Regionalized LCIA in openLCA

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Content

1 Regionalized LCIA in openLCA: GIS and parametrisation of LCIA methods

Both the inventory and the impact assessment phase of a life cycle assessment (LCA) might be affected by site-specific conditions. The inventory because technologies, production routes, farming systems, etc. used for the generation of the same good or service may vary significantly worldwide. Regarding the impact assessment, the characterization factors in many of the impact categories commonly analysed (e.g. eutrophication, land use, abiotic resource depletion, etc.) are dependent on site-specific characteristics (e.g. population densities, soil types, climate factors, etc.).

As different spatial scales may be selected for defining each of these different variables (e.g. per watershed, political unit, grid, etc.), as well as for defining the process locations, it is fundamental in a regionalized impact assessment to be able to deal with multiscale systems without compromising the correctness of the results. To overcome this challenge, geographic information systems (GIS) can be used not only for the calculation of regionalized impact factors but also for creating site-specific inventories and matching each of these. **openLCA v.1.5.0 includes the functionality for handling GIS data**, allowing the user to include this type of data in the process locations, as well as for defining site-specific impact factors in the method.

The availability of this type of impact factors has increased considerably in recent years in methods such as EDIP 2003, EcoIndicator 99+, ImpactWorld+, etc. This spatial differentiation of the factors implies also an increase in the amount of data that needs to be handled by the LCA software, even if the impact factors are provided in GIS files. Consequently, a new concept for dealing with regionalized LCIA methods in openLCA has also been developed in order to avoid compromising the computing power of the tool (Figure 1).

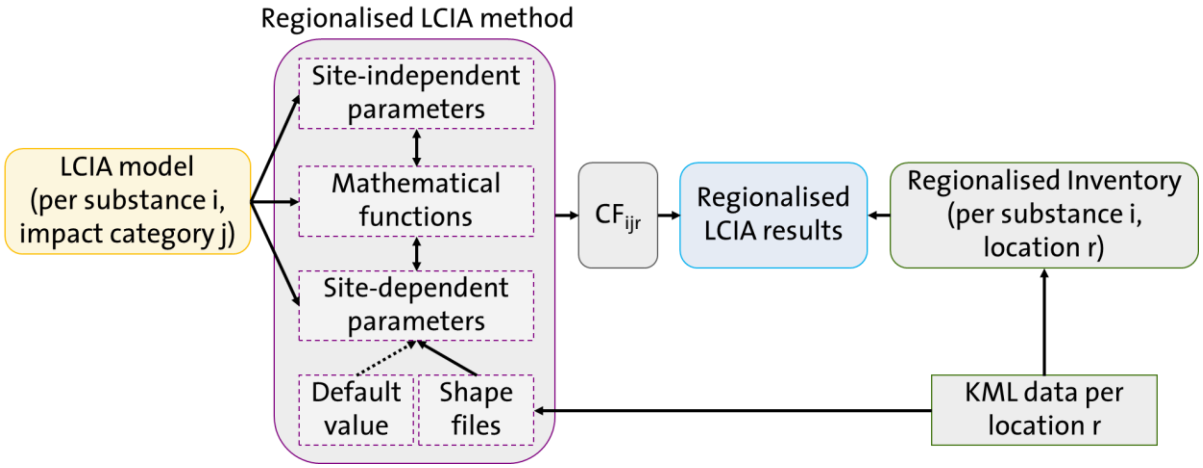


Figure 1: Schematic representation of the new approach for regionalized LCIA in openLCA

As represented in Figure 1, in this approach the mathematical functions used in the LCIA models are parameterised in order to differentiate between site-generic (i.e. dependent on substance properties) and site-specific (e.g. population density) variables. The resulted functions per substance and impact category are defined in the "Impact factors" tab of the openLCA LCIA method editor. The data for the regional characteristics is imported to openLCA in shape files (i.e. GIS vector data), being each characteristic an attribute of the existing geometries in the file. The imported attributes can then be added as new parameters in the LCIA method editor. This way, site-specific data is only needed for the regional characteristics included in the LCIA model, instead of having to import GIS files with thousands of attributes representing the impact factors of each elementary flow per impact category.

In the new "Regionalized LCIA" calculation, the value of each parameter per location used in the product system is determined based on the area of the shape files intersected by each process location. The resulting values are then used to evaluate the parameterised formulas defined in the "Impact factors" tab. A default value for the regionalized parameters can also be defined in order to apply it to site-generic inventory data or in the "Quick results" and "Analysis" calculations. The regionalized LCIA results obtained are presented in an extended editor, including new maps and tables to analyse the geographic variability of the impacts.

This document aims to guide the user through the different steps needed for performing a regionalized impact assessment in openLCA:

- Add GIS data to the inventory locations
- Create regionalized LCIA methods using shape file parameters
- Perform a regionalized LCIA calculation
- Analyse the regionalized LCIA results

In addition, the use of the new plugin LEO-SCS-002, which contains additional functionalities to the regionalized LCIA calculation, is also explained.

2 Extension of geographic information in the inventory

Data exchange formats most commonly used in LCA (i.e. EcoSpold1, ILCD, EcoSpold2) are all based on extended markup language (XML). The geographical information included in them has evolved from a location code in EcoSpold 1, to the addition of a latitude and longitude pair in ILCD and finally to the integration of keyhole markup language (KML) geographic descriptions in EcoSpold2. As the geospatial information stored in KML files can be used by GIS, a KML editor for the locations was added in openLCA. New locations including KML data can be created in two ways in openLCA 1.5.0: from the navigation pane or from a process editor.

2.1 Create locations in the navigation pane

Locations are now included in openLCA as a specific element within the “Background data” folder in the navigation pane. Thus, new locations can be created in the same way as other elements in the database (e.g. flows, processes, sources, actors, etc.): right click on the folder “Locations” or on any category included in it and select “New location” (Figure 2).

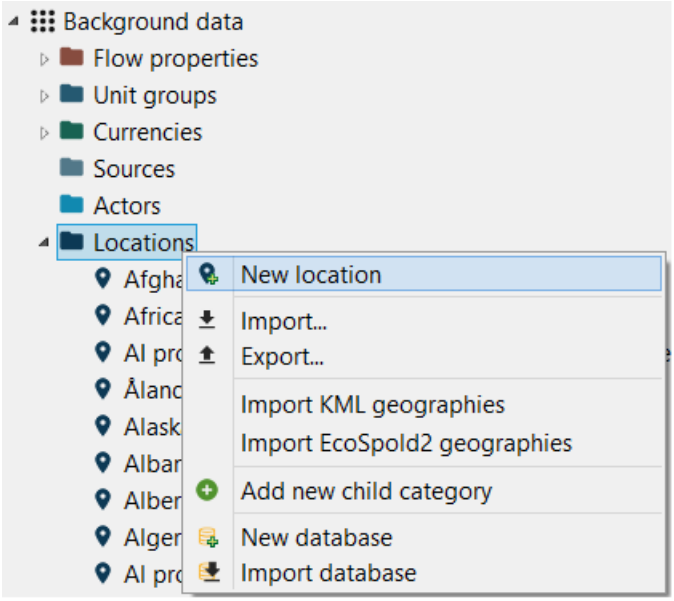


Figure 2: Create a new location in openLCA v.1.5.0

A new window will be opened where the name and the description of the new location can be added (Figure 3).

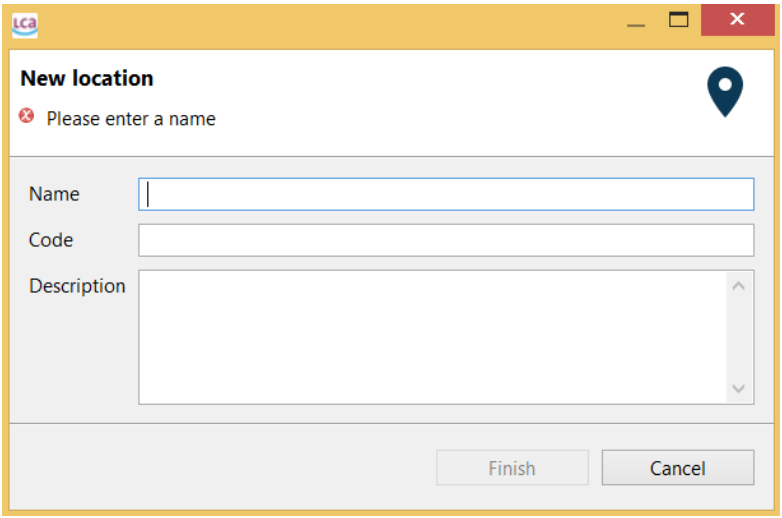


Figure 3: New location pop-up window

After selecting “Finish” a new editor will be opened where additional information and KML data can be added to the newly created location (Figure 4). The “Code” field is very useful because it is the information displayed next to the process or flow name in the navigation

pane (e.g. “GLO”, “RER”, “US”, etc.), and thus facilitates the identification of processes without needing to open it in the editor. Moreover, the code is the field used for generating the unique identifier of the location when it is created, which is used for mapping locations during the import of files (see section 2.3 for more details). The average “Longitude” and “Latitude” information might be interesting to add if you want to export the locations in ILCD format, as this is the only geographical information included in it. It is also the geographic data used in the “Locations” tab of the “Quick results” and “Analysis” results editor. It should be taken into account that this data is not used in the regionalized calculation, only the data defined in the KML editor. This means that **if none of the locations included in the product system contains KML data, the regionalized LCIA calculation will not be possible.**

