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Comparative study of the years 2017, 2018 and 2019 of PM 10 particle sampling of the frontera, Comalcalco and paraíso municipalities

Estudio comparativo de los años 2017, 2018 y 2019 de muestreos de particulas PM 10 de los municipios frontera, Comalcalco y Paraíso

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Abstract

Air pollution is currently one of the greatest health risks. Among the effects that have been associated with atmospheric pollution are increases in respiratory and cardiovascular diseases, which are generated by fixed and mobile sources. One of the main pollutants in the atmosphere is particulate matter, which is a complex mixture of substances in a liquid or solid state that remains in suspension for a certain period of time. Due to this, the following work was carried out to evaluate the periods of highest concentrations of PM10 particles of the years 2017, 2018, and 2019 and compare them with meteorological data; temperature, and humidity of the municipalities of Centla, Comalcalco, and Paraíso. To achieve the development of this research, the data from each of the meteorological settled stations were downloaded, in order to give each one a previous treatment of the data in Excel by averaging the sampled days. For the treatment of the data, an Excel database was created to later manage them in the Minitad software to obtain the scatter plots where the concentrations of each of the municipalities were compared. In conclusion, we can say that the only municipality that exceeded the Metropolitan Air Quality Index (IMECA) was the municipality of Comalcalco where 11 dates were presented that exceeded the LMP, with values ranging from 76 µg /m3 to 110 µg /m3 . In graphs 4, 5, and 6, we can say that despite having ascending regression lines and positive correlations ranging from r= 0.1 to 0.4, we could not interpret that there is a correlation between both variables. As graphs 7, 8, and 9 show, we could also observe ascending and descending regression lines with mostly negative correlations ranging from r= -0.1 to -0.4, so we could say that their correlation is inverse, that the higher the increase in relative humidity, the lower the concentration of particulate matter.

Air quality, Particulate matter, Maximum Permissible Limit (LMP), Atmospheric pollution

Resumen

La contaminación del aire actualmente es uno de los mayores riesgos para la salud, entre los efectos que se han asociado con la contaminación atmosférica están los incrementos de enfermedades respiratorias, cardiovasculares, estas son generadas por fuentes fijas y móviles. Uno de los principales contaminantes encontrados en la atmósfera es el material particulado, que es una mezcla compleja de sustancias en estado líquido o sólido que permanece un cierto tiempo en suspensión. Debido a esto se realizó el siguiente trabajo para evaluar los periodos de más altas concentraciones de partículas PM10 de los años 2017, 2018 y 2019 y compararlos con datos meteorológicos; temperatura y humedad de los municipios de Centla, Comalcalco y Paraíso. Para lograr el desarrollo de esta investigación se descargaron los datos meteorológicos de cada una de las estaciones meteorológicas de Centla, Comalcalco y Paraíso, para así a cada una darle un previo tratamiento de los datos en Excel promediando los días muestreados. Para el tratamiento de los datos se creó una base en Excel para luego manejarlos en el Software Minitad para la obtención de las gráficas de dispersión en donde se comparó las concentraciones de cada uno de los municipios. Como conclusión podemos decir que el único municipio que rebaso el Índice Metropolitano de la Calidad del Aire (IMECA) fue el municipio de Comalcalco en donde se presentaron 11 fechas que rebasaron los LMP siendo valores desde 76 µg /m3 a 110 µg /m3 . Ante las gráficas 4, 5 y 6 podemos decir que a pesar de tener líneas de regresión ascendentes y de tener de igual manera correlación positivas que van desde r= 0.1 a 0.4 no podríamos interpretar que exista una correlación entre ambas variables y en las gráficas 7, 8 y 9 se pudo observar de igual manera líneas de regresión ascendentes y descendentes teniendo mayoría de correlaciones negativas que van desde r= -0.1 a -0.4 ante esto podríamos decir que su correlación es inversa que, entre mayor incremento de la humedad relativa, la concentración de partículas disminuye.

