



Multi-criteria decision analysis (MCDM) to assess sustainability and circularity in the management of ordinary waste in tanneries.

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Abstract:

Introduction: The leather industry commonly operates under a linear production model that generates large amounts of ordinary solid waste and significant environmental impacts, highlighting the need to implement circular economy strategies. **Objective:** To evaluate circularity in the management of ordinary waste in a tannery through the application of Multi-Criteria Decision-Making (MCDM) methods to support strategic decision-making. **Materials and methods:** A mixed-methods approach was implemented, including the review of sustainability reports and the Integrated Solid Waste Management Plan (PMIRS), field visits, material flow analysis, waste characterization and prioritization, and a systematic literature review based on the PRISMA methodology. Subsequently, the MCDM method combined with the Analytic Hierarchy Process (AHP) was applied to assess technical, economic, and environmental criteria. The information obtained was organized into a decision matrix using Microsoft Excel Solver. **Results:** Five ordinary waste streams with valorization potential were prioritized, and alternatives for their reintegration



into circular economy processes were identified. In addition, the decision matrix served as a roadmap for circular economy implementation within the tannery sector. **Conclusions:** The MCDM-AHP approach proved to be an effective tool for integrating multiple sustainability criteria and facilitating strategic decision-making toward sustainable waste management in the leather industry.

Keywords: Circular economy strategies, leather industry, systems, subsystems, recovery of ordinary solid waste, multicriteria analysis method.



Comparison of indicators for the circular economy in the context of Colombian companies

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Abstract:

The lack of consensus and standardized metrics for reporting organizational actions related to the circular economy (CE) hampers sectoral evaluation and comparison of CE indicators. To address this issue, a systematic review of the scientific literature was conducted alongside a documentary analysis of sustainability reports from 25 Colombian companies recognized for their sustainability performance at the national level. The literature search adhered to specific inclusion and exclusion criteria, and the identified indicators were organized into matrices to identify patterns and sectoral relationships. The primary objective was to identify and analyze the CE indicators reported in these companies' sustainability reports, thereby promoting greater comparability of sustainability practices across sectors. The findings enabled the consolidation of key CE indicators, the establishment of comparability criteria, and the provision of a reference framework to enhance sustainability reporting within the Colombian context. This study contributes to strengthening the measurement and reporting of CE practices, aligning them with international standards and sustainable development goals (SDGs). Key words

Keywords:

Sustainability reports - Circular economy indicators - Circular economy - GRI standards – stakeholders



End-of-Life Tire-Derived Carbon for Peroxymonosulfate Activation and Carbocatalytic Degradation of Acetaminophen

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Abstract:

The increasing generation of end-of-life tires and the presence of emerging contaminants such as acetaminophen pose significant environmental challenges because of their persistence and limited removal by conventional treatment processes. This study aimed to evaluate the efficiency of a tire-derived carbon material for the carbocatalytic degradation of acetaminophen via peroxymonosulfate activation and to assess the influence of water matrix complexity on system performance. A carbonaceous material was obtained from the thermal pyrolysis of end-of-life tires at 650 °C under an inert atmosphere. The material was characterized by physicochemical techniques, and its catalytic performance was evaluated in acetaminophen degradation assays using peroxymonosulfate. Experiments were conducted in ultrapure water and treated wastewater to assess the effects of the matrix. The material exhibited a BET surface area of 71 m² g⁻¹, near-neutral surface properties (pI_{pH}= 7.51), and the presence of residual heteroatoms. The carbocatalytic system achieved over 90% removal of acetaminophen within 20 min, outperforming the adsorption and direct oxidation processes. The synergistic effects ($S > 1$) confirmed the enhanced catalytic interaction. In treated wastewater, a decrease in the degradation rate was observed, indicating matrix-induced inhibition due to competing species. These findings demonstrate the potential of end-of-life tires as precursors for effective carbocatalysts in advanced oxidation processes, contributing to sustainable strategies for the remediation of pharmaceutical-contaminated water.

Keywords:

Acetaminophen; advanced oxidation processes; carbocatalysis; end-of-life tires; peroxymonosulfate; wastewater.



Assessment of risks to human health and environmental hazards associated with gold mining activities in the Bajo Cauca region of Antioquia.

