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SHORT COMMUNICATION

Environmental and health risk assessment of PM 2,5 and microplastics in Morales

Evaluación del riesgo ambiental y sanitario por PM 2,5 y microplásticos en Morales

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ABSTRACT

The research analyzed the impact of fine particulate matter (PM2,5) on atmospheric quality in the district of Morales, San Martin province, during the year 2022. PM2,5, with an aerodynamic diameter of less than 2,5 µm, was identified as one of the most dangerous pollutants worldwide, associated with millions of premature deaths and chronic respiratory diseases, lung cancer and other disorders. It was highlighted that its concentrations were determined by emissions, meteorological conditions and physicochemical transformations. In Morales, possible sources included rice milling plants, brick kilns, vulcanizing plants, service stations and agricultural activities. In addition, the possible presence of microplastics in the composition of PM2,5 was considered, which represented an additional risk to health and the environment. The research was justified on theoretical, social, economic and environmental criteria, underlining the need for monitoring and control. The lack of previous studies in Peru on the joint presence of PM2,5 and microplastics, as well as the limited real-time measurement infrastructure, motivated the study. The study sought to compare local concentrations with international references and national regulations, evaluating their significance in the deterioration of air quality. It was concluded that PM2,5 air pollution in Morales could have relevant impacts on public health and environmental quality, and that the identification of sources and characteristics of these particles was essential to develop effective mitigation and protection strategies for the population and the ecosystem.

Keywords: PM2,5; Air Pollution; Microplastics; Public Health; Morales.

RESUMEN

La investigación analizó el impacto del material particulado fino (PM2,5) en la calidad atmosférica del distrito de Morales, provincia de San Martín, durante el año 2022. El PM2,5, con un diámetro aerodinámico menor a 2,5 µm, fue identificado como uno de los contaminantes más peligrosos a nivel mundial, asociado a millones de muertes prematuras y a enfermedades respiratorias crónicas, cáncer pulmonar y otros trastornos. Se destacó que sus concentraciones estaban determinadas por emisiones, condiciones meteorológicas y transformaciones fisicoquímicas. En Morales, las posibles fuentes incluyeron plantas molineras de arroz, ladrilleras, vulcanizadoras, estaciones de servicio y actividades agrícolas. Además, se consideró la posible presencia de microplásticos en la composición del PM2,5, lo cual representó un riesgo adicional para la salud y el ambiente. La investigación se justificó en criterios teóricos, sociales, económicos y ambientales, subrayando la necesidad de monitoreo y control. La falta de estudios previos en el Perú sobre la presencia conjunta de PM2,5 y microplásticos, así como la limitada infraestructura de medición en tiempo real, motivó el estudio. Este buscó comparar las concentraciones locales con referencias internacionales y normativas

nacionales, evaluando su significancia en el deterioro de la calidad del aire. Se concluyó que la contaminación atmosférica por PM2,5 en Morales podía tener impactos relevantes en la salud pública y en la calidad ambiental, y que la identificación de fuentes y características de estas partículas era esencial para desarrollar estrategias efectivas de mitigación y protección de la población y del ecosistema.

Palabras clave: PM2,5; Contaminación Atmosférica; Microplásticos; Salud Pública; Morales.

BACKGROUND

Particulate matter in the atmosphere generates pollution. Particles with an aerodynamic diameter of less than 2,5 µm (PM2,5) are a major environmental risk factor and the fifth leading cause of death worldwide and economic growth.[1] Suspended particles block incoming shortwave radiation, producing a cooling effect as a manifestation of widespread changes in human settlement patterns and associated anthropogenic processes. In humans, the presence of PM2,5 affects the first line of defense of the upper respiratory tract, thus people who breathe high levels of pollutants are more likely to develop chronic respiratory conditions. The concentration of PM2,5 at a specific place and time is collectively determined by various factors, such as emissions, meteorological factors, the microenvironment, and physicochemical transformations.[2]

