

OPENLCA CASE STUDY: CONVENTIONAL VS ORGANIC VITICULTURE

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This case study (and others) can also be accessed on the internet: www.openlca.org/documentation

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1 Tutorial goal

This tutorial aims at explaining a typical Life Cycle Assessment example, while using and discovering openLCA software. Please consider that this is not a real LCA. Though personal research, these figures are given as example and are not meant to be accurate.

Using a step-by-step method, this tutorial should allow you understanding how openLCA works. If you feel that some steps are missing (instructions are not clear enough), please first refer to the basic help documentation. Otherwise consider using the forum to ask your question:

www.openlca.org/openlca-forum

2 Context and objective

As you work in a local agricultural union, you accepted the mission to improve environmental impacts of the local wine-growers. One of the obvious options seems to develop organic viticulture. To do so, you need figures to convince them that they can substantially reduce their impact while producing a good wine (taste is too subjective to be considered in this case).

You surveyed conventional and organic wine growers to find out their inputs and outputs. The ecoinvent database can provide a large list of “already built” processes that fit your needs. This will help you to model both options and provide reasonable comparison. To ensure the comparison is adapted to a wine grower level, you do not consider the wine productions processes, the bottles, or the transport to customers.

3 Description

Functional Unit: 1 kg of grapes.

Time and geography: France, Bordeaux area

Model 1: “organic viticulture”:

Input:

Flow type	Category	Flow	Amount	Unit
Product	Agricultural means of production/organic fertiliser	Compost, at plant	2	kg
Product	Oil/fuel	Diesel, at regional storage	0.005	kg
Product	Agricultural means of production/organic fertiliser	Horn meal, at regional storehouse	1	kg
Element	Ressource/Land	Occupation, arable	0.00286*1	m2*a
Product	Transport systems/road	Transport, lorry 7,5-16t, EURO5	0.248	t*km

Output:

Flow type	Category	Flow	Amount	Unit
Product		Grapes (<i>reference flow</i>)	1	kg
Element	Water/ground-	Ammonium, ion	0.000067	kg
Element	Water/ground-	Nitrate	0.074	kg
Element	Water/ground-	Phosphate	0.000053	kg

Model 2: “conventional viticulture”:

Input:

Flow type	Category	Flow	Amount	Unit
Element	Ressource/Land	Occupation, arable	0.002*1	m2*a
Product	Chemicals/inorganics	Boric oxide, at plant	0.002*0,1	kg
Product	Agricultural means of production/organic fertiliser	Diammonium phosphate, as P ₂ O ₅ , at regional storehouse	0.046	kg
Product	Oil/fuels	Diesel, at regional stage	0.005	kg
Product	Agricultural means of production/pesticides	Fungicides, at regional storehouse	0.56	kg
Product	Agricultural means of production/pesticides	Herbicides, at regional storehouse	0.0526	kg
Product	Agricultural means of production/organic fertiliser	Horn meal, at regional storehouse	0.01	kg
Product	Agricultural means of production/pesticides	Insecticides, at regional storehouse	0.0008	kg
Product	Chemicals/inorganics	Magnesium oxide, at plant	0.002*38	kg
Product	Agricultural means of production/mineral fertiliser	Potassium nitrate, as K ₂ O, at regional storehouse	0.21	kg
Product	Transport systems/road	Transport, lorry 3.5-7.5t, EURO5	0.248	t*km

Output:

Flow type	Category	Flow	Amount	Unit
Product		Grapes (<i>reference flow</i>)	1	kg
Element	Water/ground-	Ammonium, ion	0.00014	kg
Element	Water/ground-	Nitrate	0.566	kg
Element	Water/ground-	Phosphate	0.00012	kg

4 Build and compare systems

4.1 Get the ecoinvent database

If you have not yet installed the ecoinvent database, you can first have some information here:

<http://www.ecoinvent.org/database/> , and also buy the license from us:

http://www.openlca.org/documentation/index.php/Contact_and_Feedback .