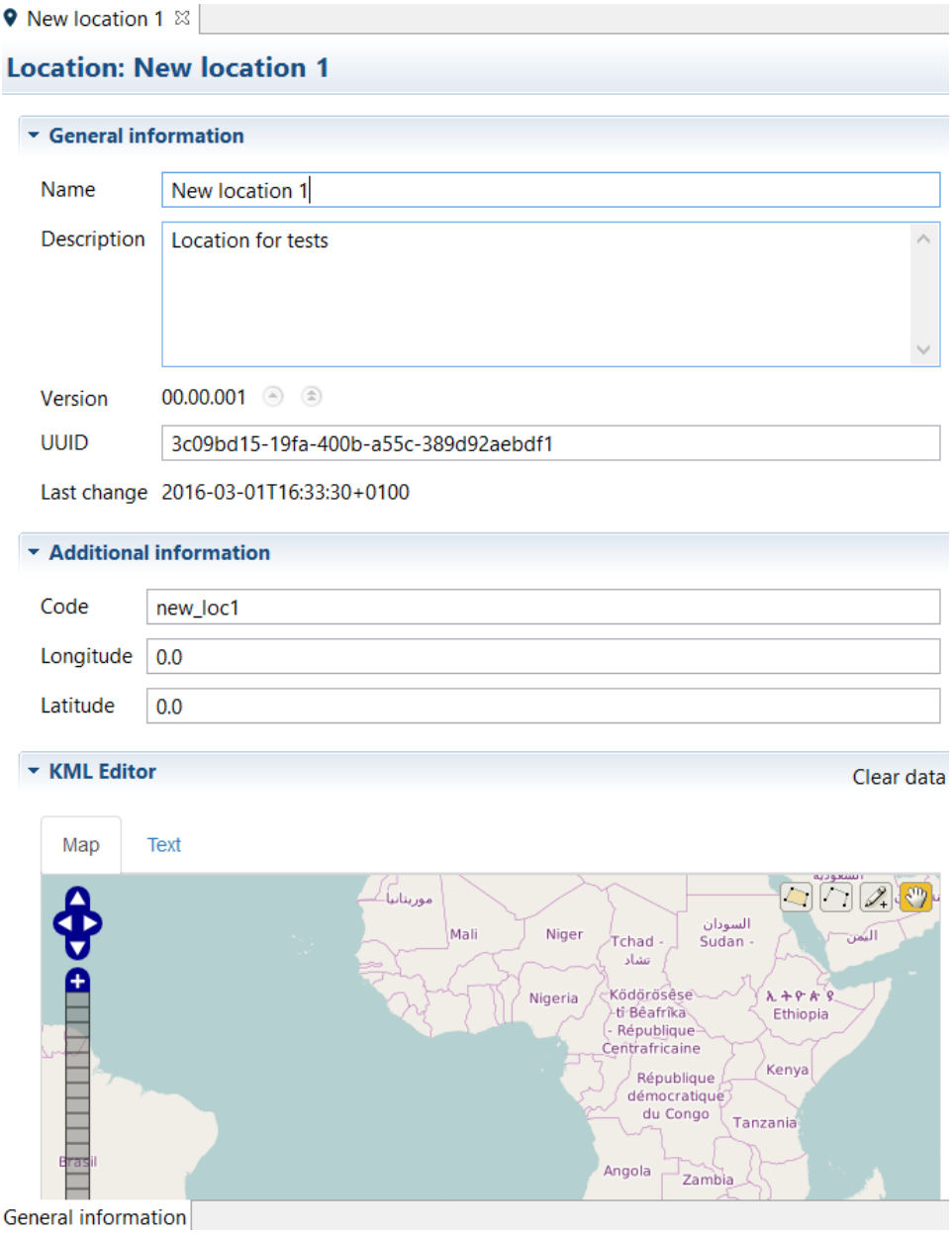


Figure 4: Location editor in openLCA v.1.5.0

2.1.1 KML editor in the location editor

Geographic information of the location can be defined/modified in two ways: graphically in the "Map" tab (Figure 6) or typing the coordinates in the "Text" tab (Figure 7). Indistinctly of which option is used, the content of the inactive tab will be updated with the data added/modified in the active one.

In the KML editor the locations can be defined using three types of geometries: point, line and polygon. For example, polygons can be used to represent country or state borders, lines for transportation routes and points for specific plant locations. Several geometries of the same type can be used for the same location (i.e. multi-polygons, multi-lines, multi-points). However, **it is not possible to combine two types of geometries in the same location**. This means that the same location cannot contain polygons and lines and points. An error message will be shown if trying to create multi geometries of different types (Figure 5).

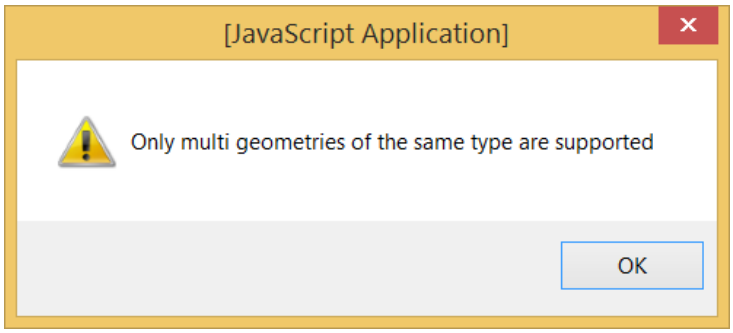


Figure 5: Error message when trying to add KML data containing multi geometries of different types

2.1.1.1 Map tab in the KML Editor

In order to add a new geometry in the map, first select the type of geometry in the top right corner (i.e. polygon, line, point). Then click on the map to add the new geometry; in the case of polygons and lines, the shape will not be finished until a double-click is done. It is possible to delete the data added by selecting the option "Clear data" available in the right corner of the "KML Editor" section's title (Figure 6). Please, note that all the data included in the KML Editor will be deleted, not only the last geometry added.

It is also possible to zoom in and out from the map with the zoom bar in the left side of the map, either by using the "+" and "-" buttons or by moving the slider to the scale needed. Navigation through the map can be done using the "hand" button in the top right corner or the arrows in the top left corner of the map. The latter allows the user to move through the map while creating a new polygon or line without needing to finish the shape before.

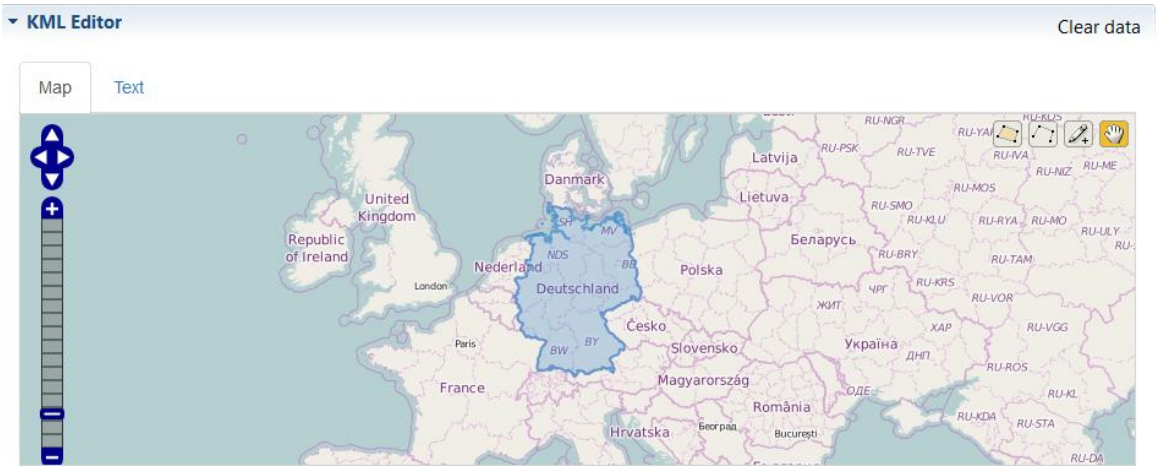


Figure 6: "Map" tab of the KML editor in the Location editor

2.1.1.2 Text tab in the KML Editor

The coordinates defining the geometries of the location can be added or modified in the "Text" tab as in a normal text editor. However, the xml format used should be equal to the one automatically created when using the map. Figure 7 shows examples of the different fields included when using points, lines or polygons.

