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Re-imagine Waste

Towards a wasteless future or a wasteful planet?

27 – 29 October 2025

Centro de Convenciones de Buenos Aires (CEC)

City of Buenos Aires, Argentina

The **ISWA 2025 World** Congress & Exhibition "Re-imagine Waste - Towards a wasteless future or a wasteful planet?" organized by ARS, ISWA National Member in Argentina and with the support of the ISWA LAC Regional Chapter, brought together policymakers, government officials, industry leaders, scientists, and waste management professionals to exchange knowledge and present innovative solutions for sustainable waste management and circular economy.

This volume compiles the peer-reviewed abstracts selected for presentation during the conference, including the afternoon oral sessions and the poster sessions.

The abstracts are organized into thematic sections corresponding to the conference program.

We extend our gratitude to the Scientific Committee, reviewers, session chairs, and all contributors who made the event possible.

November, 2025

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SECTION I – ABSTRACTS SELECTED FOR ORAL PRESENTATIONS

I. PART 1 – ABSTRACTS IN ENGLISH

CLIMATE CHANGE & WASTE MANAGEMENT

1. **Towards a circular transition: Reduced plastic to incineration in Sweden.**
   Clark, Tony

Avfall Sverige – Swedish Waste Management

Plastic waste going to waste incineration is a significant source of fossil carbon dioxide emissions in Sweden and accounts for around seven percent of the country's total emissions. Despite efforts to reduce plastic to incineration, emissions continue to increase. To achieve climate goals – such as the EU's goal of climate neutrality by 2050 and Sweden's goal of net-zero emissions by 2045 – a more circular and sustainable value chain for plastics is required, from design and manufacturing to use, sorting, reuse and recycling.

Several industries have developed roadmaps for fossil-free competitiveness and are actively working to replace virgin fossil raw materials. But plastic flows are complex and fragmented, requiring collaboration across the entire value chain – from producers to recyclers and incinerators. We have developed a cross-sectoral action plan that presents concrete measures to reduce the amount of plastic waste sent to incineration and increase the circulation of selected plastic flows.

The plan is designed to reduce climate impact through more efficient resource use and reduced incineration of plastic. Although the challenge is greater than what individual actors can solve on their own, this action plan shows how shared responsibility and cooperation can drive the necessary system transformation – with international relevance.

Keywords: fossil co2 emissions, circular plastics, cross-sector collaboration, climate action plan

2. **'Beyond Waste' - The development and delivery of Carbon Net Zero and Circular Economy Roadmaps for the recycling, resources and waste sector in the UK: Key learnings for other countries and economies.**
   Cooke, Dan

(1) Chartered Institution of Wastes Management

The UK has developed strategies and targets for the effective management of resources and waste, including targets for recycling, landfill, residual waste reduction, resource productivity, etc.

The new UK Government is more ambitious and has made achieving a zero-waste economy a priority. It has set out the opportunity for the achievement of its environmental and climate commitments, and to deliver economic benefits by developing and implementing net zero and circular economy frameworks.

In 2025, it established a Circular Economy Taskforce and a Net Zero Council. Each will deliver a strategy and series of sector roadmaps, including roadmaps for the resources and waste sector. These are expected in autumn 2025 and spring 2026.

How does the UK's approach compare to that of other countries and economies? What are the key learnings for policymakers and resource and waste managers?

This presentation will set out the following for ISWA delegates:

Headline material flows in the UK economy, carbon emissions from the waste sector, volumes of waste streams produced, recycling levels, infrastructure capacity, etc;

A critique of the UK's current strategies, targets and measures currently being implemented (informed by, but separate from, the associated European Union Framework Directives and Programmes), including:

- Packaging Extended Producer Responsibility
- Emissions Trading Scheme for waste to energy facilities
- Consistent Collection schemes ('Simpler Recycling') for businesses and households
- Deposit Return Schemes
- Plastics Packaging Tax
- Landfill Tax escalator
- Carriers, Brokers and Dealers Regulations
- Digital Waste Tracking
- Environmental Improvement Plan strategic targets to:
- reduce residual waste per head of population to 287kg by 2042
- eliminate avoidable waste and double resource productivity by 2050, and
- eliminate waste crime and illegal sites by 2042;

The government, working across departments and with business, is now preparing its Circular Economy Strategy and sector roadmaps (for construction, textiles, plastics, chemicals, agri-food, and electronics) to incentivise circular resource use and to deliver economic opportunities for substantial net material savings, reduced exposure to price volatility, increased job creation and the potential to increase GDP by nearly £25 billion by 2035. The key elements of these roadmaps will be shared in the presentation.

All these measures are driven by the needs for resource security and reduction of carbon emissions.

In 2025, the Government's Net Zero Council is preparing a roadmap for the resources and waste sector itself to achieve net zero (from its current contribution of 6% of total emissions) by 2050.

This will include policy and economic measures to reduce emissions from transport, landfill, recycling and waste to energy plants, including practical requirements to decarbonise the residual waste stream and to ensure the skills, technology and data required. These will be set out.

Keywords: Net Zero, Climate, Strategy

3. **Sustainable Waste Management Strategies for Emerging Economies: A North African Case Study.**
FAKRA, Vanessa

Manuela GOULART , Juan David CHAMAT

Kanadevia Inova

This study presents a comparative analysis of waste management technologies for a North African emerging country, focusing on environmental (GHG reduction, leachate, resource recovery, soil occupation and soil use ...) and economic impacts .

We evaluate the performance of various waste treatment solutions: conventional landfills without gas recovery, managed landfills with gas capture (different scenario of capture will be

considered), landfills and Refuse-Derived Fuel (RDF) produced , Waste to Energy solution, and integrated solution including : presorting, anaerobic digestion and Waste-to-Energy (WtE).

A life cycle assessment (LCA) will be conducted to quantify GHG emissions and identify key environmental hotspots for each technology.

We will highlight how a Waste to Energy facility can free land and how we could come with innovative solutions to optimise the utilisation of this land.

An Economic analysis will complement the study based on ranges of capex and operational cost, and estimate of revenues based on different scenario (energy price, use of the recovered gas and associated revenue, potential carbon finance).

The results will highlight the environmental benefits and economic viability, providing insights for policymakers and stakeholders to optimize waste management strategies in emerging economies.

Keywords: Waste Management, North Africa, Emerging Economies, Waste composition, Comparative Analysis, Life Cycle (LCA), Economic Analysis, Landfills, Refuse-Derived Fuel (RDF) Waste-to-Energy (WtE) Anaerobic Digestion Greenhouse GasWaste to Energy , Landfills, gas Recovery, RDF, Anaerobic Digestion, Methane Emissions ,Leachate, Resource Recovery ,Sustainability, Climate Change, Affordability, Integrated Waste Management

4. **Current reality of the non-recovery of organic waste: An analysis of the lack of effective strategies.**

Fernández Cañas, Patricia Virginia

Walter Ordinas

Undersecretariat of Environment of Argentina.

Argentina's 2020 NDC commits to a 19% emissions reduction by 2030, focusing on integrated waste management and circular economy. Despite laws since 2004 promoting source separation, recovery, and landfill avoidance, efforts have largely focused on inorganic recycling. Organic fraction recovery remains below 5 %; more than 5,000 open dumps (two per municipality) emit methane. The waste sector contributes 5.83 % of total GHG emissions (23,314 ktCO2e in 2022), projected to reach 161 million tons by 2030. Daily OFMSW generation exceeds 24,000 tons, plus 250 million tons per year from livestock, agriculture, and industry.

Problem scale and missed opportunities

Surveys of 60 municipalities (2022–2024) show that only 15 % have incipient OFMSW valorization initiatives and lack long-term plans. Around 90 % showed no interest, even though organics constitute 45–60 % of waste. Existing infrastructure includes over 70 composting plants (15 municipal) and 100 anaerobic digestion (AD) plants (3 municipal), mostly at private agro-industrial scale. These facilities generate bioproducts but are not yet accounted for in national emission inventories. Argentina, the world's third-largest food exporter, has vast biomass resources for profitable biogas, biomethane, and agrobioproducts, yet non-recovery imposes significant environmental and social costs.

Challenges across dimensions

- Economics: High AD capital and operating costs; unsustainable MSW models; need for incentives and disposal taxes.
- Technical: Capacity and separation gaps; need for MSW system optimization.
- Regulatory: Updating by-product policies; strengthening provincial and municipal agencies; biogas regulation; simplified approvals.
- Behavioral: Integrating waste and effluent management into production; citizen composting; stronger public–private alliances.
- Policy: Systematic planning and monitoring; national registries; intergovernmental circular economy coordination; renewable energy diversification.

Key operational strategies

1. Source separation: Essential for high-quality by-products; tax incentives and public–private agreements.
2. Regionalization and supply–demand models: Consortia for small municipalities; logistics that optimize waste availability, transport-related emissions, and by-product markets.

3. Public–private alliances and policies: Strengthening municipal capacities; engaging private sector, NGOs, and universities; territorial policies with monitoring.

Six implementation pillars

(1) Legal and governance framework,
(2) Regional infrastructure and logistics,

(3) Economic instruments (funds, PPPs),
(4) By-product markets and certification,
(5) Data and innovation systems,
(6) Education and social inclusion for green jobs.

The AR-21-001-CCAC-MAyDS-UNEP project (2022–2024) trained over 2,000 municipal stakeholders, held 10 webinars, and contributed to developing and providing technical assistance for projects focused on organic waste valorization, while building specialist networks. Organic recovery offers climate mitigation, energy diversification, employment, and resilience, but scaling it up requires sustained political will..

Keywords: Organic Solid Waste, Methane Emmisions, Policies, GHG

5. Comprehensive indicator framework for methane mitigation in municipal organic waste management.

Garay, A. (1)
Rojas, A. (1), Gallo, S. (1), Siegel, K. (2), Garzon, I. (2), Garcia, P. (2)

(1) Ambire Global, Bogotá, Colombia, (2) Clean Air Task Force, Boston, USA

Global municipal solid waste generation is projected to rise from 2.3 billion tonnes in 2023 to 3.8 billion tonnes by 2050, intensifying waste management challenges and methane emissions from landfill decomposition. Methane, a potent greenhouse gas, demands urgent attention due to its environmental, social, and economic impacts.

To support local governments, CATF And Ambire developed a comprehensive framework of indicators to assess and improve municipal performance in mitigating methane emissions from the solid waste sector. The framework consists of nine key categories: public sanitation services, source separation, organic waste treatment, climate change mitigation strategies, environmental education, private sector treatment infrastructure, formalisation of informal recyclers, differentiated organic waste collection and transportation, and final landfill conditions.

For example, the climate change indicator seeks to identify municipalities and public sanitation service providers that integrate climate change mitigation into their plans. Its purpose is to strengthen the articulation between local policies and national goals, facilitate access to green finance and encourage continuous improvement in service provision, promoting environmentally sustainable management. Also, the source separation indicator aims to measure the perceived impact in tons of organic material delivered, either to a private or public manager, by the waste generator for treatment, allowing monitoring and improving waste management processes effectively at the municipal level.

This framework offers a systematic approach to identifying gaps, guiding policy development, and tracking progress, enabling data-driven decision-making and continuous improvement. It also seeks to enhance the capacity of national governments to support and incentivize local authorities in adopting effective waste management strategies. By emphasizing efficiency, accountability, and sustainability, the framework aligns with global methane reduction goals while promoting inclusive approaches that incorporate informal workers and engage the private sector.

This can serve as a basis for cities to align their waste management systems with the international climate and sustainability commitments such as the Paris Agreement and Global Methane Pledge and help them in their transition toward low-emission, resilient waste systems.

Keywords: waste, methane, indicators, organics, landfill

6. Reducing Methane and Landfill Best Practices for LAC.

Garzón, Isabel

Global municipal solid waste is projected to increase from 2.3 to 3.8 billion tonnes by 2050, worsening waste management challenges and driving up methane emissions from landfills. Methane, a potent greenhouse gas with a global warming potential 84 times greater than CO_2 over 20 years, has far-reaching environmental, social, and economic impacts. Poorly managed landfills are a major global source of methane. However, adopting landfill best practices can significantly reduce emissions, protect public health, and support the transition to a circular economy.

In Latin America and the Caribbean (LAC), a large share of waste is still disposed of in open dumps or poorly managed landfills, contributing substantially to methane emissions. While some progress has been made in policy and infrastructure, practical gaps remain. Implementing landfill best practices offers a cost-effective opportunity for reducing emissions and enhancing solid waste management.

Sanitary landfills, unlike open dumps, are engineered to minimize risks. Effective management includes proper site preparation with liners and drainage; controlled waste reception and compaction; daily and intermediate cover; leachate collection and treatment; and gas capture systems to recover methane for flaring or energy use. Environmental monitoring during and after landfill operation ensures long-term effectiveness. These practices not only reduce emissions but also improve waste handling and public health outcomes.

Source separation is a key step in reducing organic waste in landfills. In many LAC cities, organics make up most of the municipal waste stream, yet diversion rates are low. Separating organics enables composting and biogas production, supporting local economies while cutting methane emissions.

Small and medium-sized cities—which make up the majority of LAC municipalities—generate high volumes of organic waste but often lack infrastructure. With coordinated support, these cities can adopt low-cost aerobic and anaerobic solutions like composting and biodigesters. When paired with improved landfill operations, these approaches deliver significant environmental and community benefits.

While extensive technical knowledge exists on landfill operation—including best practices for compaction, leachate control, and methane capture—this information is often not formalized or widely disseminated by national governments. Many municipalities, especially smaller ones, lack clear guidelines and training, leaving decisions to operator discretion. Without policy integration and investment in capacity-building, proven practices are rarely implemented. Closing this gap is critical to scaling methane reduction and improving organic waste management across the region.

Keywords: Landfill best practices; Methane emissions; Organic waste; Source separation; Sanitary landfills

7. **Future-Proofing Waste Infrastructure: Geosynthetics as a Key Tool for Climate Change Adaptation.**
   Husemann, Jovana

Baharuddin, I. (1), Niehues, C. (1)

Naue Group, Espelkamp, Germany

Although landfilling is the least preferred waste management option, it remains integral to managing residual waste safely. The World Bank reports that over 54% of waste in upper-middle-income countries and more than 90% in low-income countries is disposed of in landfills or unregulated dumps, underscoring the critical need for robust landfill infrastructure. Rapid urbanization, increasing municipal solid waste volumes, and intensifying climate change impacts present considerable engineering and ecological challenges. Extreme weather events, notably heavy rainfall, exacerbate landfill slope failures, endangering public safety, infrastructure stability, and environmental health. High-profile incidents, such as those in Shenzhen (China, 2015), Bandung (Indonesia, 2005), and Payatas (Philippines, 2000), highlight the urgent need for climate adaptation measures within the waste management sector.

This study evaluates geosynthetic-based engineering solutions for strengthening landfill embankments, controlling surface water accumulation, minimizing leachate infiltration, and optimizing landfill capacity and lifespan. Risk management through geosynthetics includes establishing adequate buffer zones, reinforcing slope embankments, and installing sealing caps using products like geogrids and geomats. These geosynthetic products effectively control erosion, reduce rainfall infiltration, and improve slope stability. In Germany, geosynthetics designed for a lifespan exceeding 100 years are standard practice, providing permanent, effective risk mitigation.

Through case studies from Germany (Am Knochen landfill) and Indonesia (Sarbagita landfill), this paper demonstrates the long-term resilience and environmental benefits achieved by integrating geosynthetics into landfill designs.

The use of geosynthetics aligns closely with the United Nations Sustainable Development Goals (SDGs). Reinforced embankments mitigate climate-related disaster risks (SDG 13 - Climate Action), improve urban safety (SDG 11 - Sustainable Cities and Communities), prevent groundwater contamination by controlling leachate (SDG 6 - Clean Water and Sanitation), and support sustainable industry and resilient infrastructure through innovative geotechnical solutions (SDG 9).

