Journal of Posthumanism
2025
Volume: 5, No: 6, pp. 3866–3873
ISSN: 2634-3576 (Print) | ISSN 2634-3584 (Online)
posthumanism.co.uk

DOI: https://doi.org/10.63332/joph.v5i6.2551

Comparative Analysis of the Degree of Acidity of Rainfall in the City of Cusco and its Diagnosis in 2017

Jonny Tello-Yarina[1], Salinova Carrillo Seguraa[2], Mayra Irina Garcia La Torre[3], Eddy Tello Yarin[4], Maribel Palomino Gamarra[5], Juvenal Pérez Huallpa[6], Venancia Ccollatupa Ballón[7], Rubén Ingles Atauchi[8]

Abstract

As in the latter city of Cusco, second-hand and new vehicles have been significantly increased, but without any specification and control of environmental issues, such as vehicle emissions filters, resulting in atmospheric pollution that has increased in form Alarming the emission of gases that go to the atmosphere and when rainfall occurs, these are producing chemical reactions with SOx and NOx, which fall and increase the acidity of rainwater, if the acidity is the same Or less than pH 5.6- Arauzo, G. (2007) is considered acid rain. The general objective of this study is to perform the comparative analysis of the degree of acidity of rainfall in the city of Cusco and its diagnosis in 2017 and as specific objectives: Identify the district with the highest acidity of rainfall; Identify the months with the highest degree of rain acidity; establish the confidence limits of acidity of rainfall in the city of Cusco and compare with the permissible limit.The present study has as general objective to determine the degree of acidity of rainfall in the city of Cusco in 2015 and 2016, and as specific objectives the measurement of the pH of rainwater in the months of rainy season and the Comparing the acid rain pH of the literature with data obtained from the pH of rainfall in the city of Cusco. It is concluded that in the city of Cusco there is no acid rain since the average acidity is 5, 728 pH, but in the months of November and December there is the presence of acid rain with average values of 5,317 and 5,16 pH respectively.

Keywords: *Atmospheric Pollution, Acid Grade, PH.*

Introduction

Rainwater in natural conditions has a pH of 5.6 acidity, mainly due to the CO2 at which it is dissolved. When the acidity of rainwater is higher than this value, it is when the rain is considered to be acidic. One of the problems associated with air pollution is acid rain, the first appearances of this phenomenon were observed in Sweden (1848), England (1877) and Germany (1867), where it was published that for some reason the rains were more acidic than normal, it was in that sense that Lee

M. and Thomas pointed out that naturally rainwater can be 5.6 percent, because water is an excellent solvent and when it falls , it dissolves some of the carbon dioxide (CO2) present in the

[1] Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Perú, Email: jonny.tello@unsaac.edu.pe
[2] Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Perú, Email: salinova.carrillo@unsaac.edu.pe
[3] Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Perú, Email: irina.garcia@unsaac.edu.pe
[4] Universidad Andina del Cusco (UANDINA), Perú, Email: etello@uandina.edu.pe
[5] Universidad Andina del Cusco (UANDINA), Perú, Email: mpalominog@uandina.edu.pe
[6] Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Perú, Email: juvenal.perez@unsaac.edu.pe
[7] Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Perú, Email: venanci.ccollatupa@unsaac.edu.pe
[8] Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Perú, Email: ruben.ingles@unsaac.edu.pe

atmosphere and returns to the Earth's surface in the form of carbonic acid. For this reason, these authors reported that this environmental damage would not naturally worsen if acid emissions did not exceed the current level reported in that year. In the late 1980s and early 1990s, industrialized countries began to develop environmental strategies and policies to control the emission of greenhouse gases, and as a preventive measure, taxes were issued to all industries that emitted SOx, NOx or other types of air pollutants. Unfortunately, this regulatory body was not effective, because for more than a decade the emission of greenhouse gases has been advancing by leaps and bounds and despite all the control and mitigation measures, the adverse environmental effects on the atmosphere cannot be controlled. Acid rain is currently one of the environmental problems facing our planet (Robertson N. and Wender S. 2005)(17).