Calidad del aire, Material particulado, Límite máximo permisible (LMP), Contaminación atmosférica

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Introduction

Air pollution is currently one of the greatest risks to human health, property and the environment due to the presence or accumulation of air pollutants such as dust, fumes, gases and particles, for which there is a great diversity of sources that emit air pollutants, including industrial and mobile sources (Cortez Chávez, 2019). Among the effects that have been associated with air pollution are increases in respiratory and cardiovascular diseases, premature mortality, use of medical services and lost work days. These and other health impacts from exposure to air pollution not only diminish quality of life, but also have economic repercussions for the individual and for society as a whole (ProAire, 2010).

One of the main pollutants found in the atmosphere is particulate matter, which is a complex mixture of substances in liquid or solid state, which remains suspended in the atmosphere for varying periods of time and affects more people than any other pollutant (Suarez García, Zarate, Pérez Duran, & Reyes Hernández, 2018). The main components of particulate matter are sulphates, nitrates, ammonia, sodium chloride, soot, mineral dusts and water. They consist of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air (WHO, 2016).

According to their aerodynamic diameter, they can be classified as less than or equal to 10 microns (PM10), less than or equal to 2.5 microns (PM2.5) and less than or equal to 0.1 microns (PM0.1). Size is an important parameter to characterise their behaviour in the atmosphere and, therefore, the concentration to which the population may be exposed; it also determines the capacity for penetration and retention in various regions of the respiratory tract (NOM-025-SSA1-2014, 2014).

The WHO has established the relationship between particulate matter and public health, where the health effects are broad, related in some cases to symptoms in the upper respiratory tract, such as allergic reactions, nasal congestion, sinusitis, cough, hay fever, eye irritation, among others. Some 4.3 million premature deaths in 2012 were attributable to household air pollution. Therefore, the need for reliable and quality information on air pollution levels is evident.

This means the urgent implementation and modernisation of monitoring systems that increase the representativeness, compatibility and validity of the information collected (NOM156-SEMARNAT-2012, 2012). This instrumentation is the air quality monitoring where it takes a fundamental importance to identify and provide the necessary information in order to evaluate the air quality of each region and its entities.

Problem statement

Particulate matter is a complex mixture of substances in liquid or solid state, which remains suspended in the atmosphere for varying periods of time, PM10 is one of the main air quality problems in several areas of the country. As a consequence, air pollutants are responsible for contributing to the increase in overall mortality, and hospitalisations for respiratory and cardiac diseases.

Air quality monitoring takes on a fundamental importance to identify and provide the necessary information to evaluate air quality in order to develop strategies for the prevention and control of air pollution, therefore it is necessary to determine the main variables that affect or reduce air quality in the city, in this case it is therefore necessary to measure PM10 particulate pollutants.

Modelling is used to find out, among other things, how the concentration or mixing ratio of a substance or trace usually identified as a criteria pollutant changes over time and space, in this case PM10 particulate matter concentrations. In this work we seek to evaluate the highest concentrations of PM10 particles in the municipalities of Centla, Paraíso and Comalcalco for a period of 2017, 2018 and 2019.

It will be studied under two variables which are time (years) and concentration (PM10 particles) in order to study the correlation coefficient between both variables and evaluate the trend (increasing or decreasing) in the data. Correlation coefficients can therefore be positive or negative. What these coefficients express is well understood by their graphical representation, by means of scatter diagrams in which the two variables are symbolised by the letters X and Y.

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General Objective:

To evaluate the periods of highest PM10 particulate matter concentrations for the years 2017, 2018 and 2019 and compare them with meteorological data; temperature and humidity.

Objetivos Específicos:

a) Process the PM10 particle concentrations data from Excel to Minitab software where the data will be analysed.

b) Perform a comparative analysis of the results with the NOM-025- SSA1-2014 standard to identify if the particle concentrations exceed the maximum permissible limits.

c) Identify the existence of a relationship or correlation of PM10 particle concentrations data for 2017, 2018 and 2019 with the meteorological parameters: humidity and temperature.

d) Propose prevention and reduction measures for PM10 emitting sources.

