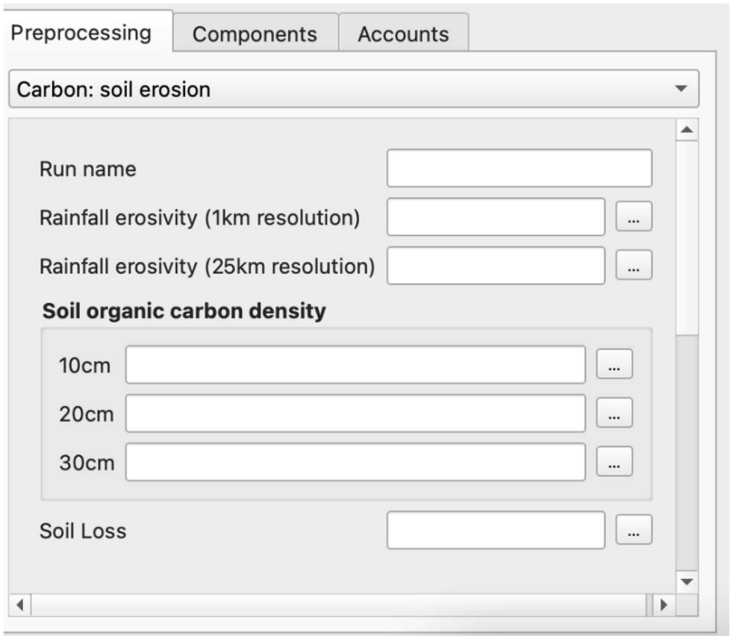
Objective: create raster map of account year of the carbon stock (ton) within the soil up to 1m depth, with values for each raster cell within AoI.



1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: soil stock pre-processor will be saved.
2. Mangrove: code(s) of land cover class representing mangroves
3. Urban: code(s) of land cover class representing urban area
4. Non-soil: code(s) of land cover class representing non-soil
5. Fraction soil sealing in urban area: value between 0 and 1 representing the fraction of the urban area grid that is sealed.
6. Soil organic carbon - Land: raster map of the carbon stock (ton C) per grid within terrestrial soil up to 1m depth for the given accounting year. The datasets provided by the ISRIC World Soil Information can be used as data source: https://files.isric.org/soilgrids/former/2017-03-10/data/.
7. Soil organic carbon - Aquatic (mangroves): raster map of the carbon stock (ton C) per grid within aquatic soil up to 1m depth for the given accounting year. The datasets provided by Woods Hole Research Center can be used as data source: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/OCYUIT.

3.2.3 Carbon: soil erosion

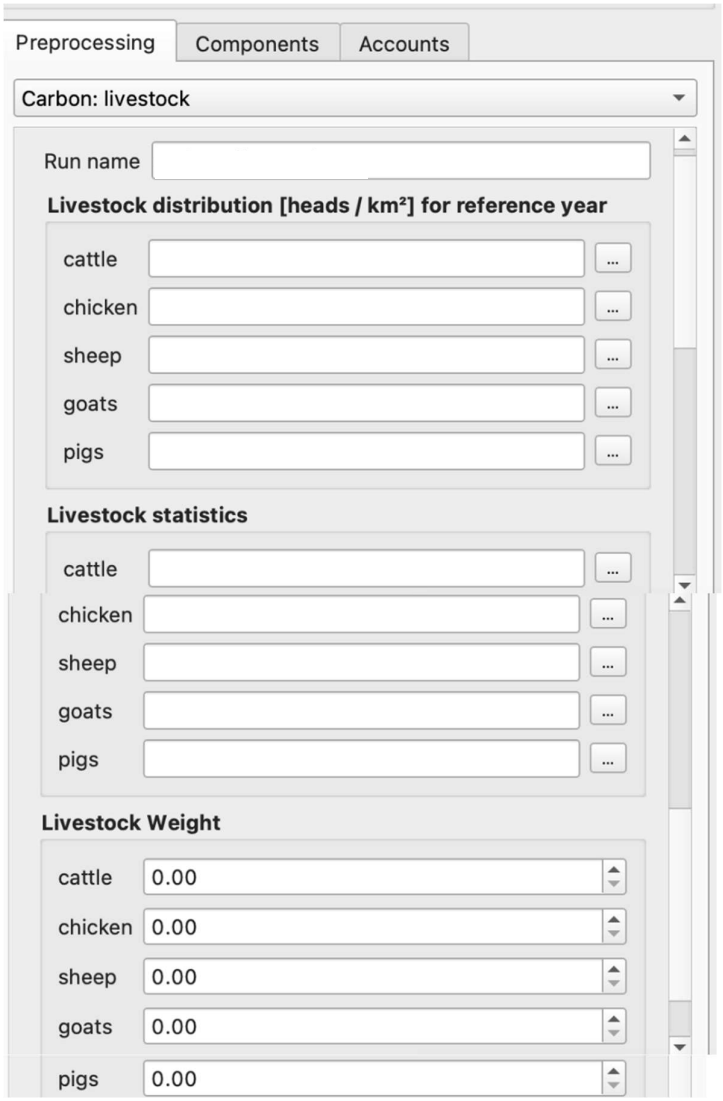
Objective: create raster maps of account year of the carbon loss (ton/year) due to erosion, with values for each raster cell within AoI.