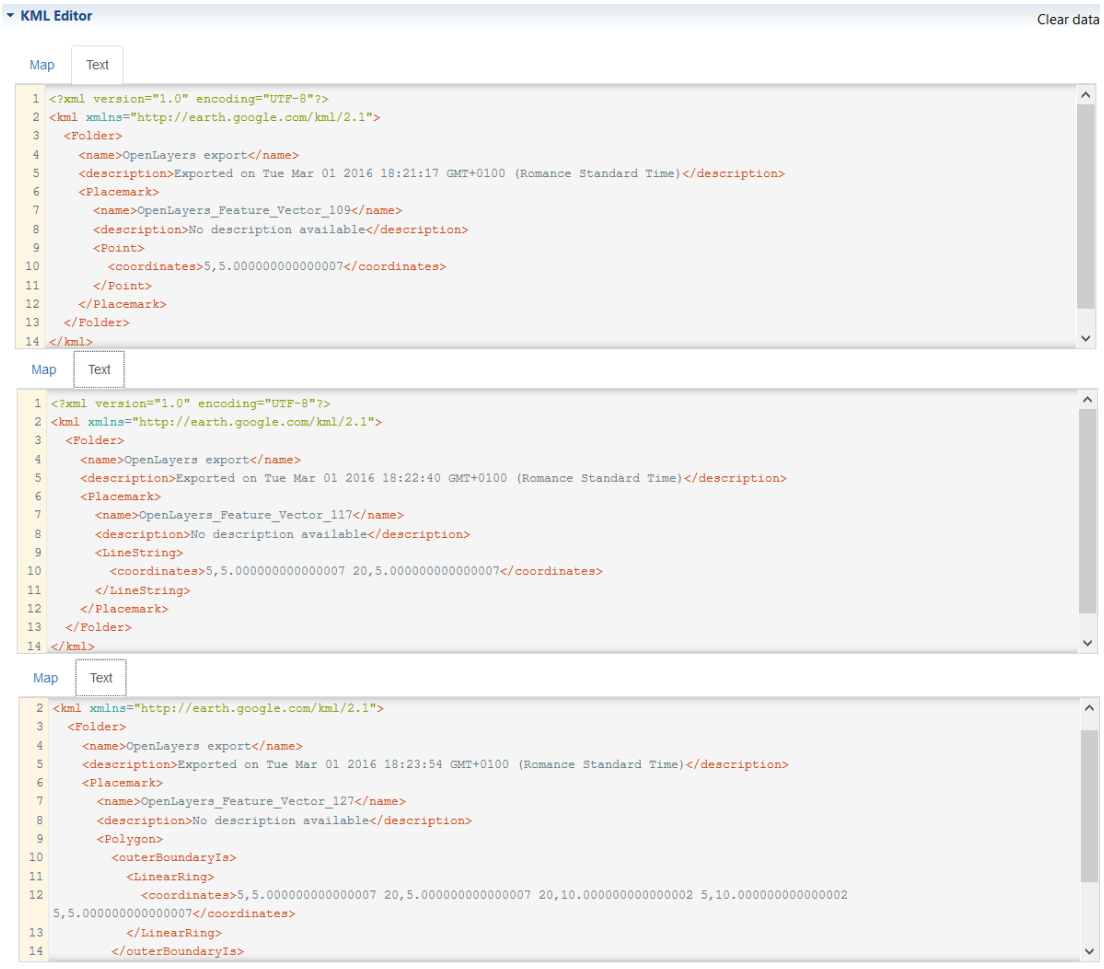


Figure 7: Examples of point (top), line (middle) or polygon (bottom) geographic data in the "Text" tab of the KML editor

2.2 Create/select locations in the process editor

The process location is defined in the section “Geography” of the “General Information” tab in the process editor. The drop-down menu contains all the locations already existing in the database. The KML data of the selected location can be displayed in a KML editor by either clicking on the button “Map editor” or on the KML data information displayed in light blue below the drop-down menu (Figure 8). If no KML data is included in the selected location, “none” will be displayed as KML data information in the geography section and the KML editor will be empty.

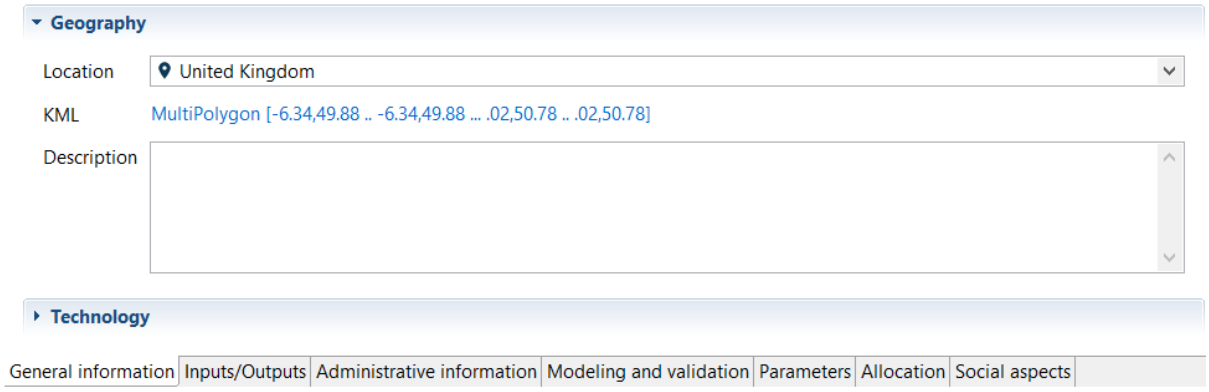


Figure 8: “Geography” section in the “General information” tab of a process editor

2.2.1 KML editor in the process editor

The KML editor in the process editor is very similar to the one included in the location editor (Figure 9). The differences rely on the fact that the **KML data of existing locations cannot be modified within the KML editor of the process**. Therefore, the KML Editor of the process can only be used for:

- displaying geographic data of an existing location,
- opening the existing location in its correspondent location editor to modify it, or
- creating a new location.

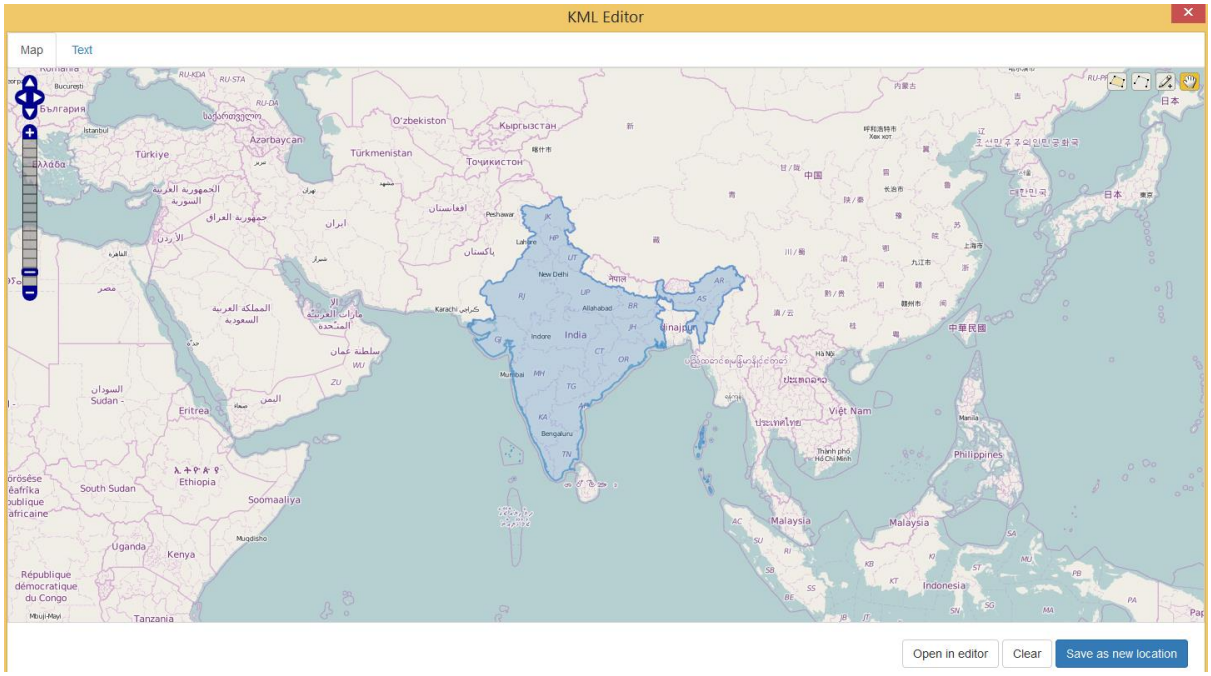


Figure 9: "KML Editor" of a process editor

The new location can be created from an empty KML editor or from data of an existing location. New geometries can be added in the same way as explained in section 2.1.1. All the displayed KML data can be deleted by clicking the button "Clear" in the bottom right corner of the editor. This action will not affect the geographic content of the existing location, only of the new location to be created. Once all the geometries representing the new location have been added, the location can be created by clicking "Save as new location". A new window will pop-up asking for the name and code of the new location (Figure 10).

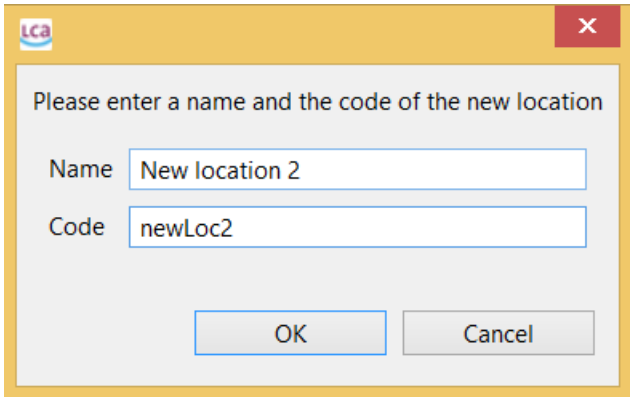


Figure 10: Window for saving a new location from the "KML Editor" of a process editor

After clicking "OK", the KML editor will be closed and the newly created location will be automatically selected as the location of the process. If the new location needs to be modified afterwards, it will be necessary to open it in its location editor either by clicking the button

"Open in editor" of the process KML editor (Figure 8) or from the navigation pane (i.e. right click on the location name and select "Open in editor" or double-click on the location's name) (Figure 11).

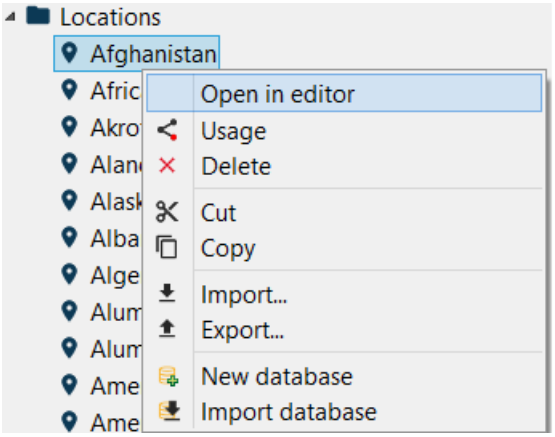


Figure 11: "Geography" section in the "General information" tab of a process editor

2.3 Import KML data to an existing location

Geographic data for existing locations can be imported from external files so that it is not necessary to add it manually in the KML editor of openLCA. Two file extensions are supported: *.kml and *.xml (Ecospold 2 format). The latter refers to the format used by Ecoinvent in the "Geographies.xml" file, containing KML data for all the locations used in the ecoinvent database[1]. The import wizard can be accessed from the right-click menu in the navigation pane (Figure 12) or within "File" in the menu bar. The two import options are included in the "Others" folder of the import wizard (Figure 13). After selecting one of the import options, the file must be selected in a pop-up window (Figure 14).

