LCA Case Studies

LCA Application to Russian Conditions

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Abstract. The environmental impact assessment existing in the Russian Federation at the present moment cannot provide potential scenarios of consequences for the environment from examined processes, since its goal is to calculate the money equivalent of emissions to the environment. Also, it cannot help the environmental specialist to choose the most environmentally sustainable scenario or process, proceeding from the whole life cycle of the object, because it is usually performed only for the use phase of an object.

This study also aims to show possibilities for applying LCA methodology, as accepted in the ISO standards series 14040, and as applied to Russian conditions. The main purpose was to investigate a possibility of using the existing environmental impact assessment as the inventory stage in the LCA. As the minor goal, normalisation and weighting factor data for the Russian Federation were calculated on the basis of energy consumption extrapolation.

In this paper, the environmental impacts are associated with a sewage wastewater facility. The inventory analysis is performed with data obtained from the MosvodokanalNIIproject (Moscow Research Institute for sewage wastewater treatment facilities) and supplemented with the SimaPro 5.0 database (the Netherlands). The environmental impact categories included and discussed in this study are eutrophication, global warming, landfill, acidification, ozone layer depletion and photochemical ozone creation. This study was performed for several design alternatives or scenarios of the wastewater facility. According to the LCA performed in this study, the most environmentally sustainable scenario is that which has the most effective and complicated treatment of sewage water and sludge.

Keywords: Case studies; life cycle impact assessment; sewage wastewater treatment facility; normalisation factors; weighting factors; Russian Federation

Introduction

LCA methodology has been developed over the last two decades in Western Europe, USA and Canada, where environmental laws were passed in the 1960s. In the Russian Federation, analogous laws were passed at the beginning of the 1980s, for example, the 'Regulations on environmental impact assessment for construction projects' were passed in the beginning of 1990. In 1991, environmental impact assessment was enforced by law in the Russian Federation for objects with considerable consequence for the environment.

The ISO standards series 14040 were recently translated into Russian and they are in the publishing stage at the VNIIKI Terminology Department (Gosstandard of Russia). Thereafter, ISO standards series 14040 will be recommended for widespread use in the Russian Federation in the near future. However, as yet, the knowledge of the ISO 14040 series is still low and Russian enterprises have no detailed manual to carry out an LCA (Zavoloko 1998). It would therefore be a logical step to analyse the possibility of applying LCA methodology from these standards to the Russian conditions.

The example of a wastewater facility was chosen for this study for the following reasons. First of all, the environmental impact assessment is carried out in the Russian Federation only for projects with considerable consequences for the environment, like the wastewater facility. Second, following from the first stage, it was possible to collect the inventory data only for the project which has data from existed monitoring systems. This study was based on a report written by the MosvodokanalNIIproject (Moscow Research Institute for sewage wastewater treatment facilities) in 1998, which contains the inventory data for the wastewater facility with Q = 110,000 m³/day and anticipated for construction in the Moscow region in 2005-2010. The study is carried out in the period from 1997 to 2001 at the Moscow State Building University. The literature used in this study reflects the state-of-the-art of LCA methodology during the above-mentioned period.

1 Goal Definition and Scope of the Study

The overall objective of this LCA study was to assess the potential environmental effects of the different stages of the wastewater facility life cycle. Also, the goal was to compare the relative environmental effects/impact of each stage of different scenarios of a construction project, and hence identify the scenario of the wastewater facility which most affects the environment.

1.1 Functional unit

In order to compare the scenarios, all emissions and all resources have been related to a functional unit. This unit has been defined as treatment of the sewage from 200,000 in-
habitants ($Q = 110,000 \text{ m}^3/\text{day}$) during one year. The study started with the production of building materials for the wastewater facility building and ended with demolition and waste treatment of this object. This study deals with the various scenarios of the production of clean water, use of auxiliary materials, transportation, demolition waste treatment, treatment of sludge from wastewater and energy use (three different scenarios of wastewater facility were examined).

### 1.2 System definition and description

The model for the whole life cycle consists of sub-systems such as the production of building materials, use phase (production of auxiliary materials, production of clean water, energy production and treatment of sludge and solid waste) and end-of-life phase (different scenarios of demolition waste treatment). The system is presented in Fig. 1.

The main data sources for different sub-systems are provided in Table 1. The most varied data quality was found in the sub-system Production of Building Materials: the data obtained was limited partly because of lack of corresponding data in Russia and partly due to the unwillingness of different companies to make their data available.

#### 2 Life Cycle Inventory Analysis

Representative inventories for all three scenarios are represented in Table 2, and composed of major input/output materials and energy use. The quantity of construction materials was obtained from the MosvodocanalNIIproject (1998). The energy consumption and emissions for building material production processes were taken from the SimaPro 5.0 database: The territory use for scenarios 1–2 comprises 10.8 ha. The territory use for scenario 3 comprises 12.0 ha. According to the MosvodocanalNIIproject's report, process schemas for all three scenarios are nearly identical. Different building materials and different constructions are used in the scenarios. Moreover, different sludge treatment systems and auxiliary materials are used in scenarios 1–3.

According to the above-mentioned report, the emissions from the wastewater treatment are nearly identical regardless of the alternatives. At the moment, there is no more precise data available from the current monitoring systems for the existing wastewater facilities.

Production of clean water in sewage plants described in the literature is often very detailed, and needs a large number of parameters as input (MosvodocanalNIIproject 1998). The purpose of this study was to calculate the emissions and

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**Fig. 1: Scheme of investigated life cycle**

![Diagram of life cycle](image)