Keywords: Geosynthetics, landfill stability, climate adaptation, SDGs, circular economy, waste management, risk mitigation, leachate control

8. **SMART-LANDFILL: Sustainable Monitoring and Analytics for Resilient Technologies in Landfills.**
Kataria, Krishna

Jonathan Hendy

4EI (4 Earth Intelligence), Veolia Group , WM Incorporated , European Space Agency (ESA), UK Space Agency

GHGSat operates a growing constellation of small satellites designed for high-resolution imaging and quantification of methane emissions, achieving ~25 m spatial resolution and sensitivity down to ~100 kg/hr. In 2023, the constellation expanded to 12 satellites, including the launch of GHGSat's first satellite equipped with a CO_2 sensor.

Climate change remains an urgent global crisis, with greenhouse gas (GHG) emissions driving rising temperatures and environmental instability. Methane (CH_4), a potent GHG, has over 80 times the global warming potential of CO_2 over a 20-year period, making it a high-impact target for mitigation. Landfills are a major methane source, as decomposing organic waste releases CH_4 when not effectively captured. Yet, current global GHG inventories for landfills rely primarily on model-based frameworks, such as those established by the IPCC. These models, while widely used, depend on static assumptions and activity data, making them poorly suited to reflect the dynamic and site-specific nature of landfill emissions.

To address this gap, the ESA-funded BASS landfill methane monitoring project is delivering a first-of-its-kind dataset that integrates space-based, aerial, and ground-based technologies to advance emissions quantification. Led by GHGSat in close collaboration with industry operators WM and Veolia, and supported by geospatial analytics partner 4EI, this two-year initiative spans landfill sites across North America, South America and Europe. The project aims to enhance methane quantification accuracy by correlating emissions with operational activity, refining methodologies for emissions modeling, and setting a new benchmark for landfill methane monitoring.

4EI plays a leading role in transforming raw geospatial data into actionable intelligence. By integrating satellite imagery with advanced analytics, 4EI enables more accurate interpretation of emissions signals in the context of landfill topography, infrastructure, and operational variables. Their expertise in geospatial modeling is critical to the development of a landfill management support tool that combines GHGSat's satellite data with third-party inputs to support both operational decisions and strategic planning.

Project participants benefit from access to a global data model that supports inter-comparison analyses, activity-emissions correlations, and real-time monitoring insights. These capabilities allow operators to detect leaks, optimize gas capture systems, and ultimately reduce their methane footprint. Preliminary results from the early phases of the project will be presented, including inter-comparison outputs and practical examples of how satellite and on-site measurements can improve IPCC-based inventories.

This innovative project not only advances methane monitoring technology but also supports the development of more robust regulatory frameworks and national GHG inventories. By bridging the gap between modeled estimates and real-world emissions,

the ESA BASS project—through the collaboration of GHGSat, WM, Veolia, and 4EI—is redefining best practices for landfill methane management and making a significant contribution to global climate mitigation efforts.

Keywords: waste, landfill, methane emissions, mitigation, climate change, global warming, climate impact, remote sensing, space technology

9. Advancing Methane Mitigation in the Waste Sector with the Global Methane Initiative's Policymaker Framework for Addressing Methane Emissions.

Mazo-Nix, Sandra

Cooley, David

Abt Global

Methane is a powerful greenhouse gas with a global warming potential 28 to 34 times greater than carbon dioxide over a 100-year period. The waste sector alone accounts for nearly 20 percent of human-caused methane emissions, making it the third largest source globally after agriculture and oil and gas. Within the waste sector, landfills and open dumpsites are the largest contributors to methane emissions due to the decomposition of organic waste in anaerobic conditions prevalent in these sites. Reducing methane emissions from the waste sector in the near term can significantly contribute to global climate mitigation while delivering economic, environmental, and health co-benefits at local and national levels.

Effective methane mitigation in the waste sector requires well-designed national-level policies and programs that promote sustainable waste management practices, encourage the diversion of organic waste from landfills, and incentivize methane capture and utilization. Without structured guidance, many governments struggle to identify cost-effective solutions, secure stakeholder support, and ensure long-term success of policies. A systematic approach helps decision-makers develop targeted strategies that address key sources of methane emissions and implement scalable interventions.

To support governments at various levels, the Global Methane Initiative (GMI) has published the Policy Maker Framework for Addressing Methane Emissions (the Framework). The Framework is a comprehensive, interactive, online resource designed to support the successful development and implementation of methane mitigation policies and programs. This presentation will introduce the Framework's step-by-step approach, guiding stakeholders through the following steps:

1) Understand the context by examining data and key documents
2) Engage stakeholders to solicit inputs on policy or program ideas
3) Establish the baseline to serve as a benchmark for evaluating emissions impact
4) Set goals to limit methane emissions by a specified annual amount by a specified date
5) Develop policies or programs
6) Implement policies or programs
7) Evaluate, report, and adapt

Attendees will learn about tools and resources relevant to each Framework step, including GMI's Waste Characterization Handbook and Solid Waste Emissions Estimation Tool (SWEET). Through case studies, attendees will learn how to leverage the Framework to address common challenges in policy or program development and maximize the impact of their methane mitigation efforts in the waste sector.

Keywords: governance, waste, methane, policy, climate

10. Case study to showcase and illustrate the results of the utilization of Biodiesel B100 in a Hauling truck for a full year.

POLIJRONOPULOS, ALEXANDROS
Cliba Ingeniería Urbana S.A., Buenos Aires, Argentina

Based on Argentina's energetic context and Cliba Buenos Aires' commitment on sustainability, the company went in search for a renewable source of energy that could lower the carbon footprint and reduce global Greenhouse gas emissions: Biodiesel.

GHG for 100% biodiesel were found to be 74% lower than those from petroleum diesel in a life cycle analysis completed by U.S. Argonne National Laboratory.

A twelve month pilot test was performed, powering a Collection truck with 100% biodiesel, without any engine modifications. Such test had never been done in Argentina and would be among the first done in Latin America.

It was important to determine if this renewable fuel would produce any wear to the engine, in addition to have enough power to correctly operate the truck.

If results were successful, then thousands of trucks in Argentina could potentially be fueled on 100% biodiesel, reducing GHG emissions and contributing to strengthen the country´s energy matrix.

In order to obtain accurate data results, Cliba partnered with Swedish truck producer Scania and with the Argentinian Chamber of Biofuels.

A case study will be showcased to illustrate the results of the utilization of Biodiesel B100 in a Hauling truck for a full year.

Keywords: Green Waste Management, renewable source of energy, Reducing GHC

11. Identifying waste methane mitigation opportunities with the Tanager-1 satellite.

Scarpelli, T.R. (1)

(1) Carbon Mapper, Pasadena, California, USA

Methane emissions from final solid waste disposal present a global opportunity for methane mitigation as landfills and dumpsites are a major source of methane emissions in many countries. There are existing mitigation opportunities through adoption of technologies and implementation of known best practices for emissions and waste reduction, and data is needed for prioritizing and implementing effective mitigation solutions. Given the global scope of waste methane, satellites can play a crucial role in delivering data for decision making in this sector. For example, there have been case studies showing the use of facility-scale remote sensing data to identify mitigation opportunities, prioritize follow-up action, and verify success for mitigation at the landfill.

We present an initial summary of methane emissions from the waste sector as detected by the Tanager-1 satellite, launched in August 2024. Tanager-1 is a point-source imaging satellite that can detect and quantify large methane emission sources at the facility-scale. We discuss initial observations in terms of mitigation opportunities in the waste sector at the global-, national-, and facility-scale, and provide an initial comparison of quantified emissions to existing bottom-up models.

Though satellites provide a unique opportunity to make data-informed decisions regarding mitigation, there can be barriers for stakeholders to adopt this data into day-to-day workflows. We identify opportunities for using satellite data for informing mitigation and the different factors to consider in terms of satellite tasking strategy and data needs by use-case. For example, the accurate quantification of an average emission is important when the satellite data is used for establishing a baseline emission estimate for reporting. The LOW-Methane Initiative's Data Strategy is one example of using point source imaging satellite data to estimate baseline emissions for sub-national jurisdictions. For other use-case examples, quantification accuracy is less important, and therefore, spatial coverage may be prioritized over temporal coverage. We outline the satellite tasking strategy (e.g., the tradeoff between spatial and temporal coverage) that is needed to support various use-cases of data for mitigation decision making at landfills and dumpsites, and we present initial examples of working with stakeholders to identify data needs and implementing corresponding tasking strategies at landfills.

Keywords: methane, inventory, satellite, landfill

12. Methodologies for balancing GHG emissions for WtE and landfill operations.

Scholz, Siegfried Michael
Kanadevia Inova AG, ESWET

Whilst WtE plants oxidise the fossil and biogenic waste fractions completely and only need to account for the biogenic fractions of their CO2 emissions, managed landfills are thought to only emit GHG emissions from the biogenic fractions deposited.

These emissions from landfills are depending on individual sites and emissions can be mitigated by increasing gas capture rates.

The article provides a comparison of methodologies to be used and offers a desk study and results from on ground and satellite observations of real landfill operations.

Keywords: Waste-to-Energy, WtE, WtX, landfill, GHG emissions, methane

13. Models to calculate methane emissions from landfills fail to account for the benefits of waste diversion projects including WTE facilities which now must count CO2 emissions in the ETS.

Stege, G.A.
SCS Engineers

Landfill methane dominates waste sector GHG emissions, yet waste management professionals have not reached a scientific consensus on a reliable method to estimate methane emissions and the reductions from diverting organics from landfills. Lifecycle assessment models estimate the long-term benefits of different waste management strategies, but are not able to produce realistic estimates of landfill methane generation and emissions that can guide short term planning efforts or monitor their progress. Landfill gas (LFG) emissions vary widely over time due to changing conditions that impact generation and the efficiency of LFG collection and control systems.

LFG models have the capability to account for such variability, but few go beyond simple methods required for reporting emissions. Emissions estimates depend on assigned values for waste decay rates (k), methane generation potential (Lo), and LFG collection system efficiency which have little empirical basis due to the inability to directly measure LFG generation or to find a valid way to solve simultaneously for these variables.

The US EPA's LandGEM uses default k values (2% or 4%) developed in 1996 for "bulk" wastes disposed in U.S. landfills. Starting in 2010, US landfills were required to report GHG emissions using slightly higher model k values assigned without referenced research. Recent reports on satellite-based methane emissions measurements suggest that EPA methods often underreport landfill methane emissions, and has fueled efforts by environmental groups to force changes to the requirements for GHG reporting. However, the changes to EPA methods were supported by research which appears more motivated by the goal to report higher emissions than accuracy. They solved for k using reported estimates of collection efficiency treated as valid "data" for model calibration.

Most European countries use the 2006 IPCC model which applies multiple waste categories for estimating landfill methane emissions. Like LandGEM, IPCC's model fails to recognize that waste decay rates vary incrementally across a wide range reflecting different climates and moisture levels in landfills. IPCC offers 4 climate categories, but only 2 for moisture levels, putting all landfills in Europe in the dry, temperate group. If landfill methane generation and emissions are underestimated, the benefits of diverting organic waste from disposal will be undervalued. The inclusion of CO2 emissions from waste-to-energy in the EU Emissions Trading System will increase the costs of WTE, and could drive an increase in landfilling, unless avoided methane emissions are fully credited.

The best public tools for estimating landfill methane generation and emissions are country-specific LFG models developed by the Global Methane Initiative and EPA's Landfill Methane Outreach Program, and created by SCS Engineers between 2007 and 2014, which use IPCC's multi-phase structure and improve on the k values to cover up to 5 climate zones.

Keywords: landfill methane, GHG emissions, modeling uncertainty

14. Wasting Away: An Analysis of Avoidable Food Waste in Mexico City Households.

Vázquez Morillas, A. (1)

Islas Maya, A. (1), Alvarez Zeferino, J. C. (1), Cruz Salas, A. A. (1), Velasco Pérez, M. (1), Espinosa Valdemar, R. M. (1), Jiménez Escamilla, I. R. (1), Turpin Marion, S.J. (1), González Cardoso, G. (1), Sotelo Navarro, P. X. (1)

(1) Universidad Autónoma Metropolitana, Ciudad de México, México

Food waste is a global problem with significant environmental, social, and economic implications, and this is particularly acute in Mexico City (CDMX), where millions of tons of food are wasted each year. This study focused on characterizing and quantifying food waste in household waste in CDMX to inform the development of sustainable management policies. The study evaluated food waste generation in CDMX, quantified household food waste generation, assessed the proportion of avoidable and unavoidable waste, and proposed strategies to reduce waste. It involved sampling across 16 municipalities in CDMX, covering three socioeconomic strata and two seasons (dry and wet). Waste was collected from a minimum of 15 households per neighborhood, totaling 388 households in the dry season and 395 in the wet season. Waste was classified into by-products, adapting the NMX-AA-022-1985 standard, and the proportion of avoidable and unavoidable food waste was analyzed to calculate per capita waste. Results showed that 17.28% of household waste in Mexico City is avoidable food waste, equivalent to 731.35 tons daily or 266,942 tons annually. Most waste is fruits and vegetables (43%), followed by bread, tortillas, and cereals (30%), with no clear trends related to socioeconomic level or season. Food waste in CDMX is a significant problem requiring urgent attention, and implementing prevention, separation, and recovery strategies, along with citizen education, is crucial to reducing waste and promoting a circular economy. This study provides valuable data for decision-making and designing public policies for sustainable waste management in CDMX

Keywords: Food waste, household waste, Mexico City, waste management, circular economy

15. The Waste Methane Toolbox: Policy Solutions for a Low Methane Future.
Zitely Tzompa Sosa

Amy Rowland, Kait Siegel

Clean Air Task Force

The waste sector, encompassing both solid waste and wastewater, is responsible for approximately 20% of global anthropogenic methane emissions — equivalent to roughly 5.4 gigatons of carbon dioxide equivalents annually. The solutions to tackle methane emissions from organic waste include waste prevention and minimization; source separation, organic waste diversion, and treatment; and improved design, engineering, and operation of final land disposal sites. While technical solutions exist, the primary challenge is insufficient understanding of the types of policies and solutions to incentivize methane mitigation within existing waste management frameworks and responsibilities.

Clean Air Task Force developed a toolkit providing a clear framework for policymakers to navigate the often-overwhelming array of classifications and taxonomies for environmental policy approaches; it's aim is to aid these decision-makers as they design and implement solutions to accelerate methane mitigation from solid waste.

The presentation will describe and provide examples of four types of policy approaches to achieve these solutions:

Legislative and regulatory approaches where the government controls or directly influences or intervenes in any aspect of waste management

Market-based approaches that rely on encouraging and incentivizing behaviors that improve efficiency

Voluntary agreements that include partnerships among countries and sometimes with the private sector to achieve stated policy goals and outcomes

Information and education approaches to increase awareness to improve waste management and achieve methane mitigation.

The presentation will conclude with a list of key considerations to ensure the successful development and implementation of the above approaches. These include coordination among levels of government, understanding existing realities, combining policy approaches, addressing all aspects of waste management, identifying and addressing roadblocks, ensuring adequate funding, facilitating scaling up, developing reporting requirements, and investing in awareness raising.

Keywords: Waste Policy, Toolkit, Decision-making, Methane Mitigation

RECYCLING & WASTE MINIMIZATION

16. Fast characterization of marine plastic litter by portable NIR spectroscopy for monitoring purposes and sustainable recycling.