1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: soil erosion pre-processor will be saved.
2. Rainfall erosivity (1km resolution): raster map of average (over e.g. 30-40 years) rainfall erosivity (MJ mm/ ha/h/year) at 1km resolution. The datasets provided by the European Soil Data Centre can be used as data source: https://esdac.jrc.ec.europa.eu/content/global-rainfall-erosivity#tabs-0-description=1.
3. Rainfall erosivity (25km resolution): raster map of average (over e.g. 30-40 years) rainfall erosivity (MJ mm/ ha/h/year) at 25km resolution. The datasets provided by the European Soil Data Centre can be used as data source: https://esdac.jrc.ec.europa.eu/content/global-soil-erosion.
4. Soil organic carbon density - 10, 20, 30 cm: raster maps of the soil carbon density (gC/kg) at around those depths. The datasets provided by the ISRIC World Soil Information can be used as data source: https://files.isric.org/soilgrids/former/2017-03-10/data/.
5. Soil loss: raster map of the soil carbon loss due to erosion (tC/ha/year). The datasets provided by the European Soil Data Centre can be used as data source: https://esdac.jrc.ec.europa.eu/content/global-soil-erosion.

3.2.4 Carbon: livestock

Objective: create raster maps of livestock, incl. cattle, biocarbon (ton C) as well as cattle only biocarbon (C ton) for account year with values for each raster cell within AoI.



1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: livestock pre-processor will be saved.
2. Livestock distribution (heads/km^2): one raster map of heads of livestock per type (cattle, chicken, sheep, goats and pigs) per km^2 per grid for a reference year. The datasets provided by Robinson et al. (2014) can be used as data source: https://livestock.geo-wiki.org/Security/login?BackURL=%2FApplication%2Findex.php.
3. Livestock statistics: one csv file per livestock type (cattle, chicken, sheep, goats and pigs) with heads of specific livestock per administrative area within or intersecting AoI. The csv file has the following structure:

ADMIN_ID	heads_<xj>	heads_<x_i>
<admin id$_j$>		
….		

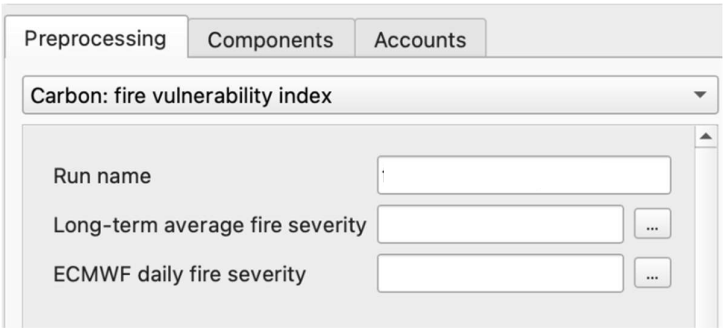
<admin id$_m$>		

With ADMIN_ID, a unique string identifier per administrative areas/countries similar as the one used in the 'Administrative boundaries' vector file, and 'heads_x_j' and 'heads_x_i' the number of animals for specific livestock type per km^2 during reference year j account year i. All values should be integers. Empty cells are not valid In case of no data for full time series (all years of interest), realistic approximations are required. In case of only no data for specific years, interpolate linearly with values provided for other years. The datasets provided by FAOSTAT can be used as data source: https://www.fao.org/faostat/en/#data/QCL.

4. Livestock weight: value per livestock type (cattle, chicken, sheep, goats and pigs) of the weight expressed in kg C.

3.2.5 Carbon: fire vulnerability

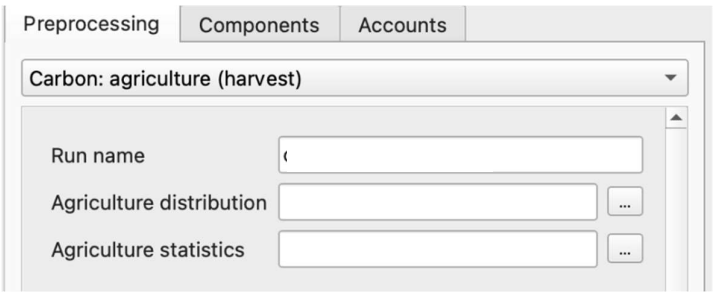
Objective: create raster maps of account year of the fire vulnerability health index, with values for each raster cell within AoI. The values of this index range between 0 and 1, with 0 as high vulnerability/poor health and 1 as low vulnerability/good health.



1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: fire vulnerability index pre-processor will be saved.
2. Long-term average fire severity: raster map of the long-term (e.g. 30-40 years average) fire severity index. The datasets provided by the Copernicus Climate Data Store can be used as data source: https://cds.climate.copernicus.eu/cdsapp#!/dataset/cems-fire-historical?tab=overview
3. ECMWF daily fire severity: folder with daily raster maps of the fire severity index for the account year. Same data source as above.

3.2.6 Carbon: agriculture (harvest)

Objective: create raster map of account year and per crop type of the carbon flow (ton/year) due to harvest of crops, with values for each raster cell of the AOI.



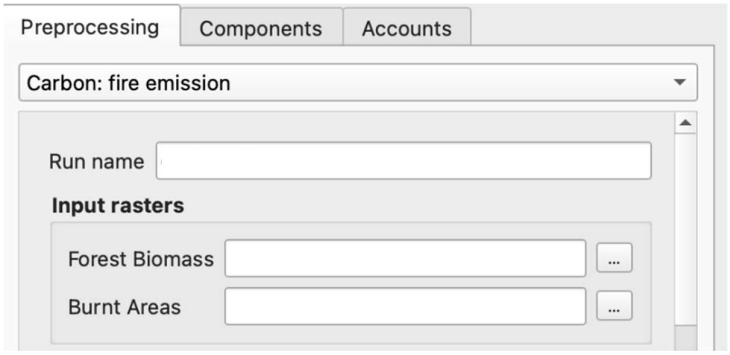
1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: agriculture (harvest) pre-processor will be saved.
2. Agriculture distribution: directory with raster maps of crop production (t/1000ha) per crop type (cereals, fiber crops, fruit, oil crops, pulses, roots, sugar, vegetables, stimulants ('café')) for reference year. The datasets provided by International Food Policy Research Institute (IFPRI) can be used as data source: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/PRFF8V.
3. Agriculture statistics: one csv file per crop type (cereals, fiber crops, fruit, oil crops, pulses, roots, sugar, Vegetables, stimulants ('café')) with yield (expressed in ton C) of specific crop per administrative area within or intersecting AoI. The csv file has the following structure:

ADMIN_ID	t_<xj>	t_<x_i>
<admin id_j>		
….		
<admin id_m>		

With ADMIN_ID, a unique string identifier per administrative areas/countries similar as the one used in the 'Administrative boundaries' vector file, and 't_x_j' and 't_x_i' the number of animals for specific livestock type per km^2 during reference year j and account year i. All values should be integers. Empty cells are not valid In case of no data for full time series (all years of interest), realistic approximations are required. In case of only no data for specific years, interpolate linearly with values provided for other years. The datasets provided by FAOSTAT can be used as data source: https://www.fao.org/faostat/en/#data/QCL.

3.2.7 Carbon: fire emission

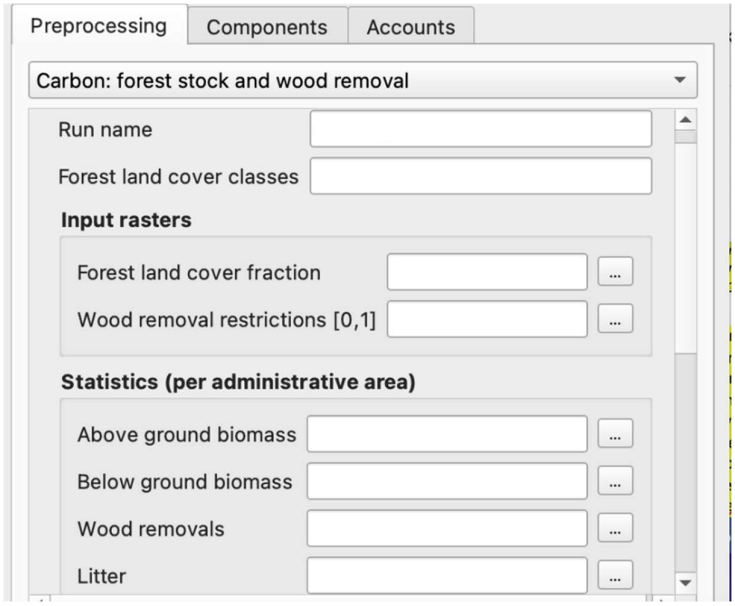
Objective: create raster maps for account year of the carbon emission due to fire (ton C/year) with values for each raster cell (of 1ha) of AoI.



1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: fire emission pre-processor will be saved.
2. Forest biomass: raster map of stock of forest above-ground biomass (ton/ha). The datasets provided by ESA's Climate Change Initiative Biomass project can be used as data source: https://data.ceda.ac.uk/neodc/esacci/biomass/data/agb/maps/v3.0/geotiff.
3. Burnt area: raster map, with value of 1 if grid burned once during account year, and value of 0, if not burned The burned area datasets provided by MCD64A1 and accessible through https://code.earthengine.google.com/ can be used as data source.

3.2.8 Carbon: forest stock and wood removal

Objective: create raster maps for account year, of the carbon stock (ton C) within the forest components; i.e. above-ground, below-ground biomass and litter as well as a map of forest wood removal (ton/year), with values for each raster cell within AoI.



1. Run name: name that will be assigned to the folder within your working directory where output of the carbon: forest stock and wood removal pre-processor will be saved.
2. Forest land cover classes: code(s) of land cover class representing forest
3. Forest landcover fraction: raster map with fraction of pixel covered by forest, representative for account year.
4. Wood removal restriction: raster map with a value between 0 and 1, depending on the restrictions on use of the ecosystem goods within the AoI; a value close to 0 means that wood removal is strongly limited while a value close to 1 means that there is not limitation.
5. Statistics (per administrative area) – above ground biomass, below ground biomass, litter and wood removal : one csv file per forest component (above ground biomass, below ground biomass, and litter) with carbon stock representative for account year per administrative area , expressed in tC/administrative area and one csv file for the carbon flux due to wood removal, expressed in tC/administrative area/year. The csv files have the following structure:

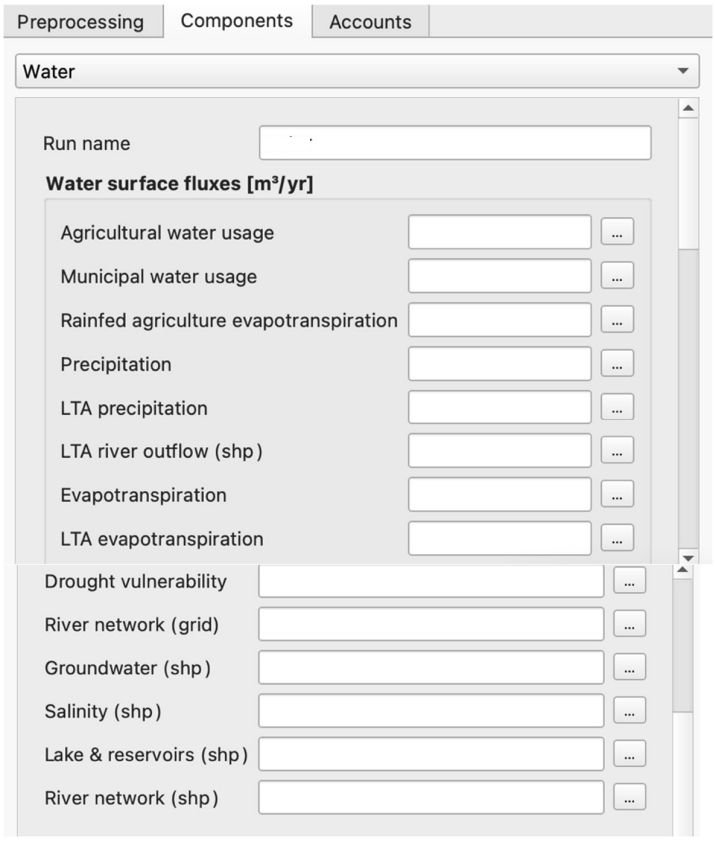
ADMIN_ID	agbCt_<x_i>
<admin id_j>	
….	
<admin id_m>	

