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Editorial

Editorial: Nano- and Micro-Contaminants and Their Effect on the Humans and Environment

Luis F. O. Silva [1,*] and Hongya Niu [2]

1 Department of Civil and Environmental Engineering, Universidad de la Costa, Calle 58 #55-66, Barranquilla 080002, Colombia
2 Key Laboratory of Resource Exploration Research of Heibei Province, Hebei University of Engineering, Handan 056038, China; niuhongya@hebeu.edu.cn
* Correspondence: lsilva8@cuc.edu.co

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Nano- and ultra-fine materials have a significant influence on construction building materials, the environment, and human health. On the other hand, these natural factors are connected to increased water contamination, the emergence of pollutants in nature, greenhouse gas production, and the toxic effects of fuels, micro/nanoplastics, and chemicals, all of which are of the utmost importance for ecological defense. This special issue (SI) of Sustainability provides an overview of nano- and microscience-based environmental applications and discoveries concerning the following: mineral mining, refining/production, and the disposal of mining wastes; atmosphereic and sea changes; soil health; general contaminant remediation strategies; and the influences on water/soil quality. These processes result in massive pollution generation which has highly significant environmental implications and human health consequences on local, regional, and even global levels. Until recently, very little was known about nano- and microparticle fractions. Recent advancements and sophistications enable us to detect, collect, and study those materials which are roughly 1 nanometer (0.001 microns) up to several tens of nanometers in size. Several contaminating materials are known to behave differently (chemically, electrically, and mechanically), relative to their macroscopic equivalents. This is what makes nano and microscience fascinating and difficult to predict, underscoring the importance of this emerging new field. This contamination incorporates extensive and distant transportation of wastes down rivers and ultimately into seas, such as is the case of mine drainages, as well as petroleum refinery, and other industrial human activities. In terms of human health, in all phases of mining, oil production/refining, use, and waste disposal, the associated pollution can be acquired through oral ingestion, inhalation, and dermal absorption. There is also currently a gap between what we know so far about the behavior of nano- and microparticles, and what remains to be determined. In addition, eco-friendly and green nanoscience hold abundant promise in terms of meeting large-scale challenges, offering solutions to these problems in the forms of preventive and remedial tools to diminish contaminants in the several ecosystems.

Urban and agricultural runoff, fossil fuel combustion, domestic and industrial wastewater effluents, and atmospheric deposition generate large volumes of nutrient-rich organic and inorganic waste. In their original state under subsurface conditions, they can remain inert and thermodynamically stable, although when some of their components are exposed to surface conditions, they undergo great physicochemical and mineralogical transformations which mobilize their constituents, often resulting in environmental contamination. These residues can be used in the production of Technosols as agricultural inputs and to aid the recovery of degraded areas. Technosol is defined as artificial soil made from organic and inorganic waste, capable of performing environmental and productive functions in a similar way to natural soils. Gonçalves [1] presents the results of international research on the use of Technosol to increase soil fertility levels and help recover degraded areas in some countries. The conclusions of the various studies served to expand the field of applicability of this line of research on Technosols in contaminated spaces. The review indicated very promising results which support the sustainability of our ecosystem; the improvement achieved with this procedure in soils is comparable to the hybridization and selection of plants that agriculture has performed for centuries to obtain better harvests. Thus, the use of a Technosol presupposes a much faster recovery without the need for any other type of intervention. On the other hand, the environmental benefits of incorporating coal fly ash (CFA) into the concrete manufacturing process as a partial substitute for Portland cement are well known [2]. What is less studied is the potential release of CFA-derived nanominerals and amorphous nanoparticles during this process of incorporation. A thorough understanding of this process makes it possible to understand the risks of exposure to particulates that are harmful to human health when CFA is mixed into concrete. The general objective of this study was to analyze airborne particulates released when CFA is mixed into concrete at the point of manufacture, focusing on the levels of nanominerals, amorphous nanoparticles, and hazardous elements (HEs) contained within which are considered harmful to human health. These airborne particulates can be easily inhaled by plant workers in the absence of personal protective equipment. The authors analyzed samples of the ash itself and collected actual airborne particulates using self-made passive samplers installed at the manufacturing plant. Regarding the ash analyzed, iron (Fe) was found in large amounts in relation to calcium (Ca), magnesium (Mg) and silicon (Si). The transportation, disposal, and application of CFA in civil construction projects can increase efficiency and reduce overall costs associated with the production of concrete. However, CFA poses a threat to human health due to the significant amount of HEs, nanominerals, and amorphous nanoparticles found to be released into the environment at the manufacturing plant. Several researchers have described the correlation between short-term contact with nanoparticulate (NP) matter in diverse coal phases and amplified death or hospitalizations for breathing disorders in humans. However, few reports have examined the short-term consequences of source-specific nanoparticles (NPs) in coal mining areas. Advanced microscopic techniques can detect the ultra-fine particles (UFPs) and nanoparticles that contain potential hazardous elements (PHEs) generated in coal mining areas. Secondary aerosols that cause multiple and complex groups of particulate matter (PM_{10}, $PM_{2.5}$, PM_1) can be collected on dry deposition [3]. In a study by Akinyemi et al. [3], scanning electron microscopy (SEM) and high-resolution transmission electron microscopy (HR-TEM) were employed to detect and define the magnitude of particulate matters on restaurants walls at coal mines due to weathering interactions. The low-cost self-made passive sampler (SMPS) documented several minerals and amorphous phases. The results indicated that most of the detected coal minerals exist in a combined form as numerous complexes comprising significant elements (e.g., Al, C, Fe, K, Mg, S, and Ti), whereas others exist as amorphous or organic compounds. Based on an analytical approach, the study findings present a comprehensive understanding of existing potential hazardous elements in the nanoparticles and ultrafine particles from coal mining areas in Brazil.