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Marine plastic litter poses a significant environmental challenge due to its persistence and widespread distribution across marine ecosystems. This study focuses on the monitoring and characterization of plastic waste pollution in coastal environments, focusing on the distribution of plastic debris in relation to distance from the shore and vegetation presence. The analysis was conducted in the Laguna de La Algaida (Cadiz, Spain), an area shaped by tidal influences and varied habitats. This region is particularly prone to the accumulation of plastic waste due to the interactions between hydrodynamic and morphological processes, making it an ideal site to study the mechanisms that influence the dispersion and accumulation of these materials. A total of 342 macroplastic samples were collected in an area divided into eight strips parallel to the lagoon shoreline, each 1 meter wide and 100 meters long, characterized by different types of vegetation cover. The aim was to assess both the role of plant species in trapping plastic debris and the distribution of plastic items in relation to their distance from the shoreline; these samples were classified by physical characteristics (object type, flexibility, degradation state and color) and analyzed with the MicroNIR spectrometer for polymer identification, with validation via FTIR-ATR spectroscopy.

Results indicated that the distribution of plastic waste was strongly influenced by coastal morphology and the presence of vegetation. The strips closest to the shoreline exhibited a higher concentration of flexible materials, such as plastic bags, strings and ropes, which were easily trapped by the vegetation. In contrast, the more distant strips predominantly accumulated rigid objects, such as cups, bottles and cutlery, as well as solid fragments that managed to pass through the vegetative barriers of the preceding zones. The degradation state of the collected items varied significantly, with more advanced alteration observed in flexible objects and less in rigid ones, while the predominant colors were transparent and black. Spectroscopic analysis allowed for the identification of polymers, with PP (56.4%) and PE (41.5%) being the most common, followed by smaller amounts of PS (1.2%) and PU (0.9%). Portable NIR spectroscopy proved to be a rapid, efficient and non-destructive tool for field analysis, allowing for the acquisition of spectral data directly in situ. The integration of FTIR-ATR analysis provided complementary insights, especially for the identification of darker or more degraded samples. The study emphasizes the importance of innovative technologies and integrated strategies for environmental monitoring and plastic waste management. By providing data on the composition and distribution of debris, these methods support more effective recycling and cleanup initiatives. In summary, the research confirms the value of advanced spectroscopic tools in tackling plastic pollution in coastal ecosystems.

Keywords: Marine plastic litter, Portable NIR spectroscopy, Environmental monitoring, Plastic polymers, Waste management

17. **Recycling technology for textile waste polyester/cotton implementing green selective separation approach.**
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The European Green Deal aims to transform the EU into a resource-efficient, competitive economy by 2050, leveraging sustainable production and consumption to build a cleaner, climate-neutral future—yet challenges like the widespread use of complex textile blends add another layer of difficulty to this mission. The incorporation of multiple fibre types in a single fabric is common because it makes it simpler to modify the fabric's characteristics to satisfy needs. Even though textiles made of a single polymer, excluding small parts like sewing yarn or labels, can be recycled mechanically or chemically to produce a valuable secondary material, recycling of textile blends is difficult. Therefore, finding solutions to recycle textile blends is crucial. By the production figures, it's no surprise that polyester/cotton is the most widely manufactured textile blend. However, the challenge of separating these fibres without compromising their quality has made recycling them particularly challenging.

To address this issue, a novel recycling process has been developed that can maintain the polymer state of cotton and polyester while preserving their properties in terms of critical parameters for use as a secondary raw material. Unlike conventional methods, which degrade one component of the blend into its monomers, this approach maintains both materials at a higher level in the textile processing chain: cotton retains its fibrous structure, while polyester remains in its polymeric form. A promising approach was identified using an innovative green solvent composed of non-toxic, inexpensive, and readily available substances. The effectiveness of the separation process and key material characteristics were analysed using a variety of techniques, including differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). Although the process is currently at the laboratory scale, it holds significant potential for industrial application, offering both economic and environmental benefits.

Keywords: recycling, textile waste, polyester/cotton, green solvent

18. A Simplified Framework for Assessing Waste Prevention and Minimisation in Developing Countries within the Context of Circular Economy, SDGs, and ESG Principles. Garcia-Tabar, A. (1)

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Waste minimisation and prevention are crucial for the Circular Economy (CE), Sustainable Development Goals (SDGs), and Environmental, Social and Governance (ESG) principles, focusing on waste elimination and resource efficiency. However, there are significant gaps in implementing effective waste minimisation strategies, mainly due to the lack of standardised waste prevention terminologies and indicators. This paper introduces a novel simplified and comprehensive framework for assessing waste prevention and minimisation measures tailored to developing countries. The primary contribution of this study lies in proposing relevant indicators aligned with SDGs, ESG standards, and CE principles, while addressing data scarcity through proxy indicators to enable effective assessment in resource-limited settings. Six key indicators were proposed: Zero Waste Index, Food Loss Index, Extended producer responsibility, Education and awareness programs for waste minimisation, Waste prevention, and Plastic Bag Reduction Ratio. Eleven countries were selected as case studies to demonstrate the framework's applicability. The findings reveal that while these countries are progressing in enacting legislation and recognising the importance of waste prevention, compliance in practice is lacking, as indicated by poor quantitative results in actual waste reduction and diversion. The framework evaluates the environmental, social, and economic implications of waste prevention measures, showing wide variations among countries. Each country faces unique challenges, but strengthening policy frameworks, investing in infrastructure, promoting public awareness, and fostering collaboration are key steps towards advancing sustainable waste management practices. The study highlights the necessity for tailored policies addressing specific weaknesses while ensuring economic viability. The integrated framework provides actionable insights and forward-thinking solutions that can be adapted, scaled, and replicated to address developing nations' unique challenges.

Keywords: Waste management, Waste minimisation, Waste prevention, Waste reduction, Developing countries, Circular Economy, SDGs, ESG.

19. Exploring the relationship between plastic packaging and food waste.

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The relationship between plastic packaging and food waste is a subject of ongoing debate. While plastic packaging is often seen as essential for extending the shelf life of food and preventing waste, it also presents significant environmental and health challenges. In this presentation we aim to explore this relationship in a balanced way, highlighting both the benefits and the limitations of plastic packaging, and discussing how alternatives can be integrated into the food packaging system.

We will start by critically assessing the commonly held view that plastic packaging is necessary for food preservation. We will explore the scale and causes of food waste and provide insights into the role that packaging plays in addressing this issue.

In addition, we will highlight best practices in the use of low-plastic or alternative packaging solutions in supermarkets, illustrating examples from various food categories (e.g., refrigerated, dry, fresh goods). A range of solutions such as alternative materials, reuse options and design adjustments will be discussed, with a particular focus on their viability and application in the Latin American region. This region is of particular interest due to its unique environmental, economic, and infrastructural challenges, and will adapt perfectly to the target group of this year's ISWA taking place in Argentina.

Our presentation will also address the challenges and limitations of implementing these alternatives. Topics will include the scalability of solutions, regulatory hurdles, health concerns for the use of recycled plastics in food packaging, and the need for standardized definitions and guidelines. It will emphasize that the use of plastic alternatives should be context-dependent, taking into account regional differences and specific product requirements.

A key conclusion is that while packaging is an important factor in reducing food waste, it is just one part of the solution. A comprehensive approach, which includes stakeholder sensitization, actions from both public and private sector, and the development of alternatives, is essential for achieving long-term reductions in food waste. We strongly encourage innovation in packaging while acknowledging the ongoing need for plastic in certain contexts, aiming for sustainable, effective solutions.

Keywords: plastic, packaging, food waste, waste

20. Advancing Circular Economy Through XRF-Based Analytical Innovations: Unlocking PCB Recycling Potential.

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From lightbulbs to supercomputers, all digital processes rely on Printed Circuit Boards (PCBs), which are complex, but often very short-lived product made of a dominant carrier material, primarily reinforced plastics, combined with a multitude of other metals and minerals. Despite being present in minuscule concentrations, many of these materials are particularly valuable and critical raw materials. Nevertheless, they place a significant strain on the raw material availability and contribute to a majority of health and environmental issues hindering circular economy goals. The efficiency of all steps in the recycling process – from sorting, pre-treatment, up to material recovery and disposal – depends on a clear insight of the material composition in both the process input and the output. This presentation aims to showcase the potential of a new X-Ray Fluorescence (XRF) analytical methodology, using printed circuit boards (PCBs) as a case study. The new methodology increases reliability of the XRF results comparable to more advanced analytical methods, i.e., ICP-OES and ICP-MS, while requiring only a fraction of the cost and time.

The methodology was developed around a material-specific post-hoc calibration of XRF analysis. The PCB sample preparation process included manual dismantling, shredding, and milling to a particle size <500 µm. The post hoc calibration was then performed with the help of Certified Reference Material in combination with optimization of XRF measurement duration, filter configuration, and sample form. The obtained XRF results show significant improvement in accuracy with divergences from the certified concentrations ranging from around 5% for elements such as Cu, Au, Pb, Ni, and As; around 10% for Sn and Cr, to 18% for Pd. Finally, the effectiveness of this methodology was tested using a sample consisting of 45 PCBs sourced from randomly collected feature phones and smartphones manufactured between 1998 and 2021.

The results show that the material composition of PCB has changed significantly over time. For example, only three elements, i.e., Cu, Ni, and Sn, account for ~65 % of a median smartphone PCB compared to ~35 % of a median feature phone PCB. Furthermore, the median Cu concentration in smartphone PCBs increased by 46 % compared to feature phone PCBs, whereas the concentrations of nearly all other elements decreased in smartphones. The Au content showed particularly sharp decrease from above 1,300 ppm in PCB manufactured around 2000 to less than 500 ppm in PCB manufactured after 2018. Similarly, the amount of Pd decreased from 100-120 ppm to less than 15 ppm per PCB for the same period. As a result, the economic incentive for recycling waste PCBs is diminishing, which may negatively impact the PCB recycling rates. Under these challenging circumstances for recycling, reliable, quick, and cost-effective analysis of advanced materials will be the key to unlocking new, circular, and decentralized recycling innovations.

Keywords: Circular Economy, Printed Circuit Boards (PCBs), X-Ray Fluorescence (XRF), Critical Raw Materials, Material Composition

21. CIRCULAR SOLUTIONS FOR WASTE MANAGEMENT IN ISLANDS AND REMOTE TOURIST DESTINATIONS

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Islands and popular remote tourist destinations (including ski resorts) are characterized by massive flows of visitors concentrated in specific periods, temporarily increasing the local consumption of resources and products which in terms relates to increased generation of waste materials. This variability in waste generation and seasonal changes in composition (e.g. plastic bottles & food waste) makes the installation and operation of local waste treatment plants in remote areas inefficient. The reason usually is related to the insufficient volume of waste over the entire year to maintain a high-cost recycling investment, to discontinuous saturation and to the demanding requirements in terms of capacity scalability and technical flexibility. Current practices involve:
(i) waste collection and transportation to close in-land recycling facilities (e.g. for islands), with high transportation costs and high environmental footprint (increased GHG emissions)
(ii) unsustainable disposal of waste, with medium-long term impact in the environment and the beauty of touristic attractions (several examples can be demonstrated).

Examples of the environmental and social consequences of this inefficient waste management schemes lead to the concentration of plastic waste in several beaches, to marine litter and micro-plastics being dispersed in the sea, and to uncontrolled burning of organic waste in hidden areas, typically far from core touristic places and resorts but close to the local residential areas.

The specific problems of waste management in islands and popular remote tourist destinations include: (i) limited land availability for treatment infrastructures including final disposal; (ii) the absence of treatment practices for hazardous wastes; (iii) significant variability of generated waste quantities for the operation of a recycling industry in small remote areas; (iv) no economically viable solutions for waste management causing increasing amounts of solid waste along coastlines and remote areas, mainly plastics; (vi) illegal waste dumping; (vii) high transportation costs for recovered materials. The European Commission through the Circular Economy Action Plan [3], the Ecodesign for Sustainable Products Regulation [4] and the Raw Material act [5], is promoting a systemic change towards the implementation of sustainable models decoupling the production of goods and the consumptions of natural resources by fostering local recycling and re-use of materials and components as well as environmentally conscious behavior of consumers.

Consumer behavior - in this case tourists - plays a pivotal role in the generation of waste (plastic waste, textile waste and food waste) in the hospitality sector. A systematic review is required to highlight that guest preferences, dining formats, and portion sizes significantly influence waste generation. Understanding these behavioral patterns is crucial for developing targeted strategies to mitigate and better manage waste.

The aim of this study is to look into applications related to Textile waste, Food waste, Plastic bottles and advanced technologies that can support circular solutions for plastics and textiles.

The main objective is to design and develop decentralised movable solutions, which are able to handle waste generation peaks in islands and remote touristic destinations on demand, meeting the needs of island citizens and tourists.

Keywords *Plastic waste*, *Textiles*, *Food Waste*, *Tourism*, *Circular Solutions.*

22. Extended producer responsibility: the Brazilian case based on reverse logistics for general packaging.

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Unlike many countries that adopt the traditional Extended Producer Responsibility (EPR) model, in which the obligation for waste management lies exclusively with manufacturers and importers, Brazil has structured its solid waste management policy based on the principle of Shared Responsibility throughout the product life cycle. This principle, established by the National Solid Waste Policy (PNRS) – Law No. 12,305/2010, allocates responsibilities among manufacturers, importers, distributors, retailers, consumers, and public authorities, aiming to minimize the environmental and social impacts associated with waste generation.

Reverse logistics is one of the main instruments of the PNRS to ensure the implementation of this shared responsibility. Decree No. 11,413/2023 introduced significant progress by consolidating guidelines for reverse logistics systems, formalizing the role of managing entities, and recognizing different implementation models. A central aspect of this regulation is the prioritization of waste picker inclusion, acknowledging their critical role in the recycling value chain and ensuring they benefit from investments in the sector.

Among the financing mechanisms for reverse logistics, Brazil has developed credit and certification models, allowing companies to fulfill their legal obligations through proof of proper waste disposal. One of the highlights is the Structuring Certificate for Reverse Logistics, which not only ensures regulatory compliance but also directs investments to waste picker organizations, strengthening their infrastructure and promoting greater efficiency in recycling.

Despite these advances, challenges remain, such as waste traceability, the need to harmonize state-level regulations, and the need to raise consumer awareness regarding their role in Shared Responsibility. Even in the face of these challenges, Brazil has made progress in building a more structured and inclusive system, with mechanisms that promote the circular economy and strengthen the role of waste pickers in the recycling chain. The Brazilian model has emerged as a relevant case of integration between public policy, the productive sector, and social inclusion, contributing to the development of a more structured, efficient, and sustainable waste management system. The continuous refinement of reverse logistics policies and implementation frameworks will be essential to ensuring a balanced distribution of responsibilities and the long-term effectiveness and sustainability of waste management practices.

Given the socio-economic similarities among Latin American countries, the Brazilian model may serve as a reference to foster the engagement of the private sector in the effective recovery of post-consumer waste and the promotion of environmentally sound waste disposal practices.

Keywords: Extended Producer Responsibility (EPR), Reverse logistics, waste pickers, inclusion, circular economy, brazilian model, solid waste management, waste disposal, credit and certification models, structuring certificate

23. Fostering a Circular Economy at Local, Regional and National Level: The Case of LIFE IP CEI Greece.

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The recognition of the interconnectedness between the circular economy, environmental sustainability, economic opportunities, and human rights is commendable. Implementing circular economy practices can positively influence society in several ways. It is encouraging that there are already good practices for fostering a circular economy at all levels, and countries around the globe can learn from these examples and adapt them to their own contexts.

Under this framework, the paper aims to provide insights and the latest outcomes of the LIFE IP CEI -Greece (https://circulargreece.gr/) project in the scope to ease the sharing of knowledge on circular economy practices in the resource and waste management sector and enhance collaboration internationally so that countries can accelerate their transition to a more sustainable and circular economy. The project itself has a national geographical scope and aims at promoting waste prevention and management policies in several Greek areas with different characteristics and needs. Actions are foreseen at different levels (national, regional, and local) to support the replication of good practice, with emphasis on insular areas of the country. Part of the project's demonstration actions is the establishment of "enhanced green centers" the development of hazardous household waste management systems at the municipal level, the application of the EU Circular Economy Package with a specific scope at Greek islands and mountainous areas, and the full-scale implementation of the PAYT "Pay as you throw" financial tool. In addition, the project focuses on advancing critical sectors of the Greek economy, such as food waste, agro-food chains, and technical standards for the use of secondary materials. In particular, the project has a decisive contribution to a crucial obligation of Greece, with the establishment of a monitoring system for domestic food waste production, registering waste annually along the entire food supply chain, from production to consumption (production, processing, retail, and other food distribution, catering services/restaurants and households).