Methodology

a) Description of the sampling site

The present investigation was carried out with PM10 particulate matter concentrations, temperature and relative humidity data from the nodes located at the Instituto Tecnológico Superior de Centla, Instituto Tecnológico Superior de Comalcalco and Universidad Politécnica del Golfo de México (see table 1). Sampling was carried out with high-volume sampling equipment (Hi-Vol.). Sampling was performed every sixth day with a duration of 24 hours, the sampler draws ambient air at a constant flow into a specially shaped orifice where the suspended particulate matter is inertially separated into fractions of one or more sizes within the PM10 size range, then collected on a separate filter for the specified sampling period. Each filter is weighed (after moisture balance) before and after use to determine its net weight gain of the PM10 collected, using the gravimetric method.

Municipality	Institution	Key	Address	Coordenadas
Centla	Instituto Tecnologico Superior de Centla	ITSCentla	Calle Ejido S/N Colonia Siglo XXI Frontera, Centla, Tabasco .	18° 31.942'N 92° 37.989'O
Paradise	Polytechnical Furnace of the Gulf of Mexico	UPGM	Carretera Federal Malpaso- El Bellote Km. 171/ Ranchería Monte Adentro, Paraíso, Tabasco .	18° 22.092'N 93° 11.855'O
Comalcalco	Instituto Tecnologico Superior de Comalcalco	ITSC	Carretera Vecinal Comalcalco-Paraíso Km 2, Ra. Occidente 3era sección Comalcalco, Tabasco .	18° 17 42'N 93° 13.08'w

Table 1 Location of sampling points

b) Design and implementation of the sampling plan.

The methodological design was established with the objective of evaluating the air quality and the influence of meteorological parameters of the three municipalities mentioned above. Sampling was carried out based on the criteria established by NOM-035-SEMARNAT-1999, where each sampling was performed every 6th day with a duration of 4 hours, the meteorological data is permanently downloaded every 15 minutes through the DAVIS meteorological station. The process and breakdown of activities are shown below:

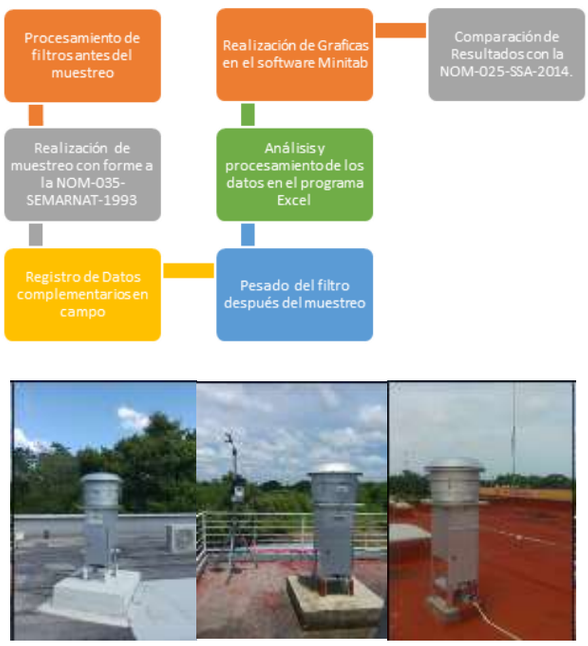
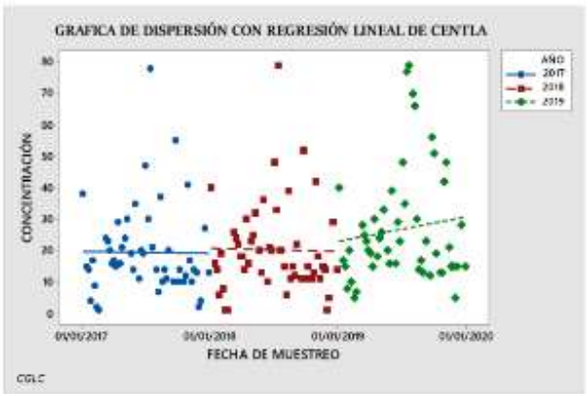