With ADMIN_ID, a unique string identifier per administrative areas/countries similar as the one used in the 'Administrative boundaries' vector file, and 'agbCt_x_j' (or bgbCt_x_j', litterCt_x_j' and woodrmCt_x_j'), the carbon stock within above ground biomass (or below ground biomass and litter) or carbon flux due to wood removal for account year i. All values should be integers. Empty cells are not valid In case of no data for full time series (all years of interest), realistic approximations are required. In case of only no data for specific years, interpolate linearly with values provided for other years. The datasets provided by FAOSTAT can be used as data source: https://www.fao.org/faostat/en/#data/QCL.

4 Water module

4.1 Water accounting

The water module computes ecosystem water accounts for all SELU's within the AoI. All input files for this module are rasters, except those flagged with a '(shp)', covering the full Area of Interest (AoI).



1. Run name: name that will be assigned to the folder within your working directory where output of the water processor will be saved
2. Agriculture water usage: raster map of the water usage for irrigation during account year (m3/year) -> see pre-processing
3. Municipal water usage: raster map of the water usage by households during account year (m3/year) -> see pre-processing
4. Rainfed agriculture evapotranspiration: raster map of the evapotranspiration over rainfed agricultural and pastoral land during account year (m3/year) -> see pre-processing
5. Precipitation: raster map of the total precipitation during account year (m3/year) -> see pre-processing
6. LTA precipitation: raster map of the long-term average (30 years) annual precipitation (m3/year) -> see pre-processing

7. LTA river outflow (shp): vector file of the river network with 'HYBAS_ID' and 'Q_max' as mandatory fields, with HYBAS_ID' the unique string identifier per SELU polygon and 'Q_max', the long-term average (30 years) of water outflow from each SELU (in m3/year). This file is constructed based on the river dataset provided by the Global River Classification GloRiC, which can be downloaded at https://www.hydrosheds.org/page/gloric.
8. Evapotranspiration: raster map of the total evapotranspiration during account year (m3/year) --> see pre-processing
9. LTA evapotranspiration: raster map of the long-term average (30 years) annual evapotranspiration (m3/year) -> see pre-processing
10. Drought vulnerability: raster map of values between 0 and 1 based on the vulnerability of the ecosystem to drought, with a value of 1 for low vulnerability (good health) and 0 for high vulnerability (poor heath), per grid for the given accounting year -> see pre-processing
11. River network (grid): raster map of river network, with value of 1, if river section crosses grid and value of 0, if no river crosses the grid -> see pre-processing
12. Groundwater (shp): vector file with polygons representing groundwater resources and recharge with information on discharge classification. The datasets provided by World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP) can be used as data source: https://produktcenter.bgr.de/terraCatalog/OpenSearch.do?search=29949f35-6fe1-4775-bc97-62274a30c70b&type=/Query/OpenSearch.do
13. Salinity (shp): vector file with polygons representing the saline aquifers. The datasets provided by World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP) can be used as data source: https://produktcenter.bgr.de/terraCatalog/OpenSearch.do?search=29949f35-6fe1-4775-bc97-62274a30c70b&type=/Query/OpenSearch.do
14. Lake & reservoirs (shp): vector file with polygons representing the lake and reservoir, with information on discharge (m/s) and volume (million m3). The datasets provided by HydroLAKES can be used as data source: https://www.hydrosheds.org/pages/hydrolakes.
15. River network (shp): vector file of river network, with river types and sub-classifications. The dataset provided by the Global River Classification GloRiC can be used as data source: https://www.hydrosheds.org/page/gloric -> see pre-processing water: drought vulnerability (output vector file in temp folder) for Gloric file clipped to the extent of the AoI.

4.2 Water pre-processing

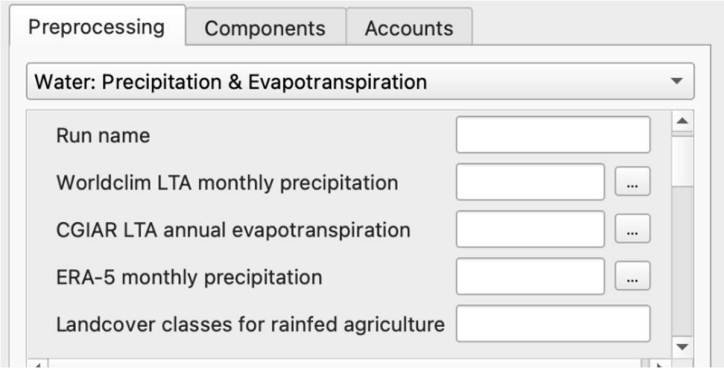
In this section, the pre-processing water modules to create the input data for the water module are described.

