LIFE CYCLE ASSESSMENT (LCA) OF AN INDOOR PILOT AQUAPONICS PRODUCTION FACILITY IN BELGIUM

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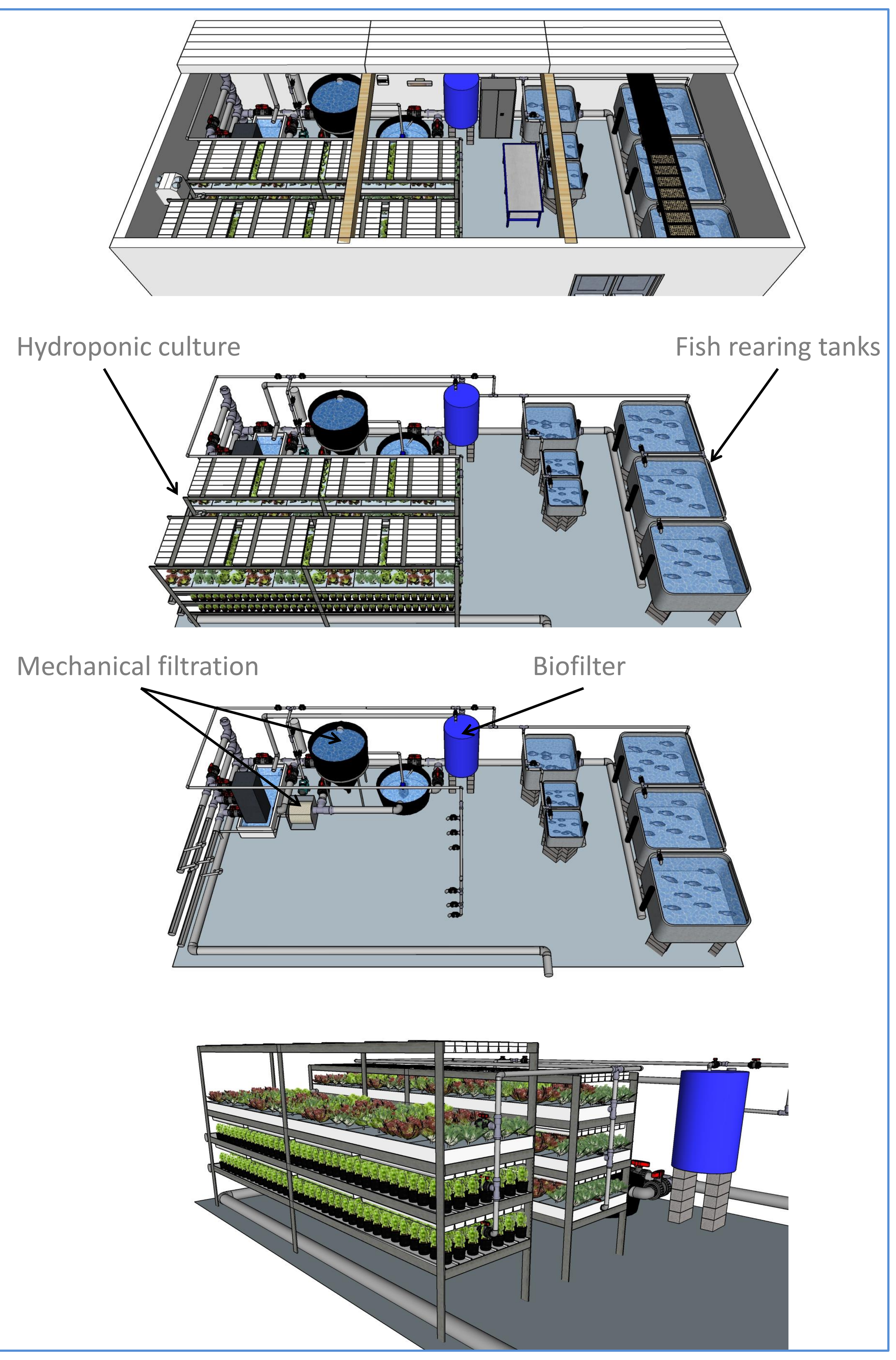
Introduction