However, exposure to PM2,5 suspended particles in humans through dust remains unclear, mainly due to difficulties associated with the manifestation of PM mass. Although the adverse effects of PM2,5 ingestion in humans are debatable, many pollutants, e.g. e.g., phthalates (PAE), bisphenol A (BPA), and hydrophobic aromatic compounds.[3]

PM2,5 is one of the most dangerous pollutants compared to PM10. In China, it is considered one of the causes of diseases such as lung cancer and respiratory tract infections, as well as causing headaches, disorders, nausea, etc. As a result, there are 1,1 million premature deaths, which means that PM2,5 endangers the health of the population.[4]

Air pollution generated by particulate matter is identified through monitoring, which measures fine PM2,5 particles. PM2,5 concentrations significantly affect the respiratory tract and lungs. PM2,5 particles are a health risk because they penetrate the human body. Exposure to outdoor air is considered the fifth leading risk factor worldwide, accounting for 4,2 million deaths over more than 100 million years.[5]

Pollution from environmental particles smaller than 2,5 mm (PM2,5) is considered a significant global health problem, causing mortality and various morbidities.

However, nearly 500 000 deaths from CL and 1,6 million victims of COPD in 2016 were attributed to environmental PM2,5 particles as a major health hazard to the global population.[6]

It is estimated that PM2,5 suspended particle pollution will become even more harmful in the coming decades.

This is a consequence of ongoing excessive urbanization. This pollution from PM2,5 particulate matter affects our planet, where it has global implications of great importance through effective transport by meteorological conditions to the troposphere and lower stratosphere, where the polluting materials can be redistributed on a global scale and thus disrupt global climate forcing and air quality. In addition, intensive emissions and meteorological conditions that are detrimental to dispersion can significantly increase PM2,5 and cause dangerous short-term exposure with high health risks.[1,7]

Identifying seasonal and diurnal variations in urban PM2,5 concentrations and their relationships with meteorology is key to understanding the drivers of air pollution and designing effective mitigation strategies in cities.[8]

Long-term in situ follow-up studies are essential to understand these factors; however, only a few studies have been conducted that provide long-term research on PM2,5, and most of these have focused only on places with large populations.

The composition of PM2,5 varies from minerals to microplastics, which also deserve special attention in this case. They are considered an emerging concern worldwide, as recent studies have determined that microplastics are not microplastics, just as pesticides are not pesticides. “Microplastics,” like other types of chemical pollutants, is a general term for a variety of unique chemical compounds. However, many scientific publications, policy reports, and news articles present microplastics as if they were simply a single compound or type of material. The most recent definition of microplastics follows the international standard nomenclature for microplastics = 5 mm − 1 µm. Furthermore, the number of peer-reviewed publications on microplastics has increased rapidly over the last decade in almost all environmental systems,[9] as well as in human food and beverages.

On the other hand, worldwide, plastic production has increased significantly from 1,5 million tons in 1950 to 368 million tons in 2019, revealing the growth in the amount of waste generated by humans. Living on the

move requires the use of easy-to-use disposable products, such as cans and soft drink bottles, causing plastic pollution to increase worldwide.[10] Estimates suggest that plastic production is increasing by 3 % each year worldwide; this increase in production, together with the ever-growing human population, has led to the generation of large volumes of plastic waste. It has been estimated that 55 % of the total amount of plastic waste generated worldwide was discarded into the environment, while 25 % and 20 % were incinerated and recycled, respectively, in 2015.[11]

However, the implications of microplastics in the environment are unclear, and some studies suggest negative impacts on organisms, such as lower growth rates, higher levels of contaminants, and deformities. This is because microplastics can be physical (mechanical) and/or chemical (toxicological) in nature. including the leaching of plastics from, for example, carcinogenic contaminants.[12]

The variability in the nature of microplastics is very wide, as there is a range of polymers, particle sizes, colors, morphologies, and associated contaminants. In addition, microplastics are often found in irregular concentrations with complex mixtures of particle types, making it difficult to determine the ecological risk posed by microplastics in the environment.[13]

With regard to their presence in the air, there are still very few studies on their characteristics or distribution, especially for particles with diameters smaller than 2,5 µm or 10 µm (PM2,5 and PM10). It is known that the deposition rates of microplastics in the air vary with atmospheric elevation. Airborne microplastics move more than those found in sediments or water.[10,14]

Airborne microplastics are complex and dynamic mixtures generally composed of polymers, minerals, plastic degradation by-products, and other associated chemicals that can change with environmental conditions and affect their environmental impacts. Synthetic plastics widely used on a daily basis are produced from polystyrene (PS), polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET), and polyvinyl chloride (PVC), which can enter the environment and transform into microplastics in the atmosphere.

