



Scuola Superiore
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Assessing the environmental benefits of circular economy through Life Cycle Assessment (LCA)

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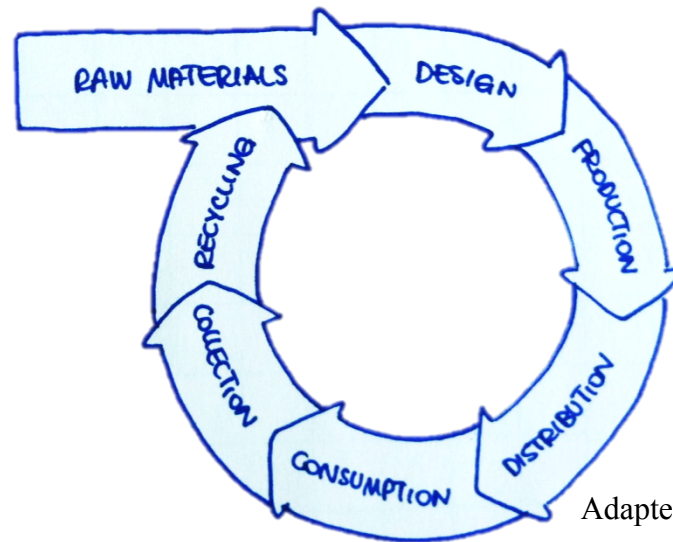
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Circular economy

- Resource abundance led developed economies to a linear model:



- Environmental policy makers are aiming at a perfect circle:



Adapted from: COM 2014/398/EC

Objective of the study

Life Cycle Assessment (LCA) and circular economy are two strictly linked topics.

Many studies used LCA to highlight the benefits of circular economy even if the way on how to use LCA in these fields is still under discussion.

The originality of this study is the use LCA **to assess the environmental benefits of circular economy at the territorial level**, by using as case study a tannery industrial cluster of SMEs

LCA a tool to assess the impact through the entire life cycle of a product

LCA: A systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle (ISO14040)



The relevance tannery industrial clusters

Industrial cluster could be defined as “a group of firms, related economic actors, and institutions that are located near each other and have reached a sufficient scale to develop specialised expertise, services, resources, suppliers and skills” (COM(2008) 652)

Example:
diffusion of
leather
products
Regional
Clusters

Source: <http://www.clusterobservatory.eu>

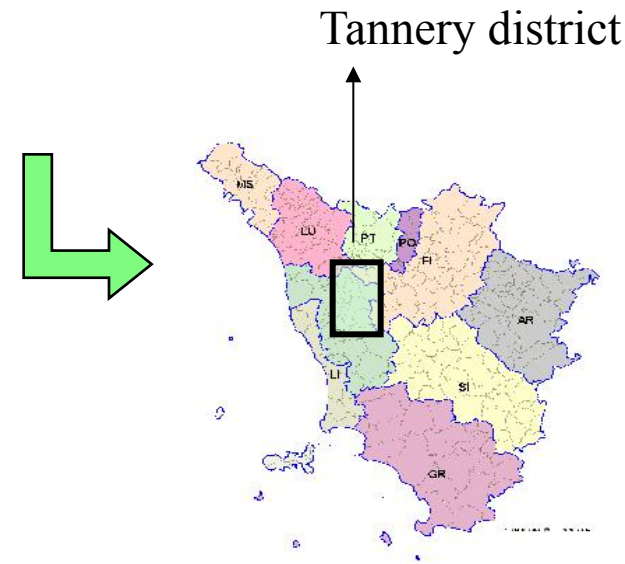


Case study: the tannery cluster of S.Croce sull'Arno

Italy provides **66% of EU production** tanned leather, it is the most important location in EU

S.Croce is the biggest tannery cluster in Italy providing **35%** of the Italian production of **tanned leather** and **98%** of the Italian production of **sole leather**.