4.2.1 Water: precipitation & evapotranspiration

Objective: create raster maps of the following water fluxes, with values for each raster cell within AoI:

- Total precipitation during account year (m3/year)
- Total evapotranspiration during account year (m3/year)
- Evapotranspiration over rainfed agricultural and pastoral land during account year (m3/year)

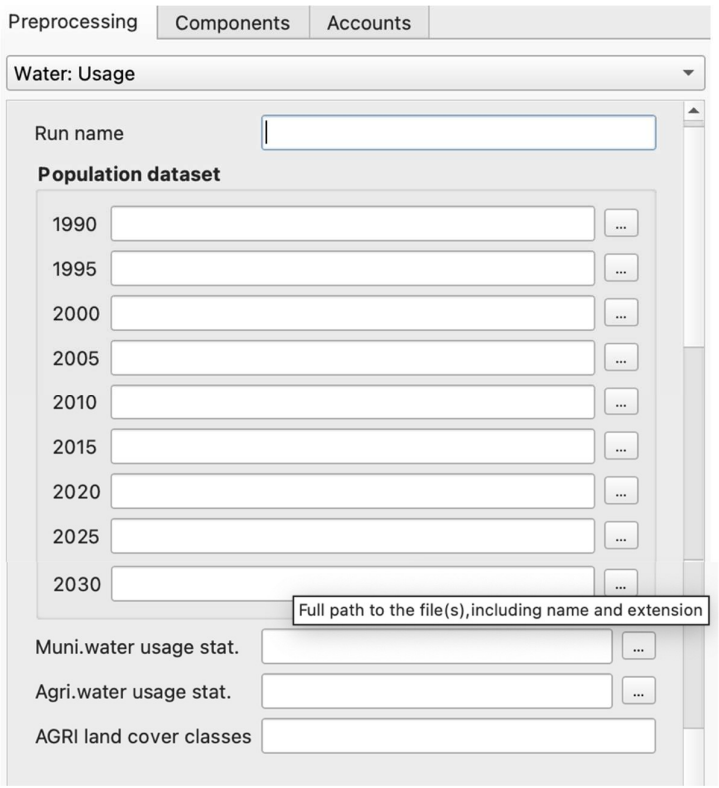
- Long-term average (30 years) annual precipitation (m3/year)
- Long-term average (30 years) annual evapotranspiration (m3/year)



1. Run name: name that will be assigned to the folder within your working directory where output of the water: precipitation & evapotranspiration pre-processor will be saved.
2. WorldClim LTA monthly precipitation: raster map of the long-term average (over e.g. 30 years) monthly precipitation(mm/month). The datasets provided by WorldClim can be used as data source: https://biogeo.ucdavis.edu/data/worldclim/v2.1/base/wc2.1_30s_prec.zip
3. CGIAR LTA annual evapotranspiration: raster map of the long-term average (over e.g. 30 years) monthly evapotranspiration (mm). The datasets provided by CGIAR can be used as data source: https://figshare.com/articles/dataset/Global_High-Resolution_Soil-Water_Balance/7707605.
4. ERA-5 monthly precipitation: raster maps of monthly precipitation during account year (mm/month). The datasets provided by ERA5-Land can be used as data source: https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land-monthly-means?tab=form.
5. Landcover classes for rainfed agriculture: code(s) of land cover class representing rainfed agriculture.

4.2.2 Water: usage

Objective: create raster maps of the following water fluxes, with values for each raster cell within AoI:
- Water used for irrigation per account year (m3/year)
- Water used by households per account year (m3/year)



1. Run name: name that will be assigned to the folder within your working directory where output of the water: usage pre-processor will be saved.
2. Human Settlement Layer can be used as data source: https://ghsl.jrc.ec.europa.eu/download.php?ds=pop
4. Muni. water usage: one csv file with the amount of water used by the households during account year per administrative area(s) within or intersecting the AoI (expressed in m3/administrative area/year). The csv file has the following structure:

ADMIN_ID	MWWm3per_<xi>
<admin id_j>	
….	
<admin id_m>	

With ADMIN_ID, a unique string identifier per administrative areas/countries similar as the one used in the 'Administrative boundaries' vector file, and 'MWWm3per_x_i' the amount of water used by the households during account year I per administrative area. All values should be integers. Empty cells are not valid. In case of no data, realistic approximations are required. The datasets provided by AQUASTAT can be used as data source : https://www.fao.org/aquastat/statistics/query/index.html?lang=en

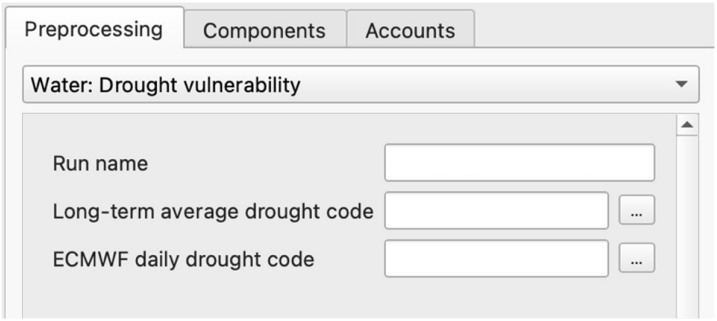
5. Agri. water usage: one csv file with the amount of water used for agricultural purpose (expressed in m3/ha/administrative area/year) per administrative area within or intersecting AoI. The csv file has the following structure:

ADMIN_ID	AWWm3per_x_i
<admin id_j>	
….	
<admin id_m>	

3. With ADMIN_ID, a unique string identifier per administrative areas/countries similar as the one used in the 'Administrative boundaries' vector file, and 'AWWm3per_x_i' the amount of water used for agricultural purpose during account year I per administrative area. All values should be integers. Empty cells are not valid. In case of no data, realistic approximations are required. The datasets provided by AQUASTAT can be used as data source: : https://www.fao.org/aquastat/statistics/query/index.html?lang=en
4. AGRI land cover classes: code(s) of land cover class representing irrigated agriculture.

