Circular approach for industrial water management via water balance and LCA: A poultry slaughterhouse

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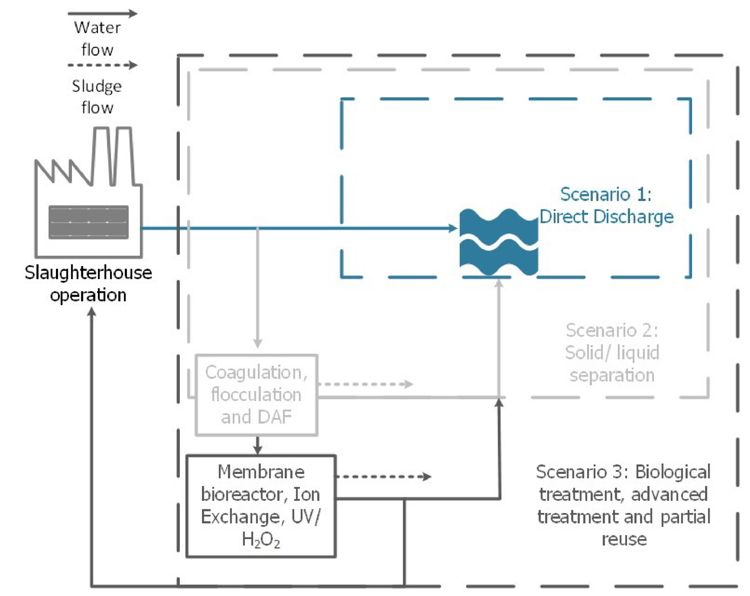
Introduction

The livestock industry is growing rapidly due to population growth, rising affluence, and urbanization, but this growth has led to environmental concerns, especially in slaughterhouses. Slaughterhouses consume large amounts of water and produce significant pollution, which can negatively impact local ecosystems. To address these issues, sustainable water use and wastewater management practices are urgently needed. Decentralized wastewater treatment is seen as a potential solution as it offers benefits such as preventing decreased surface water quality, maximized reuse potential, and improved environmental sustainability. Biological treatment is commonly used to treat slaughterhouse wastewater due to its effectiveness and low cost, while advanced oxidation processes can complement biological treatment for enhanced removal of organics and disinfection for water reuse. When designing wastewater treatment technologies, the extent of pollutant removal must be weighed against potential resource consumption and environmental impacts. Life Cycle Assessment can evaluate the sustainability of wastewater treatment systems by allocating environmental impacts across the value chain and capturing trade-offs across various categories of environmental concern.

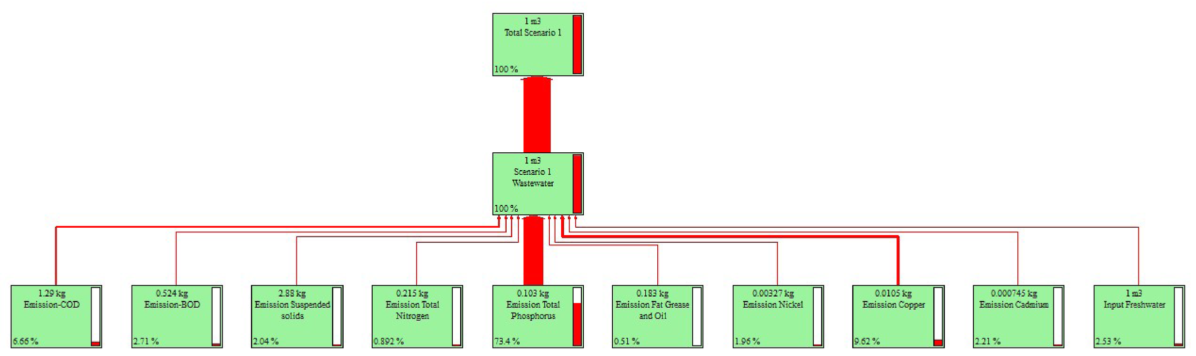
Methodology

Guidelines	ISO 14040 and ISO 14044
Goal and Scope	The goal of the LCA is to compare the environmental performance of the three alternative industrial scale slaughterhouse wastewater treatment scenarios
Functional Unit	1m³ of wastewater effluent prior to entering the wastewater treatment system
Impact Assessment Method	Environmental Footprint 3.0 assessment method
Tools	Simapro v9.1