To install the database, simply follow these steps:

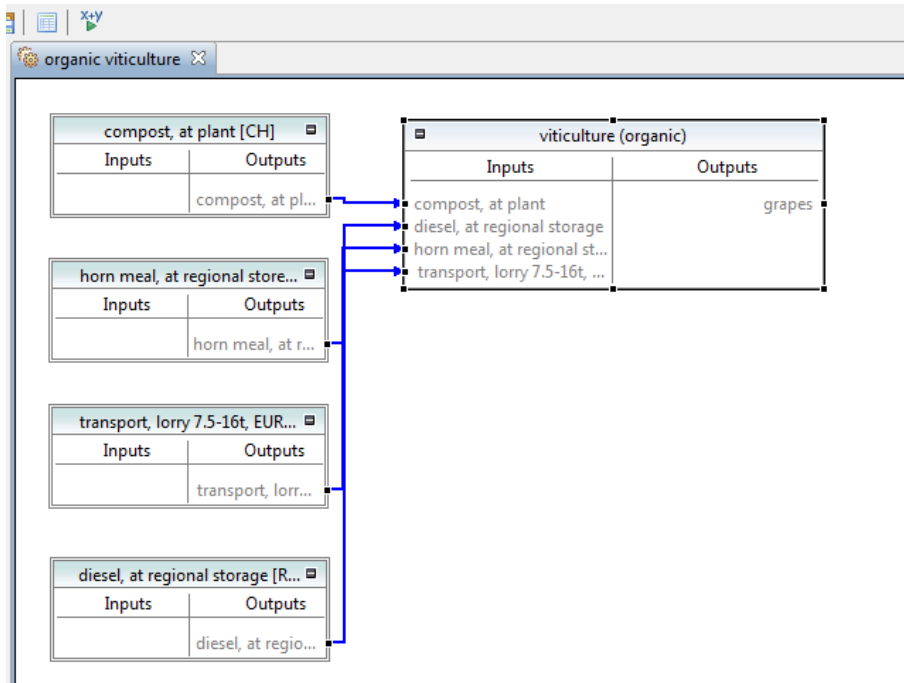
http://www.openlca.org/documentation/index.php/Getting_started#Connecting_to_a_database .

4.2 Build the organic viticulture model

- Create a new folder (add a new child category) into “Flows” called “Viticulture example”. Do the same into the “Processes”, the “Product systems” and “Projects”. This way, you can keep everything you will create altogether.
- Right click on the new folder and “Create a new flow” :
 - Name: grapes
 - Flow type: Product flow
 - Reference flow property : Mass
- Create a new process:
 - Name: viticulture (organic)
 - Quantitative reference: grapes
 - Add inputs and outputs as written above
 - Save and close
- Create a new product system:
 - Name: organic viticulture
 - Reference process: viticulture (organic)

- Ensure “Add connected processes” and “Connect with system processes if possible” (so it will connect the upstream chain) are checked
- Click Finish

■ Connections should look like this:



■ To access the impact assessment:

- Click on the “x+y” button
- Select the LCIA method “CML 2001”
- Click calculate
- You can now have a look at the full impact assessment data of this model.

4.3 Build the conventional viticulture model

■ Create a new process:

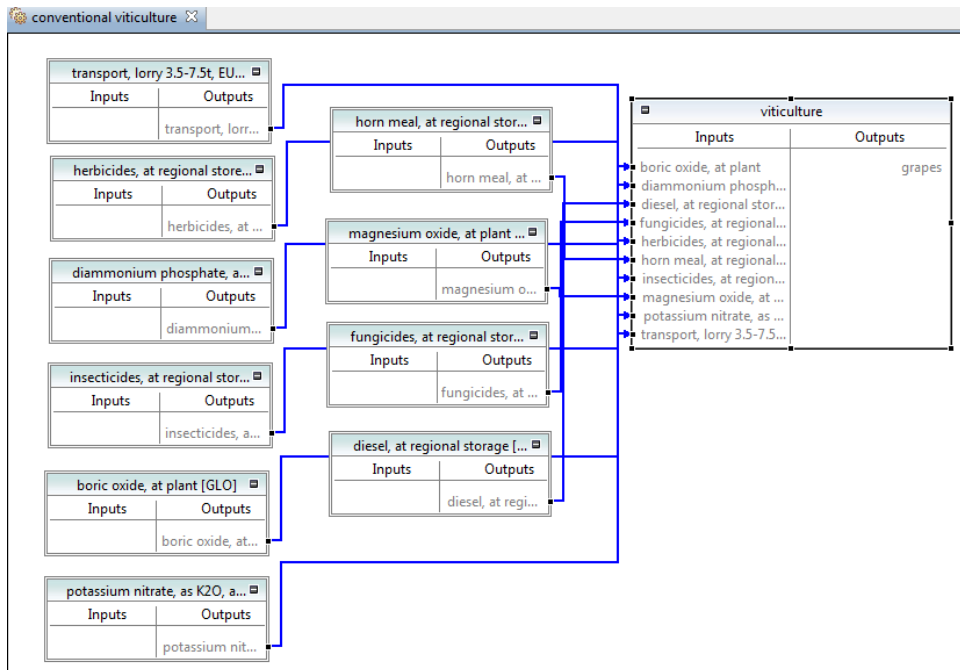
- Click on the “x+y” button
- Name: viticulture (conventional)
- Quantitative reference: grapes
- Add inputs and outputs as written above
- Save and close

■ Create a new product system:

- Name: conventional viticulture
- Reference process: viticulture (conventional)

- Ensure “Add connected processes” and “Connect with system processes if possible” (so it will connect the upstream chain) are checked
- Click Finish

■ Connections should look like this:

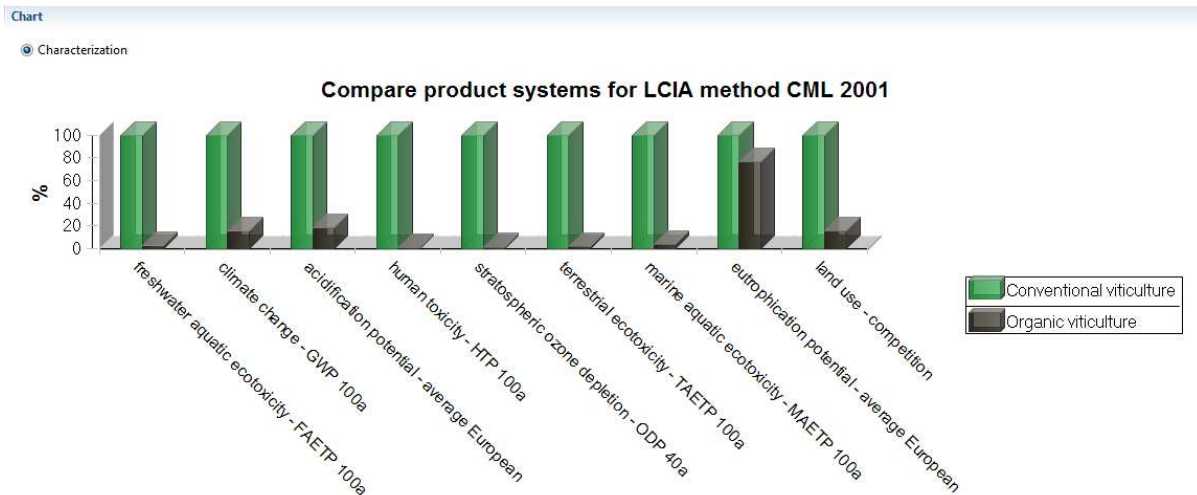


■ Create the impact assessment with the LCIA method “CML 2001” (cf above)