4.2.3 Water: drought vulnerability

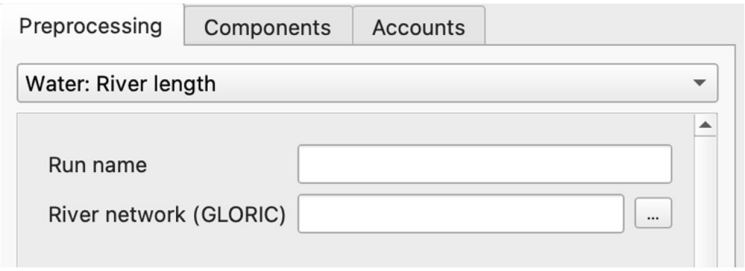
Objective: create raster maps of account year of the drought vulnerability health index, with values for each raster cell within AoI. The values of this index range between 0 and 1, with 0 as high vulnerability/poor health and 1 as low vulnerability/good health.



4. Run name: name that will be assigned to the folder within your working directory where output of the water: drought vulnerability index pre-processor will be saved.
5. Long-term average drought code: raster map of the long-term (e.g. 30-40 years average) drought code. The datasets provided by the Copernicus Climate Data Store can be used as data source: https://cds.climate.copernicus.eu/cdsapp#!/dataset/cems-fire-historical?tab=overview
6. ECMWF daily drought code: folder with daily raster maps of the fire drought code for the account year. Same data source as above.

4.2.4 Water: river length

Objective: create raster maps of river network, with value of 1, if river section crosses grid and value of 0, if no river crosses the grid.

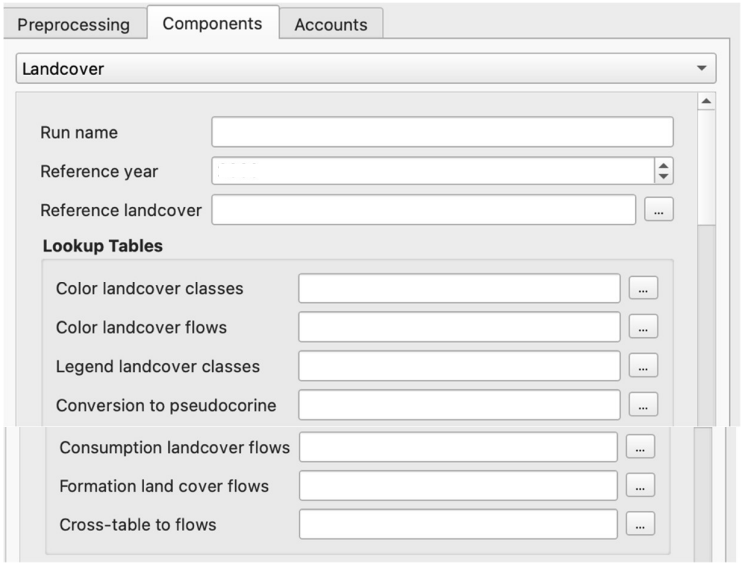


7. Run name: name that will be assigned to the folder within your working directory where output of the water: River length index pre-processor will be saved.
8. River network (GLORIC): vector file of river network, with river types and sub-classifications. The dataset provided by the Global River Classification GloRiC can be used as data source: https://www.hydrosheds.org/page/gloric.

5 Landcover module

5.1 Landcover accounting

The landcover module computes the landcover account for all SELU's within the AoI. The input files consist of the raster landcover maps of the reference year and of the account year, as well as a set of csv files.



1. Run name: name that will be assigned to the folder within your working directory where output of the landcover processor will be saved.
2. Reference year: reference year against which the changes and flows are computed for the actual account year. To run the landcover module for the reference year adapt year and landcover map in study scope section, and set reference year to 0 and leave reference landcover blank.
3. Reference landcover: land cover map in raster format covering the whole extent of the administrative boundaries of interest, including all spatial accounting units within and intersecting the area of interest, and representative for the selected 'Reference year'. Band 1 contains the code of the landcover classes for lookup table with legend. Leave reference landcover blank in case the landcover module is run for the reference year.
4. Look-up tables – Color landcover classes: look-up table to assign color codes to the different land cover codes for creating landcover color maps
5. Look-up tables – Color landcover flows: : look-up table to assign color codes to the different land cover flow types for creating landcover flow color maps
6. Look-up tables – legend landcover classes: look-up table to assign codes to the (pseudo-corine) land cover classes that will be used for creating land cover (change/flow) accounting table -> see appendix B
7. Look-up tables – Conversion to pseudocorine: look-up table to convert input land cover map code into pseudo-corine (standardized) coding scheme -> see appendix A

8. Look-up tables – Consumption landcover flow: look-up table to assign codes and names to consumption landcover flows that have been computed between two years; e.g. account year and reference year
9. Look-up tables – Formation landcover flow: look-up table to assign codes and names to formation landcover flows that have been computed between two years; e.g. account year and reference year
10. Look-up tables – Cross-table to flows: look-up table combining previous two.