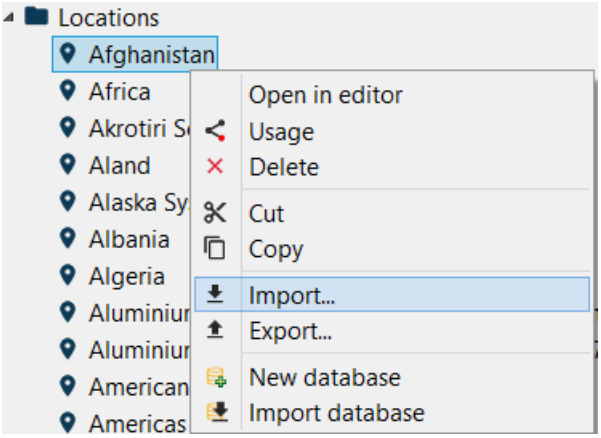


Figure 12: Import geographic data as KML or EcoSpold2 format to existing locations, step 2

[1] http://geography.ecoinvent.org/report

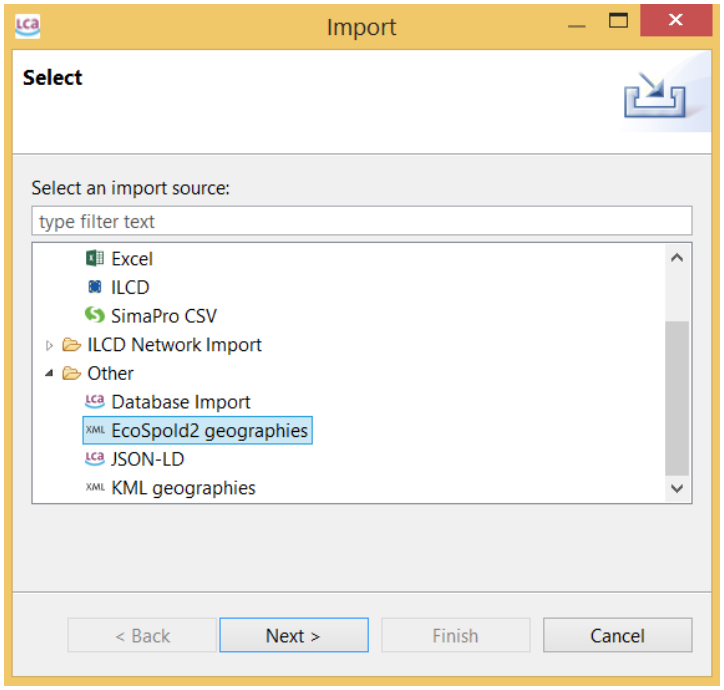


Figure 13: Import geographic data as KML or EcoSpold2 format to existing locations, step 2

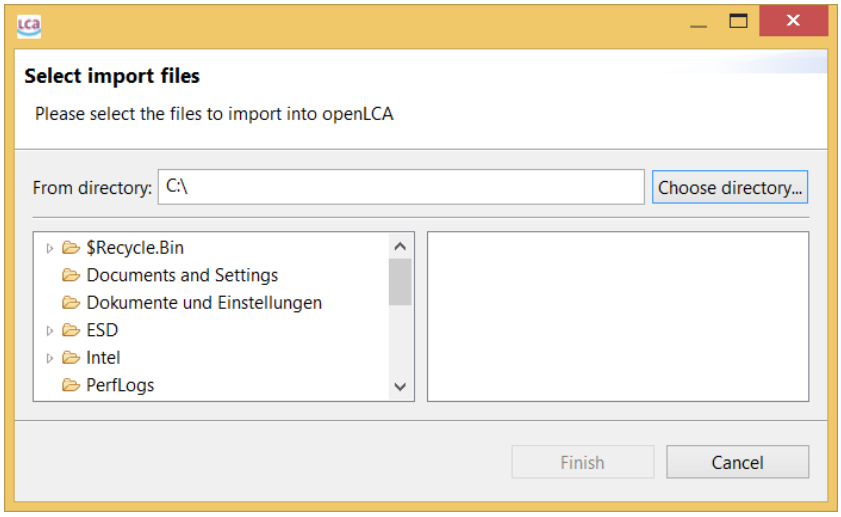


Figure 14: Import geographic data as KML or EcoSpold2 format to existing locations, step 3

The linkages between the data in the files and the existing locations in openLCA are done by the UUID generated from the location code (i.e. field "Short name" in EcoSpold2, "HASC_2" in KML). Thus, if the location had a different code when it was created in openLCA than in the file, the KML data will not be imported to the existing location[2]. Instead, a new location will be

[2] For those databases available in Nexus, a mapping file is included in the import in order to match their locations to openLCA's reference locations

created. The UUID of the new location will be generated from the code in the file. If no code is defined in the files, a random UUID will be generated during the import.

3 Create regionalized LCIA methods

As explained in section 1, the parametrisation of LCIA methods is the approach followed in openLCA for their regionalization. In addition to the global, input and dependent parameters available in the "Parameters" tab of the process editor, the LCIA method editor includes also the option of adding Shape file parameters. These type of parameters can have different values per geographical feature included in the GIS file (e.g. country, watershed, grid, etc.). All type of parameters can be used in the "Impact factors" tab to define the values of the characterisation factors per elementary flow and impact category (Figure 15). In addition, uncertainty of each characterization factor can be added in the "Impact factors" tab and of each parameter in the "Parameters" tab.

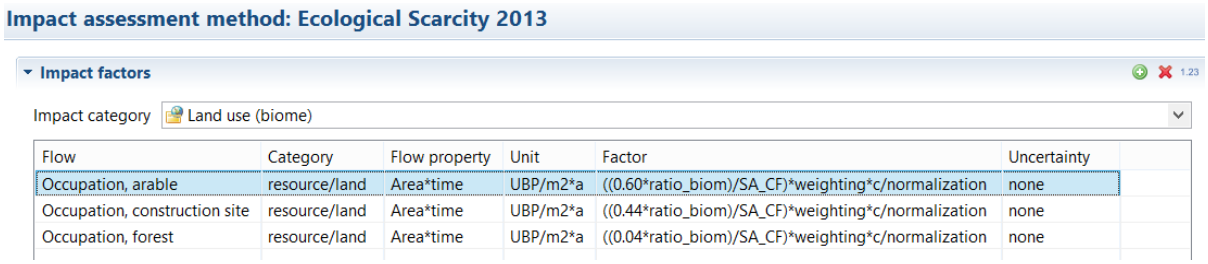


Figure 15. "Impact factors" tab in LCIA method editor

3.1 Add shape file parameters

Shape file parameters are created in openLCA by importing GIS files of extension *.shp which contain the parameters as numerical attributes of each feature included in the file. Further requirements for the GIS files supported in openLCA are specified in section 3.1.1. For importing the GIS file, click "Import" in the "Shape files" tab of the LCIA method editor and select the file to import. Once the shape file has been imported, the numerical attributes included in it will be added as parameters in openLCA. The name of the parameter will be the name of the attribute in the shape file and its minimum and maximum values will be displayed in the table.

The different values per location and parameter can also be checked in a map. For this, right-click on the parameter name and select "**Show in map**" (Figure 16).

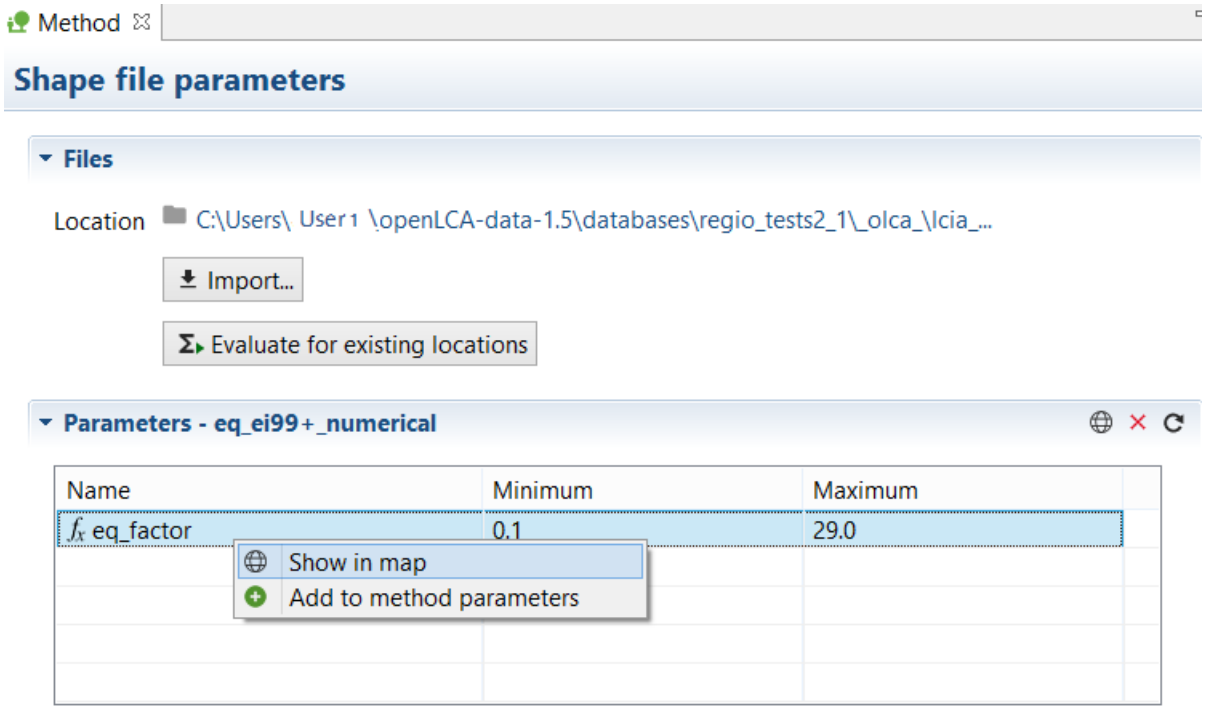


Figure 16. "Shape files" tab in LCIA method editor

The value of each feature included in the shape file can be checked selecting the function "i" available in top left corner of the pop-up window (Figure 17), and then clicking on the point of interest in the map. An additional pop-up window will show the different information available in the shape file for the feature that includes the selected point.