Based on the increase in coal mining activities and recent population growth projections in Colombia, large quantities of nanoparticles (NPs) and potentially hazardous elements (PHEs) will be of major concern to mine workers, indigenous residents, and surrounding communities [4]. This study highlights the need to regulate the pollution from Colombian mining activities that comply with regional regulations and global strategies. Colombian coal rejects (CRs) from the Cesar Basin, Colombia, were studied primarily by advanced electron microscopic and analytical procedures. Therefore, the goal of this research is to evaluate the role of NPs in the alteration of CRs' structure in a renewed zone at Cerrejón coal area (La Guajira, Colombia) through advanced electron microscopic methods (AEMs). The AEMs provided comprehensive insights into the geochemical evolution of CRs. Consequently, the AEMs can be used as essential tools for CR management in coal mining areas. The regular dimension of detected NPs was found to be above 2 nm. Ultrafine particles of quartz were identified by the advanced electron microscopy. Furthermore, the findings also revealed aluminium, calcium, potassium, titanium, iron oxides, and PHEs in the CRs. The extensive water practice in the coal extraction process combined with atmospheric oxygen supports oxidations of iron sulphide, thereby releasing PHEs into the surrounding environment. Dehydrated sulphate salts fluctuate at consistent humidity in the coal mine environments. The study demonstrates the great influence of coal mining activities on the environment and human health.

Selenium is an essential trace element for human health with crucial biological functions. Hao [5] showed Se concentrations and physicochemical properties of soils in China by determining their spatial distribution, enrichment degree, influencing factor, and geological source. The results show that: (1) Se concentrations vary from 0.00 to 1.95 μg/g, with an average of 0.45 μg/g, which exceed the mean of Se in soils in China (0.29 μg/g) and the Hebei Plain area (0.21 μg/g). (2) A continuous and irregular ring-like area showing significant enrichment of Se could be identified in Handan city, Yongnian District, Wu'an City, and in Fengfeng Mining District. It can be defined as a positive abnormal Se zone, which is mainly located in the hilly area in the west of Handan City and east of the Taihang Mountains, and the plains near Handan City. (3) Comprehensively, Se enrichment in the soil is principally affected by rock weathering, mining activities, and coal combustion. (4) As far as the single-factor pollution index (SFPI) is concerned, most of the study areas are in the safety domain and slightly polluted domain and are at low ecological risk. According to the Nemerow integrated pollution index (NIPI), the moderately and seriously polluted domains are distributed in Handan City, Fengfeng Mining District, and other central areas.