It has also been reported that particles (PM2,5) and microplastics could act as carriers of polycyclic aromatic hydrocarbons (PAHs) that may increase the potential risk of cancer.

In the town of Morales, San Martín province, Peru, possible sources of PM2,5 pollution have been identified, whose composition could include microplastics. Among the sources are rice mills, brick factories, tire repair shops, gas stations, agriculture, shopping centers, and workshops dedicated to plastic reuse. Based on these considerations, 10 sampling points were determined in the study area to collect PM2,5 samples and assess the presence of microplastics that could affect the health of the residents of Morales. Despite existing studies worldwide on PM2,5 and MP, in Peru, there is still no monitoring system capable of maintaining real-time sampling networks or the technology to identify MP. In the country's most populated cities, the network is still very limited and only a few entities have it. To date, there are no research reports demonstrating the presence of MP with PM2,5 that poses a high health risk in that location. It is important to cover this information in order to provide a management tool for decision-makers, local governments, and competent authorities, as they can optimize the control of emission sources and ensure air quality for the benefit of all living beings and the environment.

The research is justified on four criteria: theoretical, social, economic, and environmental. The theoretical justification discusses the size and persistence of these PM2,5 particles, which lead to environmental accumulation with possible consequences for organisms. It is relevant to identify the physicochemical processes related to the presence and concentration of PM2,5 and MP.[16]

With regard to social justification, because PM2,5 and microplastics may be present in the environment, such as in water or terrestrial ecosystems, including mountainous areas, there is a potential danger of deterioration in human living conditions. Demographic expansion causes humans to consume and/oruse plastic products, which are often disposed of irresponsibly in landfills or generated by human activities. Therefore, the research aims to disseminate the current levels of PM2,5 and MP to raise awareness among the general population and authorities so that they can amend regulations and improve their control and prevention measures.[17]

In economic terms, most airborne fibers are natural fibers (such as cotton), but polyester (polyethylene terephthalate, also known as PET) is one of the most common synthetic fibers. This study suggests that readers reduce their purchases and consumption of plastics used in our daily activities, as the world's leading countries use this material for many different social and military purposes.[18,19]

In terms of environmental justification, air pollution and deterioration are a major risk to environmental hygiene. Air pollution is estimated to cause 6,7 million premature deaths each year worldwide.[20] Particulate matter (PM2,5) is believed to be the main cause of harmful health effects caused by air pollution, but the most toxic components and/or sources of PM2,5 have not been definitively determined. In this context, the research seeks to measure the impacts of suspended matter (PM2,5) and microplastics on air quality in Morales as a tool that can be taken into account to improve local air quality management and conditions.

Given the above, the following problem is posed:

P.G What is the impact of Particulate Matter 2,5 on air quality in the district of Morales, San Martín Province,

in 2022?

PE1. Are the concentrations of particulate matter 2,5 comparable with international reference values?

PE2. Are the concentrations of particulate matter 2,5 comparable with national regulations?

O.G. Evaluate the impact of particulate matter 2,5 on air quality in the Morales district, San Martín province, in 2022.

SO1. Analyze concentrations of particulate matter 2,5 against international reference values.

SO2. Analyze the influence of particulate matter 2,5 concentrations against national regulations

H.G. The impact of particulate matter (PM2,5) on air quality in the District of Morales, Province of San Martín, in 2022 is significant.

HE1. Particulate matter 2,5 concentrations are not comparable with international reference values

HE2. Concentrations of particulate matter 2,5 are not comparable with national regulations.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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