System Boundary

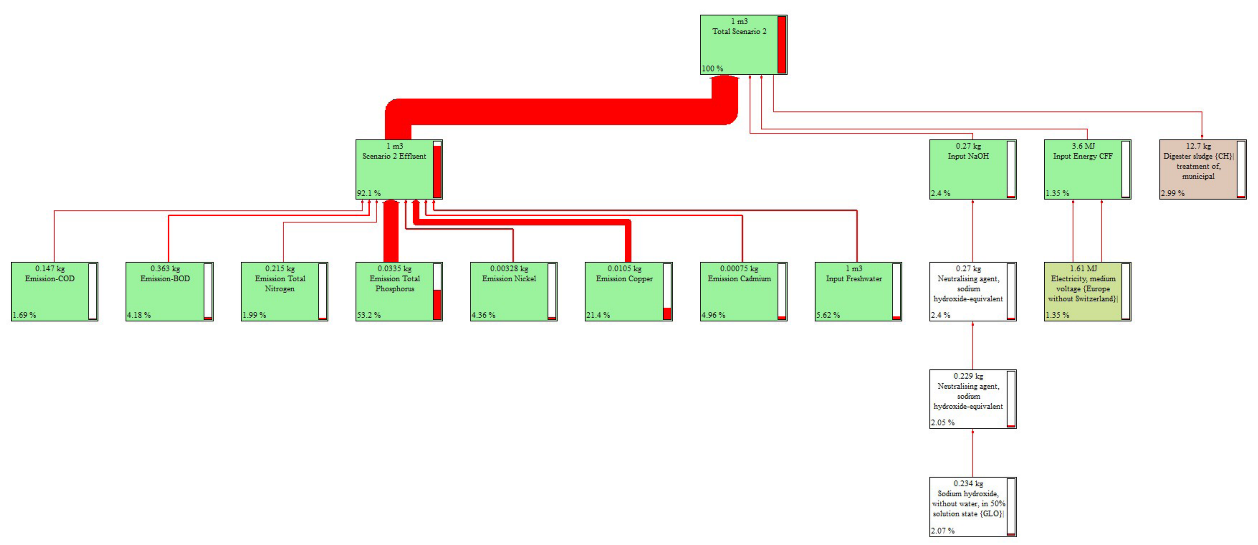


Result Scenario 1



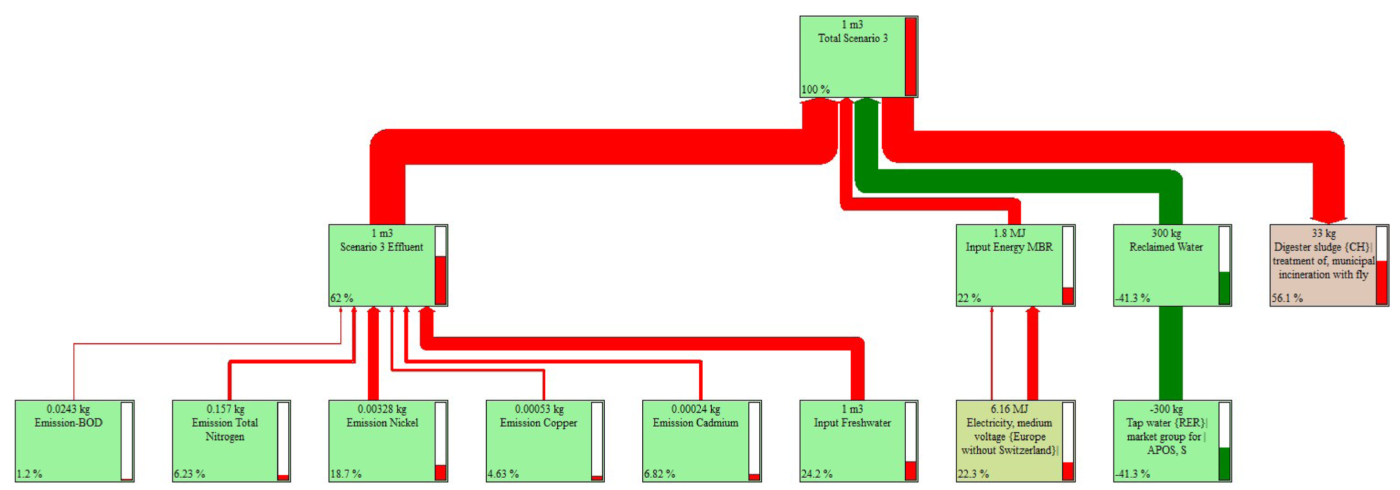
The figure shows in scenario 1 where no additional treatment is applied, all the environmental impact is caused by the quality of the effluent, in which, emission from total phosphorus has contributed towards the highest impact (73.4%). A high concentration of Phosphorus could contribute to primarily a high freshwater eutrophication potential. The emission copper (and other heavy metals) also causes an impact towards the environment, predominantly freshwater ecotoxicity.

