Regionalized LCA in openLCA – AWARE implementation

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Regionalized LCA in openLCA

Regionalized LCIA consists on assessing environmental impacts according to the location where they happen, what is specially relevant to assess water consumption impacts due to the highly variable availability of water in different watersheds. To calculate regionalized impacts, openLCA handles GIS shapefiles and allows the user to specify the process' location by drawing polygons using a KML editor. [1]

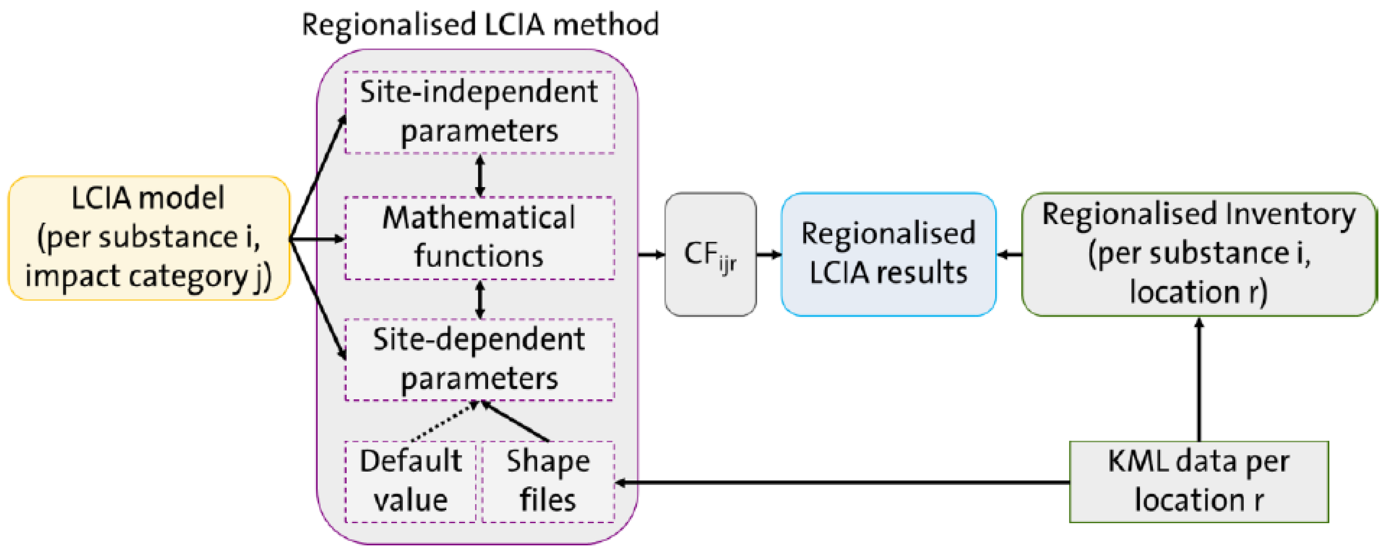

Figure 1: Schematic representation of the openLCA approach for regionalized LCIA. [1]

AWARE

AWARE is a regionalized water scarcity footprint (WF) method result of a two year consensus building process developed by WULCA, a working group of the UNEP SETAC Life Cycle Initiative.
AWARE is in accordance with the ISO 14046 and represents the state-of-the-art of the current water LCIA methods. [2]

CFs aggregation in openLCA

To calculate the water scarcity footprint using AWARE it is necessary to define the process location to define the Characterization factor (CF) or aggregated CF that should be used. The native CFs are based on monthly water availability and consumption, WULCA provides aggregated CFs for specific countries corresponding to a time lapse of one year.