The paper will finally highlight how local governance is vital for executing these strategies, enabling communities to manage resources effectively and foster inclusive economic growth. Moreover, it will show how incorporating circular economy principles into policies at all levels will enhance infrastructure resilience and community involvement in sustainable initiatives.

Keywords: circular economy, Greece, recycling, recovery, waste, minimisation

24. Africa Gears Up: Free resources to help develop action plans in response to the UN Global Plastics Treaty.

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Africa is the second most polluted continent in the world. The exact amount of waste entering the sea from the African continent remains unknown, but it is clear the rapid development of Africa has seen waste accumulation outpace management capacity. Added to this, Africa is set to undergo a major transformation over the next century as its population surges and cities urbanise along with an increased demand for adequate housing, shelter, food and energy. Research shows that the average waste collection rate in most African countries isn't enough to meet increased consumerism and changing consumption patterns. Addressing Africa's growing plastic waste problem while simultaneously unlocking the socio-economic benefits of sustainable waste management requires an urgent and comprehensive systems response by governments, businesses, and civil society. The UN Global Plastics Treaty presents a significant opportunity for countries to address the accelerating challenge of plastic waste, but the obligations could prove onerous for African developing states. Signatories must draw up detailed action plans that outline how they will tackle plastic waste, set future targets, and monitor progress. Thus, SST has developed the Plastic-Free Seas Guidebook as an Africa-appropriate response to the Global Plastics Treaty, clarifying exactly what actions must be taken at every step of the plastic value chain and addressing how cross-cutting issues – such as education, behaviour change, and fiscal incentives – need to be considered. The Guidebook provides an easy-to-understand, easy-to-use guide on all aspects of plastic waste and its management in Africa. It features free editable templates, downloadable via the SST website, which are structured in a way that allows for localised application and execution, supporting an Africa-appropriate response. The Guidebook recognises that not all African countries are the same. For example, investing in recycling plants may not make economic sense for some island states or smaller countries. Therefore, regional collaborations are highlighted as a necessary tactic to turn the tide on waste. Beyond the Guidebook, SST has also created a more technical, extensive plastics information resource in the African Resource Book Series: A Guide to Plastics. This publication is aimed at industry professionals, academics, researchers and the like and features an A-Z on the properties and applications of plastics, including the sources, pathways and drivers of plastic pollution and the policies that already exist in Africa to manage the impacts thereof. SST believes that these resources, coupled with relevant training and education, can create a practical and tangible strategy for African nations, and beyond, to take control of their waste management, preserve marine ecosystems, and create healthy, flourishing communities by contributing to the Blue Economy.

Keywords: Waste, International Treaties, UN Global Plastics Treaty, Blue Economy, Circular Economy

25. Implementing separete waste collection for Santa Juana, Chile.

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This work developed the implementation of a door-to-door separate waste collection system in Santa Juana.

Santa Juana is a city, in the region of Biobio, central Chile.

The program was divided in three-stage action plan:

- Communication program based on Environmental Education for the Santa Juana community.
- Delivery of Equipment to each home in the city
- Implementation of the new separate waste collection calendar.

The new waste management system, along with the waste treatment plant, represents an opportunity to substacially reduce waste in the community that ends up in the landfill - 80 km away from the city - as disposable waste, thus reducing environmental pollution and greenhouse gas emissions.

In the first phase, a waste characterization was carried out as the first activity. This determined the amount of waste generated daily and its composition. The results made it possible to adjust the management and collection system, as well as allow to foccus the environmental education program. The main objective of this phase was the implementation of a powerful communication and education plan throughout the community, with special emphasis on schools and social organizations, training all of the private and public schools, the 21 social organizations and municipality workers. GeoCiclos conducted more than 360 educational workshops and trained more than 3,500 people in the community. In addition, to reinforce what was taught in the workshops, a promotional video of the new waste collection system was produced, involving residents, students, and authorities in the initiative.

During the second stage, a set of containers was delivered to the community to separate their waste. These sets include a Blue 40 L bin for paper and cardboard, a red 40 L bin for recyclable waste, a 10 L aerated bin and compostable bags to separate organic waste in the kitchen, and a green 20 L bin to store compostable bags full of organic waste until they are removed by the collection service, as shown in the image 1.

At the third phase, the new collection schedule was designed with the municipal authority and local stakeholders. This calendar was implemented once the treatment Plant started operating. At this phase, a new local regulation about waste management at homes was published by municipality, making mandatory the separate collection for all the citizens in Santa Juana.

At the end of the program, a final characterization was developed to measure results, obtaining a reduction of 35% of organic waste and a reduction of 47% of recycling materials and a reduction of 25% the total waste to landfill in the city, reducing fuel collection costs by more than 50%. There are improvements to do, but is a big step in a circular model and sustainable waste management in Chile.

Keywords: WAste, separate collection, recycling, composting

26. Profiling waste reclaimers, their operations and health and safety risks at a landfill in Gauteng, South Africa.

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Informal waste reclaimers play a crucial yet undervalued role in recycling at South African landfills, including the Chloorkop Landfill Site (CLS) in Gauteng. This study aimed to profile waste reclaimers, describe their operations, identify challenges faced during waste collection and separation, and examine their working conditions and associated health risks. The research adopted both a qualitative and a quantitative approach collecting data through structured questionnaires completed by 37 participants. Both descriptive statistical and thematic analysis were used to analyse data.

The majority of the waste reclaimers where male (80%), Black (96.7%), completed some high school (43.3%) and were unemployed (46.7%) before they started working in waste reclaiming. The years of experience among waste reclaimers in this study vary widely, with a minimum of 2 years and a maximum of 26 years – with an average of 8 years. Most waste reclaimers (70%) did not receive any training and some of those who did receive training use their knowledge and expertise to train newcomers in the waste reclaiming field.

Waste reclaimers priorities collecting metal, making it the most frequently targeted material (80%) as it is viewed as a valuable commodity. Following metal, plastic (66.7%), cardboard (63.3%) and textiles (56.7%) were the most collected recyclables. Waste reclaimers sell recovered materials to a variety of buyers, with recycling companies (38.9%) and buy-back centres (33.3%) the most common outlets.

Safety equipment was used by reclaimers and 76.7% reported they used gloves, 73.3% used safety glasses but only 11% used a hat or helmet. However, injuries related to work were prevalent with 40% of waste reclaimers reported that they often get hand injuries, 43.3% often got back injuries and arm and shoulder injuries were also often reported with 46.7% and 43.3% respectively. Other work-related health problems were not as often reported with 46.7% never having any skin problems or eye irritation, and more than half (53.3%) never experienced respiratory problems.

Waste reclaimers worked long hours in physically demanding and dangerous conditions, often without adequate protective equipment. Despite these challenges, they demonstrated resilience

Keywords: waste reclaimers, recycling, landfill, health & safety

27. Unlocking flexible plastics recycling in Latin American cities.

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Flexible plastics represent a large share of plastics disposed in municipal solid waste, posing severe environmental challenges. Their lightweight, contamination and challenges in collection contribute to over one-third leaking into the environment, a number projected to triple by 2040. A large proportion of these materials consists of mono-layer low density polyethylene (LDPE) and polypropylene (PP), which are recyclable, highlighting a substantial economic and environmental lost opportunity due to reliance on virgin fossil-based materials.

This paper presents findings from our pilot program in Greater Buenos Aires, a metropolitan region of 14 million citizens, demonstrating that targeted interventions can rapidly and economically enable post-consumer flexible plastic recycling. Over two years, this strategy facilitated the mechanical recycling of LDPE and is now diverting 500 tons per month from landfills—enough bales to fill an Olympic swimming pool.

The approach optimizes the existing value chain by connecting supply with demand, strategically investing in recycling infrastructure and partnering with hundreds of waste workers, thereby improving their livelihoods. Previously, even when residents and businesses separated LDPE for recycling, sorting centers often rejected it, sending it to landfills. Now, this material is successfully repurposed into new bags and film, all without requiring large-scale investments in waste management infrastructure or new regulations.

These first steps are impactful but insufficient. At best, they could raise post-consumer flexible plastics recycling rates in Latin American cities from 2% to 10%. The next challenge is to increase affordable access to feedstock by efficiently separating flexible plastics from mixed waste streams.

In a cross-sector partnership between a waste management company, plastic producer, recyclers and converters —we are exploring the technical feasibility of flexible plastic separation at the CEAMSE Norte III Mechanical Biological Treatment (MBT) facility in Buenos Aires. This proof-of-concept is sorting up to 100 tons per month of flexible plastics from mixed waste using criteria like transparency, polymer, size, and contamination level and recycling it into rLDPE pellets suitable for new applications. With targeted investments in separation technologies, we estimate that this volume could increase tenfold, enabling a significant diversion of flexible LDPE from landfills.

In parallel, a demand-side shift is crucial for scaling impact. There is an opportunity to replace virgin plastics in non-food applications, which account for 75% of all PE flexible films produced, including packaging, bags, agricultural films, and construction materials.

This paper synthesizes these insights and offers tactical, scalable strategies for recyclers, producers, converters, and brands across Latin America - and potentially the Global South - to significantly increase flexible plastic recycling rates.

Keywords: Flexible plastics LDPE mechanical recycling automated sortation separation waste workers Buenos Aires Argentina

28. Local governance policies to strengthen the circularity of reused and recycled material products in the construction sector.

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The construction sector is responsible for over 40% of greenhouse gas emissions and generates the largest waste stream in the European Union. Transitioning to a circular construction economy is therefore critical, with local governance playing a central role in driving this shift. This paper explores how local governments in the Netherlands, Norway, and Spain are shaping policies to foster the reuse and recycling of material products in construction. The study draws on a comparative analysis of urban regions engaged in the Horizon Europe project "Creating materials banks from digital urban mining" (SUM4Re), which focuses on unlocking secondary material flows from the built environment through advanced data and identification tools.

SUM4Re supports cities in identifying, analyzing, and managing materials from existing buildings using digital techniques such as AI, automated scanning, and blockchain-based registries. The goal is to establish localized material banks and improve standards like Building Information Modeling (BIM) to support circular practices.

Based on interviews with public officials and experts, field visits, and document analysis, the research investigates how municipalities mobilize resources, collaborate with stakeholders, and adapt regulations to enable circularity. The findings reveal that success depends not only on technological solutions but also on governance capacity, coordination, and experimentation.

In the Netherlands, frontrunner cities integrate circularity into procurement and planning via pilot zones, material passports, and circular tenders. Norway, particularly in remote regions like Svalbard, promotes circular pilots through public housing initiatives and national policy alignment. In Spain, experimentation occurs through collaborative platforms and reuse of vacant buildings, despite institutional fragmentation.

Three key governance levers emerge: (1) embedding circularity in local policies and procurement; (2) creating intermediary platforms to connect actors and material flows; and (3) using demonstration projects to scale innovation. Across all three countries, the findings highlight the importance of multi-level coordination and policy support to mainstream successful local practices.

This contribution offers actionable insights for policymakers and practitioners aiming to improve waste prevention and resource efficiency. It emphasizes that circularity in construction is as much about governance innovation as it is about technological advancement.

Keywords: circular construction, local governance, material reuse, urban mining, policy innovation

GOVERNANCE & LEGAL ISSUES

29. Failing waste collection in developing countries. Using System Dynamics to analyze societal causes in general and with a focus on Belize, Bolivia, the Dominican Republic, Ecuador, Panama and Paraguay.

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Around 35% of the global population is not being serviced with waste collection. This paper is about the societal causes of failing waste collection in developing countries, with a focus on Latin America. The hypothesis is that the relevant societal processes are entangled, dynamic and different per country. System dynamics is a suitable method to understand such systems.

A causal loop diagram (CLD) of all relevant societal processes is constructed. Graph theory is used to analyze the CLD. The first conclusion is that the root cause of low service-coverage must be sought in the interplay of strong population growth, urbanization and economic growth.

The next step turns the CLD into a quantitative stock and flow diagram (SFD). SFDs enable simulating the development of societal systems over time. Historical data for six Latin-American countries are used to calibrate the model. The results allow for comparing the countries. Growth of population is in a strong reinforcing cycle together with economic growth, quality of government and availability of budgets. But the reinforcement can go multiple ways. Panama and The Dominican Republic show strong economic growth, leading to sufficient government revenues but inertia within the governance system prevents them to translate these budgets into improved waste collection. Ecuador and Paraguay show the opposite; despite low growth in government revenues, their efficiency enables them to improve services and to outpace the growth of population and waste. Belize shows growth in government revenues, but quality of the government is declining leading to a steady decrease in service coverage. Bolivia seems to be the only country where urbanization is the cause of the problem.

The last part of the research uses the model for a more detailed case study in Bolivia. The SFD is further augmented based on interviews with experts. It is then calibrated against additional historical data. The results cast new light on the role of the service-efficiency. Trying to reach more and more citizens, leads to increasing costs per citizen. This logic of diminishing returns is negatively influenced by a strong rate of urbanization and by a basic lack of trust in, and appreciation of the government. It leads to low public participation which further deteriorates the efficiency of public waste collection services. The effect is that the percentage of the population being serviced is levelling at around 60%. Neglect of the rural areas doesn't seem to play a role. Bolivia should aim at isolating the public appreciation of waste collection from the general situation of social unrest in the country. Any small improvement there will have a strong impact. Extra budgets and improving technical efficiencies will also pay-off but not in a proportional way.

The model provides plausible insights in what actually happens in developing countries. But still it should be put to the test in other countries and under other political, social and cultural circumstances.

Keywords: waste, collection, failure, causes, societal, system dynamics, latin america

30. Promoting the Circular Economy in São José do Rio Preto: The Beginning of a Regional Journey through Collaborative Governance.

Casemiro, K. R. P.
Silva Filho, Carlos R. V. (1)

(1) S2F Partners, Sao Paulo, Brasil

When we are faced with the planetary dynamics of consumption on one hand, and with the indicators of exponential exploitation of natural resources along with records of extinctions and scarcity on the other, we observe how far we still are from achieving a change in human behavior toward the environment. This is because the execution of various economic activities aimed at satisfying human needs still depends on an extractivist model for acquiring raw materials and inputs from nature, guided by another model—the 'extract-manufacture-discard' paradigm of a completely linear economy. However, the demand for resources has witnessed accelerated growth—whether due to population increase, rising individual consumption, or design and manufacturing strategies whereby products are deliberately conceived to have a limited lifespan. These behaviors are confirmed by statistics; according to UN data, resource extraction has grown rapidly over the past 50 years. Extraction reached 92 billion tons in 2017 compared to 27 billion tons in 1970, followed by urban solid waste generation, which has increased at a similarly exponential and critical pace, from 110 million tons per year in 1900 to about 2.1 billion tons per year in 2020—and, if the current trend continues, is expected to accelerate, with estimates reaching 3.8 billion tons per year by 2050. In the Brazilian context, according to ABRELPE, 79.6 million tons of waste were generated in 2020, with estimates reaching 100 million tons by 2033, maintaining a continuous increase of nearly 11 million tons per decade until 2050. Considering all this, we recognize that we are facing a major crisis for which all actors and scenarios within the historical chain of consumption are responsible, but at the same time, we see an important opportunity to realign production processes and waste disposal strategies. São José do Rio Preto, located in the State of São Paulo, Brazil—a municipality of 500,000 inhabitants that reaches 600,000 when including the metropolitan region—aptly represents this dichotomy mentioned above. Through initiatives by the local public administration and a non-profit private civil association, Collaborative Governance, which brings together companies and entrepreneurs, efforts have been made to incorporate new values and support a sustainable transition that adds local and regional value, benefiting the economy, society, and the environment. This represents a positive example of the adoption of this new approach, with the potential for replication in Brazil and other regions of the world.

