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Assessing the Environmental risk in using Wastewater of municipal sewage treatment plant in agricultural irrigation

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ABSTRACT: The use of refined municipal sewage for agricultural irrigation in addition to saving fresh water, Because of fertilizer materials in wastewater can be a good source of nutrients for plants and strengthening field. But in case of high levels of physicochemical and biological sewage compounds it cause problems for consumers of agricultural products. In this study to determine the risk factors effective in the study of municipal sewage AHP index is used. The parameters that were considered for this study include: Total coliform, gastrointestinal coliform, parasites, lead, copper, cadmium, zinc, total dissolved solids, nitrate, phosphate, sodium, potassium, calcium, magnesium, sulfate, chloride and conductivity. Given that each factor has a specific standard for this reason, a ratio of 1 to 3 Due to the standard amount was allocated to each factor, So that for each parameter based on the permissible limit value of the EPA standard three domains of acceptable, convenient and low were determined. And the weight ratio of the points obtained by using analytic hierarchy process shows the final impact of each risk factor for using municipal sewage in agriculture. The results showed that lead by weight of 127/0 1 was the most important factor in the risk of using municipal sewage of treatment plant in Ardebil for irrigating agricultural crops And then was nitrate parameter with value of 101/0. In general, the results showed that the heavy metals lead, cadmium, lead and zinc are the most important risk factors in using of municipal sewage in agricultural production. Therefore, in the use of Wastewater for agricultural production values such as heavy metals, nitrate and microbial parameters must be carefully considered.

Keywords: Risk assessment, Waste water reuse, treated wastewater, AHP.

INTRODUCTION

Due to the increasing population and expanding human activities in various sectors, per capita consumption of water has increased sharply. The use of unconventional water including treatment plant wastewater in various sectors especially in the agricultural sector, which accounted for the majority of water use, achieves particular importance (Danesh and Alizadeh, 2012). Iran in recent years due to limited water resources, population growth, urbanization, industry and agriculture and the development and implementation of various projects and wastewater collection, Wastewater use in agriculture lands became very important and is in priority for the management of water resources planning (happiness, 1385). Sewage is one of the environment pollution factors that should be collected in a sanitary way, refined and again bring back to water cycle in nature (Abbasi, 2013). In relation to the use of wastewater in agriculture researches has been conducted in the country and abroad, Including the study of Mehrabi *et al* (2012) that examined the effect of irrigation with treated wastewater on the chemical properties of soil in cultivated urban garden Pistachio in Rafsanjan city that The result of this study showed a positive effect in increasing the product by using Wastewater. Khorram et al (2007) in a study by using risk assessment started to determine strategies priorities and AHP method for the reuse of wastewater. The research was conducted in the city of Hamedan by using the method of AHP and by determining criteria and a questionnaire completed by experts; shows the use of wastewater for irrigating forest had the first priority. Qanyan *et al* (2010) for the need to risk assessment to re-use of treated wastewater in agriculture achieved these results that refined Wastewater containing multiple biological and chemical contaminants that the presence of each of these factors in recycled water, leaves Various risks to water, soil, plants and human health.

To assess the risks of reuse, chemical and microbial risk assessment should be done as combined. Alavi *et al* (2012) in the risk assessment of wastewater for agricultural irrigation using AHP method concluded that treated wastewater because of Benefits such as reducing limited water resources and reduce environmental pollution is considered and used in agricultural sector. But there are dangers, such as heavy metals, salts, nitrates, and their effect on human and plant that created limitation for the use of it. Finally, this study showed that the risk is obtained by multiplying the risk index in effects index and by determining the amount of risks, dangers are identified. Pourang *et al* (2013) in A study showed that Replacing the old system and wastewater collection wells with integrated sewage system collection, in addition to preventing the pollution of groundwater and maintain the security of risks of the fluid of the underground area, Background for wastewater treatment is provided and reuse for non-potable uses, partially compensated water shortages in Iran. Omid Bakhsh *et al* (2011) in a study evaluated the effects of municipal sewage on the chemical properties changes of calcareous soils. The results showed that irrigating by municipal sewage may increase the concentration of potassium, phosphorus, organic carbon and soil salinity. Asparza Correll *et al* (2014) in a research called selection of a sustainable disinfection method for municipal sewage for reuse concluded that the combination of AHP, Delphi method and VIKOR technique is most useful method to reuse municipal sewage. AKyka *et al* (2009) in a research studied waste management and stats that Waste management and restoration of swage to the agricultural cycle can save mankind from water shortage and solve the water problem in many parts of the world. Aylt *et al* (1988) in a study showed that although some micronutrients in sludge and wastewater are essential for biological growth but concentrations slightly above the threshold, can be very risky to plant and animal life. Weber *et al.* (2005) in another study as a risk assessment of organic pollutants in reforming wastewater for irrigation concluded that Pollution has considerable risk to human health through the food produced in the soil irrigated with it. Asparza Correll *et al* (2014) in a study titled the selection of a sustainable approach to wastewater disinfection for reuse, found that combination of AHP using the Delphi method and VIKOR technique is most useful method to reuse wastewater. Yasin *et al* (2007) in reviewing the supply of water resources and non-conventional sewage for irrigation of agricultural crops in the Jordan realized that MCA and AHP tools are potential integration method for a good decision in the evaluation and ranking Given that Wastewater of municipal sewage treatment plant is used indirectly after discharged into the river of Gharehsou in Ardebil And during low water season and due to drying of the river is use directly in agricultural production area, Therefore, awareness of the risks of using the treatment plant wastewater in the production of agricultural products was necessary and was evaluated in this study.