Figure 1 Sampling equipment at sampling sites sampling points

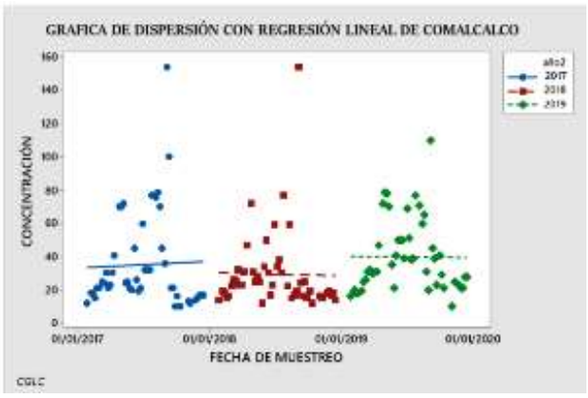
Results

The results shown below are derived from sampling conducted in 2017, 2018 and 2019.

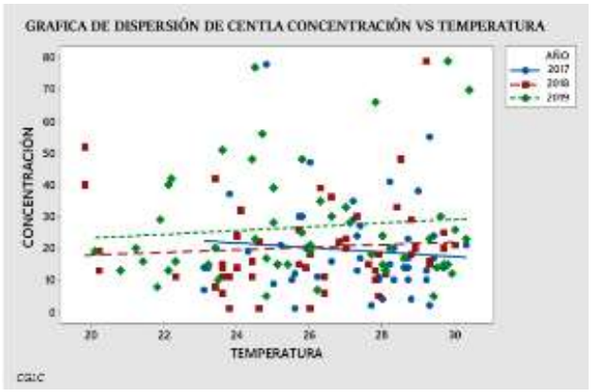


Graph 1 Particulate matter behaviour in 2017, 2018 and 2019 in the municipality of Centla

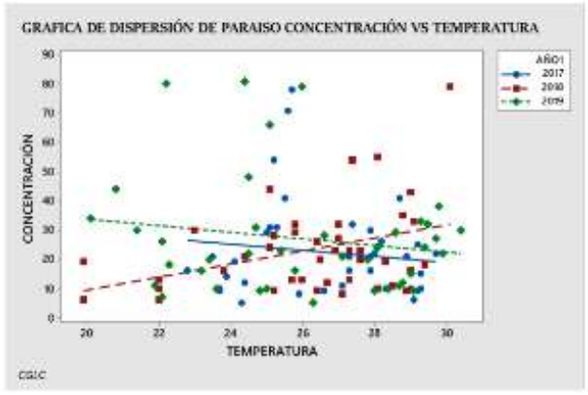
Graph 2 Particulate matter behaviour in 2017, 2018 and 2019 in the municipality of Paraíso



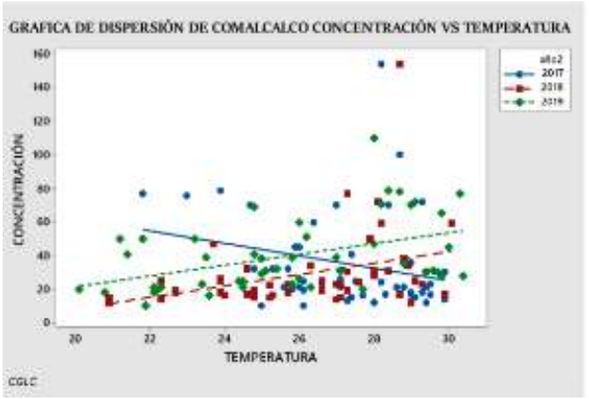
Graph 3. Particulate matter behaviour in 2017, 2018 and 2019 in the municipality of Comalcalco



Graph 4 Identification of the existence of correlation of concentrations vs. temperature in the municipality of Centla in 2017, 2018 and 2019