According to reports from the Northeast of the United States and several other industrialized countries considered to be the first emitters of greenhouse gases, they show that air degradation is having a significant effect on plants, as other countries are seeing their forest fragments die due to the effect of acid rain. Phenomenon which is undoubtedly affecting several cultivation areas and endangering the sustainability of the forests by affecting the entire ecosystem.

In this sense, and according to the Rio de Janeiro Climate Change Convention (1992), a mechanism of compensation or payments for environmental services was established, which allows less developed countries to acquire resources from industrialized countries, among these environmental services are: protection of watersheds, conservation of biodiversity, carbon fixation-storage and maintenance of forests, because these ecosystems are the only ones that can maintain the ecological balance because they are regulators of the climate in a global way.

Methodology

Type of Research

The research is basic, descriptive.

Level of Research

According to the nature of the research study, the descriptive and explanatory characteristic falls by its level.

Research Design

The research design is Non-Experimental, according to Hernández, Fernandez and Baptista (2001) "It is that which is carried out without deliberately manipulating variables. It is fundamentally based on the observation of phenomena as they occur in their natural context in order to analyze them later. In this type of research, there are no conditions or stimuli to which the study subjects are exposed. Subjects are observed in their natural environment."

Population and Sample

The population will consist of acidity samples taken in 2017 in the districts of San Sebastián, Wanchaq and Santiago.

The sample type was intentional non-probabilistic.

Techniques and Instruments

The research technique used in this study is observation and documentary type. The research instruments used were observation and data recording.

Statistical Treatment

For the statistical analysis, the statgraphics centurion xvii software was used.

Results and Discussion

DEGREE OF ACIDITY (in pH) OF THE RAINFALL IN 2017 in Three districts			
	San Sebastian	**Wanchaq**	**Santiago**
JANUARY	5,86	5,77	5,66
FEBRUARY	5,88	5,77	6,00
MARCH	5,92	5,90	5,60
APRIL	6,10	6,50	5,75
JUNE	5,65	5,55	5,70
JULY	5,75	5,60	5,65
SEPTEMBER	6,00	6,10	6,10
OCTOBER	5,86	5,92	5,82
NOVEMBER	5,20	5,25	5,50
DECEMBER	4,80	5,00	5,68
AVERAGE	5,696	5,736	5,746

TABLE N° 01

pH graph for San Sebastian

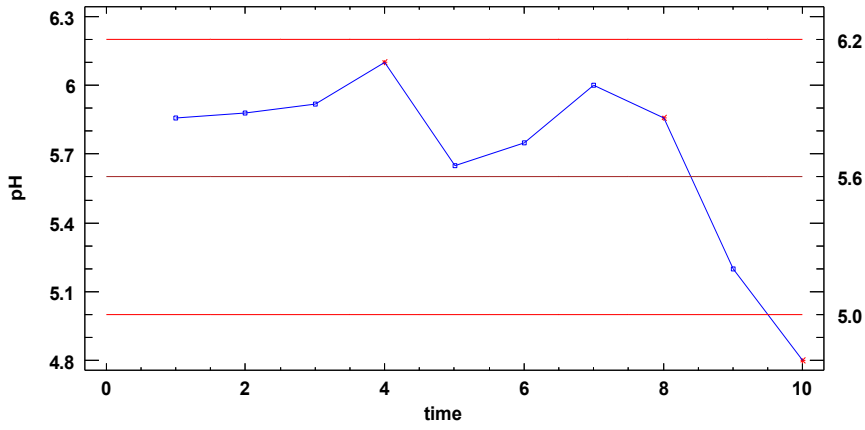


Figure 01. Acidity of Rainfall in the District of San Sebastián

Source: Own elaboration

This graph clarifies the following:

Reference value of acidity is 5.6 pH- Arauzo, G. (2007).

