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Pollutants present in the wastewater of the city of Pachuca and their relation to economic activities

Los contaminantes presentes en las aguas residuales de la ciudad de Pachuca y su relación con las actividades económicas

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Abstract

To Propose a statistical model who allows us to determine in any area either in the countryside or urban the relation that could be existed between the economic activities that are carried out in Pachuca city and the different pollutants that these activities discharge into the waste water system, with the principle goal to propose a technical solutions, the one who allows to have a correct treatment of waste water as well as better public policies, who helps handling these contaminants in order to try to inhibit the contribution of highly harmful pollutants in the waste water system.

Pollutants, Wastewater, Public policies, Statistical model

Resumen

Proponer un modelo estadístico que nos permita determinar en cualquier espacio, ya sea este rural o urbano la relación existente entre las actividades económicas que se realizan y los contaminantes que esas actividades descargan en las aguas residuales, con el propósito de proponer soluciones técnicas que permitan el correcto tratamiento de las aguas de desecho, así como políticas públicas que inhiban la aportación de contaminantes altamente dañinos en ellas.

Contaminantes, Aguas residuales, Políticas públicas, Modelo estadístico

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Introduction

Taking the decision to treat wastewater generated in urban or rural areas is undoubtedly a great contribution to protect ecosystems, natural resources and human subsistence; but this decision cannot be taken lightly, a series of aspects must be considered, including the pollutants that are present in the water to be treated, the daily volume to be treated, the level of purity to be obtained, how the water will be used and what technology is available; as can be seen, this decision goes beyond just wanting to do it.

Generally, the characterisation of wastewater is done without considering the contributors of the same, this analysis will allow us to identify the specific pollutants that each economic activity contributes to the drainage system or to the bodies of water, therefore, if there is environmental damage due to the presence of the same, we will know who the cause is and take the necessary steps to compensate for it.

The volume of wastewater generated in a population, as well as the types of pollutants present in them and their concentration levels, are closely linked to the economic and domestic activities that are carried out in these physical spaces; it is therefore important to analyse the relationship that exists between the economic units and the types of pollutants present in the wastewater, in order to be able to take preventive measures that allow us to protect water resources and ecosystems, thus collaborating with the environmental sustainability of the planet.

Development methodology

Sample collection: Regardless of the type of sample to be taken, there are three factors that intervene to have a reliable sample, which are the type of container for storage and transport, the collection procedure and the conditions of transport of the sample.

Analysis of samples, identification of contaminants and evaluation of the levels of contamination of the wastewater of the city of Pachuca and its surrounding area.

Sampling was carried out during 6 continuous months, from July to December 2013, at the end of this period the results obtained by type of pollutant were averaged in each of the monitored collectors, in order to determine the existence of a relationship between the predominant economic activity of the region and the level of contamination of its wastewater, as well as the type of pollutants present in them.

At the time of sampling, the only physical parameter that could be determined was temperature, due to the lack of equipment to determine conductivity, while the remaining parameters were determined by the Centro de Investigaciones Químicas de la Universidad Autónoma del Estado de Hidalgo (CIQ).

With respect to the concentration of pollutants present in the wastewater of the city of Pachuca and its conurbation with Mineral de la Reforma, the central hypothesis of this work is that they exceed the parameters established by the Mexican Official Standards.

To test this assumption, we will use a statistical tool called hypothesis testing, which is based on the affirmation or assumption of a parameter, which allows us to explain the behaviour of an economic, political, physical, biological, etc. process, and on the theory of probability, to determine whether the hypothesis put forward is a reasonable statement. This process is made up of five steps, which are set out below. a) Putting forward the null hypothesis and the alternative hypothesis.

The null hypothesis for the purposes of this work will sustain that the average value of each of the parameters that determine the degree of contamination of the wastewater to be evaluated are within the limits established by the NOM 001 and NOM 002 Standards. While the alternative or researcher's hypothesis will sustain that the average value of pollutants presents in the wastewater of the city of Pachuca and its suburban area, exceed the limits allowed by the aforementioned norms.