Graph 5 Identification of the existence of correlation of concentrations vs. temperature in the municipality of Paraíso in 2017, 2018 and 2019



Graph 6 Identification of the existence of correlation of concentrations vs temperature in the municipality of Comalcalco in 2017, 2018 and 2019

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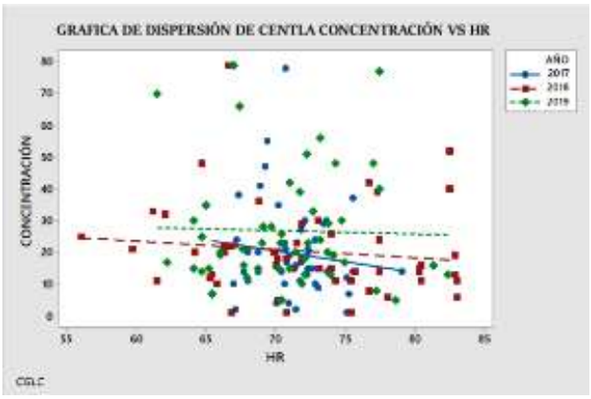
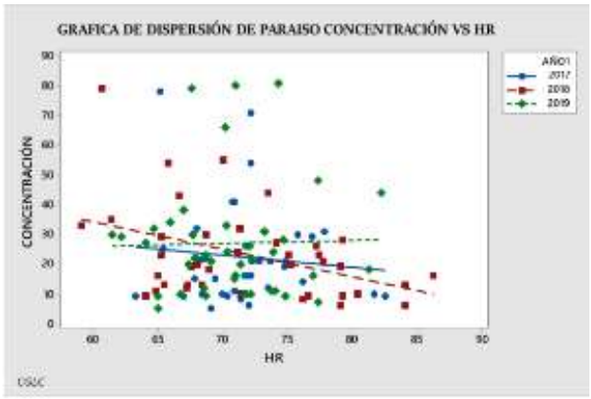
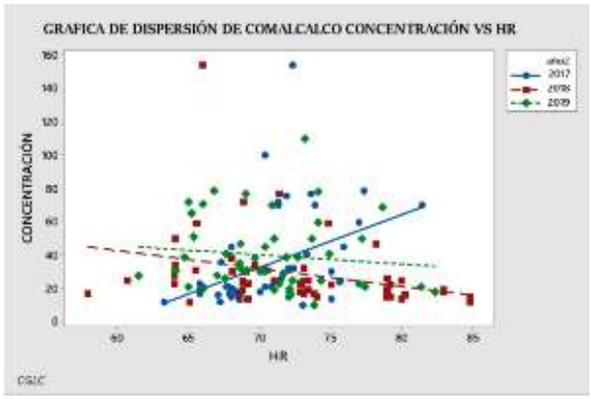


Graph 7 Identification of the existence of correlation of concentrations vs. RH in the municipality of Centla in 2017, 2018 and 2019



Graph 8 Identification of the existence of correlation of concentrations vs Hr in the municipality of Centla for the years 2017, 2018 and 2019



Graph 9 Identification of the existence of correlation of concentrations vs Hr in the municipality of Centla for the years 2017, 2018 and 2019

Conclusion

Based on the Metropolitan Air Quality Index (IMECA), the air quality of the municipalities of Centla, Paraíso is good and the air quality of Comalcalco is regular given that in the month in 11 samplings concentrations of up to 76 to 110 µg/m3 were reported.

Recommendations

- Avoid burning tyres, rubbish and any kind of waste, as well as fireworks.
- Reduce the use of cars.
- Avoid forest fires, burning of pastures and preparation of cultivated land.
- Avoid or reduce the use of domestic fireplaces, also known as open fires.
- Raise public awareness of the health problems caused by PM10.
- Have the correct chimney height.
- If we apply these simple but effective measures we will avoid:
- Increase the frequency of chronic and acute respiratory diseases.
-
- Reduce respiratory capacity.
- Increase asthma episodes. ✓ Increased cases of cardiovascular disease.
- Lung cancer risks

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