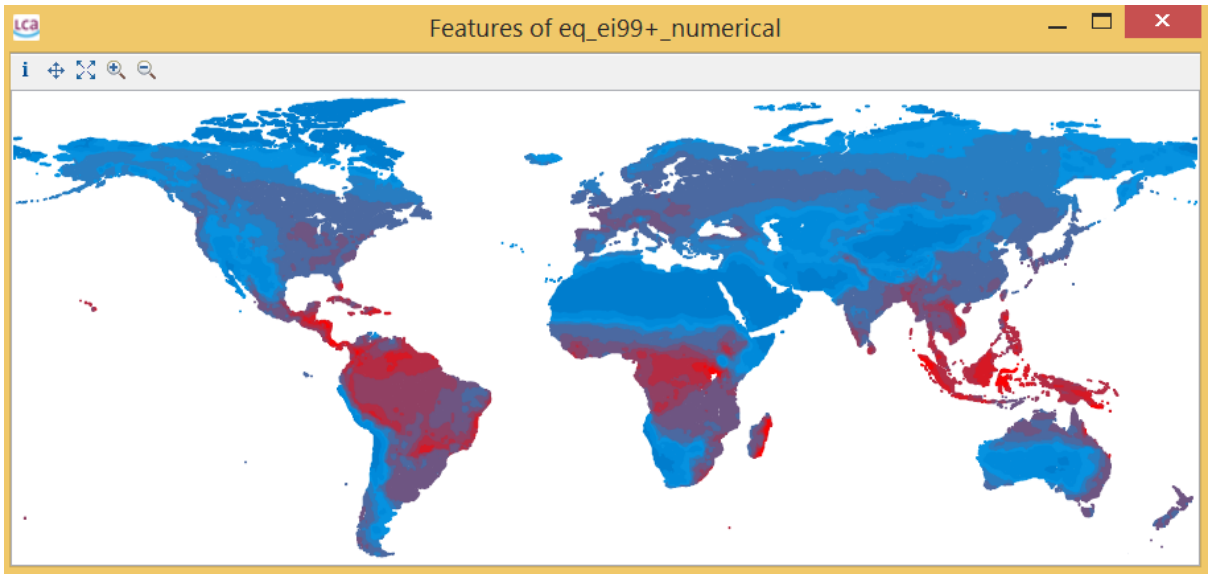


Figure 17. Map displaying the values of the selected parameter for all the features included in the imported shape file

Shape file parameters can be added to the LCIA method input parameters table by right clicking on the name of the shape file parameter and selecting "**Add to method parameters**". The parameter will be automatically added to the "Input parameters" area in the "Parameters" tab. As it can be observed in Figure 18, the "External source" field refers to the shape file which

provides the data for the parameter. The mean value, which is the default value to be used when no regionalized LCIA is performed, can be modified if necessary. The uncertainty is automatically calculated from the values contained in the shape file.

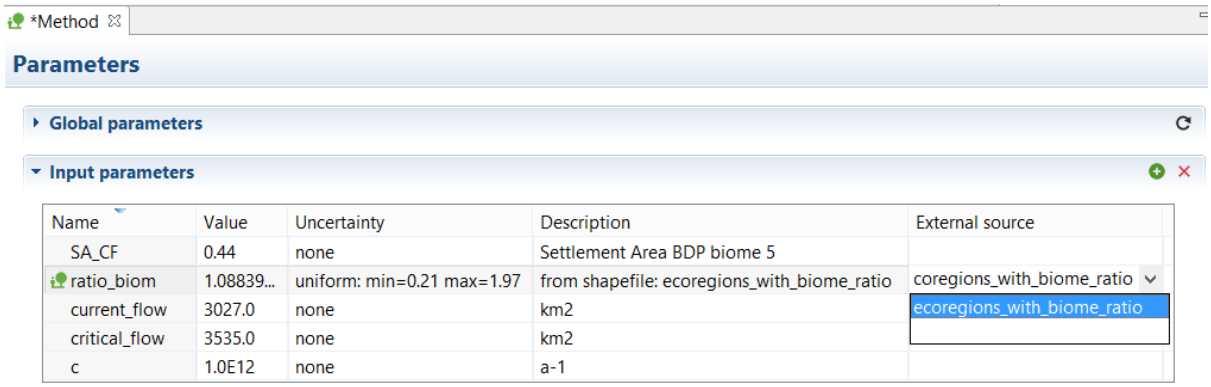


Figure 18. Shape file parameter in the "Parameters" tab of the LCIA method editor

If there is more than one shape file containing a parameter with the same name, the external source can be changed in the “Parameters” tab using the drop-down menu in the correspondent row of the column “External source”. The mean value and the uncertainty will be recalculated with the selected shape file.

If you want to update the values of the shapefile parameters with the content of a new shapefile without having to create all the links to the method’s parameters again, you can use the “**Update**” button existing in the top right corner of each shapefile section (Figure 19). The software will substitute the current shapefile by the one you select. If any method’s parameter was using the substituted shapefile as source, the links to the new shapefile will automatically be created. However, those method’s parameters linked to parameters of the old shapefile which do not exist in the new one, will be unlinked and will remain in the “Parameters” tab as normal input parameters.

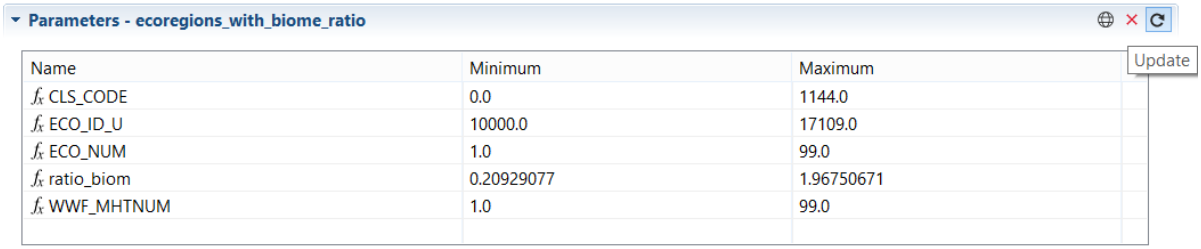


Figure 19. Update shape file parameters in the "Shape files" tab of the LCIA method editor

The feature “Evaluate for existing locations” available in the “Shape files” tab of the LCIA method editor is related to the regionalized LCIA calculation procedure and, therefore, it is explained in section 4.

As the shape files are stored in the LCA database, they can be easily exported with the database.

3.1.1 Specifications for GIS files used in the LCIA methods

- Shape file format.
- Coordinate reference system: WGS84, EPSG:4326
- There must be a single layer in each file.
- Site-dependent characteristics/CFs as attributes of the different features (i.e. geometries). They must be numerical.
- The name of the attribute will be the name of the parameter used in the functions of the LCIA method. Therefore, if multiple shape files are going to be used within a single method, the attributes must be named differently.
- The features should not overlap (e.g. the same shape file cannot contain features for Europe and Germany).

3.2 Link existing input parameters to shape file parameters

Shape file parameters can also be bound to existing input parameters in the “Parameters” tab. This means, that after linking an existing parameter to the shape file parameter, the values of the shape file parameter will be used when regionalized LCIA calculation is performed.

To this end, in the “Parameters” tab of the LCIA method editor, select in the drop-down menu of the field “External source” the shape file that should be used as data source for the parameter (Figure 18). Please, take into account that only those shape files containing a parameter (i.e. attribute) with the same name as the existing parameter will be listed.

4 Regionalized LCIA calculation

In order to perform a regionalized LCIA calculation, select “Calculate” in the product system editor or in the toolbar; then select a regionalized LCIA method existing in the database and the option “Regionalized LCIA” in the calculation properties window that pop-ups (Figure 20).

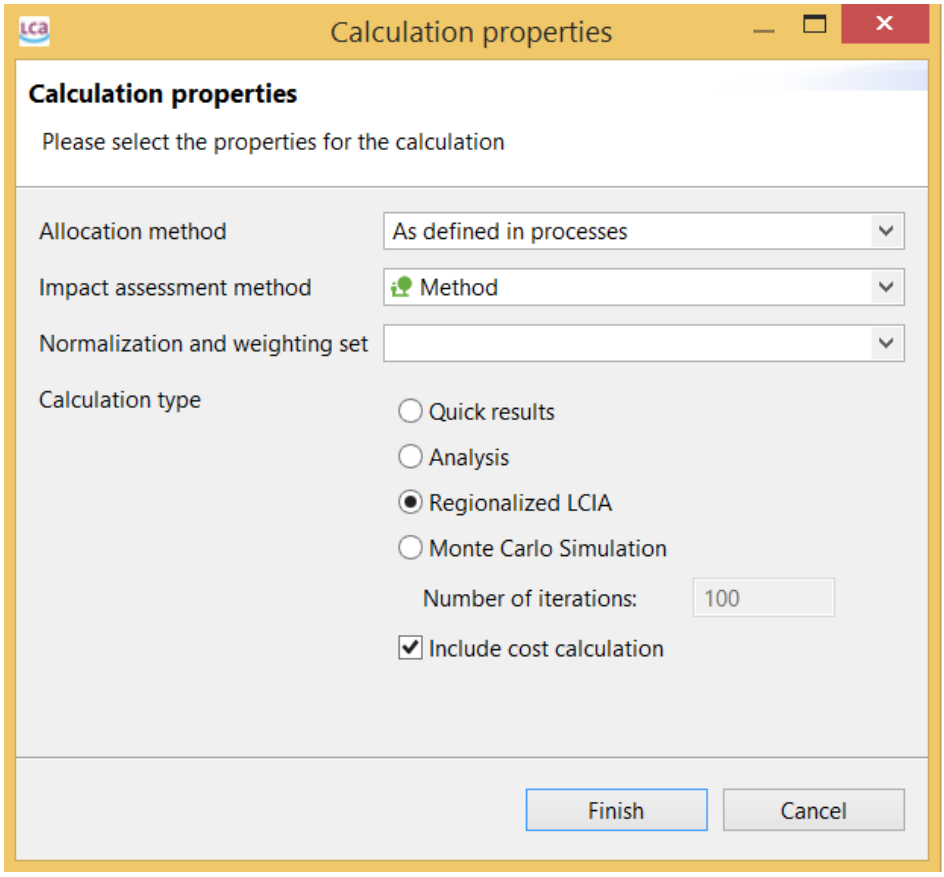


Figure 20: Calculation properties window in openLCA v.1.5.0

If there is no shape file parameter added in the "Parameters" tab in the LCIA method or there is no KML data included in any location used in the product system, a message informing that no regionalized calculation can be performed will be shown (Figure 21).