$\mu \leq$ limits established by the NOMS.

$\mu o >$ limits established by the NOMS.

Select a significance level.

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The significance level is the probability of rejecting the null hypothesis when it is true; for this analysis we will take a value of 5 %.

Calculate the test statistic

Depending on the number of available data to be evaluated, a type of statistic is chosen, which will serve as a support to accept or reject the null hypothesis. Due to the number of samples taken for this research, a Student's t-test will be used, because the number of samples is less than 30.

Formulate the decision rule

The decision rule to accept or reject the null hypothesis will depend on a critical value which delimits the areas of acceptance or rejection of the null hypothesis.

Making a decision

Finally, the decision to accept or reject the null hypothesis must be made based on the test statistic.

For the statistical analysis we will make use of the SPSS programme, which is an immensely powerful tool that will give us reliable results in a very short time.

Relationship between economic activities and pollutants present in wastewater

The volume of wastewater generated in a population, as well as the types of pollutants present in them and their concentration levels, are closely linked to the economic and domestic activities that are carried out in these physical spaces; therefore, it is important to analyse the relationship that exists between economic units and the types of pollutants present in wastewater, in order to be able to take preventive measures that allow us to protect water resources and ecosystems, thus collaborating with the environmental sustainability of the planet.

Not all economic activities pollute, for this reason, to evaluate the level of pollution in the city's sewage system and its relationship with economic activities, we considered those activities that when producing a good or performing a service.

Use, generate or dispose of any substance, particle or gas that seriously alters the physical, chemical, and biological characteristics of water.

To carry out a correlation exercise, at least two variables are needed, where one of them is the dependent variable and the other or others are the independent variables. For the purposes of this research, we will consider as dependent variables the monthly values of the pollution parameters sampled by collector (y) and as independent variables we will take each of the economic units of the same type that discharge their wastewater into these collectors (x).

$$y = B_0 + B_1 X_1 \quad (1)$$

The correlation will determine the cause-effect relationship between two variables, i.e., the alteration that the independent variable will cause in the dependent variable, this correlation will be measured through Pearson's r coefficient. This can take any value between -1 and 1, and the results can be interpreted as shown in the following figure.

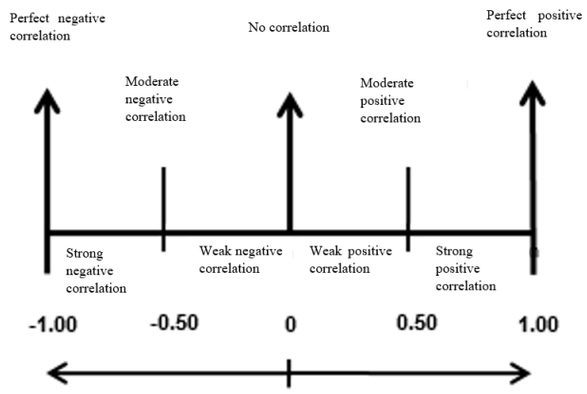

Figure 1 Criteria for assessing the correlation of variables in linear regression

Results and discussions

Sampling: To determine the types of pollutants present in the city's wastewater, as well as their characteristics, it was necessary to carry out a sampling of this water, for which each of the city's collectors, the type of sample, the type of container in which the sample was to be kept and the conditions of its transport, as well as a specific time, were taken into account as sampling locations.

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All in strict adherence to the provisions of the operating manual for wastewater treatment plants of the Centro Mexicano de Capacitación y Saneamiento, A.C. (Mexican Centre for Training and Sanitation, A.C.). Dependent on CONAGUA.

Characterisation and concentration of pollutants

Tables 1 and 2 show the pollutants that could be detected in the wastewater analysed and whose parameters were significant. It should be clarified that those pollutants whose concentration is ephemeral and is within the limits allowed by the standards NOM- 001-ECOL 1996 and NOM-002-ECOL1996 were discarded.