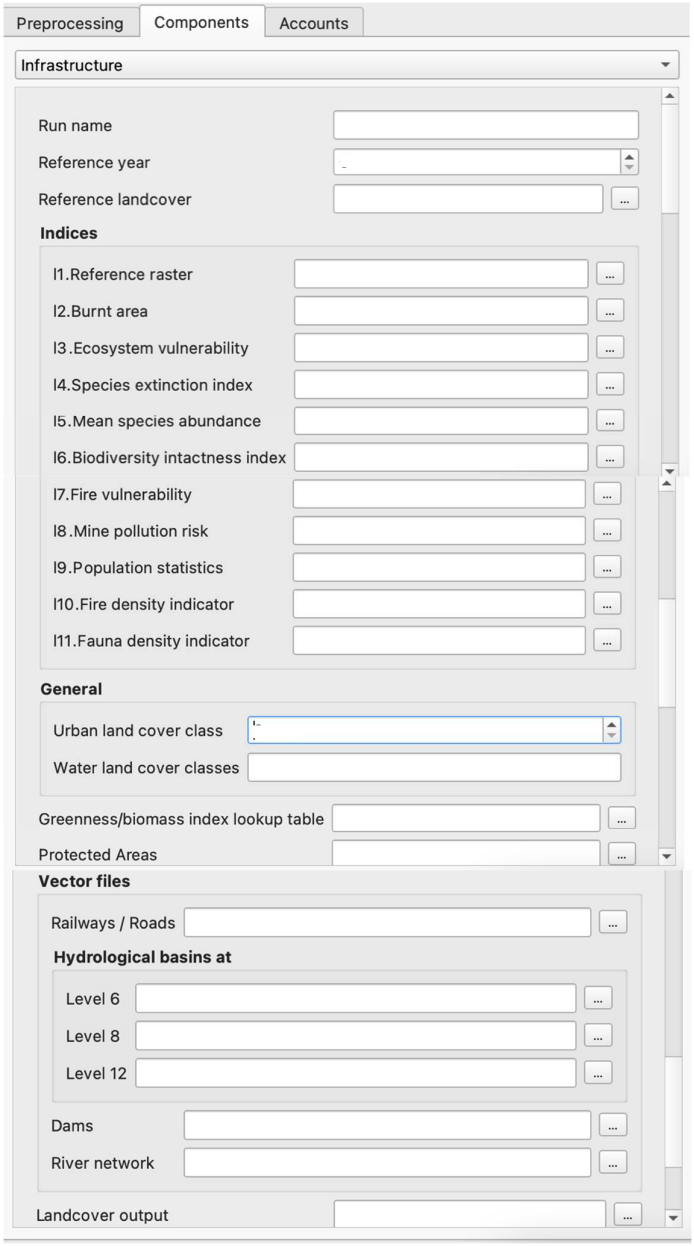
5.2 Landcover pre-processing

No pre-processing modules are available for the landcover module.

6 Infrastructure module

6.1 Infrastructure accounting

The infrastructure module computes the infrastructure account for all SELU's within the AoI. The input files consist of a set of raster files; i.e. Indices, landcover and protected area maps, a set of vector files; i.e. railways/road, dams, river network and hydrological basins maps as well as a csv file including the greenness/biomass index look-up table. All maps are required to cover the full AoI.



1. Run name: name that will be assigned to the folder within your working directory where output of the Infrastructure processor will be saved
2. Reference year: reference year against which the changes and flows are computed for the actual account year. To run the infrastructure module for the reference year adapt year and landcover map in study scope section, and set reference year to 0 and leave reference landcover blank.
3. Reference landcover: land cover map in raster format covering the whole extent of the administrative boundaries of interest, including all spatial accounting units within and intersecting the area of interest, and representative for the selected 'Reference year'. Band 1 contains the code of the landcover classes for lookup table with legend. Leave reference landcover blank in case the Infrastructure module is run for the reference year
4. Indices – I1. Reference raster – raster with the same grid size as the "Land cover map" provided under the 'Study scope' section, and with an extent defined by the Area of Interest (AoI), which includes all polygons within the "Spatial accounting units" file.
5. Indices – I2.Burnt area: raster map, with value of 1 if grid burned once during account year, and value of 0, if not burned. The burned area datasets provided by MCD64A1 and accessible through https://code.earthengine.google.com/ can be used as data source.
6. Indices – I3.Ecosystem vulnerability: raster map, of account year, of ecosystem vulnerability, with values between 0 and 1.
7. Indices – I4.Species extinction index: raster map, of account year, of Species extinction index, with values between 0 and 1.
8. Indices – I5.Mean species abundance: raster map, of account year, of Mean species abundance, with values between 0 and 1.
9. Indices – I6.Biodiversity intactness index: raster map, of account year, of Biodiversity intactness index, with values between 0 and 1.
10. Indices – I7.Fire vulnerability: raster map, of account year, of Fire vulnerability, with values between 0 and 1. This map is created through the Carbon: fire vulnerability pre-processor.
11. Indices – I8.Mine pollution risk: raster map, of account year, of Mine pollution risk, with values between 0 and 1.
5. Indices – I9.Population statistics: raster map with number of people within each grid cell. The datasets provided by the Global Human Settlement Layer can be used as data source: https://ghsl.jrc.ec.europa.eu/download.php?ds=pop. ->See pre-processing output (temp) of water usage pre-processing
12. Indices – I10.Fire density indicator: raster map, of account year, of Fire density indicator, with values between 0 and 1.
13. Indices – I11.Fauna density indicator: raster map, of account year, of Fauna density indicator, with values between 0 and 1.
14. Urban land cover class: code(s) of land cover class representing urban area, within Pseudo Corine landcover classification.
15. Water landcover classes: code(s) of land cover class representing aquatic ecosystems, within Pseudo Corine landcover classification.
16. Greenness/biomass index look-up table: Look-up table to assign greenness/biomass index values, which is the biomass potential independent from cultivation, to landcover type codes.
17. Protected areas: raster map with values ranging between 1 and 10, where a value of 1 is assigned to a grid with low nature value and a value of 10 to a grid with high nature value. The datasets provided by World Database on Protected Areas (WDPA) and the Key Biodiversity Areas (KBA) can be used as data source:

https://www.openstreetmap.org/#map=7/47.001/28.377 and http://www.keybiodiversityareas.org/home.