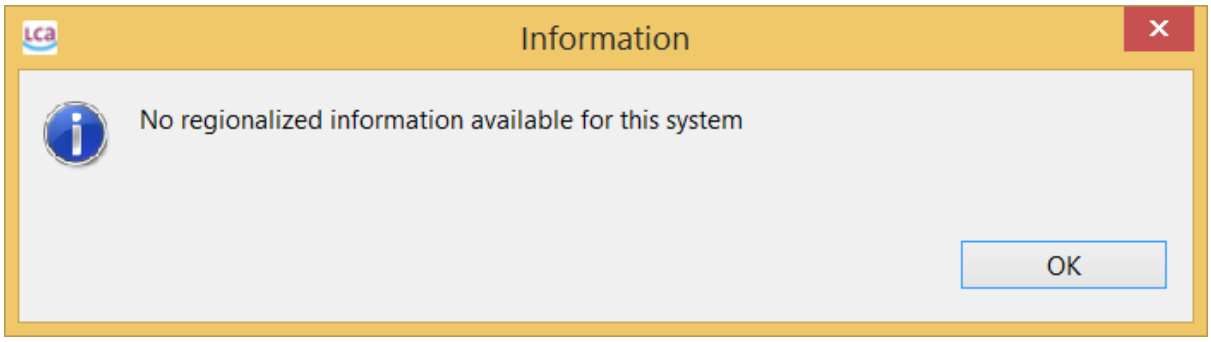


Figure 21: Message informing that now regionalized information is available for the selected product system (i.e. Regionalized LCIA calculation is not possible)

During the regionalized LCIA calculation, openLCA needs to determine the value of each impact factor per flow and location in the inventory. To this end, openLCA first calculates the intersections between the shapes defined in the shape file and those defined in the openLCA locations used in the product system. This task might be very time intensive depending on the

amount of locations containing KML data in the product system. If your product systems only use a few different locations, there will not be a high impact on calculation times. On the other hand, if product systems with many locations need to be calculated, it would be more convenient to run once in the background the function "**Evaluate for existing locations**", which is available in the "Shape files" tab of the LCIA method editor (Figure 16) (i.e. use the function while doing other tasks not requiring the use of openLCA). This function pre-calculates the intersections with all the locations in the database. If the intersections are not pre-calculated and a regionalized LCIA calculation is performed, the intersections for the locations used by the product system will be determined during the calculation and saved for later use.

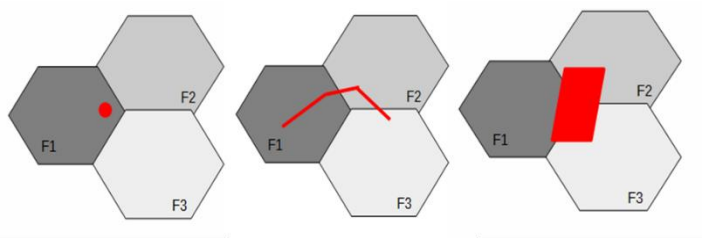


Figure 22: Schematic representation of the calculation of the intersected spatial units from the LCIA method (F_i) by the process geometries point (left), line (centre) and polygon (right).

Once the intersections are calculated, a weighted average value for each parameter is obtained and the formulas defined in the impact factors are evaluated with the correspondent parameters values. If no KML data is available for a location, the default value of the parameter is used in the calculation of the impact factor. The resultant impact factors are finally applied to the regionalized inventory and site-specific impact results are calculated.

5 Regionalized LCIA results

After the calculation is finished, an editor with the regionalized results will be opened. The following tabs allow an analysis of the contributions per location:

- **Result map**: it shows a map coloured depending on the magnitude of the direct contributions of each location to the inventory flow or impact category selected. The locations shown are based on the KML data included in each location used in the product system. It is possible to move around the map using the mouse, and zooming with the "+" and "-" buttons in the top left corner. Please, take into account that the locations of the flows are the locations of the processes consuming/producing them.

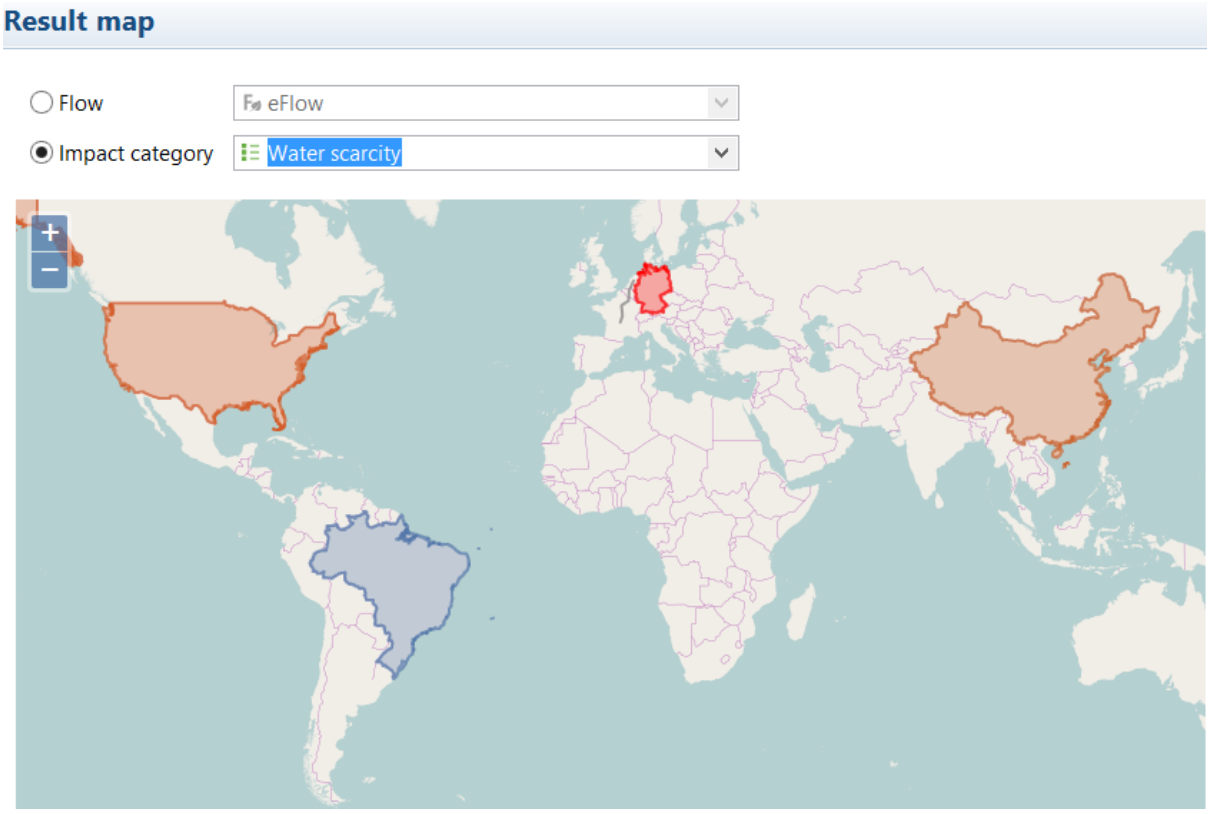
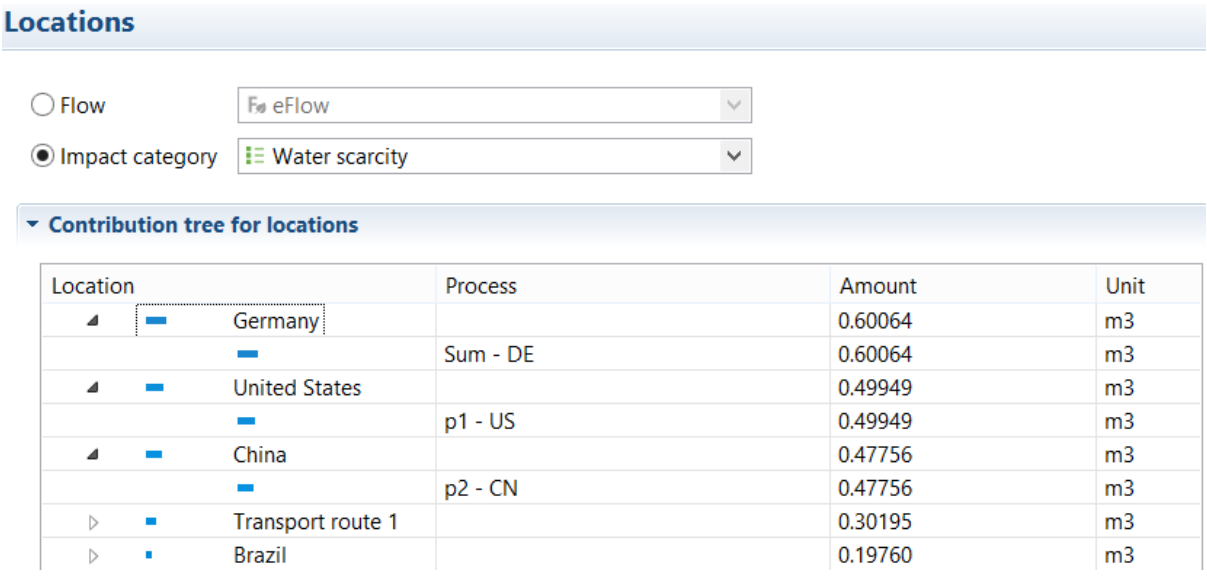


Figure 23: "Results map" tab in regionalized LCIA results editor

- **Locations**: it contains the contribution of each location to the inventory flow or impact category selected. The contribution of each location is also broke down into the direct contributions of the processes within that specific location.