- Location: Tuscany Region (prov. Pisa)
- Territorial area: 4 municipalities, 240km²
- Employment: 800 firms, 10.000 employees
- Size: 90% of enterprises have less than 9 employees



Tannery cluster of S.Croce: the challenges of sustainability

- the tanning process has always been associated with odours and other important impacts on air, surface and ground water and solid waste (*environmental challenges*);
- in the last years eco-innovation is perceived as a driver for competitiveness, especially to face up to competitors operating in third countries, as India and Pakistan (*economic challenges*);
- in the territorial area of S.Croce sull'Arno, local communities have showed over time a high awareness and sensitiveness on environmental issues (*social challenges*);





Tannery cluster of S.Croce: circular economy initiatives

In the tannery cluster of S.Croce sull'Arno there is a large presence of circular economy initiatives:

1. *Aquarno wastewater treatment plant* receives about 3.600.000 m³ of industrial water emissions per year, with a pipeline send 100.000 tons of *sludge* per year to *Ecoespanso plant* that recover the sludge for *construction sector*;
2. *Cuoiodepur wastewater treatment plant* receives about 1.700.000 m³ of industrial water emissions per year and it recovers its sludge as fertilizers
3. *Chromium recovery plant*: plant located in the industrial cluster receives yearly until 70.000 tons of exhaust chromium from the tanneries and regenerate them to re-use in the cluster;
4. *Shavings and flashings waste recovery plant*: it receives from the tanneries about 80.000 tons per year of waste shavings and flashings to be reused out of the cluster;



Research questions

RQ1: Which kind of environmental benefits are producing these initiatives grounded on the circular economy principles?

RQ2: Can these benefits be quantified with a LCA?



The framework of the study: PREFER project



Product environmental footprint Enhanced by Regions

PREFER - *PR*oduct *E*nvironmental *F*ootprint *E*nhanched by *R*egions.

The project is aimed to test a new european methodology to assess the environmental footprint of products and services. "*PEF – Product Environmental Footprint*" is a Life Cycle Assessment (LCA) based methodology approved by European Commission and will be tested to assess the environmental impacts of 8 products selected in 8 clusters.





Method

1

- Calculate an **average LCA** of a representative m2 of finished leather of the industrial cluster in the current situation with large presence of “circular economy initiatives” (SCENARIO 1)

2

- Identify the **LCA impact categories** values of SCENARIO 1

3

- Suppose a **second scenario** (SCENARIO 2) where the circular economy initiatives are less developed or not present

4

- Identify average **LCA impact categories values of scenario 2**

5

- **Compare the difference** between LCA results of **scenario 1 and scenario 2**



