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New Methodology in Life Cycle Impact Assessment (LCIA) of Waste Water Treatment

ABSTRACT

Reducing environmental problems related to wastewater effluents containing micropollutants requires resources in terms of energy, chemicals, infrastructure, installations for wastewater treatment, thus, involves advantages as well as disadvantages to the environment and society. But how does one chose among different waste water treatments? Which ones are most beneficial in a holistic perspective? Here, the life cycle assessment (LCA) approach as a decision supporting tool may help because its goal is to allow quantification and direct comparison of characteristics as diverse as energy consumption, CO_2 emission, toxicity impacts, nutrient enrichment and consumption of various resources. However, the relatively newly discovered impacts of micropollutants like endocrine disruption, and effects of pathogens have not yet been included in life cycle impact assessment (LCIA). As part of the new EU research project "NEPTUNE" focusing on nutrient recycling, micropollutants and ecotoxicity removal, energy production, and reuse of sludge and of its resources, this paper will present the first results of the development of a new methodology for assessing advances in wastewater treatment including the environmental significance of micropollutants. The methodology is building on scientific state-of-the-art LCA complemented with aspects of specific relevance to assessing wastewater treatment like site-dependency. Special focus will be on the inclusion of impacts from micropollutants showing specific toxic mode of action, like endocrine disruption.

Background

This poster is based on preliminary results of the newly started EU FP6 project NEPTUNE (www.eu-neptune.org). The background for NEPTUNE is the Water Framework Directive (WFD) (EC 2000, 2002) and the main goal is to develop new and optimize existing waste water treatment technologies (WWTT) and sludge handling methods for municipal waste water. A special focus area is micropollutants (e.g. endocrine disrupters and metals). As part of this work a holistic based prioritisation among technologies and optimisations is to be done. Tools for this prioritisation include cost/efficiency and life cycle assessment (LCA). The first considerations about the LCA part are actually what this poster is presenting.