MATERIALS AND METHODS

A. Research Methodology

In this study to determine the factors affecting in evaluation of the risk of using urban wastewater for irrigation of agricultural crops in the Ardebil region, the measured values of physical and chemical and biological parameters were used. To determine the weight of effectiveness of the studied parameters, Paired comparison questionnaire was used by experts related to water and sanitation and experts and farmers who were producing agricultural product. The results of the questionnaire entered to software expert choice. Since each factor (parameter) has a certain standard is therefore a ratio of 1 to 3 according to the standard amount was allocated to each factor, So that for each parameter based on the permissible limit value of the standard in EPA were determined for agricultural purposes to three domains of an acceptable, convenient and low. And finally product of applied Score with weight obtained from Analytical Hierarchy Process, the final value of impact in each wastewater risk factor was found in.

Studied parameters: As was pointed out to assess the risk of the use of urban wastewater for agricultural irrigation, the physical and chemical and biological parameters were used. Table 1 shows the considered parameters.

Method of Analytical Hierarchy Process: So far, a number of multi-criteria decision-making methods, including methods of weighting, method of limit, method similar to the ideal setting (TOPSIS) and Analytical Hierarchy Process (AHP) is presented (Said, 2009). Multi-criteria decision-making method has successfully been used in the field of environmental issues (Huang, 2011). Several applications of this method have shown that they are a useful tool in the decision-making process (Silk, 2005).

Table 1: Studied parameters.

Parameter	Parameter	Parameter
(MPN/100ml) Total coliforms	cadmium	(ppm) potassium
(MPN/100ml) Gastrointestinal coliforms	zinc	(ppm) calcium
pH	(mg/l) TDS	(ppm) Mg
parasite	(mg/l-NO3) nitrate	(ppm) sulphate
lead	(mg/l-P) phosphate	(ppm) chloride
copper	(ppm) sodium	(µS/cm) EC

AHP is useful method for working with multiple processes and multiple criteria. This method is able to consider the environmental, social and cultural with important objectives of the economic goals in the selection process of waste water treatment (Alice, 1991). Analytical Hierarchy Process is a consistent method with standards and multiple objectives in decision making (Saaty, 1977). This method is able to evaluate different purposes, and the difference between the two options is determined by the priority vector (Tsiporkova, 2006). Multi-criteria decision-making process consists of four basic problem identification, assessment and weight, superior best choice using MADM and sensitivity analysis and selection of final options (Mianabadia, 2008). In identification and assessment stage, identifying decision makers, selecting criteria and identifying options were done and evaluating of options was carried out in front of the measures. Selection criteria and appropriate indicators, have the most important effect on the final ranking of the options. Analytical Hierarchy Process is a decision-making technique to solve sophisticated multi-criteria problems in different areas of work, and is a flexible and quantitative method to select options based on their relative performance to one or more criteria (Boroushaki, 2008). Thus, in this study MADM method was used to assess the risk of using treated wastewater in agriculture irrigation. To increase the accuracy in the final weight assigned to each criterion (parameters) of the scoring range of 1 to 3 were used.

Low standard of parameter = 3
the average amount of parameter = 2
High levels of parameter standard = 1

The product of obtained weight from paired comparisons in the analytic hierarchy process in assigned rating as the weighted rating to each parameter was used for determining risk of treatment plant wastewater in Ardabil.