Keywords: circular economy, collaborative governance, waste management, regional partnerships, shared responsibility, global partnership

31. The Nordic Biogas Model – Global potential for circular transformation.

Clark, Tony

Sweden

The Nordic Biogas Model (NBM) is a concept for biogas system that combines efficient waste management with the production of renewable fuels and biofertilizers. The model is based on the use of organic waste from cities – such as food waste, sewage sludge and food industry waste – which is digested into biogas and digestate. The biogas is upgraded to biomethane and used as vehicle fuel, while the digestate is returned to agricultural land as fertilizer.

What makes the NBM unique is its multifunctionality: it solves several societal challenges at the same time – reducing greenhouse gas emissions, contributing to cleaner cities and strengthening the agricultural cycle.

Although the model was developed in the Nordic region, it has great international relevance. All over the world, cities are struggling with growing waste volumes, air pollution and the need for sustainable transport solutions – while rural areas are dependent on imported fertilizers. NBM offers a way to reconnect the flow of nutrients and energy between city and country.

However, for NBM to have a global impact, better knowledge of its functions and effects is required, as well as coordinated policy that reflects the model's many societal benefits. With the right support and instruments, countries with inadequate waste management can take major steps towards circular and climate-friendly development – with NBM as a guide.

Keywords: Biogas, Organic waste, Renewable fuel, Circular economy, Nutrient recycling

32. Intermunicipal cooperation as a driver for efficient and effective household waste management.

Coopman, Piet

Interafval

Over a period of more than 30 years, Flanders (Belgium) went from 18% separate collection in 1991 of household waste to over 70% separate collection for recycling as material or production of high quality compost. This a result of a combination of different factors, going from ambitious waste management planning from the national government, cooperation between stakeholders throughout the value chain and local governments taking responsibility to efficiently and effectively organizing the collection and treatment of household waste. The latter would have never have been possible without the active role of intermunicipal cooperations in waste management. The concept of intermunicipal cooperations remain a good practice for both developed and developing countries to set up an efficient and effective household waste management system and further realize the goals of circular economy.

Flemish municipalities are responsible for organizing the collection and treatment of household waste since Napoleon decreed them to take care of this. Until the 1960s and 1970s their activities were limited to collecting and landfilling waste. Under the influence of public awareness and European legislation, separate collection systems and other waste treatment technologies were introduced. Single municipalities often lacked the finances and capacity to set up the necessary infrastructure and policies. In Flanders, municipalities created intermunicipal cooperations. These had the financial capacity to invest in infrastructure and build the knowledge. Moreover, financial risks of big investments in treating facilities could be spread over different municipalities. A strong political link to the local authorities lead to a tailor-made policy based on local circumstances. In combination with the introduction of 'pay as you throw' schemes, impressive results were obtained in separate collection and recycling. Local responsibility and intermunicipal cooperation has proven to be a success factor and should be considered in many emerging countries, as was also mentioned in the first UNEP 'Global Waste Management Outlook'.

But also in highly developed systems of waste management, intermunicipal cooperation can still play a role to move closer towards a circular economy. Sustainable product cycles are easier to guarantee and manage if solutions are found within short distances. Most municipalities often lack scale to play an active role in creating these short product cycles. But through intermunicipal cooperation, local authorities can enable themselves to create local opportunities in balancing the presence of nutrients and secondary materials with needs for resources.

Keywords: intermunicipal cooperation, local government, household waste, financing, infrastructure

33. Waste Flow Modeling in 10 Cities of Colombia and Assessment of Its Circularity Potential: A System Dynamics and Artificial Intelligence Approach.

Ibarra Vega, Danny
Universidad de Antioquia

Efficient management of urban solid waste remains a key challenge in the transition toward circular economy models. This study presents the system dynamics modeling and simulation process of waste flow in the 10 main cities of Colombia over a 20-year horizon, evaluating their circularity potential.

The model was developed using system dynamics and validated through differential equations. To ensure behavioral validation and model calibration, artificial intelligence techniques were applied.

Waste generation is modeled based on population growth, per capita generation rates, and waste type distribution (organic, plastics, paper/cardboard, glass, and textiles). The development of installed capacity for waste recovery and recycling is included, assuming progressive infrastructure and technology growth, with specific targets set for different years.

The model enables the analysis of various waste management scenarios, including strategies to increase recycling capacity, reduce waste generation, and implement public policies that incentivize the circular economy.

The results highlight that a systemic approach is essential for effective waste management and policymaking. Recycling and source separation strategies alone are insufficient without investment in technology, infrastructure, and resource recovery capacities.

Currently, the recovery rate in Colombia remains very low, and without interventions focused on circularity, the amount of waste sent to final disposal will continue to increase, leading to environmental and economic impacts for the 10 evaluated cities.

A long-term planning approach is recommended, incorporating systemic models, incentives for waste reduction at the source, strengthening the recycling industry, and appropriate infrastructure for processing reusable materials. Additionally, the creation of demand for materials or by-products derived from waste is crucial.

This study represents a significant contribution to decision-making in sustainable urban waste management and promotes a data-driven and dynamic modeling approach to enhance circularity in cities. The methodology can also be replicated in other countries.

Keywords: System Dynamics; Waste Management; Modeling; Cities, Circular Economy

34. The Extended Producer Responsibility applied to the Mining Sector as key tool to achieve challenging commitments regarding CO2 emissions reduction. Composite mill liners Case Study.

Leiva Neumann, R. (1)
Pertho, M. (1)

FLSmidth, Copenhagen, Denmark

FLSmidth launched a pilot project to voluntarily implement the Extended Producer Responsibility (EPR) for ware parts of equipment it supplies to various mining operations for ore processing worldwide.

The pilot project is highly specific and is based on a machine designed and built in Denmark to prepare rubber and composite mill liners (CML) made of metal alloys and rubber for reuse and recycling at the end-of-life stage. The machine separates the rubber from the metal components of worn CML, allowing both the rubber and the metal to be subsequently transported to certified facilities for reuse and recycling. This machine's function is vital and innovative, as these worn CML cannot otherwise be recycled; they are disposed of in landfills or clandestinely processed by informal operators who burn these CML to remove the rubber and thus be able to sell the metal. FLSmidth will process only FLSmidth-manufactured composite mill liners (CML) at its facilities (service centers) close to costumers mining-sites as part of a recovery service. This service will be included in the CML supply contracts signed with customers (mining sites), thereby assuming operational and financial responsibility of the end-of-life of these ware parts under an Extended Producer Responsibility (EPR) model.

If a contract is signed with a customer (mining site) to supply new liners to a mill that previously used liners from another manufacturer, the new liners supply contract may stipulate that FLSmidth will handle third-party liners removed from the mill for subsequent recovery.

FLSmidth recycling concept consider the pick-up of worn CML on-site, the shipment to the facility where the CML components separation will take place, shipment of separated components for reuse or recycling facilities (recyclers), issuance of reuse and recycling certificates for costumers and CO2 emissions savings reports.

Keywords: EPR, recycling, circular economy, CO2 emissions savings, mining sector, end-of-life, Extended Producer Responsibility

35. Building self-sufficient waste management systems: A South–South approach to local enterprise, policy support and affordable interventions.

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In many parts of the Global South, the absence of formal waste management services is a daily reality. Open dumping and burning remain common practice, with severe impacts on human health, livelihoods and the environment. Yet these same contexts are often overlooked in global waste policy and financing discussions – deemed too expensive, too remote, or too difficult to serve.

This paper shares insights from Global Waste Lab and partners working to change that narrative by piloting affordable, low-tech, and community-rooted interventions. Drawing on practical experience in Indonesia, India, The Gambia, and East Africa, the approach prioritises independence in waste management – enabling municipalities and communities to get started using what they have, rather than waiting for large-scale investment.

Instead of relying on donor funding or costly foreign consultants, the model focuses on building an enabling environment for small-scale recovery and recycling enterprises – with local training, practical policy advice, and simple infrastructure. These programmes support job creation, circular economy enterprise, and inclusion of the informal sector, while improving environmental outcomes at minimal cost.

South–South learning plays a key role. Through peer knowledge exchanges, stakeholders in The Gambia have applied lessons from similar peri-urban and shoreline communities in Asia, adapting simple interventions to their own context. In parallel, municipal support programmes and training toolkits have been co-developed to strengthen local government leadership in solid waste management – helping to clarify roles, unlock internal resources, and build interdepartmental collaboration.

Partnership is central. Global Waste Lab works closely with the Flipflopi Project, whose own advocacy efforts – including a proposed Single Use Plastics Bill for the East African Community in partnership with legal alliance ALN – illustrate the need for joined-up approaches that combine policy, enterprise, and public participation. Flipflopi's experience has also shaped new digital and training tools designed for use by municipalities, community groups, and CBOs in remote or under-served areas.

This session will share examples of what's working, challenges faced, and how technical consultants, donors, and policymakers can help scale this type of work across low-income settings. It will explore how modest investments, if carefully targeted, can have outsized impacts – particularly when they build on existing systems, community knowledge, and enterprise potential.

Keywords: South–South cooperation, Waste financing, Open burning, Informal sector inclusion, Enabling environment, Circular economy, Municipal capacity building, Low-cost interventions

36. CIRCULAR ECONOMY AND WASTE MANAGEMENT AT G20: A PRIORITY UNDER THE BRAZILIAN PRESIDENCY.

Ribeiro, F. M.
Santos Catholic University (Unisantos)

In recent years, the G20—the group of the world's 20 largest economies—has increasingly integrated environmental and sustainability issues into its annual discussions, with particular attention to the challenges of climate change and other topics linked to multilateral environmental agreements. In 2024, under Brazil's presidency, the G20 formally incorporated "waste and circular economy" as one of the four pillars of the Environment and Climate Sustainability Working Group. This move followed precedents set by previous presidencies—such as Germany, Japan, Italy, and India—which had already introduced themes like resource efficiency and also references to circular economy (CE) in G20 decisions. Brazil's approach was notably supported by organizations such as the United Nations, contributing to the inclusion of the topic in the presidency's technical paper and the final ministerial declaration. The document highlights pressing global waste management statistics: 38% of waste is still disposed of in an uncontrolled manner, and only 19% is recycled, leading to significant environmental, social, and economic challenges. For instance, poor waste management is associated with health issues affecting over 400,000 people in the Global South, and the sector is responsible for emitting 1.6 billion tons of CO_2 equivalent. In this context, the CE is presented as a potential solution, both by preventing waste generation (e.g., through product and packaging ecodesign) and by enhancing value recovery (e.g., via recycling and composting). On the social front, the document proposes a novel definition and set of principles for an "inclusive CE", advocating for a just transition that leaves no one behind. Brazil's G20 presidency outlines four key priorities: 1. The global closure of open dumpsites; 2. Empowerment of informal waste sector workers, emphasizing the vital role of waste pickers in developing countries; 3. Reduction and management of food loss and waste across production and consumption chains; and 4. Promotion of CE practices and waste management to combat plastic pollution. As a concluding proposal, G20 members are encouraged to act along three strategic axes: Implementing inclusive CE initiatives domestically; Creating global enabling conditions for a circular transition; and Supporting the inclusive CE agenda through partnerships and international collaboration. Beyond its policy significance, this work also holds potential to shape future developments in international environmental law, including the drafting or revision of protocols and treaties, to harmonize sustainability strategies and approaches on a global scale.

Keywords: Circular Economy; Waste Management; G20; Environmental Governance

37. Advancing Pilot Solutions for Marine Litter Prevention in Caribbean SIDS – Phase II of the PROMAR Project.

Berner, Richard

Munnolimath, Amarnath, Hegmann, Evita

Adelphi, Berlin, Germany

Marine litter, particularly plastic waste, poses a significant challenge to Small Island Developing States (SIDS), where limited waste infrastructure and geographic isolation worsen the impacts of climate change on marine ecosystems, coastal communities, and waste management systems. The PROMAR project, funded by the German Federal Ministry for the Environment, addresses these interconnected issues by promoting innovative waste management and circular economy solutions that contribute to climate resilience. Building on the successes of Phase I, Phase II (2025–2026) focuses on piloting tailored interventions in five Caribbean SIDS: Suriname, the British Virgin Islands (BVI), Trinidad and Tobago, St. Kitts and Nevis, and Guyana.

In Phase I, demonstration sites in the Dominican Republic, Costa Rica, and Colombia provided critical insights into marine litter sources and composition through waste sampling and monitoring activities. For example, in Costa Rica, waste flow mapping and beach sampling identified plastic bottles, Styrofoam fragments, and other single-use plastics as the most critical litter types. These findings informed pilot interventions such as floating river booms to capture waste, community awareness campaigns, and the integration of marine litter prevention into municipal waste management plans. In Colombia, circular economy pilots strengthened recycling systems by empowering waste picker associations, introducing selective collection routes, and linking recyclers directly with material processors. These efforts prevented thousands of tons of plastic pollution while creating scalable models and cutting carbon emissions.

In Phase II, PROMAR expands to the aforementioned five countries, where demonstration sites have been identified, and waste sampling and material flow analysis (MFA) are underway. Innovative methods, such as weekly sampling from river booms, complement traditional approaches like beach cleanups to establish baseline data. This will inform pilot solutions, ranging from upstream measures like reusable packaging systems to downstream interventions such as waste capture technologies, household segregation programs, and community sensitization campaigns. Tailored to each SIDS's unique context, these pilots address waste composition, infrastructure gaps, and community needs, with Extended Producer Responsibility (EPR) as a potential complementary policy tool.

The PROMAR project demonstrates how innovative waste management solutions can address the dual crises of marine litter and climate change in SIDS. By combining upstream and downstream interventions with community engagement and capacity building, Phase II aims to create scalable models that prevent marine litter and enhance climate resilience. The ISWA 2025 PROMAR poster will provide an up-to-date snapshot of these pilot interventions, showcasing their progress and potential for replication across the Caribbean and beyond.

Keywords: Marine, Pollution, SIDS, EPR, Waste, Governance, Policy, Training, Prototyping, Circularity

38. Understanding the limitations of recycling and utilization targets for circular plastics management: a general economic equilibrium model including material flow analysis. Rivic, Stefani

Rechberger, H. (1), Freiberger, M. (2), Fürnkranz-Prskawetz, A. (1), Cencic, O. (1), Scharff, C. (1)

(1) TU Wien, (2) IIASA

Increasing consumption of plastics and improper waste management have pushed management of plastics into the focus of EU policies in recent years aiming to increase the recycling of plastics. However, the COV19 pandemic has led to some distortions in the recycling sector. In particular, the recycling of plastic packaging has been made more difficult by the drop in the price of crude oil and the associated significantly lower prices for primary plastic. Thus, the recyclers had difficulties getting their recyclates into the market, but recycling quotas still needed to be fulfilled. The competitiveness of recyclers is therefore severely at risk. There have been calls for mandatory minimum recycled content rates (MRCR) in plastic packaging, which should enable recyclers to sell their recyclates independently of such price fluctuations. Nevertheless, the effectiveness of such policy measures is argued and not discussed scientifically yet. In order to better understand the underlying relationships, we model the plastic packaging system as a material flow system and combine it with an economic general equilibrium model. We embed the consumption goods sector, the plastic packaging production sector, the recycling sector and household sector explicitly in the model. Furthermore, the model integrates the role of Extended Producer Responsibility (EPR) through the inclusion of licensing fees. The primary theoretical contribution lies in demonstrating that waste management systems can be modelled analytically, thereby enabling decision-making grounded in rigorous research. Remarkably, the analysis reveals that even seemingly straightforward material flows—such as those associated with plastic packaging—give rise to mathematically complex models that require advanced solution techniques. From a practical perspective, the model offers two key outcomes: first, it provides an analytical framework for identifying structural failures within the circular economy of plastic packaging; and second, it serves as a robust tool for designing and evaluating potential policy interventions. Using various scenarios, we examine how the system reacts to drastically lower primary plastic prices and the introduction of a MRCR. For the latter experiment, we find that a MRCR does not have the power to increase the recyclate production significantly, which is surprising and a consequence of the special market structure in the recycling sector. The simulation results show that the model reflects the real impacts very well in terms of quality and hence enables us to provide scientifically validated input to recent discussions on plastic packaging recycling issues. Despite that, we point up that if decisions makers as the government seek a more comprehensive understanding of the system, there is a need for increased availability of public data. Only with the right understanding of the system and sufficient data, policies can be set successfully.

