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Evaluation of Greenhouse Gases Emission and Human Health Risk Levels Due to Operation and Maintenance of Sareyn City Wastewater Treatment Plant

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Abstract

In the present study, LCA method was used to evaluate the environmental impact of the Sareyn City wastewater treatment plant and RAIS method was used to perform its human health risk assessment. For this purpose, information entering the system, effluent output, and amount of energy and consumable chemicals were collected, and the amount of exhaust gases of methane and carbon dioxide were calculated and analyzed by Simapro software. Also to assess the health effects of treated wastewater used by farmers for irrigation in the area two scenarios were determined. The results of this study showed that in the life cycle assessment method, chlorine is an important factor with the most adverse effects on the environment. And the highest hazard quotient in the health risk assessment method is related to nitrite. In the life cycle assessment method, carcinogenicity has a 90.9% effect on human health which is based on air releases and expressed in terms of equivalent of benzene (C_6H_6) in grams, while in the risk assessment method, no carcinogenic risk was observed which is evaluated based on the effluent from the treatment plant. The use of effluent for irrigation is risky in terms of non-carcinogenic hazards.

Keywords: Life cycle assessment, Impact classes, Health risk assessment, Hazard quotient, Wastewater treatment

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Introduction

In many developing countries, traditional irrigation of agricultural lands using raw and untreated wastewater has consequences such as contamination of agricultural products as well as the spread of disease. Hence, the adverse environmental and health effects of improper wastewater disposal have led to design and implementation of treatment plant and wastewater collection network. Since the early 1990s, the "Life Cycle Assessment" is a "cradle to grave" approach to assess systems that has been widely used in many countries around the world and has been able to overshadow the view of decision makers towards systems and processes. Sareyn City did not have a treatment plant system and a sewage collection network and also due to the touristic area and peak of passengers in the first six months of each year, discharge of domestic sewage has been occurred by the hotels and even houses to canals in the city. In addition to the adverse effect on the aesthetics of the city, it was considered as a threat to public health in the region and due to the high groundwater level and the existence of water resources, there were potential risks in the infiltration of domestic wastewater into groundwater and hot springs, and of course microbial contamination of water and people, and the prevalence of epidemics and intestinal diseases. The effluent is also used by farmers to irrigate agricultural land which can also have environmental and health effects. Therefore, the purpose of this study is to evaluate the possible environmental and health effects of effluent from the treatment plant that is used for irrigation.

Materials and Methods

For the present study, first the quality of the effluent was analyzed and the necessary data were collected and calculated then by using Simapro software, the system was evaluated in terms of environmental and different effect classes. Also, the possible effects of the effluent on farmers who use it to irrigate agricultural fields were investigated from a health perspective by using the risk assessment information system method. to examining the system from an environmental perspective by using life cycle assessment, four steps of the LCA regarding the wastewater treatment system were determined as follows: Definition of goal and scope: The purpose of this study is to investigate the effects of effluent on the wastewater treatment system of Sareyn City in order to monitor the environmental and health performance of the wastewater treatment plant
after the operation of the system, which is used as water for irrigation of downstream farms. Functional unit: The operational unit is the measurement of the performance of the production system. The primary purpose of the operations unit is to provide a reference for linking inputs and outputs to ensure comparable results. In this study, the operating unit of one liter of wastewater was considered to compare different wastewater treatment processes. System boundary: In this research the boundaries of the system were demarcated from the entrance of the treatment plant to its output (operational phase). Check list and System vector analysis and its interpretation: In this research, energy and raw materials consuming and the amount of methane and carbon dioxide emissions per day calculated to treat a liter of wastewater. Information obtained was analyzed by using Simapro software and basic data of Greenhouse gas protocol, IPCC 2013 and BEES^{+}. For the health risk assessment two scenarios were considered: 1- Activation of the treatment plant based on the performance of the first 6 months (high tourist load) 2- Activation of the system for the second 6 months. The health effects of two scenarios were analyzed
based on the rate of Chronic Daily Intake and the hazard quotient for both groups of children and adults through different routes of exposure.

Discussion of Results

Analysis of the results in the Sequencing Batch Reactor System showed that by Greenhouse Gas Protocol method there are four categories, which include carbon-based fossil fuels, biogenic carbon, carbon from the Earth's evolution and carbon uptake. The result showed that in the class of the effect of carbon dioxide per fossil fuel, the effluent from the treatment system with the participation of 99.7% has the greatest environmental impact followed by electricity consumption with 0.284%. In the class of biogenic carbon dioxide, nitrogen (74.6%) and phosphorus (25.4%) of the fertilizer obtained

from the treatment process have the most impact, respectively. And in the category of carbon dioxide absorption effect, the highest effect is related to chlorine consumption with participation of 99.9%. The results of the IPCC 2013 method were as follows: Evaluation of effects is shown in terms of the equivalent of kilograms of carbon dioxide. The effluent from sequencing batch reactor treatment system has the greatest (99.9%) direct impact on the global warming potential for a period of 20 years compared to other parameters, followed by on-site electricity consumption, which is related to energy consumption and indicates high energy consumption by the system. Also, like the GHG protocol method, the evaluation criterion is kilogram equivalent to carbon dioxide. In the system evaluation by BEES + method the results showed that in the class of the effect of global warming in terms of grams equivalent to carbon dioxide, the effluent from the treatment has the greatest impact with participation of 99.6% and in the class of acidification effect, electricity and chlorine consumption have the most effect with 85.8% and 13.9%, respectively. Also in the classes of non-carcinogenic and carcinogenic effects, chlorine consumption has the greatest effect with participation of 99.6 and 90.9%, respectively. In the category of the effect of air pollution criteria, electricity consumption has the most impact (83.6%). In the eutrophication effect class, the effluent from sequencing batch reactor treatment has the greatest effect (87.9%). In terms of eco-toxicity, chlorine consumption has the greatest impact with participation of 96.9%. In the smog category, the greatest impact is related to the sequencing batch reactor treatment system, which affects 92.4% of this index. In the category of the effect of natural resources depletion, electricity consumption has the greatest impact (91.2%) and in the classes of the effect of indoor air quality and habitat alteration, none of the parameters have an effect. In the category of water intake, chlorine has the greatest effect with participation of 87.5% and in the ozone layer depletion class; chlorine plays the most destructive role in the environment with participation of 99.98%.

Results of RAIS according to the first scenario showed that regarding the hazard quotient (HQ) through ingestion in children and adult categories, nitrite with the participation of 5,09E + 00 and 3,06E + 00 respectively, has the greatest adverse effects. Similar results were observed in the second scenario with HQ values of 4,09E+00 and 2,46E+00 for children and adults respectively in digestion exposure to nitrite.

Conclusions

The results showed that in each of methods, categories have different effects and the parameters measured in these classes express different results. In the life cycle assessment method, carcinogenicity affects the human health by 90.9%, which is expressed in terms of emissions equivalent to benzene (C_6H_6) based on airborne emissions. However, in the risk assessment method, which was based on the effluent from the treatment, there was observed no carcinogenic risk. The results of this study showed that the parameters participating in the life cycle assessment method such as chlorine is an important factor with the most adverse effects on the environment and in the risk assessment method, nitrite has the most adverse effect on human health. Also, by comparing two scenarios in the health risk assessment method, it can be seen that the use of the treated wastewater for irrigation, although has no cancer risk is still concerning regarding non-carcinogenic hazards.