RESULTS

In order to evaluate the risks of the various values of physico-chemical and biological parameters, and determine the maximum risk associated with the parameters, AHP method was used. For this purpose, paired comparison matrix was used in Expert Choice software. Fig. 1 and diagram 1. Shows the values of applying studied paired comparisons parameters to it.

	coliform	pH	angal	pb	cu	cd	zn	TDS	no3	po4	na	k	so4	ca	mg	cl	Ec
coliform total	3.0	2.0	1.0	4.0	2.0	5.0	2.0	4.0	5.0	3.0	2.0	2.0	2.0	3.0	2.0	2.0	2.0
coliform		2.0	1.0	3.0	2.0	4.0	2.0	3.0	5.0	3.0	2.0	2.0	2.0	3.0	2.0	2.0	2.0
pH			2.0	3.0	2.0	2.0	2.0	1.0	3.0	2.0	2.0	1.0	1.0	1.0	1.0	2.0	1.0
angal				4.0	2.0	2.0	1.0	2.0	1.0	2.0	3.0	3.0	2.0	3.0	3.0	4.0	3.0
pb					2.0	3.0	4.0	4.0	2.0	2.0	3.0	4.0	4.0	4.0	5.0	5.0	3.0
cu						2.0	1.0	2.0	1.0	3.0	3.0	3.0	2.0	3.0	3.0	4.0	3.0
cd							1.0	3.0	1.0	3.0	3.0	3.0	4.0	4.0	4.0	5.0	2.0
zn								2.0	1.0	3.0	3.0	3.0	2.0	3.0	3.0	4.0	2.0
TDS									3.0	2.0	2.0	2.0	1.0	3.0	3.0	4.0	1.0
no3										3.0	4.0	4.0	3.0	4.0	4.0	5.0	2.0
po4											2.0	2.0	1.0	2.0	2.0	3.0	2.0
na												1.0	2.0	2.0	2.0	3.0	1.0
k													3.0	2.0	1.0	1.0	2.0
so4														4.0	4.0	4.0	1.0
ca															1.0	2.0	2.0
mg																3.0	2.0
cl																	4.0
Ec																	

Fig. 1. The results of the paired comparison matrix of studied parameters from Expert Choice software.

Fig. 2. The weight of criteria (parameters) to select the most effective parameter to investigate the risk of using the treatment plant sewage in the city of Ardabil

Table 2: Final weight criteria (parameters) based on the weight coefficient of analytic hierarchy process and standard rating of each parameter.

Row	Parameters	Weight	Score	Weight scores
1	Total coliforms	0/041	1	0/041
2	Gastrointestinal coliforms	0/045	1	0/045
3	PH	0/039	2	0/078
4	parasite	0/093	3	0/279
5	Lead	0/127	3	0/381
6	copper	0/087	3	0/261
7	cadmium	0/091	3	0/274
8	lead	0/075	3	0/225
9	Total dissolved solids	0/038	1	0/038
10	nitrate	0/101	2	0/020
11	phosphate	0/050	2	0/1
12	sodium	0/031	1	0/031
13	potassium	0/03	1	0/03
14	sulphate	0/047	1	0/047
15	calcium	0/02	1	0/02
16	Mg	0/029	1	0/029
17	chloride	0/015	1	0/015
18	The electrical conductivity	0/039	1	0/039

Table 2 shows that on the basis of paired Comparison results of parameters, Lead metal by weight of 127/0 is the most important risk factor in using the urban treatment plant wastewater to irrigate agricultural crops in Ardebil city And then was nitrate parameter with value of 101/0. However, due to the impact of each factor in humans and plants and determining rate from 1 to 3 for each factor, it was finally indicated that Metals lead, cadmium, copper and zinc greatest impact on the risk of using wastewater for agricultural irrigation and In case of violation of international and national standards, could have irreparable effects on ecological systems and health of consumers of produced agricultural products.

CONCLUSIONS

Use of Wastewater of municipal sewage treatment plant for irrigation of crops requires accurate analysis. Determine the factors influencing the health risks of using wastewater in agricultural production for humans and plants are very difficult. But today, due to lack of water and the unavailability of it, urban wastewater for agriculture is being used in developing countries. However determining the level of risk factors in soil quality and products is essential. So that if any of the factors in the production of agricultural products violates the standard, indicates poor condition and unsuitable sewage for using in agriculture.

In this study the risk level of 18 parameters in urban wastewater treatment plant to be used in agricultural production in Ardebil region was determined that The 18 factors including total coliform, coliform gastrointestinal, parasites, lead, copper, cadmium, zinc, total dissolved solids, nitrate, phosphate, sodium, potassium, calcium, magnesium, sulfate, chloride and conductivity. For this reason, in this study the method of analytic hierarchy process through paired comparisons and also the score for each factor based on standard values of the Environment, was used. The final results showed that the metal of lead and nitrate had the highest risk. If the amount is higher than the standard limit In the case of approaching the groundwater and accumulation in plant tissues it could have dangerous effects for plants and human. Therefore, the results suggest that in using sewage for agriculture, important values such as heavy metals, nitrates and biological parameters should be carefully considered.

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