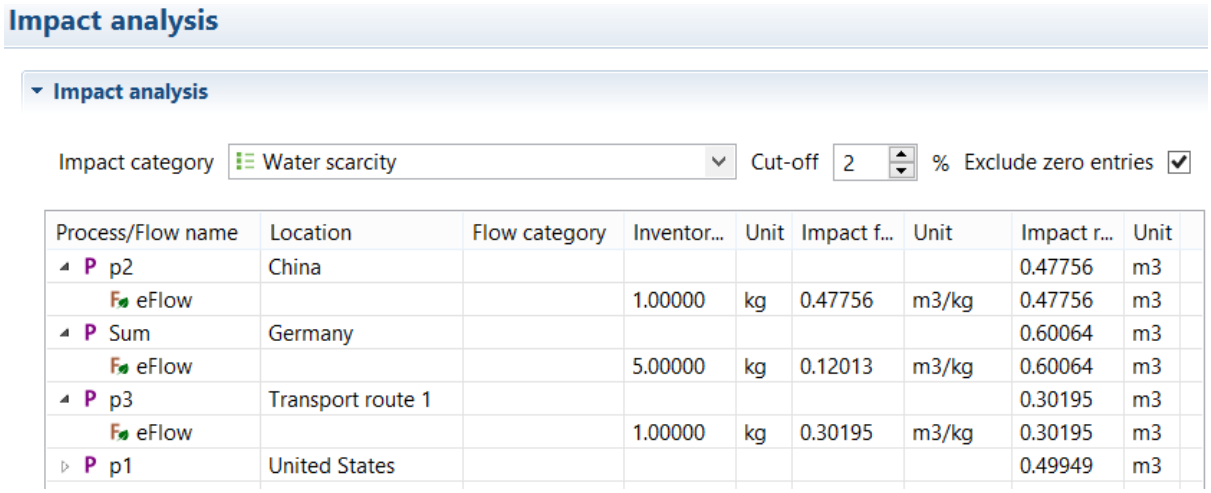


Location	Process	Amount	Unit
Germany		0.60064	m3
	Sum - DE	0.60064	m3
United States		0.49949	m3
	p1 - US	0.49949	m3
China		0.47756	m3
	p2 - CN	0.47756	m3
Transport route 1		0.30195	m3
Brazil		0.19760	m3

Figure 24: "Locations" tab in regionalized LCIA results editor

- **Impact analysis**: it contains a table showing per impact category the direct contributions of each process, displayed along with the process location. The

contribution of each process is broke down into the impact and inventory contributions of each flow consumed or emitted by it. The impact factors applied to the flows are also included. As it can be observed in Figure 25, the impact factor for the same flow varies depending on the location of the process that consumes/produces it. A cut-off for the results displayed can also be set, as well as determine if the null contributions should not be shown by checking the box "Exclude zero entries".



Process/Flow name	Location	Flow category	Inventor...	Unit	Impact f...	Unit	Impact r...	Unit
P p2	China						0.47756	m3
eFlow			1.00000	kg	0.47756	m3/kg	0.47756	m3
P Sum	Germany						0.60064	m3
eFlow			5.00000	kg	0.12013	m3/kg	0.60064	m3
P p3	Transport route 1						0.30195	m3
eFlow			1.00000	kg	0.30195	m3/kg	0.30195	m3
P p1	United States						0.49949	m3

Figure 25: "Impact analysis" tab in regionalized LCIA results editor

In addition, the following tabs are also included in the results editor:

- **General Information**: it contains a summary of the product system calculated and LCIA method used, as well as two pie charts displaying the five process with the highest direct contributions to the inventory and impact categories.
- **Inventory results**: it contains a table with all the inputs and outputs of the product system. Additionally, it contains a table "**Total requirements**", which shows the amount of each product per provider required for obtaining the target amount of the reference product. And, if the "Include cost calculation" box was checked in the calculation set-up, the costs results will also be displayed in this tab.
- **LCIA results**: it contains the LCIA results for each impact category in the method selected. In case a normalization and weighting set is selected when setting the calculation options, an additional tab "Normalization and weighting" will also be included in the results editor.
- **Process contributions**: it contains tables with the direct contributions of processes to the inventory and LCIA results.

- **Process results**: it contains direct and upstream total contributions of a selected process to each inventory flow and impact category.
- **Flow contributions**: it contains the direct contributions of each flow of the inventory to the impact categories analysed.
- **Contribution tree**: it provides the upstream total LCI or LCIA results per tier in the product system, breaking down the results into the upstream total contributions of the providing processes within each supply chain.
- **Grouping**: it allows to group processes to show their cumulative direct contributions to the inventory and impact categories.
- **Sankey diagram**: graphical illustration of the direct and upstream total contributions of processes to specific flows in the inventory or impact categories.

For further details about these tabs already existing in the "Analysis" results, check the openLCA user manual available in the website.

6 Plugin LEO-SCS-002

The plugin LEO-SCS-002 allows to override the locations specified in the existing process data sets for a specific product system by using the so-called "virtual locations". The plugin can be installed using the Plugin Manager of openLCA (Figure 27). This is available under File in the menu bar (Figure 26).

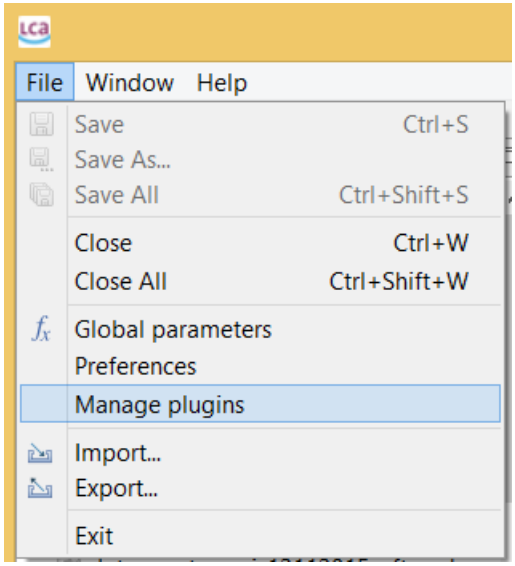


Figure 26: Installation of plugin LEO-SCS-002, step 1

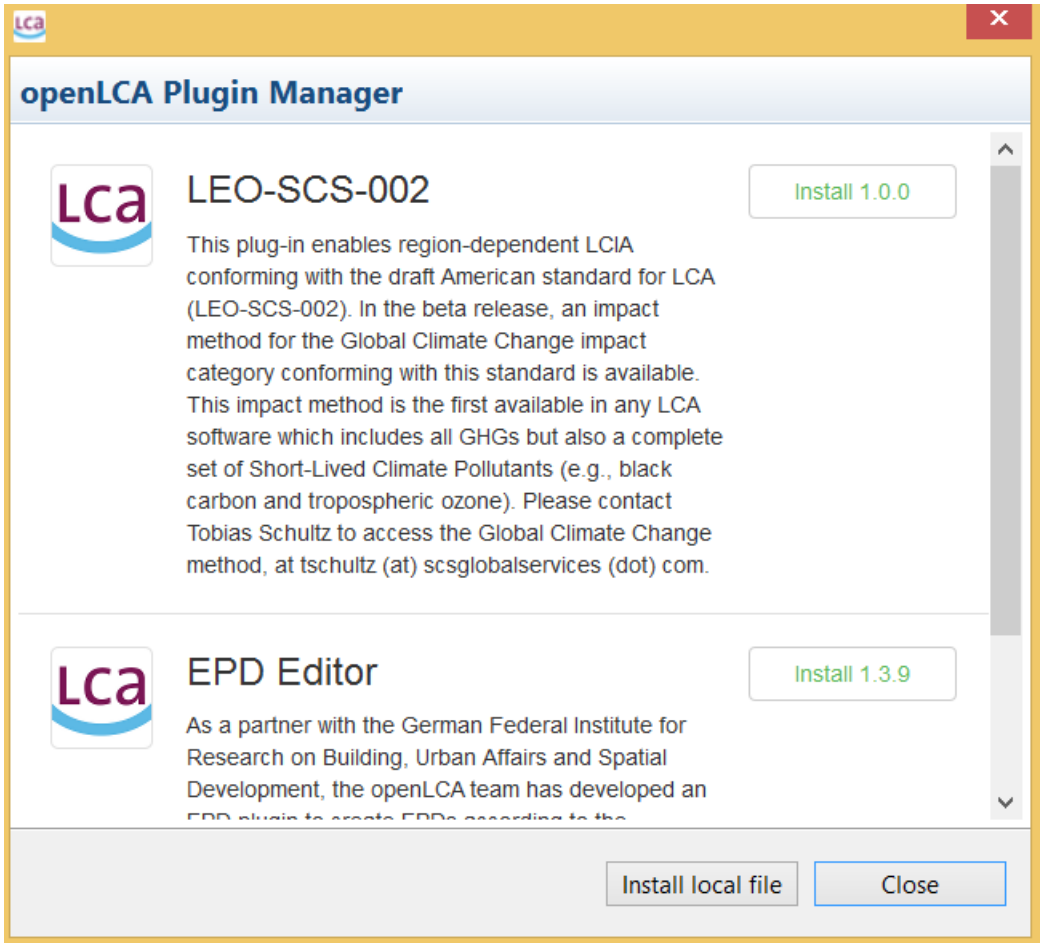


Figure 27: Installation of plugin LEO-SCS-002, step 2

After installing the plugin, a new menu "LEO-SCS-002" will appear in the menu bar of openLCA.

