

Comparative LCA for natural vs. glass fibre as reinforcement for composites

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Context

- Nilmini is in month nine of her PhD
- she is from Sri Lanka
- the waiting list for visas to enter Spain was longer than the gap between acceptance of this paper and today!

Overview

- Introduction
- Fibre Production: Natural & Glass
- LCA
- Environmental impact classification factors
- Results
- Discussion
- Conclusion
- Questions?

Introduction

- natural fibres perceived to be more environmentally friendly than synthetic fibres
- long-term aim is to gather quantitative data to confirm or refute that perception
- flax is (a) temperate zone plant and (b) more resource intensive than hemp, so this is the system we propose to study.

Natural Fibres - agriculture

- ploughing
- drilling
- fertiliser
- weed & pest control
- desiccation
- harvest



Flax Field, Providence by Hazel Barker

From http://www.art.com/asp/sp-asp/_/pd-10125356/Flax_Field_Providence.htm

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Natural Fibres - processing

- rippling
- retting
- decortication
- hackling
- carding
- spinning
- weaving

Glass Fibre Production

- raw material processing
- melting
- spinning
- forming
- curing & cooling
- weaving

Life Cycle Assessment

- The goal & scope definition
- Life Cycle Inventory analysis (LCI)
- Life Cycle Impact Assessment (LCIA)
- Life Cycle Interpretation

Environmental Impact Classification Factors:

ISO/TR 14047:2003(E)	Azapagic et al
Acidification	Acidification Potential (AP)
Ecotoxicity	Aquatic Toxicity Potential (ATP)
Eutrophication / Nitrification	Eutrophication Potential (EP)
Climate Change	Global Warming Potential (GWP)
Human Toxicity	Human Toxicity Potential (HTP)
Depletion of abiotic /biotic resources	Non-Renewable / Abiotic Resource Depletion (NRADP)
Stratospheric ozone depletion	Ozone Depletion Potential (ODP)
Photo-oxidant formation	Photochemical Oxidants Creation Potential (POCP)

Acidification of surface water and soil :

- nitrogen leaching from fertiliser

Eco/Human toxicity

- **plant fibre**
 - fertiliser (N, P, K), herbicides, insecticides, fungicides
- **glass fibre**
 - aluminosilicate dust

Eutrophication/Nitrification

- phosphorus/nitrogen leaching from fertiliser
- retting flax and hemp
 - e.g.: Dallund Sø (lake in Denmark)

Climate Change/Global Warming

- energy used for **glass** fibre
 - melting and spinning
- energy used for **natural** fibre production
 - power for agricultural equipment
 - production/application of fertiliser/pesticides
 - release of CO₂ from decomposition and oxidation of soil organic carbon (SOC)

Depletion of resources

- quartz and feldspar used in glass manufacturing process
- feldspar used in fertiliser production
- loss of soil fertility and reduction in soil pH through long term conventional tillage



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Ozone Depletion / Photo-oxidant formation

No significant issues identified
at this stage of the study.

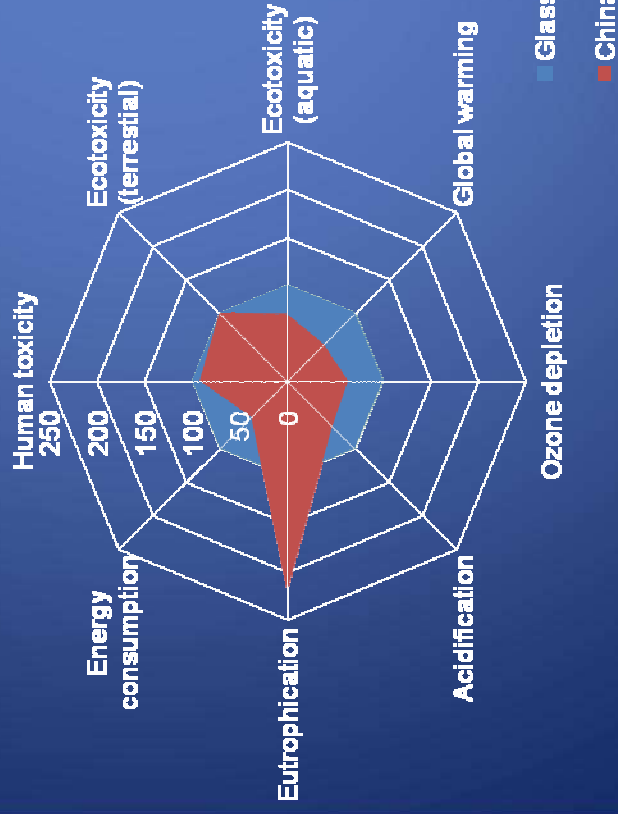


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Previous study/model output

- Corbière-Nicollier on China Reed vs Glass



Results

Environmental Impact for Flax fibre:

Environmental Impact Classification Factor	Land clearance	Ploughing	Sowing	Water	Herbicides	Pesticides	Fertiliser	Dessication	Harvest	Rippling	Retting	Decoritication	Hacking	Carding	Spinning
Acidification Potential (AP)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Aquatic Toxicity Potential (ATP)	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green	Green
Eutrophication Potential (EP)	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green	Green
Global Warming Potential (GWP)	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green	Green
Human Toxicity Potential (HTP)	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green	Green
Non-Renewable/Abiotic Resource Depletion (NRADP)	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green	Green
Ozone Depletion Potential (ODP)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Photochemical Oxidants Creation Potential (POCP)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Noise and Vibration	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Odour	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green
Loss of biodiversity	Yellow	Yellow	Yellow	Green	Red	Red	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green
Very High Effect	Red														
Low Effect	Yellow														
No Effect	Green														

Environmental Impact for Glass fibre:

Environmental Impact Classification Factor	Raw material handling	Raw material storage	Crushing	Weighing	Mixing	Melting	Refining	Forming	Sizing	Binding	Spinning	Oven Drying	Oven Curing	Fabrication	Packaging
Acidification Potential (AP)															
Aquatic Toxicity Potential (ATP)															
Eutrophication Potential (EP)															
Global Warming Potential (GWP)															
Human Toxicity Potential (HTP)															
Non-Renewable/Abiotic Resource Depletion (NRADP)															
Ozone Depletion Potential (ODP)															
Photochemical Oxidants Creation Potential (POCP)															
Noise and Vibration															
Odour															
Loss of biodiversity															
Fugitive Dust															
KEY															
Very High Effect															
Low Effect															
No Effect															

Discussion

- Key issues (**red** in preceding Figures)
 - flax fibre production:
 - eutrophication, eco/human toxicity, global warming, abiotic resource depletion
 - glass fibre production:
 - global warming, human toxicity

Conclusion

- main environmental issues are identified
- need to determine variation between worst and best practice in each case
- need to acquire more comprehensive data
 - clues welcome !

Any questions



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