Manifold	DBO	DQO	SST	G and A
July 11	347.20	929.60	358.10	76.40
Loreto	97.00	188.30	94.00	21.40
May 5	540.10	958.80	451.20	118.00
Ven-Can	422.20	882.10	321.90	93.70
Tulipanes	356.80	863.40	302.50	88.70
Columbia	308.10	747.50	249.00	89.80
Reforma	396.30	842.20	377.60	135.20
Providencia	453.00	831.00	320.50	163.00
Maximum limits allowed	150	200	60	15

Table 1 Average of chemical and physical pollutants in natural and man-made reservoirs (concentration in mg/L)

Cities are the largest consumers of electricity, water, and natural resources, as well as the largest generators of solid waste and wastewater. The environmental impact of the pollutants generated in them goes beyond their territorial boundaries, as they travel through the air and bodies of water, altering the ecosystems with which they come into contact, which is why what appears to be a local problem becomes a regional and global problem.

Manifold	S. Sed	NT	PT
July 11	5.10	59.60	10.50
Loreto	1.10	2.40	0.70
May 5	4.40	70.10	11.80
Ven-Can	4.50	70.10	11.80
Tulipanes	3.40	72.00	10.00
Columbia	2.10	56.20	8.40
Reforma	5.70	81.90	11.00
Providencia	3.50	69.20	10.30
Maximum limits allowed	1	15	5

Table 2 Half-yearly average of chemical and physical pollutants in natural and man-made reservoirs (concentration in mg/L)

Relationship between economic activities and pollutants

The economic dynamics of the cities directly affect the environmental sustainability of the localities or municipalities that are in their surroundings. For example, the city of Pachuca, to satisfy its needs for drinking water supply to its inhabitants and its economic activities, extracts the vital liquid from the aquifers that are located along the Mexico-Pachuca highway, to later dispose of the water generated in the city through the river of the avenues.

As can be seen, there is an unconscious use of water resources as they are exploited without compensating for the damage caused to ecosystems or these resources or their sources.

Pollutant	Economic activity	Correlation index
BDO	Industry	0.512
	Hotels	0.542
	Printers	0.484
DBO	Hotels	0.483
SST	Industry	0.619
SSed	Industry	0.526
NT	Dry cleaners	0.505
	Hospitals	0.630
	Bakery	0.496
G and A	Industry	0.475

Table 3 Correlation between economic units and pollutants

Out of the 12 selected economic activities, three of them can be considered the biggest polluters, namely industry, hotels, and hospitals.

Industry has an important influence on the presence of BOD, COD, TSS, SSed and G&A; while hotels contribute significant amounts of BOD, COD and TSS; finally, hospitals contribute to the presence of G&A, TN and PT.

The number of industries established in the study area is small but nevertheless their contribution of pollutants is important, this activity is located within the basins of contribution of the collectors 5 de Mayo and Reforma, which presented high levels of BOD, COD, TSS, G&A and GSSed.

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Conclusions

Central cities such as Pachuca produce a large amount of waste, since their economic activities are destined to satisfy the consumption needs not only of their inhabitants, but also of the municipalities within their area of influence.

Undoubtedly, the environmental sustainability of wastewater in cities must be evaluated taking into account the sewerage and sanitation infrastructure they have, as well as their strict adherence to regulations and the sanctioning of pollutants generated in urban centres are closely linked to the type of inputs, processes and products of the economic activities they generate, processes and products of the economic activities carried out within their territory (industry, commerce, agriculture and services), as well as domestic activities (food preparation, household cleaning, personal hygiene), the number of inhabitants and existing economic units, in addition to the mobility of people who come to work in these centres or in search of goods or services offered there.

Public policies on environmental issues cannot be issued if there is no prior technical study that determines the affected areas, the types of pollutants, their levels of contamination, the sources of generation, as well as the possible solutions and their impact on the environment or on human beings. (To support the actions to be taken)

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