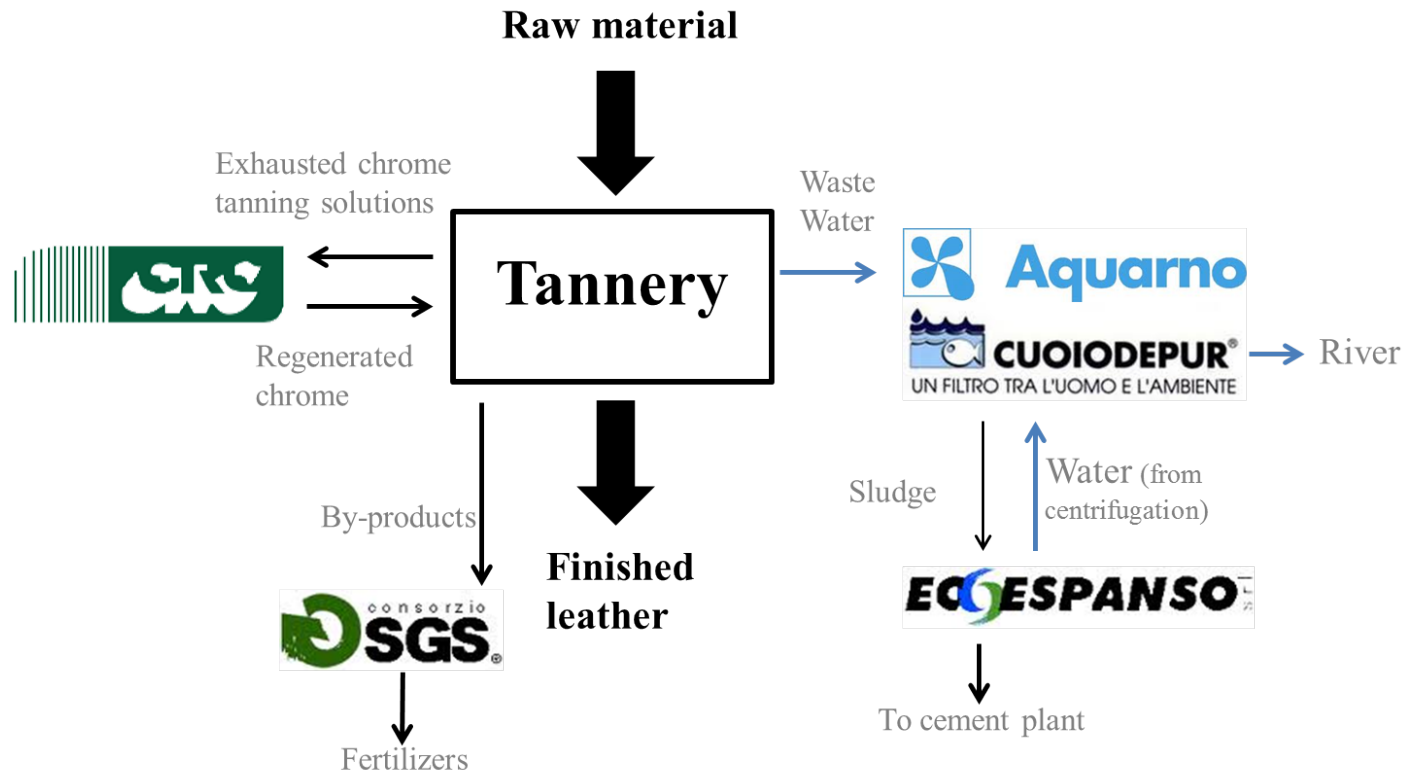
Average LCA: successful examples

- **Apples** from Trentino Alto Adige – Assomela
- **Kiwi fruits** from Greece – Export company that represents 99 producers
- **Bitumen Roof waterproofing system** – Bitumen Waterproofing association
- **Extra-virgin olive oil** – Assoproli Bari
- **Extra-virgin olive oil** from Greece – 3 farmers organizations
- **Steel for the reinforcement of concrete** – weldable reinforcing steel – PCR developed by SISMIC (5 EPDs)