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Abstract:

The lack of methodologies in Colombia for assessing the environmental and human health risks associated with gold mining environmental liabilities (GEMEL) limits our understanding and prioritization of the impacts on ecosystems and nearby communities, especially in areas with high mining activity such as Nechí, El Bagre, and Zaragoza. This study assessed the environmental and carcinogenic risks associated with GEMEL, considering the release of potentially toxic elements (As, Cd, Pb, and Cr) into soils, using the methodology of the Geological Survey of Spain based on probability and severity indices. A total of 92 tailings samples were analyzed, and it was found that 72.83% exceeded natural reference levels, with Pb being the most critical element, with concentrations up to 50 times higher. Although 78.3% of the cases presented a low risk, El Bagre showed higher levels of contamination associated with mining activity. The carcinogenic risk assessment (LCR) revealed greater vulnerability in children than in adults. Arsenic (As) was the primary contributor, exceeding the limit of 1×10^{-4} at 100% of the monitoring points for children and at 82.6% for adults, with Zaragoza standing out as the most critical area. Cd exceeded the threshold in 98.9% of cases for children and 26.1% for adults, while Pb and Cr exceeded the threshold only in the child population. These results indicate unacceptable risks to human health and the presence of critical areas requiring prioritization, highlighting the need to implement methodologies adapted to the Colombian context.

Keywords: Geospatial analysis, mine tailings, potentially toxic elements, risk analysis.



Life Cycle Analysis of the production of conventional and recycled drywall

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Abstract:

Gypsum board is a widely used construction material due to its efficiency and low cost; however, its manufacturing process generates significant environmental impacts, primarily due to the consumption of natural resources and energy, and the emission of pollutants. This research developed a life cycle assessment focused on the production stage, with the objective of evaluating and comparing the environmental performance of conventional gypsum board against an alternative made with recycled material. The study was conducted following the ISO 14040:2006 standard, ensuring a rigorous methodological approach.

The results, obtained using the ReCiPe Midpoint method, showed that the Climate Change category (GWP100) has the greatest impact, with approximately 1.85 kg CO₂-eq per m², mainly associated with energy consumption and industrial processes. Similarly, Earth Acidification (TAP100) showed significant contributions derived from the use of energy and raw materials.



As an improvement strategy, a scenario with 30% recycled material was proposed, maintaining the same functional unit. This comparison showed significant reductions in environmental impacts, demonstrating better performance of the recycled material in the production stage

Keywords:

Life cycle analysis, drywall, construction and demolition waste (RCD), sustainability



Biochar production from biosolids: A circular economy approach for enhancing methane generation and waste valorization

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Abstract:

The management of biosolids generated in wastewater treatment plants (WWTPs) represents an environmental challenge, as their conventional disposal produces emissions, leachates, and nutrient loss. This study proposes their valorization through the production of biochar via slow pyrolysis at 700 °C and its use as an additive in the anaerobic digestion of primary effluent, under a circular economy approach.

The biochar was characterized using BET, SEM, FTIR, and CHNS analyses, showing high surface area, porosity, the presence of oxygenated functional groups, and high cation exchange capacity. These properties promote the adsorption of inhibitory compounds, microbial support, and indirect electron transfer, improving the anaerobic process.

The methodology followed the VDI 4630 protocol, using 1 L bottles with a working volume of 600 mL and an inoculum-to-substrate ratio of 2:1. A control and two biochar doses (0.5 and 1.0 g/L) were evaluated, all conducted in triplicate to ensure result reliability. An increase in the Biochemical Methane Potential and greater system stability are expected.



This strategy contributes to SDGs 6, 7, 9, 12, and 13 by promoting sustainable resource use, energy generation, and environmental impact reduction.