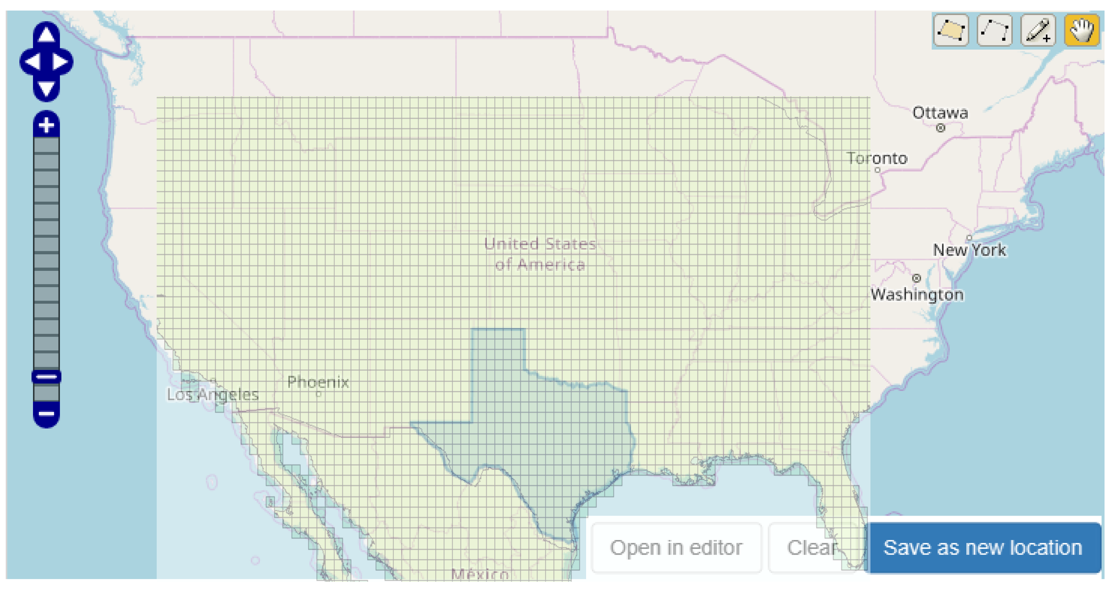

Figure 2: Example of GIS consumption raster data at native scale (0.5° x 0.5°) with the Texas state selected.

1. Native CFs

The native CFs are first calculated as the water Availability subtracting the Demand (AMD) of humans and aquatic ecosystems and is relative to the area (m3 m-2 month-1). Afterwards the AMD is normalized with the world average, thus the native CF represents the relative value in comparison with the world average water consumption. [3]

2. CFs aggregation in openLCA

If the polygon drawn for a process intersects more than one watershed the native CFs must be aggregated before calculating the WF.

$$\text{aggCF} = \frac{\sum_{i=1}^{n} CF \times c_i}{\sum_{i=1}^{n} ci} \qquad CF \times c_i = m_i \qquad aggCF = \frac{m_i/2}{c_i/2}$$

Figure 3: Consumption weighted aggregation of CFs in openLCA.

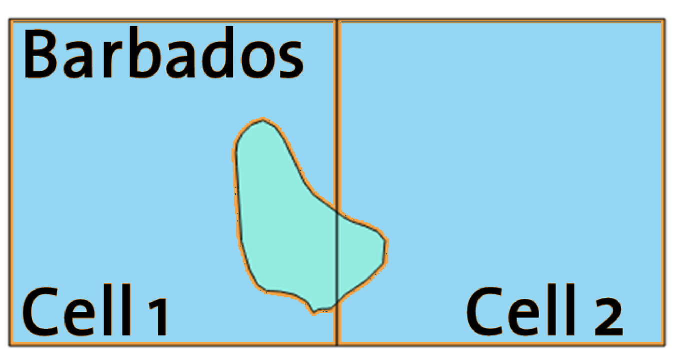

Figure 4: Example of Barbados CF aggregation. The selected polygon intersects 2 watersheds (cell 1 and cell 2) whose CFs have to be aggregated using the consumption weighted average.

Table 1: results of CF aggregation for Barbados considering irrigation, non-irrigation and unspecified water consumption.

Flow type		Watershed native CF	Consumption (ci)	Consumption share (ci/c_total)	Aggregated CF (aggCF)
Irrigation	cell 1	18.88	1350622	0.697	17.51
	cell 2	14.35	585772	0.303	
Non-irrigation	cell 1	7.67	6564496	0.915	7.6
	cell 2	6.91	610736	0.085	
Unknown (unspecified)	cell 1	9.58	7915091	0.869	9.7
	cell 2	10.55	1196508	0.131	

The country CFs obtained in openLCA and the CFs provided on WULCA website should be similar as the aggregation method is the same. However, the results do not coincide due to a systematic mistake on WULCA's calculations that were not detected during the peer reviews.

Table 2: Comparison of CFs calculated by openLCA and country CFs published by WULCA.