Keywords: Plastic packaging, Circular economy, Material flow analysis, General economic equilibrium model, minimum recycled content rate

39. Overview of Reverse Logistics Systems in Brazil.

Soler, Fabricio

S2F Partners, Brazil

The Federal Law No. 12.305, of 2010, establishes Brazil's Solid Waste Policy and provides for shared responsibility for the life cycle of cycle of products, defined as a set of individualized and chained responsibilities of manufacturers, importers, distributors and traders, consumers and public service consumers and holders of public urban cleaning and solid waste management services, to minimize and solid waste management services, to minimize the volume of solid waste and waste generated, as well as to reduce the impacts caused to human health and environmental quality resulting from the life cycle of products.

Within the scope of the duties of manufacturers, importers, distributors and traders, the Law determines that it is the responsibility of the business sector to collect products and packaging after use, discarded by consumers, and disposed of them in an environmentally disposal. This is the reverse logistics system, which comprises an integrated set of actions, procedures and means designed to enable the collection, sorting and return of recyclable products or packaging to the business sector for sector, for reuse in their own or other production cycles, recycling or other cycles, recycling or another appropriate disposal.

Reverse logistics systems can be regulated by a Regulation (Decree), Sectoral Agreement or Term of Commitment, which are contracts signed by the private sector with the Ministry of Environment and Climate Change. Implementation, in turn, is preferably carried out by Management Entities (PRO), which can be a non-profit association and/or consulting firm responsible for managing the structuring and operationalization of reverse logistics in a collective model, covering a group of manufacturers, importers, distributors and traders.

Keywords: EPR, Share Responsability, Reverse logistics system, Brazil

BIOLOGICAL WASTE TREATMENT

40. The upscaling potential of community-based waste management systems.

Allen, Cecilia
GAIA

The increased demand to cut methane emissions is driving unprecedented attention to address the organic stream of municipal solid waste. Several policies and commitments have been launched in the past years, elevating the need to address waste impacts globally. These include the Global Methane Pledge launched in 2021, the UN General Assembly Resolution A/RES/77/161 on Zero Waste, the COP29 Declaration on Reducing Methane from Organic Waste, as well as national and local policies and increasing financial schemes.

Community-based and waste picker organizations from all over the world are working to mainstream just methane reduction in the waste sector through a zero waste approach. Part of this work entails implementing decentralized waste management projects-- in many cases partnering with local governments- that include the informal sector, rely on community engagement and accessible treatment technologies, especially in so-called global south countries.

These systems are proving great results such as high engagement rates, several above 80% and waste diversion rates over 70%. Benefits of these systems have been studied, such as the potential of job creation, climate mitigation and adaptation, cost savings and environmental health benefits (GAIA, 2022).

Upscaling and replicating these systems requires the convergence of community-groups, waste workers and local governments responsible for waste management, as well as the design of policy and financial mechanisms that can build from these experiences and support a waste management approach that is upstream oriented and is implemented in a decentralized manner. Some studies are being undertaken in Brazil and Indonesia (CPI, 2025).

A study analyzing business models of community-based and waste picker organizations in a current and scaled-up version is being conducted for the cities of Accra (Ghana), Buenos Aires (Argentina) and Quezon City (Philippines), complemented with a projection of greenhouse gas emissions savings. The research study is coordinated by GAIA, in partnership with LUMEC, an economic development research organisation from South Africa, and local organizations in the three cities: Green Youth Africa Organization, FACCyR and Mother Earth Foundation. The study aims to analyze how the organic waste management systems managed by community groups and waste picker organizations can be scaled up in a financially sustainable way, and what is their potential of greenhouse gas emissions reductions. The presentation will share initial findings of this study.

Understanding how decentralized waste management systems based on a zero waste approach can be incorporated into public waste management services and what policy and financial mechanisms can enable these processes will support the compliance of the global and national pledges and policies to reduce methane emissions in the waste sector.

Keywords: waste, waste pickers, community engagement, NGO, organic waste, methane

41. Public policies on large generators as an incentive for decentralized composting: case study in Brasília, Brazil.

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The treatment of the organic fraction of municipal solid waste (OFMSW) via decentralized composting (DC) systems has the advantages of low transportation, maintenance and operating costs, although the labor force is an important factor. Separating waste at source contributes to improving quality of the compost produced and reducing landfill disposal. However, the existing literature to date indicates that DC initiatives have rarely been conducted outside Europe and the United States. In this context, this article aims to discuss decentralized composting as a strategy for the adaptation of large waste generators to Brazilian legal provisions. In Brazil, the national Policy on Solid Waste establishes that generators of non-hazardous waste that cannot be equated to Household Waste due to composition or volume must prepare their own Waste Management Plan (PGRS) and be responsible for their own waste collection and disposal; laws at municipal/district level have been regulating the figure of the so-called 'large generators'. In Brasília, the Brazilian capital, a 2016 district law classifies as large generators non-residential establishments that generate more than 120 liters/day of undifferentiated solid waste; such establishments are responsible for properly managing all solid waste similar to the household waste they manage, and bearing the corresponding costs. A case study was carried out in a public agency located in Brasilia, initially classified as a large generator. The diagnosis of the generation and characterization of solid waste identified an average daily generation of 125 kg of Municipal Solid Waste (MSW); most of it corresponded to OFMSW, but due to inadequate segregation it was handled as undifferentiated waste, and its final disposal in landfill began to entail additional costs. The actions adopted included the construction, in 2019, of a composting yard with 3 composters; in the same year, two others were installed and 3 more were built in 2023, totalling 8 composters of 2 m^3 each. The patio receives food scraps and pruning and weeding residues from the green areas of the site, which in turn receive the compost produced there. A year after implementation, the agency was reclassified as a small generator, and in April 2021 it already had a diversion rate of 97% from the landfill. The measures adopted contributed to the fact that in 2023, the agency reached an average generation of 50 kg of MSW - a reduction of 60% - and a landfill diversion rate of 98%. The facility currently manages 100% of the OFMSW generated on site, which corresponds to more than 1 ton per month. It is found that the establishment of public policies at the municipal/district level can foster the adoption of decentralized composting solutions, which contribute to the valorization of organic waste and at the same time the reduction of dependence on landfill disposal.

Keywords: solid waste management, decentralized composting, large generators, Organic Fraction of Municipal Solid Waste (OFMSW)

42. The Nordic Biogas Model – Global potential for circular transformation

Clark, Tony
Sweden

The Nordic Biogas Model (NBM) is a concept for biogas system that combines efficient waste management with the production of renewable fuels and biofertilizers. The model is based on the use of organic waste from cities – such as food waste, sewage sludge and food industry waste – which is digested into biogas and digestate. The biogas is upgraded to biomethane and used as vehicle fuel, while the digestate is returned to agricultural land as fertilizer.

What makes the NBM unique is its multifunctionality: it solves several societal challenges at the same time – reducing greenhouse gas emissions, contributing to cleaner cities and strengthening the agricultural cycle.

Although the model was developed in the Nordic region, it has great international relevance. All over the world, cities are struggling with growing waste volumes, air pollution and the need for sustainable transport solutions – while rural areas are dependent on imported fertilizers. NBM offers a way to reconnect the flow of nutrients and energy between city and country.

However, for NBM to have a global impact, better knowledge of its functions and effects is required, as well as coordinated policy that reflects the model's many societal benefits. With the right support and instruments, countries with inadequate waste management can take major steps towards circular and climate-friendly development – with NBM as a guide.

Keywords: Biogas, Organic waste, Renewable fuel, Circular economy, Nutrient recycling

43. A NEW WAY FOR BIOWASTE : TRIFYL has chosen a complete organic waste management solution on its territory at the lowest cost and with the best environmental footprint.

DEMAZURE, Camille

TRIFYL , French solid waste partnership

In the TRIFYL territory, the sorting of bio-waste at source is carried out at the lower cost and with the best environmental footprint.

The bio-waste is collected in the same container as the household garbage and through the supply of a small volume orange bag. These bags are covered with DATA MATRIX inscriptions that allow you to trace the origin of the bag. The innovative TRIFYL plant will recognize these bags and direct them to their dedicated processing unit after being recognized by cameras. Subsequently, they will undergo a series of steps to be prepared, methanized and then refined to produce compost meeting the best standards of the moment.

In terms of results, this system allows to quickly mobilize quantities of bio-waste diverted from the rest of the garbage and with the best quality. In average, no more than 3% of the unwanted items are present inside the bags. All refusals resulting from this processing are directed to the production of RDF.

This model allows to supply energy for a territory (injection into the gas grid), fertilizer materials but also to contain the cost of collection and treatment of bio-waste.. This complete chain ensures the best possible recovery of bio-waste in addition to individual and local composting practices.

To minimize greenhouse gas emissions, TRIFYL captures the CO2 from biogas cleaning. This CO2 is liquefied to be sold for the market gardening industry and accelerated growth of tomato plants.

The TRIFYL model is now widely recognized. We cooperate with French, European and international communities to export our experience and try to improve waste management performances. TRIFYL is an active member of the French Solid Waste Partnership. For this project, the European Investment Bank has provided support of 40 millions of euros.

Keywords: biowaste, compost, energy, biogas, climate change

44. Sustainable finance in the selective collection of bio-waste under co-collection scheme and biogas production.
Dias, Joao

Tratolixo, E.I.M., S.A.

Climate change reinforces the urgency of aligning investment decisions with sustainable practices capable of generating environmental, social, and economic benefits. This article analyses the application of sustainable finance instruments to the selective collection of biowaste in co-collection and its valorisation through anaerobic digestion within the Tratolixo system, covering four municipalities in Greater Lisbon. The model has been fully implemented since January 2024 and integrates circular economy principles by diverting organic waste from landfill and transforming it into renewable energy and biofertiliser.

Using a qualitative case-study approach based on operational data, institutional documents, and recognised international methodologies, the work demonstrates how selective biowaste collection enhances resource efficiency, extends landfill lifetime, and significantly reduces greenhouse-gas emissions. In 2024, anaerobic digestion generated around 10 million m^3 of biogas—equivalent to 21 GWh of electricity—avoiding approximately 110,000 tCO_2e, positioning the project as “carbon negative”. Methodological validation under the AMS-III.AO framework (Verra) confirms the eligibility of the project for participation in the voluntary carbon market, enabling the issuance of around 101,000 carbon credits.

The study also analyses the role of green financial instruments—particularly green bonds and carbon credits—in supporting investment in waste-management infrastructures, highlighting regulatory requirements under the European Taxonomy, CSRD, CSDDD, and other EU sustainability frameworks. ESG indicators relevant to biowaste collection and biogas production are presented, demonstrating their integration into strategic and operational management at Tratolixo.

The findings show that coupling biowaste co-collection with sustainable finance mechanisms strengthens financial sustainability, supports compliance with European environmental objectives, creates additional revenue streams, and enhances the replicability of the model in other waste-management systems. The article concludes that the Tratolixo experience offers a robust example of how sustainable finance can accelerate the transition to circular and regenerative economic models in the waste sector.

Keywords: sustainable finance, selective collection, biogas, sustainability, ESG

45. Biowaste to Biomass: Utilizing Water Hyacinths as a Resource in Black Soldier Fly Waste Systems.

Peguero, D.A.

Diener, S. , Zurbruegg, C.

(1) Eawag: Swiss Federal Institute of Aquatic Science and Technology, Department of Sanitation, Water and Solid Waste for Development (SANDEC), Dübendorf, Switzerland, (2) Eclose GmbH, Kirchberg SG, Switzerland

Water hyacinths (Pontederia crassipes), are fast-growing invasive aquatic plants that thrive in tropical and subtropical regions. In Uganda, their rapid proliferation has led to severe ecological issues, including blocked waterways, displaced native biodiversity, and deteriorated water quality—particularly in Lake Victoria. The conventional method of managing these plants through open burning contributes further to environmental degradation. This study explores an alternative wase-to-valuepathway: the use of water hyacinth as a feeding substrate for the larvae of the black soldier fly, BSFL. BSFL are highly efficient decomposers of biowaste, transforming it into valuable protein and lipid-rich biomass, reducing landfill usage or open burning, and producing insect protein for animal feed, as well as fertilizer from their residual byproduct (e.g., frass). Integrating BSFL processing of water hyacinths could offer an innovative approach to addressing both water pollution and biowaste management challenges. As few studies have conducted BSFL feeding experiments with water hyacinths, this study first explored the potential of water hyacinths as a substrate for BSFL processing. To assess the feasibility of this approach, 10 kg (wet mass) of water hyacinths were harvested from Lake Victoria in Jinja, Uganda, and processed into three particle sizes: coarse, fine, and smooth. The larvae achieved waste reduction rates of 23–39% (dry mass), with finer particle sizes yielding the highest reduction. However, larval biomass was relatively low (31–90 mg WM) compared to typical growth on nutrient-rich substrates like food waste (~150 mg WM), suggesting water hyacinths alone may not support optimal larval development. To enhance substrate performance, a waste audit was conducted in Jinja to identify additional locally available organic wastes suitable for co-processing. These complementary substrates could be blended with water hyacinths to improve larval growth and conversion efficiency. This research demonstrates the potential of BSFL bioconversion as an innovative, low-tech solution to both invasive weed control and organic waste management in Uganda.

Keywords: BSF, organic waste, biological treatment, waste audit

46. From Waste to Resource: On-Site Valorization of MSW into Aggregates and Fuel Blends for Cement Kilns Using High-Energy Processing.
Pontiggia, Rodrigo

Inaki Garin

Ibircom , Argentina, Cyecle F , Argentina

This paper presents the technical outcomes of a patented high-energy mechanical treatment developed by IBIRCOM, designed to transform non-hazardous municipal solid waste (MSW)

into stable and inert aggregates suitable for use in cement industry and construction materials. Over atwo-year operational period in Buenos Aires, Argentina, the system was tested under realworld conditions at the Norte III landfill, the largest solid waste facility in the country.

The process is entirely physical, requiring no thermal input or chemical additives, and operates at a throughput of 800 kg to 1.2 tons per hour, achieving stabilization in under 60 seconds. Operational results include over 80% volume reduction, significant mass decrease, and odor elimination. The resulting material has proven suitable as aggregate for construction purposes and also includes a fine plastic-rich fraction.

Beyond aggregate use, this plastic-rich fraction was successfully blended at industrial scale with oily, liquid, and semi-liquid residues to produce a solid alternative fuel. This fuel was validated and used in a cement plant located in Olavarría, Argentina, effectively displacing the need to purchase biomass. This novel application expanded the value of the recovered material and confirmed its role in energy substitution strategies within the cement industry.

The system's modular and transportable design makes it ideal for deployment in areas with limited or no waste infrastructure—such as islands, mining sites, or isolated operations.

Having an end user—such as a cement plant—capable of consistently receiving and valorizing 100% of the output material is key to the model's sustainability and scalability.

This approach challenges centralized waste treatment paradigms by enabling immediate, on-site conversion of MSW into construction inputs and alternative fuels, offering a robust circular economy solution in logistically complex environments.

Palabras clave: municipal solid waste, high-energy mechanical treatment, aggregate production, alternative fuels, on-site waste processing, cement industry, Norte III landfill, Olavarría, circular economy, remote operations

COMMUNICATION & SOCIAL ISSUES

47. Sustainability for waste management companies: opportunities and benefits.. Tapparini, G.

Ambrogio A. , Moretti L., Pavan A.