Keywords:

Anaerobic digestion; Pyrolysis, Methane production, circular economy



Biosolubilization of Construction and Demolition Waste as an amendment for plant growth

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Abstract:

Construction and demolition waste (CDW) consists of materials generated during construction, renovation, and demolition activities, with global production exceeding 2.2 billion tons annually. Its improper disposal in dumps or open areas causes soil compaction, biodiversity loss, and landscape degradation. Although its reuse has mainly focused on reincorporation into construction through physicochemical and, to a lesser extent, biological treatments, studies on its agricultural potential through strategies that enhance nutrient bioavailability in soils remain limited. In this context, the objective was to evaluate the effectiveness of the solubilization of concrete, brick, and drywall CDW using *Bacillus*



megaterium as a soil amendment for plant development. A single-factor experimental design with three levels, one control, and three replicates (24 units) was used. Each treatment included 30 g of CDW per kg of soil and inoculation with 10 mL of *Bacillus megaterium* (1×10^9 CFU/mL). Growth variables were recorded over eight weeks, followed by biomass determination and foliar and soil chemical analyses. Data were analyzed using ANOVA and Duncan's test ($p < 0.05$). Results showed slight variations compared to controls, with drywall + bacteria showing the highest development. Improvements in soil pH and nutrient availability were observed, including increases in Cu and P and Mg contribution. It is concluded that biosolubilization of CDW with *Bacillus megaterium* can improve nutrient availability and promote plant development.

Keywords:

Plant development, recycling, nutrients, soil amendment, utilization of CDW waste.



Use of Biobased Materials and Microalgae for Cadmium Immobilization in Agricultural Soils and Their Effect on Plant Mineral Nutrition

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Abstract:

Cadmium is a metal naturally found in soils; however, in agricultural soils destined for cacao, coffee, and avocado, its accumulation in the final product can cause harmful health effects. Therefore, it is necessary to find alternatives for its remediation, among which the use of amendments such as biochar and compost are the most explored. However, biomaterials like digestate and microalgae, which are highly available, have not been sufficiently evaluated. Thus, the objective of this project was to evaluate the effect of biochar, digestate, biochar-digestate, and microalgae for the remediation of agricultural soils contaminated with Cd and the mineral nutrition of plants. Soil from a cacao farm in Santander with high concentrations of Cd was used, applying doses of 1% w/w of each material, alone or mixed, planting *Cucumis sativus* as a bioindicator. Results showed that the combination of biochar and microalgae was the most effective in reducing Cd bioavailability in soil and plants. In contrast, digestate exhibited an antagonistic effect, increasing metal availability. Additionally, the mixture of loaded biochar and microalgae provided higher concentrations of essential nutrients (Nitrogen, phosphorus, and potassium), improving plant nutrition.

Keywords:

Amendments, biochar, biomass, digestate, microalgae.



Environmental Economic Valuation of the La Doctora Micro-basin

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Abstract:

This study determines the socio-environmental economic value of the La Doctora micro-watershed, located in La Romera Ecological Park (Sabaneta, Antioquia), which serves as the primary water source for the village of La Doctora and its surrounding areas. Using contingent valuation, the community's Willingness to Pay (WTP) for water resource conservation was estimated by conducting surveys of a representative sample of users following a pilot test and analyzing the data using Spearman's correlation in Stata and Python. The results show that the vast majority of respondents recognize water as a priority resource or part of an integrated ecosystem; however, most fall within low WTP ranges, indicating that environmental awareness does not necessarily translate into high economic willingness to pay—a phenomenon also influenced by mistrust of government institutions. The estimated Total Economic Value supports the ecological, economic, and social importance of the micro-watershed, reinforcing the need to implement conservation measures that ensure the long-term sustainability of water resources and the well-being of the community.

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Keywords:

Valuation, contingent, environmental, micro-basin, DAP.



Evaluation of the effect of ozone on bacterial content in agricultural soil

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Abstract:

Soil microbiological quality is a key factor for agricultural sustainability and food security. In this study, the efficiency of gaseous ozone as a disinfecting agent in agricultural soils was evaluated under controlled laboratory conditions. Initially, physicochemical and microbiological characterization of two soils was conducted to determine their initial state. Subsequently, two experiments were performed: the first evaluated the effect of ozone by varying the exposed soil mass (1 g, 25 g, and 50 g) for 30 minutes, while the second analyzed the influence of exposure time (30 minutes, 1, 2, and 3 hours) using a constant soil mass. The results showed that bacterial removal depends on several factors, including soil mass, the effective applied dose, and the contact time between the gas and the soil matrix.

Keywords: Ozone, Soil, Microorganisms, Disinfection, Treatment

Keywords will be defined in the manuscript currently under preparation. (Palabras clave definidas en el manuscrito en preparación.)