4.4 Compare results

- Create a new project called: Conventional vs Organic viticulture. Add the 2 product systems.
- In the comparison tab, select the “CML 2001” LCIA method, and draw a chart with 9 main categories:
 - Acidification potential – average European
 - climate change – GWP 100a
 - eutrophication potential – average European
 - freshwater aquatic ecotoxicity – FAETP 100a
 - human toxicity – HTP 100a
 - land use – competition
 - marine aquatic ecotoxicity – MAETP 100a
 - stratospheric ozone depletion – ODP 40a
 - terrestrial ecotoxicity – TAETP 100a

■ The result should be like this:



- Another way to compare data is to export both impact assessments to Excel. To do so, once you have calculated the impact assessment, a new icon in the menu shows: “Export to MS-Excel file”. Click and save both files. You can now manage the raw data as you want and produce new charts and further calculations.

5 Improvements to the model

Your meeting with your fellow wine growers went well as some decided to change to organic viticulture (even if some want to continue their way). Also, some agreed they could easily do some efforts to produce grapes with more environmental awareness.

- To have the best improvement with the less effort, you need first to find out which processes contribute the most to the impact categories. Use the “Analysis tool” of the conventional viticulture system and define the 2 main pollutants.
- Hint: there are fungicide and herbicide...

After another meeting, during which you explained where the main problems are coming from, you all agreed on what should be the new inputs and outputs. Obviously, you want to know “how much” better it will be.

Here are the new amounts:

Input:

Flow type	Category	Flow	Amount	Unit
Element	Ressource/Land	Occupation, arable	<i>ground</i> (=0.0023)	m2*a
Product	Chemicals/inorganics	Boric oxide, at plant	ground*0,09	kg
Product	Agricultural means of pro-	Diammonium phosphate, as	0.046*0.9	kg

	duction/organic fertiliser	P ₂ O ₅ , at regional storehouse		
Product	Oil/fuels	Diesel, at regional stage	0.005	kg
Product	Agricultural means of production/pesticides	Fungicides, at regional storehouse	0.56*0.7	kg
Product	Agricultural means of production/pesticides	Herbicides, at regional storehouse	0.0526*0.7	kg
Product	Agricultural means of production/organic fertiliser	Horn meal, at regional storehouse	0.1	kg
Product	Agricultural means of production/pesticides	Insecticides, at regional storehouse	0.0008*0.9	kg
Product	Chemicals/inorganics	Magnesium oxide, at plant	ground*32	kg
Product	Agricultural means of production/mineral fertiliser	Potassium nitrate, as K ₂ O, at regional storehouse	0.18	kg
Product	Transport systems/road	Transport, lorry 3.5-7.5t, EURO ₅	0.248	t*km
Product	Agricultural means of production/organic fertiliser	Compost, at plant	0.5	kg

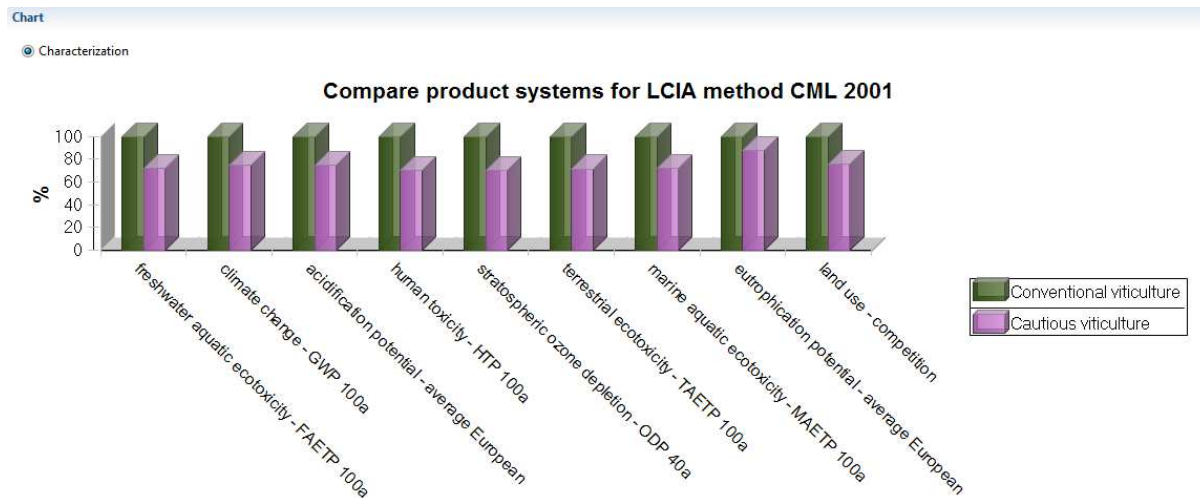
Output:

Flow type	Category	Flow	Amount	Unit
Product		Grapes (<i>reference flow</i>)	1	kg
Element	Water/ground-	Ammonium, ion	0.00014*0,7	kg
Element	Water/ground-	Nitrate	0.566*0.7	kg
Element	Water/ground-	Phosphate	0.00012*0.7	kg

To do so, follow the next steps:

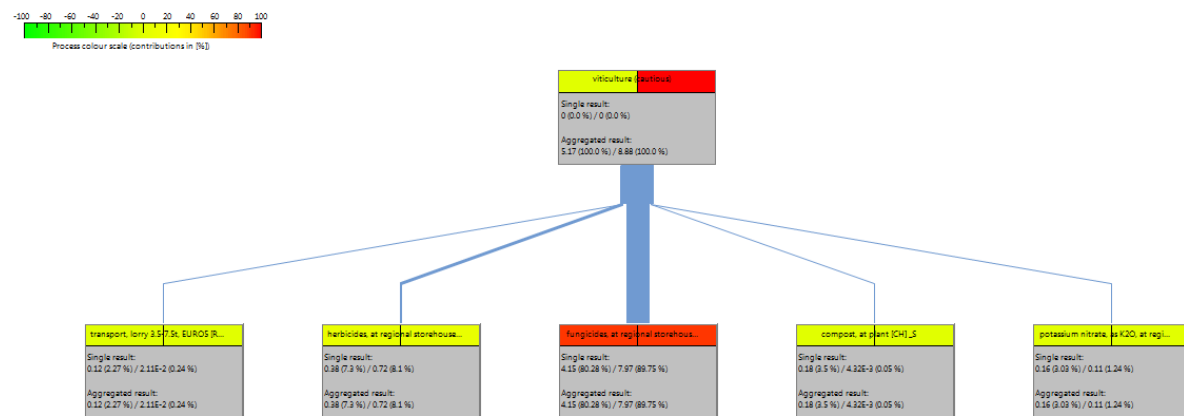
- Copy and paste the “viticulture (conventional)” process, open it and rename it to “viticulture (cautious)” (On the navigation panel, the old name remains though the change is applied. To avoid this, restart openLCA).
- Set up the parameter **ground** with its value and change all other values. To ensure your calculations are OK, you can click on the “switch view mode” button.

- Create a new product system “Cautious viticulture” and a new project with the 2 viticulture options. The result should be like this:



- A Sankey diagram can help to find the source of an impact. For the cautious viticulture, you can display the origins of 2 impact categories: “climate change - GWP 100a” and “human toxicity - HTP 100a”. This shows clearly that fungicides are still mainly responsible for environmental and human consequences.