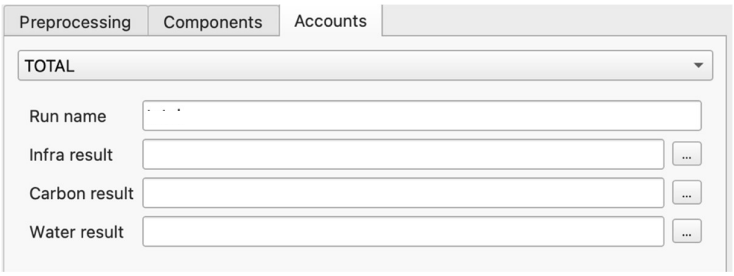
18. Railways/Roads: vector file of the road and railway network used to compute fragmentation. The datasets provided by OpenStreetMap can be used as data source: https://www.openstreetmap.org/#map=7/47.001/28.377.
19. Hydrological basins at level 6, 8 and 12 (source: https://www.hydrosheds.org).
20. Dams: vector file of dams point location. The dataset provided by FAO Aquastats can be used as data source: http://www.fao.org/nr/water/aquastat/dams/print1.stm
21. River network: vector file of river network, with river types and sub-classifications. The dataset provided by the Global River Classification GloRiC can be used as data source: https://www.hydrosheds.org/page/gloric.
22. Landcover output: land cover map in raster format covering the whole extent of the administrative boundaries of interest, and representative for the account year. Band 1 contains the code of the landcover as pseudo Corine landcover classes. This map is created through the landcover module.

6.2 Infrastructure pre-processing

No pre-processing modules are available for the Infrastructure module.

7 Total accounts

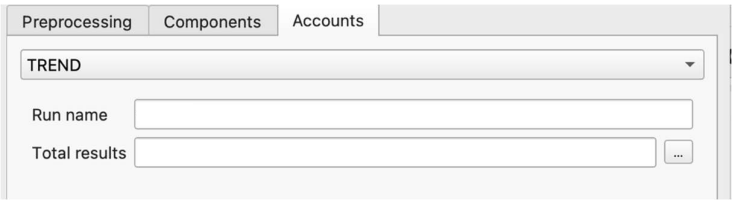
The Total accounts module creates the total accounts for all SELU's within the AoI, for the given account year. The input files consist of a set of csv files, one per component.



1. Run name: name that will be assigned to the folder within your working directory where output of the Total processor will be saved
2. Infra result: path to output folder of the Infrastructure module, for which the name has been defined under Infrastructure "Run name"
3. Carbon result: path to output folder of the Carbon module, for which the name has been defined under Carbon "Run name"
4. Water result: path to output folder of the Water module, for which the name has been defined under Water "Run name"

8 Trend accounts

The Trend accounts module computes the trend, for each SELU's within the AoI, over all yearly accounts that have been produced. It can be computed for the total accounts as well as for the different components; i.e. carbon, water and infrastructure. The input files consist of one csv file per account year.



1. Run name: name that will be assigned to the folder within your working directory where output of the Trend processor will be saved
2. Total result: path to output folder of the Total module, for which the name has been defined under Total "Run name", and where the "Statistics" folder is located.

Appendix A: Landcover look-up tables

ESACCI_2_PSCLC_Rank (lut_lc2psclc)

- Objective
  - Remapping of input land cover map to pseudo-corine (standardized) coding scheme
- Colmns
  - PSCLC_CD: list of all input (CLC) land cover codes
  - PSCLC_RANK: remapped pseudo corine land cover code

PSCLC_Rank (lut_lc)

- Objective
  - Prepare the (pseudo-corine) land cover codes for creating land cover (change/flow) accounting table
- Columns:
  - PSCLC_CD : list of pseudo-corine land cover codes
  - PSCLC_RANK : sequential number starting from 1. The last number can be used as max_LC_classes

PSCLC_lcf_C or similar for PSCLC_lcf_F (lut_lcflow_X)

- Objective
  - Map land cover changes between two years as land cover flows (consumption if land taken, formation if land created from ecological perspective)
- Columns
  - LC_CHANGE: 4 digit-number from psclc class + to psclc class (e.g. 1051)
  - ID_lcflows : land cover flow identifier (1 or 2 digit-number) referencing the to psclc class (e.g. 1)
  - CODE_lcflows: string referencing flow (e.g. lcf 1)
  - CONSUMPTION: 5 to 6 digit-number, with first 1 to 2 digits the lcf flow number + 00 + 2 digit from clc lcass
  - CD_CONSO_short: C_lcf + digit CODE_lcflows
  - CD_CONSO_long: C_lcf + digit CODE_lcflows + from psclc class
  - Lcf_Name: string description land cover flow

PSCLC_FlatMatrix (lut_lcflows)

- Objective
  - Combination of lcf_C and lcf_F
- Columns
  - LCYYYY : psclc code from year
  - LCYYYY : psclc code to year
  - LC_CHANGE : 4 digit number representing LC_CHANGE class (psclc from + psclc to)
  - ID_lcflows: see lcf_C or lcf_F
  - CODE_lcflows: see lcf_C or lcf_F
  - CONSUMPTION: see lcf_C
  - CD_CONSO_short: see lcf_C
  - CD_CONSO_long: see lcf_C

- FORMATION : see lcf_F
- CD_FORMA_short lcf_F
- CD_FORMA_long: lcf_F
- Lcf_Name: see lcf_C or lcf_F