Fondazione Operate, Italia

Background

Sustainability is now a vital element for businesses, both at the European and international levels. Companies will have to ensure that their activities align with environmental and social sustainability goals, identifying and mitigating negative impacts across the entire value chain. Companies that adopt sustainable practices comply with regulations and benefit from competitive advantages, as citizens are more inclined to prefer companies committed to protecting the environment and human rights.

Waste Companies and Sustainability

Businesses active in the waste sector are also called upon to address this new cultural and entrepreneurial paradigm. Beyond the environmental aspect, the sustainability framework requires a strategic and forward-looking commitment also from a social and governance perspective, with repercussions in financial terms.

Methodology

As part of the Operate "Sustainability Made" project, to explore how companies in the waste sector are moving within the sustainability framework, we launched a survey on the integration of sustainability issues within waste sector companies in Italy. 35 companies with 50 to over 250 employees responded, with annual revenues ranging from 2.5 to 80 million euros.

Value Proposition

Companies operating in the waste sector have already demonstrated a high level of compliance with environmental regulations, implementing sustainable practices that reduce the ecological impact of their activities. However, there is growth potential that businesses can leverage to amplify the positive impacts of their activities on people.

Challenges

The survey confirmed that the theme of sustainability is already part of the nature and daily activity of waste companies. The real challenge will be to demonstrate that sustainability has been integrated at all corporate levels. While companies prove ready, in practice, to collect data, report on their environmental commitment or their transparency in governance, they are less prepared to integrate sustainability into the objectives of the industrial plan.

Benefits

Improving the impacts of waste business activities on people brings benefits to companies. Increased productivity: a work environment that promotes employee well-being translates into motivation and engagement, with increases in productivity and work quality. Talent retention: investing in people caring policies helps retain top talent, reducing turnover and costs. Improved image: companies that care for employees and local communities enjoy a better reputation, with increased trust from citizens, suppliers, institutions, and investors. Sustainability policies lead to

long-term economic benefits, in terms of operational efficiency and reduced costs related to absenteeism and inefficiencies. Positive impact on communities: companies that invest in people's well-being contribute to the social and economic development of the communities in which they operate.

Credits: Quaderno 5 - Operate

Keywords: sustainability, human rights, waste management, environmental impacts, social impacts

48. "Recycle WEEE": environmental education for the collection of micro WEEE..

PAVAN, ANDREA

Ambrogio A.

Confini Sustainability Lab SB, Italy

Background

Global production of WEEE is increasing five times faster than its recycling. This is one of the most striking figures from the , which estimates that by 2030, global production of electrical and electronic waste will reach 82 million tons, with annual increases of 4 million tons. In this context, it is vital to ensure effective recycling solutions for all WEEE components.

The Project

Through an integrated communication and micro-collection project, it is possible to increase the collection of WEEE for recycling, following the supply chain provided by Italian legislation: in addition to disposal at municipal collection centers, bringing collection points closer to citizens helps to increase the quantity and quality of collected waste.

Methodology

The method provided by the "Recycle WEEE" project is to use visual communication channels, social media, citizen contact, education, and training in schools to support disposal at municipal collection centers and small containers for micro-WEEE (max 25 cm) placed in schools and community gathering places.

Value Proposition

The value of the project lies in the involvement of all stakeholdecitizen engagement is ensured by online and offline communication tools, such as posters and press releases, as well as direct one-to-many contact through meetings, local events, and initiatives. Using playful methods and nudge techniques, involvement and participation are stimulated to effectively communicate the destination of WEEE to collection centers. Contact with students and schools is aimed at training, educating, and engaging them to dispose of small WEEE in containers installed at schools: the educational project is further developed through training events with teachers, meetings with students, and educational materials for teachers.

Challenges

Through the tools and method, the aim is to engage and incentivize the correct disposal of WEEE by stimulating understanding of the importance of recycling. A large part of WEEE is not disposed of in the correct collection stream because it is small and little-known waste: moreover, the need to take it to collection centers does not encourage users to dispose of it correctly, but rather to dispose of it more conveniently in the nearest separate collection stream, such as non-recyclable waste collection. Bringing collection closer to citizens and emphasizing the importance of recycling are the challenges to be met to improve the quantity and quality of collected waste.

Benefits

The project has positive impacts on the territory and citizens. Legacy: the containers installed in schools and community gathering places represent a permanent collection channel that is recognized and used by students and citizens. Collection: the amount of waste collected is increased, raising users' awareness of the importance of correctly disposing of WEEE. Recycling: the quality of collected waste and recycling are improved.

Keywords: ewaste, environmental education, small weee, recycling, training, school

49. Amplifying Waste Management Engagement Through Digital Platforms and Social Media.

Bertero, Lorenzo
Impactos Ambientales S.A.

Social media has revolutionized public engagement with solid waste management, transforming it from a back-office function to a visible societal concern. This abstract examines the key role of Facebook, X, LinkedIn, and Instagram in boosting awareness and participation in sustainable waste practices.

Facebook and X serve as powerful channels for disseminating accessible information on waste reduction, recycling, and the environmental impact of improper disposal, breaking down traditional communication barriers. Engaging visuals and concise messaging, amplified by strategic hashtag usage, foster widespread public dialogue and encourage behavioral shifts at unprecedented speed and scale. Instagram's visually-driven platform further enhances this by showcasing the tangible benefits of proper waste management and the beauty of environmental stewardship, captivating a broad audience and making environmental action relatable. These platforms also facilitate the formation of online communities, enabling the rapid organization of local initiatives and the sharing of practical tips across geographical boundaries.

Meanwhile, LinkedIn provides a crucial space for waste management professionals and organizations to highlight innovative technologies, circular economy models, and advancements in the sector, fostering collaboration and knowledge exchange that can drive industry-wide progress.

In conclusion, social media has fundamentally reshaped the landscape of waste management engagement. By fostering transparency, enabling direct interaction, and visually demonstrating both the problems and the solutions, these platforms have cultivated a more informed and participatory public. This digital empowerment signifies a crucial step towards a collective commitment to sustainable waste management practices and a healthier planet, demonstrating the power of digital connectivity in addressing a critical global challenge.

Keywords: Social media, community, communication, awareness

50. Strengthening Communication and Social Engagement for Sustainable Pilgrimage: A Case Study of Shri Amarnath Ji Yatra 2024.

Shah, J. (1)

Yadav D. (2), Sharma S. (1), Gajula Thummala M.K. (3), Pandhare V. (3)

(1) Swaaha Resource Management Private Limited, India, (2) Housing and Urban Development Department, Jammu & Kashmir, India, (3) Indian Institute of Technology Indore, India

India with a population of over 1.43 billion, is home to a vast and diverse religious landscape that hosts numerous religious gatherings and yatras across the country. In 2023, 64% of India's population lived in rural areas, which often limits access to information and proper waste management infrastructure. Solid waste generation is a critical issue in India, with 62 million tonnes produced annually—only 70% of which is collected, and merely 12 million tonnes treated. Events like the Shri Amarnath Ji Yatra in 2024, which drew 5.12 lakh pilgrims over 52 days, illustrate the scale of the problem. The previous editions of Shri Amarnath Ji Yatra in 2022 and 2023 generated around 480 MT and 360 MT of municipal solid waste (MSW) respectively, emphasizing the urgent need for more sustainable waste management systems. A few critical components for sustainable waste management are effective communication and community engagement, especially during large-scale religious events that attract massive footfalls and generate significant environmental impacts.

The Jammu & Kashmir Housing and Urban Development Department (JKHUDD), in collaboration with its sustainability partner Swaaha Resource Management Private Limited (Swaaha), embarked on a transformative campaign during the Shri Amarnath Ji Yatra 2024 to address the challenges through innovative, people-centred interventions. From the use of trained volunteers (Yatra Mitras) to the distribution of sustainable pilgrimage kits to powerful street theatre (Nukkad Natak), this initiative made use of communication strategies based on social and cultural relevance. Students from nearby schools were also included, helping with grassroots cleaning and educating pilgrims about eco-friendly practices. The campaign also incorporated infrastructural solutions like Kiosks (provide real-time weather updates, alerts, guidelines, helpline numbers), Water ATMs, gender sensitive sanitation facilities (pink toilets, sanitary pad vending machines, and incinerators). Effective feedback mechanisms and active social engagement amplified the success of the campaign, fostering a legacy of sustainable spiritual journeys.

This case study exemplifies how strategic communication, community participation, and inclusive infrastructure can stimulate social change and set new reference points in sustainable solid waste management during religious events. This is evident from the fact that during this campaign around 1 million people were contacted and their collective efforts led to the mitigation of 80,000 kg of CO_2eq. GHG emissions by avoiding 4 million pieces of Single Use Plastics (SUPs), a massive 45% reduction from the previous annual pilgrimage. This approach offers a scalable model for integrating waste management with cultural sensitivity and behavioural transformation, aligning with the broader goals of ISWA in promoting circular economy and sustainable urban living.

Keywords: Sustainable Pilgrimage, Zero Landfill, Education, Communication, Social Action, Environment

51. Measuring What MatteA Service Ladder For Inclusive Solid Waste Management.

Velasquez, L.N. (1)

Zurbrügg, C. (1), Peguero, D. (1), Meternat, A. (1), Tosi Robinson, D. (1)

(1) Eawag - Swiss Federal Institute of Aquatic Science and Technology, Switzerland

Monitoring and improving the quality of solid waste management (SWM) services remains a persistent challenge, especially in low- and middle-income settings. While urban areas tend to be more regularly assessed, service levels in peri-urban and rural contexts often remain poorly documented, with available information limited to estimations or grey data. In these areas, where formal systems are frequently absent, informal or self-managed service models dominate—but are rarely captured in existing monitoring frameworks. Yet, growing evidence suggests that waste generated and mismanaged in such contexts contributes significantly to broader environmental and health impacts.

Building on the logic of established service ladders in water and sanitation (e.g., those of the Joint Monitoring Programme, JMP), we introduce a structured and adaptable Solid Waste Management Service Ladder. It integrates and expands on existing assessment tools such as the Waste Flow Diagram (WFD), the Waste Wise Cities Tool (WaCT), the Waste and Behaviour Indicators (WABI), and Practical Action's "Managing Our Waste." It is designed to be compatible with existing datasets and adaptable for future field assessments.

This structured, population-based framework categorizes service levels into five tieNo Service, Limited, Basic, Improved, and Advanced. Each level is defined by clear, objective criteria across the waste management chain—from household-level handling and segregation to the quality of collection systems, and the environmental and health safety of treatment, recycling, and disposal. It also sets "basic service" as the minimum threshold necessary to protect public health, echoing global development standards.

A key innovation of the ladder is its recognition of the diverse realities of service provision. It distinguishes between three core components:

Self-organized practices at the household level, often seen in unserved or remote areas.

Household service provision, covering source-level actions and collection.

Safe management of waste, covering treatment, disposal, and recycling of both organic and recyclable fractions.

The ladder offers a clear method to assess how waste is managed across different contexts, capturing both formal and informal systems. It helps identify service gaps, highlight inequalities, and guide targeted improvements. Designed for use by local governments, researchers, and development partners, it supports tracking progress in a way that is both comparable across contexts and rooted in local realities. As a practical and scalable monitoring tool, the ladder fills a critical gap in the sector—bringing visibility to underserved populations and enabling more inclusive, data-driven progress in solid waste management.

Presentation can be held in Spanish and/or English.

Keywords: Service Level Monitoring, Waste Ladder, Informal Waste Systems, Waste Data and Metrics, Informal Waste Systems

SANITARY LANDFILLS

52. Landfill Gas Recovery and Methane Destruction for Landfills in Developing Nations. Biderman, D.S.

Biderman Consulting, LLC

Solid waste landfills are a significant source of greenhouse gas (GHG) emissions including methane and contribute to Climate Change. The landfill gas generated by decaying material in a landfill can be converted to renewable energy or can be destroyed to eliminate adverse public health impacts.

Many landfills in the developing world, including Latin America, lack the modern landfill gas processing and destruction systems that are common in the United States and Canada. In addition, the organic content of solid waste disposed at landfills in the Global South often exceeds fifty percent, generating higher quantities of harmful landfill gas. Most larger North American landfills currently collect and process landfill gas and convert it into renewable electricity that is used by nearby users or sold to a local utility. Many smaller and closed landfills, which generate smaller but significant amounts of harmful landfill gas, destroy it through flares or new innovative technologies such as Stirling engines.

Attendees at this session will hear from an international solid waste and landfill expert on the evolution of landfill gas recovery systems in North America and their application in Latin America and other developing regions. He will discuss how different-sized landfills may approach landfill gas recovery differently, and the economic, regulatory, and other considerations that may factor into the decision about which technology to deploy. He will review how recovering landfill gas can generate a new revenue stream for a landfill through sale of the energy. He will discuss how some landfills are starting to generate “renewable natural gas” that can be used to fuel garbage trucks and other vehicles.

As the amount of waste disposed at landfills grows throughout the developing world, and as dumpsites are closed and replaced by more modern landfills, it is essential to reduce the Climate impact of all of these facilities. Learn how to capture methane and either destroy or convert it into renewable energy at this session.

Keywords: Landfill, Climate Change, Energy, Methane

53. An Overview of Elevated Temperature Causation, Characteristics, Conditions, Mitigation Strategies, & Best Management Practices.

Dick, R. E. (1)

SCS Engineers

There is an increasing trend in the occurrence and severity of heat generation and accumulation in select sanitary (municipal solid waste) landfills in the United States. These particular landfills, which have been designated as Elevated Temperature Landfills (ETLFs), present unique technical and management challenges attributed to the atypical conditions exhibited by these facilities related to extreme temperatures, pressures, settlement, gas and liquid quantities produced within the waste mass, gas and leachate composition, unique odor characteristics, constituent concentrations within fugitive gas emissions, leachate pressurized releases and seeps, and other detrimental environmental conditions as well as health and safety aspects. ETLF conditions can generally be characterized as when the typical waste decomposition processes and corresponding methanogenesis associated with anaerobic digestion of organic solid waste materials disposed in a landfill are impeded because of heat accumulation. As a result, certin abiotic (non-biological) processes and chemical reactions within the buried wastes occur instead.

This presentation will provide the attendees with an overview of the ETLF characteristics (reaction gas and reaction leachate production), differentiate ETLFs from landfill fires and subsurface oxidation, identify ETLF common physical properties, discuss suspected causes of the heat generation and accumulation, outline ETLF symptoms, reveal leading indicators and early warning signs of a developing ETLF, and communicate best management practices, mitigation strategies, and design considerations. The presentation will highlight health and safety issues as well as long-term monitoring techniques.

In future decades, this phenomenon of ETLFs may not be unique to well-managed landfills within the United States, considering the evolving global number of large, deep, wet landfills (and open dumpsites) containing diverse types of waste materials. This presentation will inform attendees of the prudent actions that can be accomplished now to monitor for indicators of excessive heat generation and accumulation and also corrective measures and abatement activities that can reduce the potential for developing ETLF conditions in landfills and open dumpsites.

Keywords: landfill, landfill gas, leachate, elevated temperature

54. Sustainable Solid Waste Management: The German Case and Lessons for South America.

Jalalipour, Haniyeh

Gert Morscheck, Michael Nelles

University of Rostock, Department of Waste and Resource Management, Justus-von Liebig Weg 6, 18059, Rostock, Germany

This is the final version of our abstract and please don't consider the previous version!!

Abstract

With nearly 80% urbanization, Latin America faces critical challenges in managing municipal solid waste (MSW), particularly the continued reliance on landfilling and the prevalence of open dumps. The region's rapid population growth, high organic waste content, and inadequate infrastructure further exacerbate health and environmental risks. In response to increasing international attention on dumpsite closure, this study examines the potential for system transitions by drawing lessons from the post-reunification evolution of waste management in Mecklenburg-Vorpommern, a rural and less industrialized state in eastern Germany.