Country	Barbados	Switzerland	USA
WULCA CF (unspecified)	10.52	1.34	33.84
openLCA CF (unspecified)	9.71	1.58	34.46

Case Study

An organic cotton production model was used to test AWARE in a full-scale application. A functional unit of 1 kg of seed cotton was adopted and the irrigation water was regionalized. The WF was calculated for Barbados, USA, Texas (US) and New Hampshire (US).

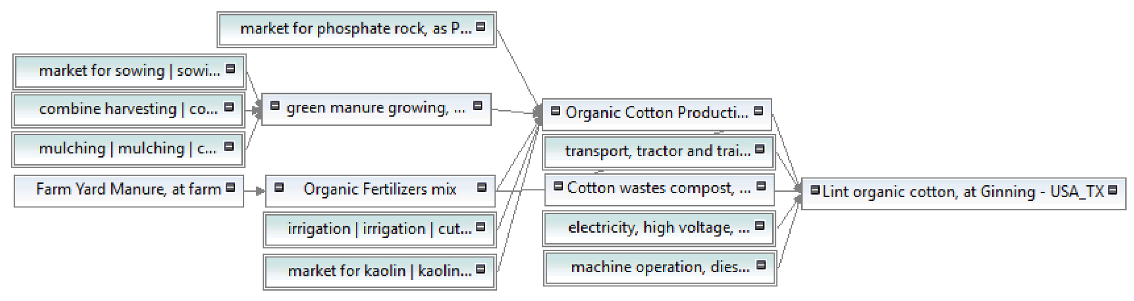

Figure 5: Graphic representation of the model in openLCA.

Table 3: Results of WF calculation for the organic cotton model, the resulting WF was calculated by multiplying the water usage from the foreground system by the aggregated CF and multiplying the water usage from the background system by standard CF values

Selected region	Inventory (irrigation)	aggCF (irrigation)	irrigation WF (m3 world eq.)	Inventory (m3)	Total WF (m3 world eq.)
BB	0.1531 m3	17.511	2.6809372	0.15342	2.747
US	0.1531 m3	35.534	5.4402539	0.15342	5.786
US-TX	0.1531 m3	27.254	4.1725139	0.15342	4.257
US-NH	0.1531 m3	0.623	0.0953813	0.15342	0.152

Conclusions

AWARE normalized WF is the result in m3 world eq. of the inventoried water times the CF, thus the case study shows that 0.1531m3 inventoried water is equivalent to consume 0.152m3 in NH-USA and 4.257m3 in TX-USA due to the different water scarcity in those regions.

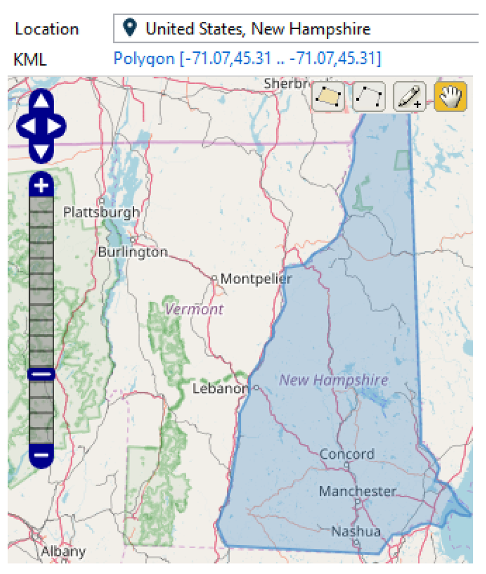

Figure 6: New Hampshire polygon used for the regionalization of irrigation water usage in openLCA KML editor.

During the implementation of AWARE a calculation mistake on the published CFs was detected. Table 2 shows small differences but sometimes the values could be up to 10m3 discrepant.
CF calculations were not verified during the peer review and a mistake was found during openLCA implementation what raises questions about the reliability of the published CFs, therefore, calculation results should also undergo a peer review to assure the reliability of results.

Literature

[1] Rodríguez, C., Greve S., (2016) Regionalized LCIA in openLCA, GreenDelta.
[2] Boulay, A.-M., J. Bare, L. Benini, M. Berger, M. J. Lathuillière, A. Manzardo, M. Margni, M. Motoshita, M. Núñez, A. V. Pastor, B. Ridoutt, T. Oki, S. Worbe and S. Pfister (2017). "The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE)." The International Journal of Life Cycle Assessment: 1-11
[3] WULCA, (2014) Description of the AWARE method, available at: http://www.wulca-waterlca.org/aware.html accessed on 30/08/2017