Even though aquaponics arouses a growing interest as a sustainable way to produce fish and vegetables, the environmental burdens of such systems are not yet deeply investigated. Life Cycle Assessment (LCA) is a powerful tool to assess environmental sustainability of a production, since it provides a comprehensive quantification of direct and indirect environmental impacts (Forchino *et al.*, 2017). LCA was run on the design data of an aquaponic pilot system that will be built in the framework of the project "Développement d'un pilote d'aquaculture intégrée associé à un circuit court de distribution (AquaLocI)" (SPW-DGO3 – EMFF project 47-1604-001).
The analysis was used to underline critical issues and identify possible technical solutions to reduce the environmental impact of this aquaponic facility.

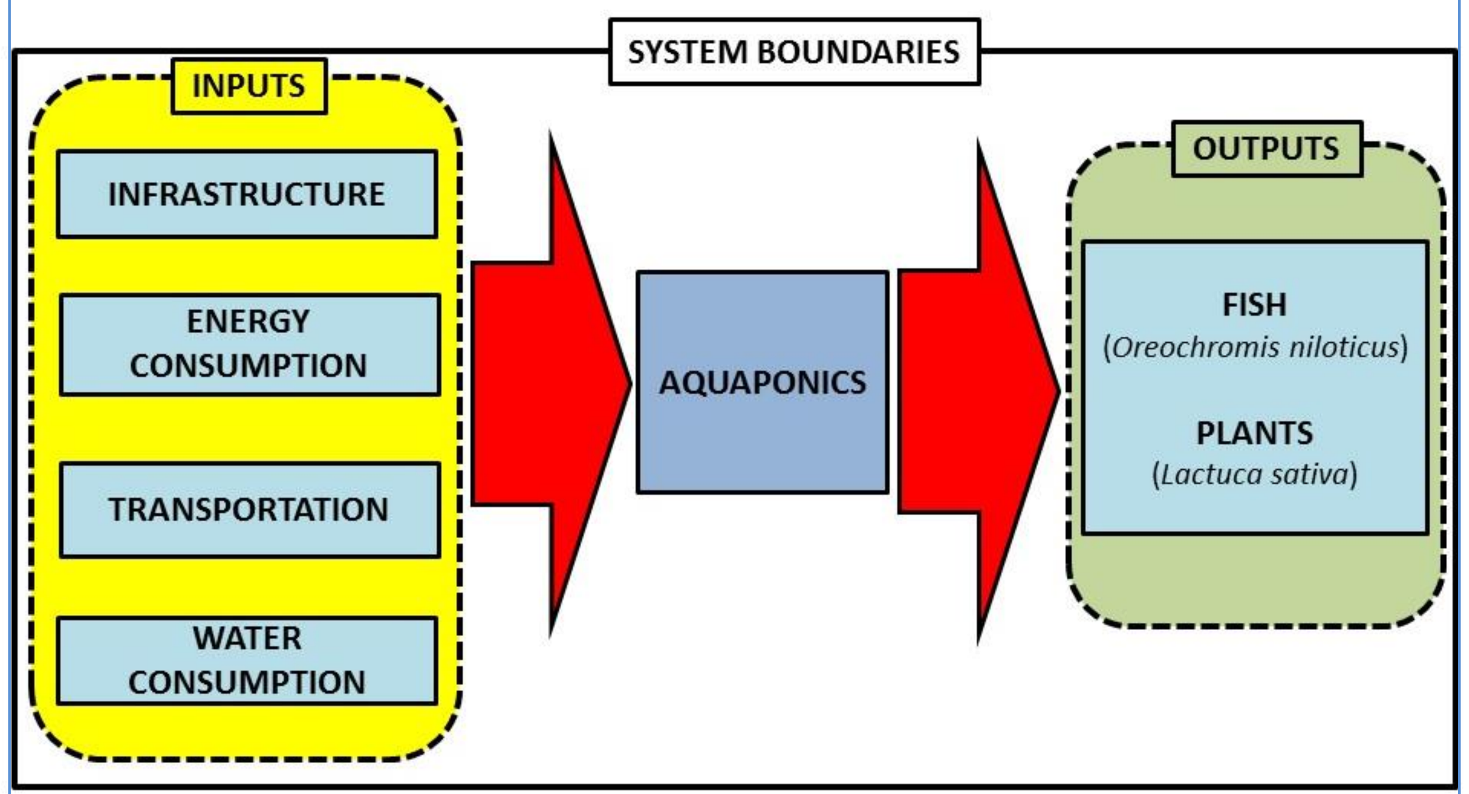
System description

TECHNICAL FEATURES		
Building	Material	Aerated concrete
	Dimensions	14.6 x 7.1 x 3.5 m
Recirculating Aquaculture System	Fish tanks	GRP, total volume 6.4 m³
	Sump tank	GRP, 1 m³
	Drum filter	30 m³/h, 250 W
	Backwash pump	1.1 kW
	Moving bed biofilter	2 m³
	Circulation pump	1.1 kW
	Air blower	1.5 kW
	UV sterilizer	120 W
	Electrical heating	9 kW
Hydroponic Deep Water Culture	Grow beds	Wood and liner, total surface 50 m²
	Lighting	LED, 6 kW

SYSTEM SET UP	
Fish expected production	Tilapia (*Oreochromis niloticus*), 1 t/y
Plant expected production	Lettuce (*Lactuca sativa*), 6 t/y
Total volume	24.4 m³
Daily refilling water	1 % total volume