Source: *www.environdec.com*

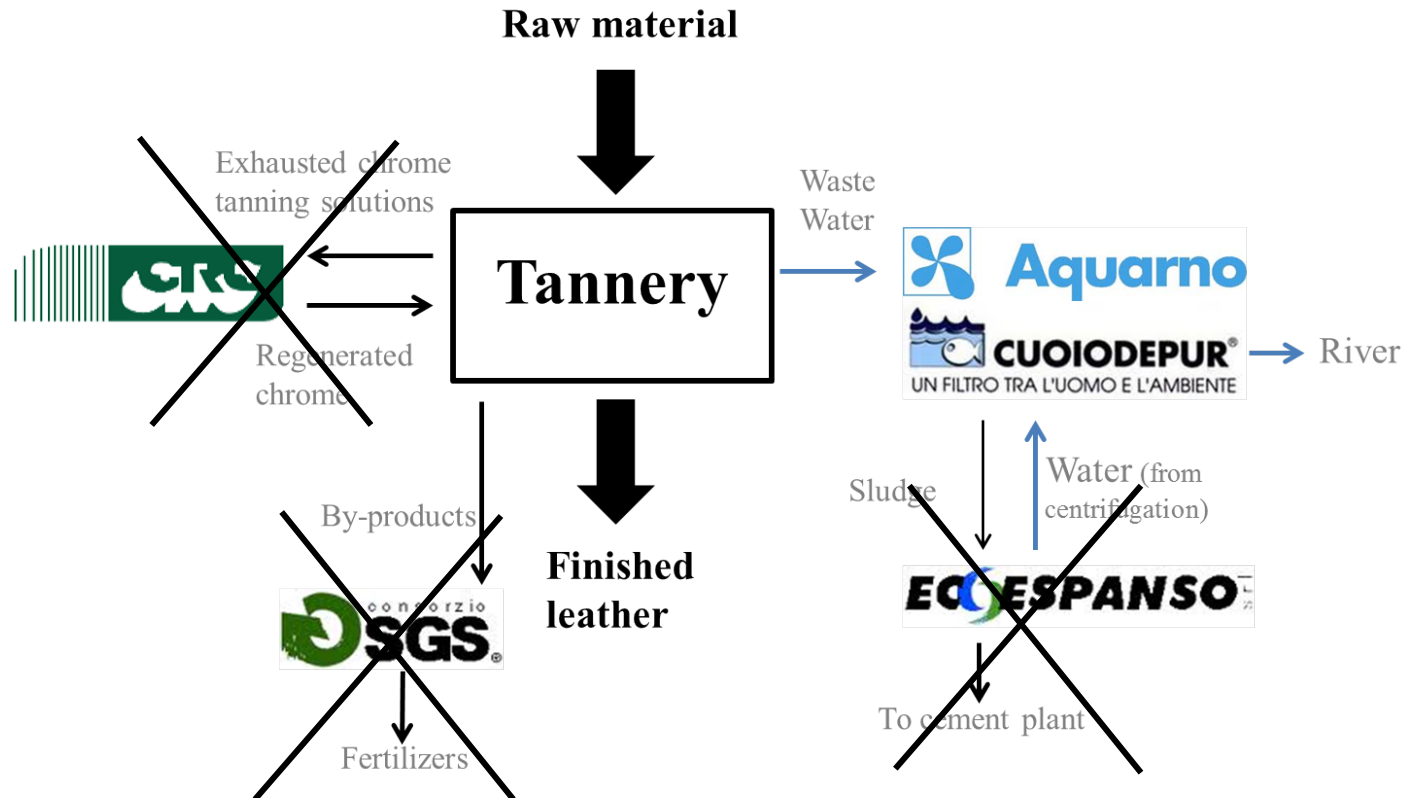
Method: graphical representation

Sectoral LCA of the current scenario (SCENARIO 1)



Method graphical representation

Sectoral LCA of SCENARIO 2 (identified according to the features of other Italian tannery clusters)





Methodological aspects

- ISO 14040 – 44, PCR: «Finished bovine leather»
- Functional unit: 1 m² of finished leather for chrome and vegetable tanned leather
- System boundaries: from cradle to gate
- Method: PEF (Product Environmental Footprint), UE Recommendation 179/2013
- Data collected referred to the years 2012-2013



Sample description

22 tanneries representing 6.300.104 m² of finished leather

(14% of the total cluster production and around 5% of Italian production)