There are two ways to override the locations specified in the existing process data sets for a specific product system in order to apply the LEO-SCS-002 "virtual locations" concept:

1) Open the respective product system and navigate to "Model Graph". Right click on the process you want to override the location (within the current product system) and select "Set virtual location". In the following dialog, please select a location from the drop down list.

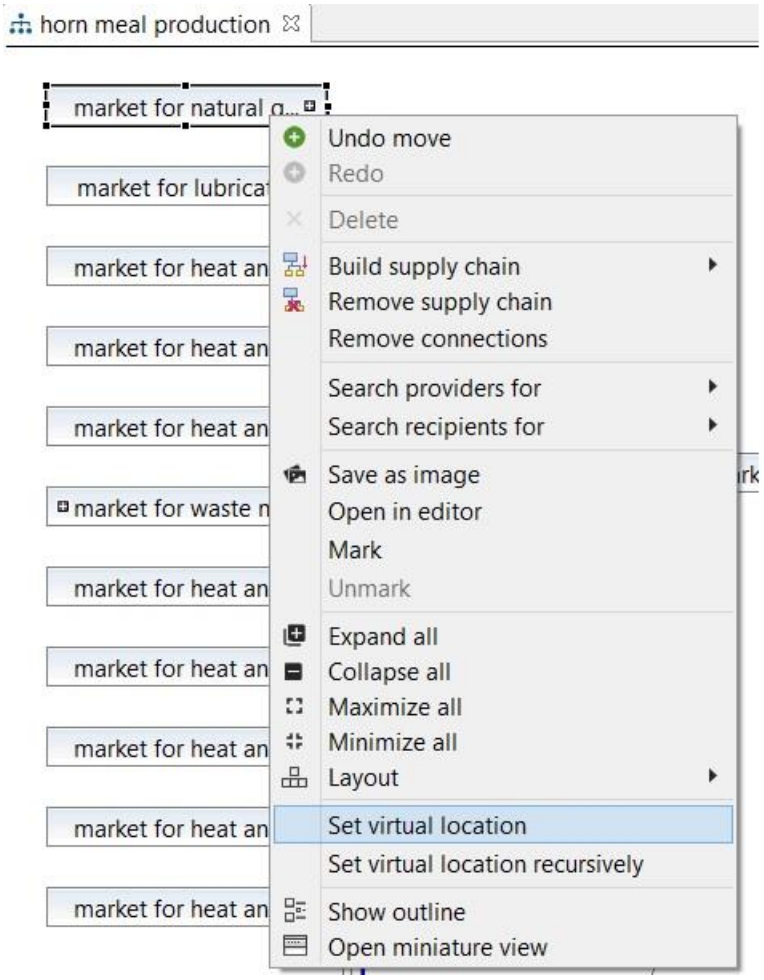


Figure 28: Set "virtual location" in the "Model graph" tab of the product system editor, step 1

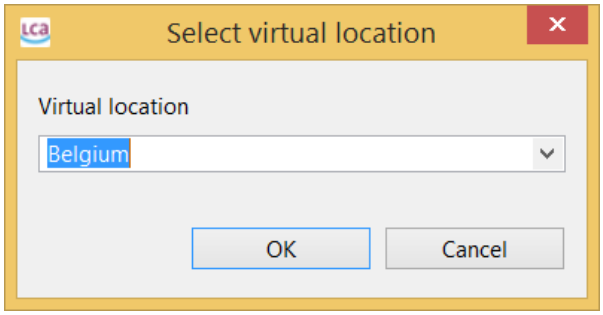


Figure 29: Set "virtual location" in the "Model graph" tab of the product system editor, step 2

The option "Set virtual location recursively" will set the location introduced for all processes in the supply chain of the selected process, considering the "depth" (i.e. tiers) specified in the pop-up window.

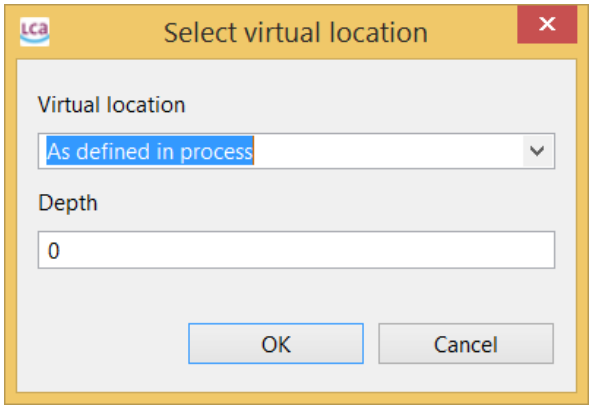


Figure 30: Window for setting a "virtual location" recursively

2) Open or select a product system and navigate to "Open virtual locations editor" option in the LEO-SCS-002 menu. An editor will be opened where you can specify in a table the virtual locations for each process included in the selected product system.

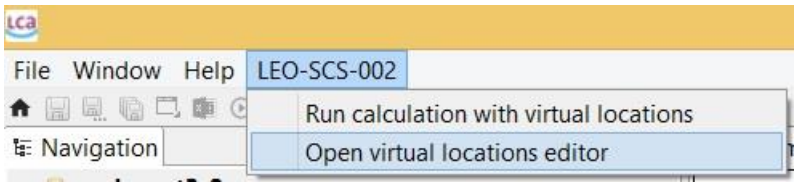


Figure 31: Open the "Virtual locations editor"

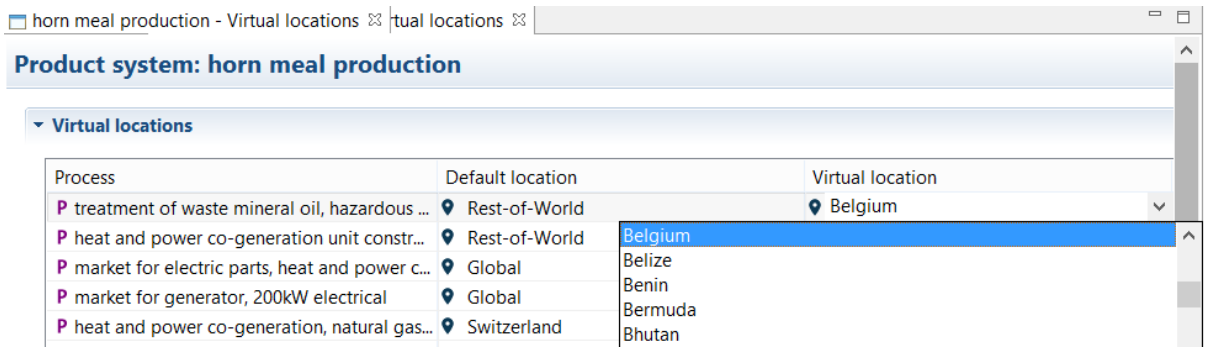


Figure 32: Set "virtual location" in the "Virtual locations editor"

To apply virtual locations instead of the default process locations in the regionalized LCIA calculation, please select the option "Run calculation with virtual locations" available in the LEO-SCS-002 menu. Then, proceed as explained in section 4 for the normal Regionalized LCIA calculation.

If no virtual locations are specified the message "No regionalized information available for this system" will pop up. This is because the virtual locations are by default "unspecified" and, consequently, no location is set when running the calculation. If you want to use the same location as the one defined in the process, you can select the option "As defined in process".

For more information regarding the LEO-SCS-002 standard and its "virtual locations" concept, check SCS website.

7 Feedback & Contact

If you have other questions not addressed by this report, need further clarifications on any of the points commented, or have comments about the regionalized LCIA calculation in openLCA, please contact us.

8 Acknowledgments

The development and implementation of the new approach for regionalized LCIA in openLCA was conducted in a project supported by the US Department of Agriculture (USDA), National Agricultural Library[3] under cooperative agreement number 58-8220-2-112F, and further improved and developed in a project supported by SCS Global Services[4].

9 Additional documentation

Rodríguez, C., Ciroth, A. (2015): Regionalized LCIA implementation in LCA software for decision-making analysis in LCM, presentation, The 7th International Conference on Life Cycle Management - LCM 2015 Bordeaux, 30 August - 2 September 2015.

Rodríguez, C., Srocka, M. (2014): Linking regionalized LCIA methods and LCA databases, concept and practical demonstration of implementation in LCA software. What is possible today?, presentation, 2nd Regionalized LCIA Workshop 2014 in San Francisco, USA, 9 October 2014.

Rodríguez, C., Ciroth, A., Srocka, M. (2014): Regionalized LCIA - new software implementation and agriculture case study, presentation, LCA Food Conference 2014 (LCA Foods 2014) in San Francisco, USA, 8-10 October 2014.

Rodríguez, C., Ciroth, A., Srocka, M. (2014): The importance of regionalized LCIA in agricultural LCA - new software implementation and case study, paper, LCA Food Conference 2014 (LCA Foods 2014) in San Francisco, USA, 8-10 October 2014.

[3] https://www.nal.usda.gov

[4] https://www.scsglobalservices.com

Rodríguez, C. (2014): Challanges of linking regionalized LCIA methods and LCA databases, presentation, Regionalized LCIA Workshop 2014 in Basel, Switzerland, 12 May 2014.

Ciroth, A. (2014): Why and when does regionalized LCIA makes sense?, presentation, Regionalized LCIA Workshop 2014 in Basel, Switzerland, 12 May 2014.

Rodríguez, C., Srocka, M. (2014): openLCA implementation of GIS-based regionalized LCA - practical demonstration of status and possibilities, presentation, Regionalized LCIA Workshop 2014 in Basel, Switzerland, 12 May 2014.