The time refers to the months: 1 (January), 2 (February), 3 (March), 4 (April), 5 (June), 6 (July), 7 (September), 8 (October), 9 (November) and 10 (December)

For the district of San Sebastián, the acidity of rainfall in 2017 is above the reference value in most months, being below this limit only in the months of November and December.

pH graph for Santiago

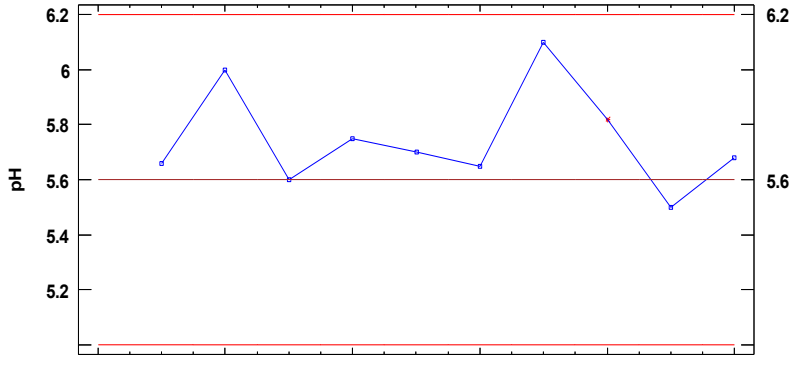


Figure 02. Acidity of Rainfall in the District of Santiago

Source: Own elaboration

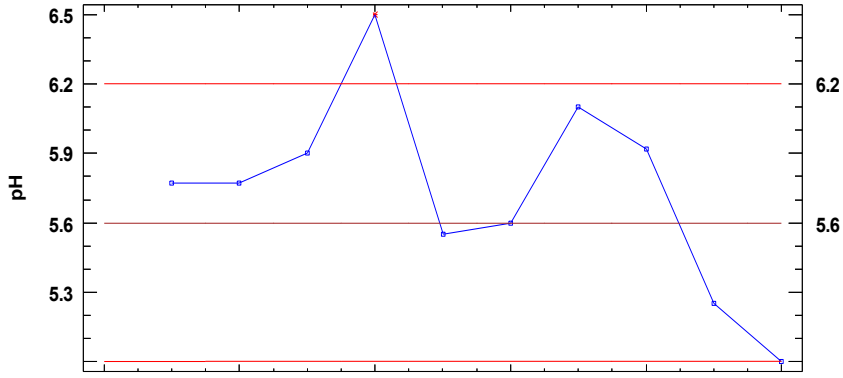
This graph clarifies the following:

Reference value of acidity is 5.6 pH- Arauzo, G. (2007).

The time refers to the months: 1 (January), 2 (February), 3 (March), 4 (April), 5 (June), 6 (July), 7 (September), 8 (October), 9 (November) and 10 (December)

For the district of Santiago, the acidity of rainfall in 2017 is above the reference value in most months, being below this limit only in the month of November.

pH Graph for Wanchaq



Graph 03. Acidity of rainfall in the District of Wanchaq

Source: Own elaboration

This graph clarifies the following:

Reference value of acidity is 5.6 pH- Arauzo, G. (2007).

The time refers to the months: 1 (January), 2 (February), 3 (March), 4 (April), 5 (June), 6 (July), 7 (September), 8 (October), 9 (November) and 10 (December)

For the district of Santiago, the acidity of rainfall in 2017 is above the reference value in most months, being below this limit only in the months of November and December.