Results

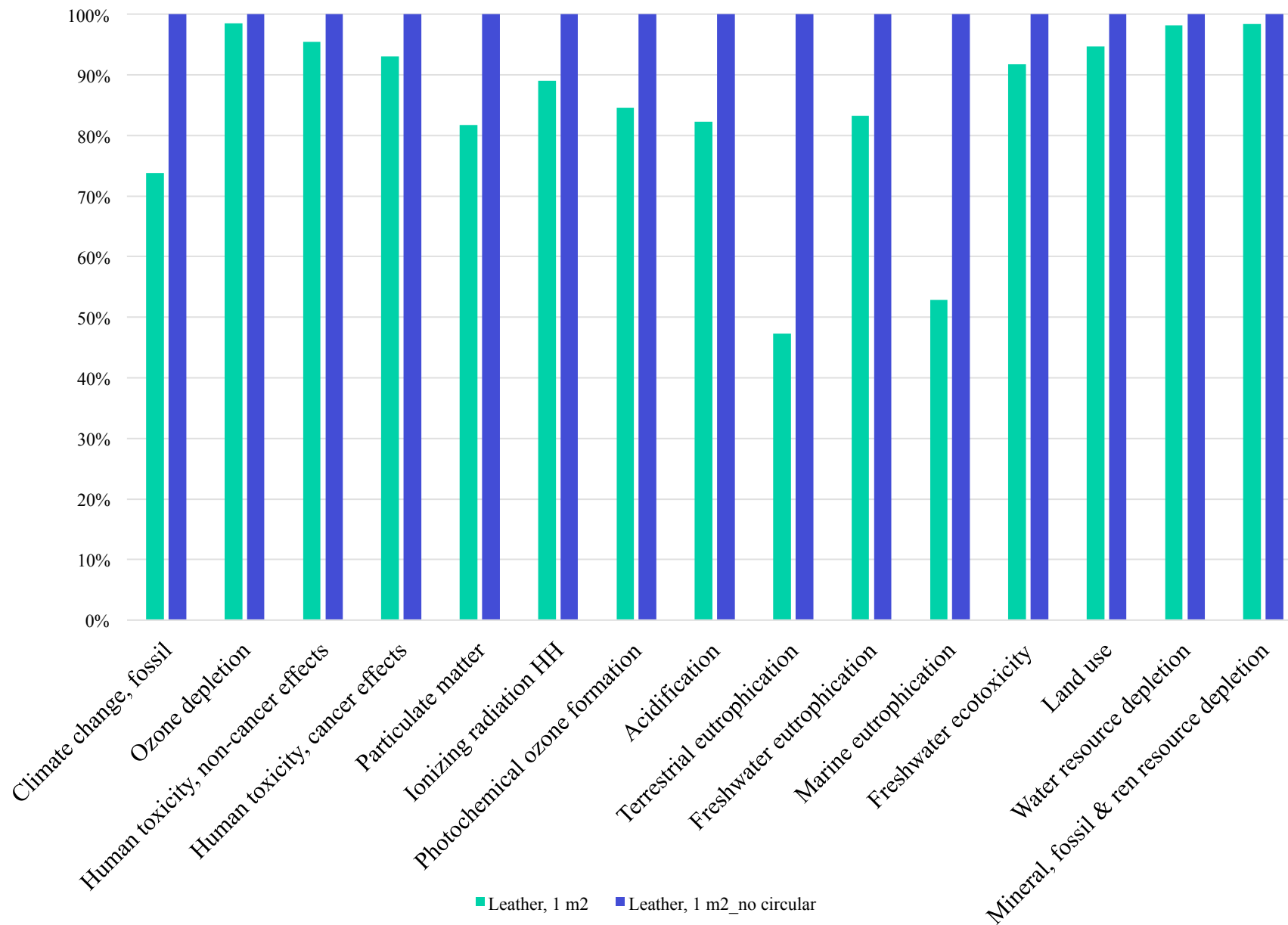


Results of average LCAs

Impact category	Unit	1 m2 of finished leather		Difference
		SCENARIO 1 <i>(with circ economy)</i>	SCENARIO 2 <i>(no circular economy)</i>	
Climate change	kg CO2 eq	12,120	16,419	-26%
Ozone depletion	kg CFC-11 eq	9,19E-06	9,321E-06	-1%
Particulate matter	kg PM2.5 eq	0,00967	0,0118	-18%
Photochemical ozone formation	kg NMVOC eq	0,0537	0,0636	-15%
Acidification	molc H+ eq	0,1164	0,1416	-18%
Terrestrial eutrophication	molc N eq	0,0780	0,1651	-53%
Freshwater eutrophication	kg P eq	0,001109	0,001333	-17%
Marine eutrophication	kg N eq	317,92	601,265	-47%



Results of average LCAs





Conclusions

Findings

- ✓ the study confirm that the average LCA can be considered a good tool to assess circular economy benefits at the territorial level;
- ✓ while some LCA impact categories has been strongly improved by the circular economy initiatives implemented in the cluster, others are less influenced;
- ✓ the method could support the policies of local policy makers that could aim to plan the territorial environmental improvement following a LCA perspective;



Conclusions

APPLICATIONS AND IMPLEMENTATION

Enhancing the Adoption of Life Cycle Assessment by Small and Medium Enterprises Grouped in an Industrial Cluster

A Case Study of the Tanning Cluster in Tuscany (Italy)

Tiberio Daddi, Benedetta Nucci, Fabio Iraldo, and Francesco Testa

Keywords:

industrial cluster
industrial ecology
life cycle assessment (LCA)
small and medium enterprises (SMEs)
tannery sector

Summary

Greenhouse gas emissions from small and medium enterprises (SMEs) account for 70% of the industrial pollution in the European Union. Owing to limited economic and human resources, only a few SMEs start procedures to evaluate the environmental impact of processes and products through life cycle assessment (LCA). In this work, a cluster life cycle assessment (Cluster-LCA) is proposed as an instrument for the diffusion and realization of LCA analysis in clustered SMEs. This methodology is illustrated with a case study in the tanning cluster in Tuscany. The different characteristics of the methodology are analyzed by identifying the intrinsic strengths, weaknesses, opportunities, and threats. The application of this methodology in a particular cluster is then discussed in order to gather some helpful insight for the application of this methodology in different clusters.





Thank you!

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