Advanced materials (e.g., lignocellulosics) have been considered as alternative sources from which liquid biofuel and fine chemicals can be produced with a moderate environmental impact. However, they can be contaminated with metals, soil, and ash, owing to the incrustation and corrosion of industrial reactors and pipelines. Santos's [6] use of ultrasound energy was applied for the removal of metals and nonmetals (Ba, Ca, Mg, Mn, P, S, Si, and Sr) from sugarcane straw. Ultrasound-assisted demineralization (UAD) experiments were carried out in ultrasonic baths at several frequencies (from 25 up to 130 kHz). The following experimental conditions were evaluated: the demineralization solution concentration (from 5 to 30% v/v), the extraction temperature (from 30 to 70 °C), the sonication time (from 5 to 45 min), and the ultrasound amplitude (from 10 to 70%). Higher-quality demineralization efficiencies (66%) were obtained by employing an ultrasound bath operating at 25 kHz for 30 min, an ultrasound amplitude of 60%, and using a diluted H2O2 solution (15% v/v) at 70 °C. When the obtained results were compared with those obtained by mechanical stirring (MS, 500 rpm), it was observed that the use of ultrasound energy increased the demineralization efficiency by up to 16%. Furthermore, acid hydrolysis was performed to evaluate the influence of US and mechanical stirring in the production of fermentable sugar. The total sugar yield (glucose, xylose, and arabinose) increased around 55% for both systems (US and MS). To prove the applicability of the proposed process, several experiments for scaling up were performed using several reaction loads (0.5 to 3 L). The attempt to scale up the proposed process was successful up to a 3 L load. Therefore, the proposed ultrasound-assisted procedure can be considered a suitable alternative for high-efficiency demineralization from sugarcane straw.

Development of Green Methods for the Determination of Elemental Impurities in Commercial Pharmaceutical Tablets is very important to human. In this context two methods based on the use of diluted acids were developed: microwave-assisted wet digestion (MAWD) and microwave-assisted ultraviolet digestion (MAWD-UV) were developed by Cauduro et al. [7]. These methods are evaluated for the digestion of oral pharmaceutical drugs and the further determination of elemental impurities from classes 1 (As, Cd, Hg and Pb) and 2A (Co, Ni and V) by inductively coupled plasma optical emission spectrometry (ICPOES). Commercial drugs for the treatment of type 2 diabetes are used. No prior comminution is performed. In this way, efficient methods are proposed for the digestion of commercial pharmaceutical tablets for further determination of class 1 and 2A elemental impurities (ICH Q3D guidelines). The determination of trace elements in complex matrices has been a major challenge in recent years for the scientific community [8].

Construction activity is a significant source of atmospheric contamination by ultrafine dust. Cognizant of this fact, those active in the use and recycling of construction materials must be aware of the risks associated with exposure to nanoparticles (NPs) and ultra-fine particles (UFPs), as well as the associated health impacts. Pinto et al. [9] analyzed NPs and UFPs generated in a small building material recycling company using high-resolution electron microscopes and X-ray diffraction. A self-made passive sampler (LSPS) that can obtain particulate samples without physical and morphological changes, especially where there is a suspension of particulate material, was used in this study. A total of 96 particulate samples, using the LSPS for three months in four seasons, were collected during the study. Thus, the dry deposition of the particles, which are considered highly harmful to human health, was found in each of the four seasons of the year. It is suggested that for future research, the toxicological evaluations of the particulates in the construction industry should be investigated through the consideration of measures to control and mitigate the health risks of workers regarding exposure to NPs and UFPs. Limited studies have been carried out in emerging nations on the correlation between environmental pollution, economic factors, and architectural heritage. For this reason, Cano et al. [10] presents an assessment of environmental parameter values on material deterioration used in architectural heritage in Cartagena de Indias; it depicts the socioeconomic effects of heritage degradation among people whose livelihoods depend on trade, tourism, and service activities. Dose–response functions were used for estimating the deterioration of carbon steel, copper, and zinc, caused by relative humidity (RH), temperature (T), sulphur dioxide deposition (DSO_2), and chloride deposition (DCl^-). In addition, the socioeconomic impact on architectural heritage was studied using a Socioeconomic Impact Survey (SEIS), with the sample of 174 individuals who work in areas of great architectural value in the city. The results show a corrosion rate (Vcorr) in the range of $80 < Vcorr < 200$, $2.8 < Vcorr < 5.6$ and $4.2 < Vcorr < 8.4$ µm/year for carbon steel, copper, and zinc, respectively, due to the high level of pollutants. The high deterioration combined with the lack of citizen culture affects the architectural heritage monuments, causing a negative impact in several economic aspects. The establishment of public programs is essential for the conservation of the city's heritage monuments. In this context, it is crucial that new building materials are developed so that civil construction is more sustainable [11] and that new studies in hostile environments can be carried out [12].

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