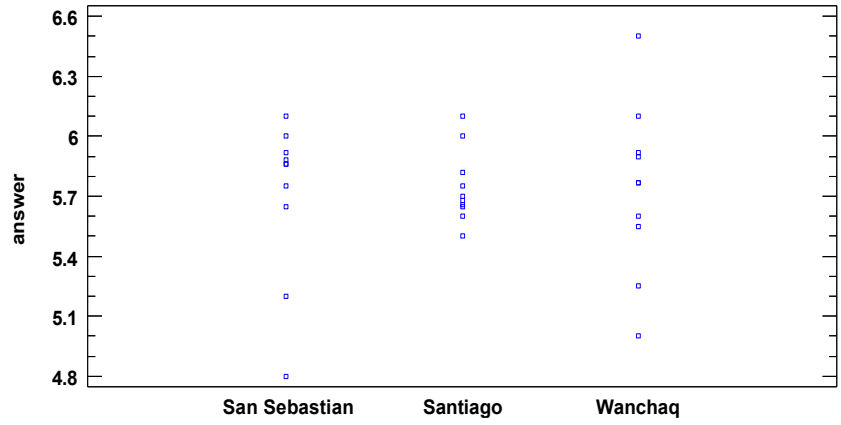
COMPARATIVE ANALYSIS OF THE DEGREE OF ACIDITY OF RAINFALL IN THE DISTRICTS OF WANCHAQ, SANTIAGO AND SAN SEBASTIAN YEAR 2017

Statistical Summary

	Recount	*Average*	*Standard deviation*	*Coefficient of Variation*	*Minimal*	*Maximum*
San Sebastián	10	5.702	0.400966	7.03202%	4.8	6.1
Santiago	10	5.746	0.182647	3.17868%	5.5	6.1
Wanchaq	10	5.736	0.422984	7.3742%	5.0	6.5
Total	30	5.728	0.340794	5.94962%	4.8	6.5

Chart 04

Dispersion by Sample



Source: Own elaboration

In this graph it is clarified that "response" is pH (acidity).

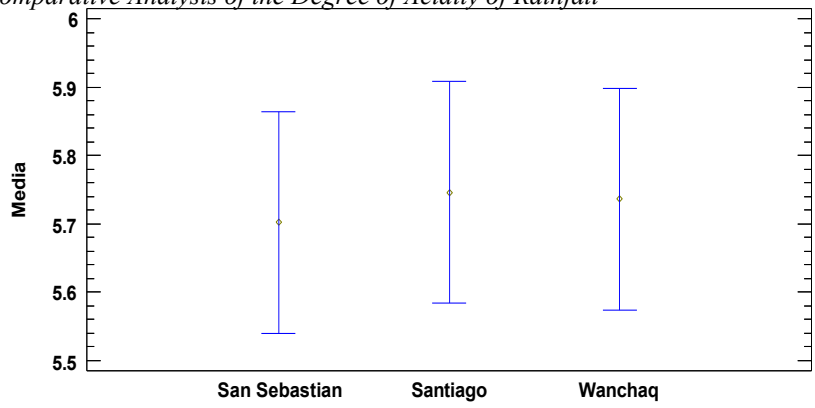
In this graph it can be seen that in the district of Santiago there is not much dispersion in the data, unlike the districts of San Sebastian and Wanchaq, which present dispersion in the data.

ANOVA Table

Fountain	*Sum of Squares*	*Gl*	*Middle Square*	*F-Reason*	*P-Value*
Between groups	0.01064	2	0.00532	0.04	0.9582
Intra groups	3.35744	27	0.12435		
Total (Corr.)	3.36808	29			

Table of Means with 95.0% confidence intervals

			Error is.		
	Cases	*Media*	*(s grouped)*	*Lower Limit*	*Upper Limit*
San Sebastián	10	5.702	0.111512	5.54021	5.86379
Santiago	10	5.746	0.111512	5.58421	5.90779
Wanchaq	10	5.736	0.111512	5.57421	5.89779
Total	30	5.728			



Graph 05: Distribution of Acidity Degree By District

Source: Own elaboration

This graph clarifies the following:

"Average" refers to the average pH in each district in 2017.

The graph shows that the average value of acidity in the district of Wanchaq is slightly below the average value of the district of Santiago from 5.736 to 5.746 and the average value of the district of Santiago is above the average value of the district of San Sebastián from 5.746 to 5.702.