Product system: Cautious viticulture
 First layer (line width): LCIA category: climate change - GWP 100a
 Second layer (box colour): LCIA category: human toxicity - HTP 100a
 Cut off for first layer (in %): 2



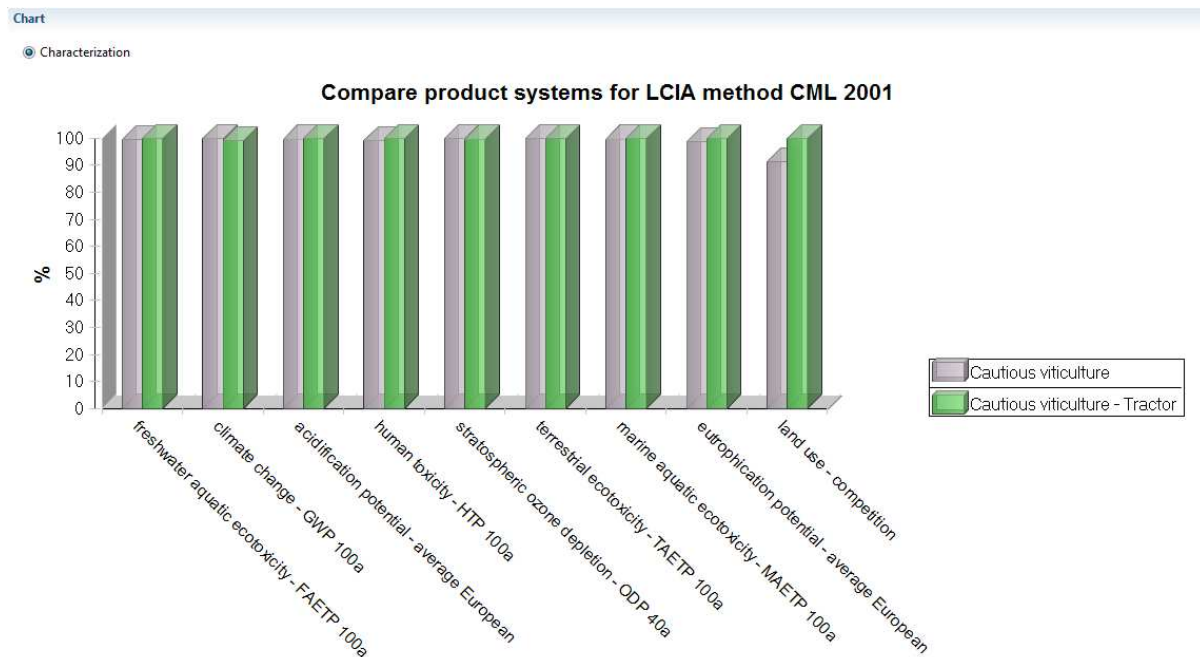
6 Sensitivity analysis

A sensitivity analysis help ensuring a variation of data does not impact too much the final result. In our study, we can point out two hot spots: the tractor transport needed in the farm and the impact assessment method.

6.1 Is a mode of transport important?

- Until now, we used a lorry transport process to model the use of a tractor within a farm.

- To study the impact of another choice for transport, you need to copy and paste the “Viticulture (cautious)”. Rename it to “Viticulture (cautious) – tractor”.
- Delete the lorry input, add “transport, tractor and trailer” and consider the same amount (=0.001*248).
- Create a new product system and project to compare both options.
- It seems that the choice of a mode of transport does not have much impact on the final result for this case (probably because it comes mainly from the fungicide).