Result Scenario 2



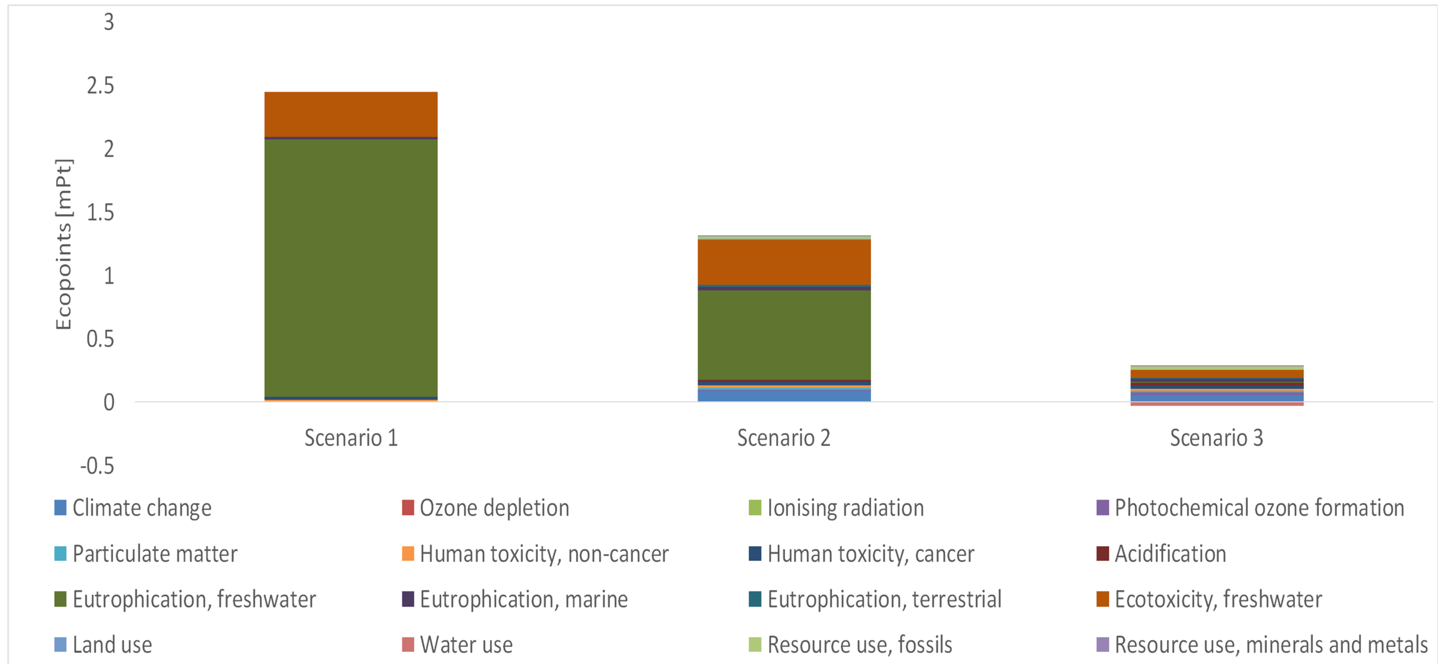
In scenario 2, the figure show she trend in the impact originated from the effluent is similar to scenario 1, at a slightly lower magnitude due to a better water quality from the addition of water treatment processes. However, the process itself also contribute towards the total impact as chemical addition and energy requirement to run the process(about 7%).

Result Scenario 3



In scenario 3, the impact caused by the quality of the effluent and the treatment are on a comparable magnitude. The three major sources of environmental impact for scenario 3 in descending order are the incineration of digested sludge, the quality of MBR effluent and the energy requirement for MBR. The incineration of digested sludge has a higher impact due to more sludge being produced per functional unit, thus, the environmental burden of the process also increases. The reuse of the effluent after the tertiary treatment has multiple benefits since incorporating treated effluent back into the system not only reduces the water consumption for the slaughterhouse's daily operation but also offsets the environmental impact caused by the production process of an equal amount of tap water.

Discussion and Conclusion



The study used Life Cycle Assessment (LCA) to compare the environmental impact of three scenarios for treating slaughterhouse wastewater. Scenario 1, without onsite treatment, had the highest impact potential. Adding CFF and MBR onsite treatment increased the impact in various categories due to energy and material consumption, but also provided benefits such as better effluent quality and potential water reuse. The freshwater eutrophication impact decreased significantly with increased treatment intensity (82.72% vs 53.94% vs 2.71%). Accordingly, the best scenario for the slaughterhouse wastewater treatment is Scenario 3 with an overall footprint of 0.26 milliecopoints, compared to 2.45 milliecopoints of Scenario 1 and 1.31 milliecopoints of Scenario 2

Additional Information

OSPP

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