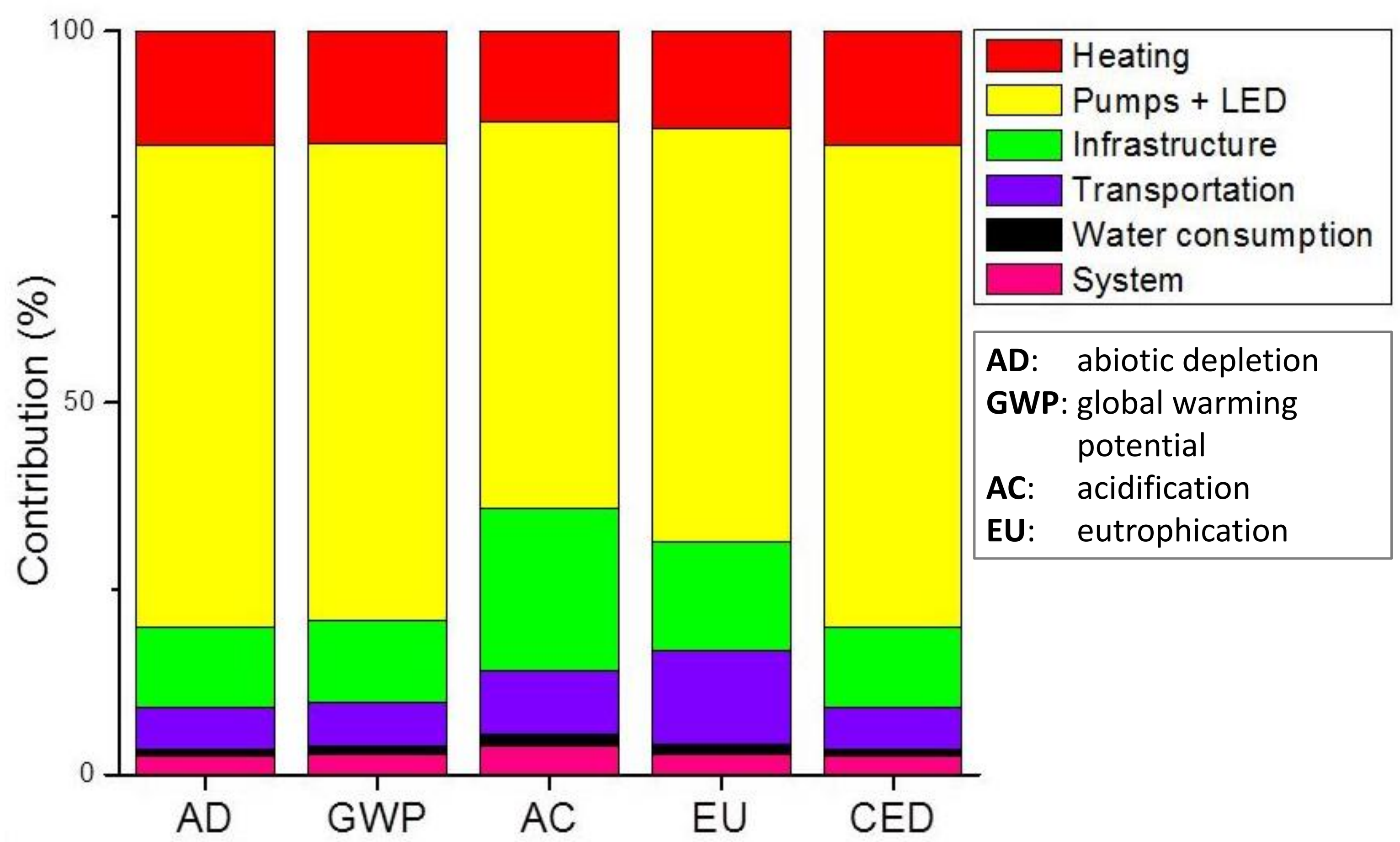


Life Cycle Assessment



LIFE CYCLE ASSESSMENT	
Functional unit	1 kg of lettuce, tilapia considered as a co-product
Input data macro-categories	• Heating: energy consumption for air and water heating • Pumps + LED: energy consumption • Infrastructure: construction materials used for the building • Transportation: standard range of 50 km set for material providing • Water use: annual water consumption of the system • System: physical equipment
Methods and impact categories	CML-IA baseline V3.01/World 2000 • **AD: abiotic depletion** (MJ) • **GWP: global warming potential** (kg CO_2 eq) • **AC: acidification** (kg of SO_2 eq) • **EU: eutrophication** (kg of PO_4^{-}eq) Cumulative Energy Demand V1.08 • **CED: cumulative energy demand** (MJ)
Software	SimaPro® version 8.0.3.14 (Prè, 2014)

Results



The LCA analysis revealed 3 main macro-categories regarding their environmental impact: "Pumps + LED", "Heating" and "Infrastructure". In particular, the energy consumption needed for heating and RAS + LED functioning represents from 64% (acidification) up to the 80% (abiotic depletion) of the total impact contribution. "Infrastructure" showed the highest contribution for acidification (21.9%) and eutrophication (14.8%) impact categories. Contributions of the other macro-categories are less relevant, except for "Transportation".

Discussion

The present analysis underlined that **energy consumption** and **infrastructure** represent the most important sources of impacts of the aquaponics facility. Moreover, these macro-categories are linked each other. In fact, the energy consumption due to the heating activities could be reduced by increasing the insulation performance of the building. On the other hand, this increment will increase the contribution to the infrastructure impacts. Even if the present analysis was run considering a standard distance of 50 km for the provision of all the equipment, the LCA suggests that **transportation** should be taken into account as a possible source of impact for the aquaponics facility. Thus, minimizing the distance for the provision would be fundamental to reduce impacts deriving from this macro-category. Finally, the present study underlined the importance of LCA as an useful tool to find new technical solutions aimed at increasing the sustainability of aquaponics and expanding this practice at a wider scale.

Future perspectives

- Refine the design of the system according to results.
- Extend the analysis including production data.
- Run an economical analysis (Life Cycle Costing, LCC) on refined data to draw an overview of the environmental and economical impacts of the aquaponic system.
- Perform LCA and LCC using primary data concerning construction and production after the system building.

References

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Project partners

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