Goal and scope

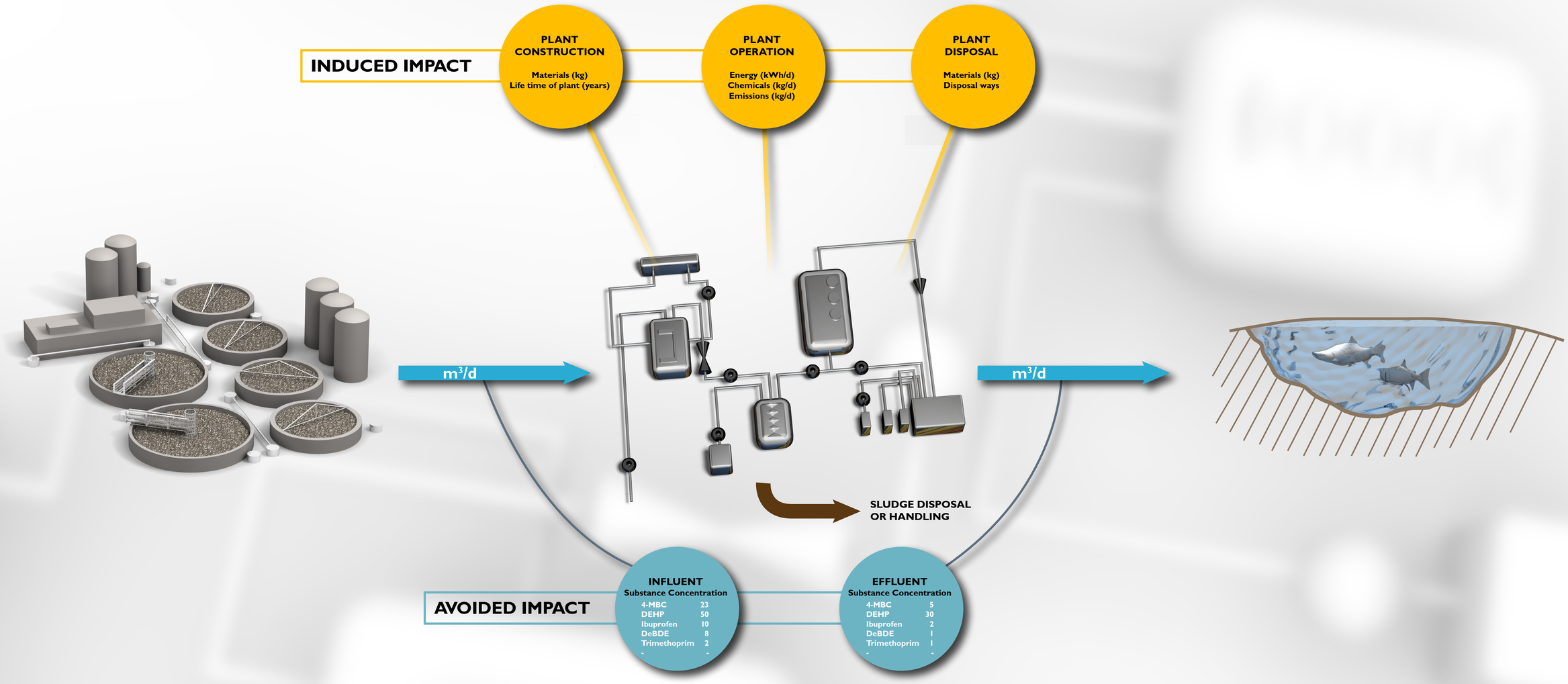
The main goal of the study is to perform a holistic environmental performance ranking (optimisation) of different WWTTs. These WWTTs include end-of-line technologies, i.e. ozonation, wetlands, activated carbon, manganese oxide treatment, ferrate treatment, and for sludge handling: incineration, pyrolysis and low temperature conversion. The objective is to assess post-treatment of municipal wastewaters to remove focus micropollutants (and pathogens) as defined in the WFD. Furthermore, fuel cells and use of in-line sensors focusing on energy production and nutrient removal are included.

The study is performed as a comparative LCA, i.e. induced impacts as compared to avoided impacts, se figure below. The Functional Unit is defined as 1 m^3 "standard" waste water, i.e. effluent water (one or a few types) from a (or a few) "standard" municipal waste water treatment plants (MWWTPs) with characterised content of micropollutants, (pathogens) etc., for (further) treatment.

Existing studies

A literature search on existing studies including LCA in the assessment of WWTT comes up with about 20 relevant studies. The main part of these studies focuses on municipal water. In total more than 25 different WWTT are studied including most of the technologies included in NEPTUNE except for fuel cells, manganese oxide treatment, ferrate treatment and low temperature conversion of sludge.

The potential impact of the effluent is only included in some cases and mostly only as nutrient enrichment or eutrophication (e.g. N, COD, DOC). Only one existing study (Clauson-Kaas et al. 2006) assesses the potential ecotoxicological impact of micropollutants in the effluent and only a limited number (13), e.g. seven metals, DEHP, nonyl phenol and 17α-ethynylestradiol, is included.



New LCIA methodology to be developed

Related to the impact category of ecotoxicity NEPTUNE is going to develop methodology for including micropollutants (e.g. endocrine disruptors, pharmaceuticals), Whole Effluent Test (WET) results and site dependent assessment. As a starting point for these developments both the existing EDIP methodology (key-property/PNEC approach) and the principles of the UNEP/SETAC consensus model USEtox, currently beta version (multimedia/PAF approach) will be included. Further, as a novel approach NEPTUNE is also going to develop an impact category for pathogens.

Time schedule

The NEPTUNE project is scheduled to run until November 2009. The new development on LCIA methodology related to micropollutants and pathogens is scheduled to be finished by March 2009 and the final decision supporting guideline based on LCA and cost/efficiency is scheduled to be finalized by October 2009.

Acknowledgement

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