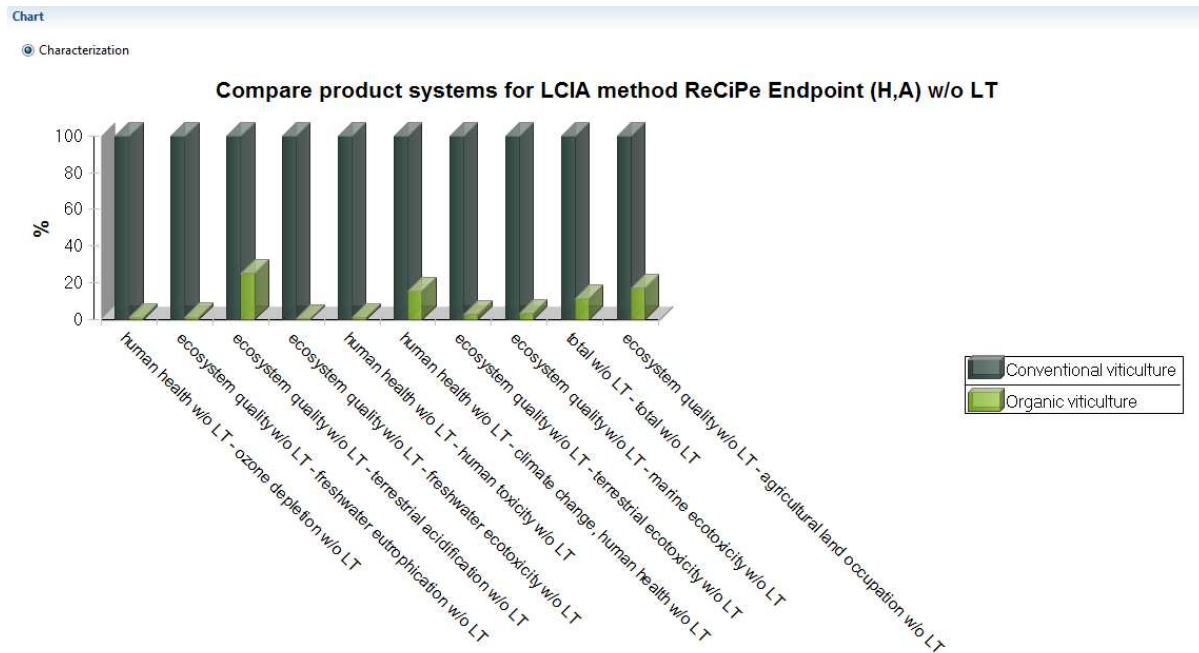
6.2 Is an impact assessment method important?

The current “Life Cycle Impact Assessment” method calculates impacts at mid-point categories. Switching for an end-point assessment method can bring different results and help analysis.

- Assess the project “conventional vs Organic viticulture” with the method “ReCiPe Endpoint (H,A) w/o LT”.
- Select categories that are close to the previous analysis:
 - Human health w/o LT – ozone depletion w/o LT
 - Ecosystem quality w/o LT – freshwater eutrophication w/o LT
 - Ecosystem quality w/o LT – terrestrial acidification w/o LT
 - Ecosystem quality w/o LT – freshwater ecotoxicity w/o LT
 - Human health w/o LT – human toxicity w/o LT
 - Human health w/o LT – climate change, human health w/o LT

- Ecosystem quality w/o LT – terrestrial ecotoxicity w/o LT
- Ecosystem quality w/o LT – marine ecotoxicity w/o LT
- Total w/o LT – total w/o LT
- Ecosystem quality w/o LT – agricultural land occupation w/o LT

■ The resulting diagram can be compared to the previous result:



In this case, we can see that results are different as units are not the same as in the CML2001 method (here is only “points”). Also for each category, the proportion between the two options result is different from the previous chart. Anyway, conventional viticulture still impacts more.

7 Conclusions

It seems obvious that some environmental improvements can be achieved using fewer pesticides (fungicide, insecticide and herbicide). Hopefully, each of your fellow wine-grower can therefore easily (know what to do to) improve his own impact.

Altogether, great improvements can be achieved at a local level (which can also be modelled in openLCA). If you need to monitor your whole project with your indicators, you can use openLCA. Regular surveys should help you to adjust inputs and outputs of your model, to export indicators and display improvement. Once again, data used in this case study might not be accurate. openLCA allows self adjustment of already-built processes; the best way seems to copy and paste a process (or a flow or a unit), to rename it and modify it.