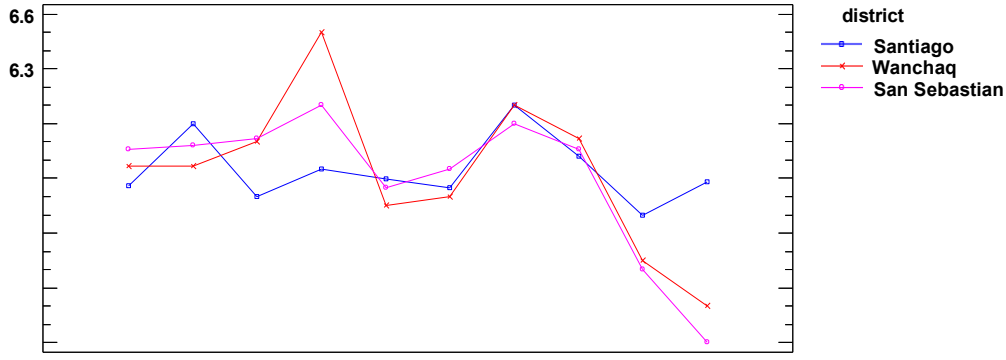


Figure 06: Distribution of Acidity by Month and District

Source: Own elaboration

This graph clarifies the following:

Reference value of acidity is 5.6 pH- Arauzo, G. (2007).

The time refers to the months: 1 (January), 2 (February), 3 (March), 4 (April), 5 (June), 6 (July), 7 (September), 8 (October), 9 (November) and 10 (December)

The graph shows that the behavior of higher and lower acidity in the districts of Santiago, Wanchaq and San Sebastián have been similar in most of the months under study. In addition, it is observed that the districts of Wanchaq and San Sebastián present acidity in the months of

November and December, unlike the district of Santiago.

Conclusions

When performing the comparative analysis of the degree of acidity of rainfall with the value given in the bibliographic reference (Arauzo, G. (2007)) of 5.6 acidity pH, in 2017 the average acidity value is 5.728 higher than 5.6 pH, therefore there is no acid rain in the city of Cusco.

1. The districts that approach the permissible value of 5.6 pH are the districts of San Sebastián, which has an average value of 5.702 pH, and the district of Wanchaq, with an average value of 5.736 pH.

2. The months with a pH value below 5.6 pH are the months of November with an average value of 5.317 pH and the month of December with an average value of 5.16 pH. In these months the rain was acidic in an intermediate value.

3. In the district of San Sebastián there is a significant difference in the permissible value of acidity in rainfall of 5.6 pH, with a range of [4.8 − 6.1] pH. In the district of Wanchaq there is a significant difference in the allowable value of acidity in rainfall of 5.6 pH, with a range of [5.0 − 6.50] pH. In the district of Santiago there is no significant difference in the permissible value of acidity in rainfall of 5.6 pH, with a range of [5.50 − 6.10] pH..

References

ARAUZO, G. (2007). "Acid Rain in Central Peru".

CABRERA, R. ROBLES, E. (1997). "Preliminary Public Health Impact Assessment of Selected Communities Exposed to Pollution and Air Pollutants."

Enkerlin, E. and Mier M.(1997). "Soil and Water. Environmental Science and Sustainable Development": 126-150.

Garza, R. A. & Enkerlin, E. (1997). "Natural Populations and their Characteristics. Environmental Science and Sustainable Development": 126-150.

Garza, C. R. & Gonzáles, L. (1997) Principles of Environmental Science. Environmental Science and Sustainable Development: 99-124.

HEDIN, L. & LIKEN, G. (1997). "Atmospheric dust and acid rain. Research and Science". Barcelona. Scientific Press .

HERNANDEZ, A. J. (1987). "Student Collective of Ecology". UNCEA S.A. Spain Madrid.

KENISETH, F. H. (2007). "Environmental Disturbances of Human Origin" – Canada.

Scragg, A. (199). "Monitoring. Environmental: Environmental Biotechnology". Verses 27-55.

Seoánes, M. (2002). "Volcanoes and Climate. Treatise on Climatology Applied to Environmental Engineering, Climate Analysis Use of Climate Analysis in Environmental Studies". 2002: 427-431.