Using a comparative approach, the study reviews trends in waste dumping across 12 South American countries, alongside a historical and regulatory analysis of Germany's transformation. Key findings show that Mecklenburg-Vorpommern transitioned from operating over 13,000 local disposal sites in 1989 to only two sanitary landfills accepting pre-treated waste in 2023, with nearly half of municipal waste now collected separately for material recovery. Residual waste is treated before final disposal, supporting both material and energy recovery.

This transition was driven by policy and regulatory reforms, political will at the national level, harmonization of standards across federal states, and a national strategy to reduce methane emissions from landfills. Additional pillars of success included the introduction of a compost quality assurance system, cost-recovery financing mechanisms, and differentiated user fees to incentivize source separation. These findings highlight the importance of long-term policy commitment and coordinated action across government levels to achieve sustainable waste management—offering relevant lessons for South American countries aiming to move away from open dumping.

Keywords: Methane mitigation, Landfill, Biological treatment, circular economy

55. Case Study - U.S. Collaboration on Landfill Gas System Design, Norte IIID+ Landfill, Buenos Aires, Argentina.

King, D.B. (1)

Bernier, Q.F. (1), Briones, J. (2), Medrano, L. (2)

(1) SCS Engineers, Midlothian, VA, USA, (2) CEAMSE and Tecsan, Buenos Aires, Argentina

This topic will delve into a case study of SCS Engineers teaming with biogas developer, Tecsan, to provide Landfill Gas (LFG) Design services for the North Module III Operational Continuity (Norte III Landfill) in Buenos Aires, Argentina.

The Landfill is located at the North III Environmental Complex, operated by CEAMSE, receiving 17,000 tons of waste per day under a 24/7 landfilling operation, making this Landfill one of the largest in South America. Its waste composition is almost 50% organic material. The design includes horizontal collectors, vertical wells to be built from the bottom up or drilled from top down, as well as a network of lateral and LFG header collection pipes that transport the gas to a centralized processing plant. SCS visited the Landfill in January 2025 with Tecsan staff to gain understanding of Tecsan's resources and their LFG projection model on estimating LFG generation. This on-site visit helped SCS understand Tecsan's gas collection goals, as well as the specific operational conditions to consider when designing the LFG System.

Tecsan is the operator of the active Norte IIID+ Landfill and will install the future LFG System infrastructure for the Norte IIID+ area. Their staff use the most up-to-date drone technology to conduct aerial flyovers at least once per month, updating GIS and CAD-based maps with topographic and surface emissions data, including landfill airspace consumption rates and projections. Communication streamlined by SCS and Tecsan staff in English and Spanish kept both parties informed of rapid filling operations with less than 3 years of airspace remaining, and LFG System action items that needed to be installed prior to completing the final design. Tecsan also provided SCS with waste composition and its own model to project peak gas generation.

Tecsan previously used concrete bottom-up wells to remove leachate from the landfill surface. This presentation will detail how to incorporate these leachate drainage wells into a LFG design, including interactions with horizontal collectors to intercept LFG during active filling. The final LFG collection system design involves an interconnected network of horizontal collectors, vertical/horizontal combination collectors, bottom-up wells, vertical extraction wells, leachate cleanout connections, diagonal collectors, and toe drain collectors aligned for purposes of resiliency. While this system is primarily designed to achieve maximum collection efficiency in extraction of LFG, it will simultaneously maximize leachate drainage to the leachate collection system. This case study and design will serve as an exemplary model for an LFG collection system in South America within local contexts.

Keywords: solid waste, landfill gas (LFG), collection system, LFG design, engineering

56. Using Drones and ArcGIS to Reduce Landfill Methane Emissions while Improving Gas Collection - It's all in the data.

Tennant, Bill

Sniffer Robotics, Inc, Ann Arbor, Michigan, USA, BRa Tecnologias Ambientales, Buenos Aries, Argentina

Summary: Using drones for at-ground, point source methane emissions measurements yields highly accurate data, essential for precise emissions reporting. When integrated with wellfield data utilizing ArcGIS for visualization, potential emissions causation can be identified. This enables the development of action plans to improve wellfield performance. Employing this technology can result in increased gas collection with demonstratable reductions in emissions. Given the current valuation of renewable natural gas, this innovative approach to methane emissions monitoring offers significant bottom-line benefits. The presenter will discuss an actual use case showcasing this capability via an ArcGIS software solution tailored for landfill operations.

Primary Audience(s) ie: Landfill and Landfill Gas

Landfill and landfill gas engineering and operations

· Gas to Energy (LFTGE) and Renewable Natural Gas (RNG) operations

Learning Objectives (bullet points)

Understanding the benefits, differences, and limitations of various drone and satellite emissions detecting technologies

· The importance of ground level point source measurements for methane detection

· How to use point source measurements to increase gas collection and ROI

· How to overlay wellfield data and high-resolution imagery into ArcGIS for greater visibility into actionable insights for both remediation and increased gas collection

· Understanding the options for leak detection reporting methodology

Keywords: Landfill, Renewable Energy, Aerial Drones, ArcGIS, Emissions Monitoring, Methane Emissions Reduction,

CLOSURE & UPGRADING OF OPEN DUMPS

57. Overcoming Regulatory Barriers to Closing Dumpsites and Implementing Sanitary Landfills in Lagos, Nigeria.

Frankiewicz, Tom

Bodas, Jyoti

Rocky Mountain Institute

Thanks to recent momentum in climate action and increasing recognition of the environmental and public health risks posed by uncontrolled waste disposal, policy officials and waste site operators in the Global South are increasingly motivated to close dumpsites and transition to safer and more sustainable waste management systems. However, they often face critical barrielack of enabling policy, insufficient stakeholder representation, and underestimation of the timeline and resources needed for success.

This presentation will share findings from RMI's regulatory barriers analysis of dumpsite closure and the implementation of sanitary landfills in Lagos, Nigeria, to offer actionable insights for jurisdictions undertaking a similar transition.

Today, a significant share of global waste ends up in dumpsites with little environmental controls, causing significant harm to the environment and human health. Decomposition of the organic waste fraction also emits methane, a super pollutant driving near-term warming.

For Lagos, home to about 10% of Nigeria's growing population and a major commercial hub in Africa, this transition is critical. Lagos generates approximately 13,000 metric tons of municipal solid waste daily, most of which ends up in dumpsites. Shifting to sanitary landfills is not just an environmental and human health imperative but a strategic lever for achieving Lagos's waste management and emissions reduction goals. However, despite Lagos' goals of decommissioning its dumpsites and commissioning a sanitary landfill with gas capture, and political will in Lagos, this process is far from straightforward. It is time-consuming, resource-intensive, and involves aligning multiple stakeholder groups. These challenges are often exacerbated or caused by the lack of a comprehensive policy framework necessary for effectively planning the systematic shift in waste disposal.

RMI's regulatory barriers analysis aims to support Lagos' ambition for dumpsite closure by conducting a policy gap analysis that identifies policy gaps in Lagos compared to other countries and offers targeted recommendations to strengthen relevant regulatory frameworks. These recommendations address key areas of this transition, including siting, permitting, design, and operations, amongst others. Importantly, these insights are applicable beyond Lagos and can offer valuable guidance for other states and municipalities across the Global South navigating similar challenges.

Beyond improving waste disposal, this work offers solutions to advance broader goals of organic waste management and circular economy by promoting the capture and utilization of landfill gas for beneficial end uses. By supporting an efficient and equitable transition to safer and more sustainable waste management, this analysis helps cities protect public health, mitigate climate impacts, and build more resilient urban environments.

Keywords: Dumpsite Closure, Global South, Climate, Methane, Regulatory Barrier Analysis

58. A Global Framework to Map Dumpsites: Understanding Environmental, Social, and Governance Impacts for Sustainable Waste Management.

Maalouf, Amani

Smith School of Enterprise and the Environment, School of Geography and the Environment, University of Oxford, Oxford, UK

We develop a comprehensive, data-driven framework to map dumpsites and assess their environmental, social, and governance (ESG) impacts, providing evidence-based resources for policymakers, investors, waste management practitioners, and researchers. Our work involves creating a global geospatial database to capture the current state of dumpsites, with the aim of supporting informed decision-making. Through the use of diverse datasets and satellite observations, we identify critical impact zones and assess the potential for methane emissions mitigation, biodiversity loss prevention, and social harm reduction. We apply geospatial analysis, statistical modelling, and AI techniques to extract and interpret data, enhancing the reliability and accuracy of our findings. Our environmental indicators focus on methane super-emitter detection, open burning, vegetation loss, greenhouse gas emissions, and risks to biodiversity and protected areas. We use these indicators to evaluate the ecological footprint of unmanaged waste disposal, highlighting potential interventions for reducing emissions, particularly methane, which contributes significantly to climate change. Our social indicators focus on the socio-economic impacts, vulnerable workers, and affected communities, while governance indicators assess national and city-level waste management frameworks, financing mechanisms, and participation in global initiatives like the Global Methane Pledge. Through this interdisciplinary approach, we offer insights to support targeted policy interventions, guide investments, and foster community resilience. Our findings contribute to ongoing global efforts to reduce dumpsite-related emissions, protect natural ecosystems, and improve social outcomes, while advancing sustainable waste management practices in alignment with climate action goals.

Keywords: Dumpsite mapping, ESG indicators, circular economy, uncontrolled disposal, methane emissions, governance, policy interventions, climate change

59. AI-Based Illegal Waste Dumping Detection System in Abu Dhabi.
Salem Mubarak, Al Braiki

Environment Agency – Abu Dhabi

This project explores the use of artificial intelligence with satellite imagery to detect and monitor illegal waste dumping in Abu Dhabi.

Pilot studies achieved over 90% detection accuracy, identifying significantly more sites than field inspections, while reducing costs by half and delivering results 85% faster. The system also supports soil and groundwater protection by preventing contamination through early detection of waste.

As the UAE's first AI-based compliance monitoring platform, it directly contributes to Abu Dhabi's target of reducing illegal dumping by 90% by 2041, with potential for wider UAE and global application.

COLLECTION & TRANSPORTATION TECHNOLOGY

60. Sustainability Assessment of Waste Vacuum Systems as a Collection Solution. Eirill, Bø

Lyng, Kari-Anne

BI Norwegian Business School, Norwegian Institute for Sustainability Research

Efficient urban waste collection requires solutions that balance environmental performance, economic feasibility, and social acceptability while minimizing spatial and ecological impacts. This study assesses the sustainability of vacuum waste collection systems in comparison with underground containers and indoor bins, using data from approximately 2500 households in a Norwegian city. Four waste fractions: plastic, residual, and paper/cardboard were analyzed across two scenarios: a fully vacuum-based system for all households, and a hybrid solution combining underground containers for 1500 households with indoor bins for 1000. The evaluation integrates three sustainability dimensions: climate impact through life cycle assessment, economic performance through lifecycle cost analysis, and social aspects through qualitative assessment.

Findings reveal that vacuum systems achieve the lowest climate impact, although the differences between systems are modest. For vacuum systems, emissions are dominated by the construction of pipe networks and terminal facilities; for underground containers, by the number of units; and for indoor bins, by transport and operational activities. Economically, vacuum systems incur 22% higher costs than the hybrid solution. However, economies of scale are evident: increasing connected households from 2500 to 3100 reduces costs by 14%, positioning vacuum systems more competitively. Socially, vacuum systems offer notable benefits, including reduced odor and noise, improved traffic safety, and decreased physical strain on personnel.

Overall, the study concludes that waste collection solutions must be tailored to site-specific conditions but highlights the scalability and social advantages of vacuum systems, which may render them a viable option for sustainable urban waste management when integrated with commercial streams.

Keywords: Urban waste management, Vacuum waste system, Underground containers, Indoor bins, Sustainability assessment, Life cycle assessment (LCA), Economies of scale

61. DRS for PET bottles: scenario analysis and Life Cycle Assessment.

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Politecnico di Milano

The research focuses on the strategies to increase the separate collection and subsequent recycling of PET bottles in Italy, that requires an additional boost to achieve the ambitious 90% target set by the EU Packaging and Packaging Waste Regulation (PPWR), as well as the Single Use Plastic (SUP) Directive. The current system is based on PET bottles being collected together with all other plastic packaging waste, or comingled with metals ad even other light packaging (paper, beverage cartons). Sorting takes place in facilities equipped with advanced optical sorters for polymers and colour separation, the latter being applied mainly to PET to separate between transparent, light blue and mixed coloured.

In order to tackle the stringent requirements of the new EU Packaging and Packaging Waste Regulation (PPWR), the national consortium for plastic packaging materials is considering to introduce a Deposit Return System (DRS), in addition or as an alternative to the current source separation.

A number of operational scenarios have been defined and analysed in terms of mass flows (using Material Flow Analysis - MFA techniques) and environmental performance (e.g. Life Cycle Assessment). They include a Business-as-Usual scenario, one based on compacting machines additional to the standard collection and one based on full DRS implementation.

The analysis is being performed on two geographical contexts: a big City (Milan) and a smaller province (Pescara, in central Italy). Results will allow to give valuable policy feedbacks on whether the introduction of a brand new DRS in an already well performing collection and recycling system is the best solution in terms of environmental performance.

Keywords: Collection, Deposit Return Systems, LCA

ENERGY RECOVERY

62. Can Waste-to-Energy become affordable for Africa and Latin America and help to close dumpsites?.

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Can Waste-to-Energy become affordable for Africa and Latin America and help to close dumpsites?

Waste-to-Energy (WtE) are capital-intensive solutions with relatively high operating costs. In what scenarios and under what conditions could WtE become affordable for Africa and Latin America? Can it be feasible to close dumpsites for untreated municipal waste, recover material and energy in WtE plants and thereby avoid methane emissions from dumpsites?

Case studies for Casablanca, Marocco and Mexico City will be used to illustrate the prerequisites for this and the resulting financial and environmental impact.

Keywords: closing dumpsites, methane emissions, Waste-to-Energy, energy recovery, material recovery

63. Combined thermochemical processing of organic residues for enhanced hydrogen syngas production.

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This study explores the potential of chicken bone waste (CBW)-derived biochar as a feedstock for hydrogen production via steam gasification. Two distinct experimental campaigns were performed: (i) non-catalytic steam gasification, and (ii) catalytic gasification. The catalysts developed are based on CBW ash, one consisting of ash and the other doped with nickel (Ni), to enhance hydrogen production. Through these findings, the study highlights the usage of animal-derived waste both as gasification char feedstock and as an ash-based catalyst support, thereby promoting sustainable hydrogen generation, circular economy strategies, and reduced environmental impact from waste disposal.

The organic residues were utilized both as solid fuel and catalyst in the gasification process. The CBW was cleaned of impurities, dried, milled, and pyrolyzed at 600 °C to produce biochar. This biochar was subsequently used as the feedstock for the steam gasification experiments. The gasification process was performed at 900 °C in a tubular batch reactor, with a 1 ml/min steam flow. Two catalysts were tested: (i) pure ash derived from air gasification of CBW biochar at 950 °C, and (ii) the ash-based material impregnated with 5% Ni.

The experimental findings show that introducing catalysts in the steam gasification process can significantly influence the syngas composition and final product yields. Hydrogen concentrations in the non-catalytic case and the pure-ash case are nearly the same value (~ 26%). However, once Ni is introduced (Ash + Ni 5%), H_2 content reaches over 42%. The low methane (CH4) and heavier hydrocarbons (≥ C2) presence in the syngas (below ~2%) confirms that the syngas was not superposed with volatile matters released during the heating stage of the sample. Variable carbon conversion rates were noticed reaching between 88% and 91% when Ash-Ni catalyst was added to the process. Compared to catalyst free gasification, the presence of catalysts enhanced the syngas production by 75%. This suggests that the CBW ash itself can catalyze reforming reactions, converting more carbon from the solid phase into the gaseous products. When the ash is doped with 5% Ni, the syngas yield increases slightly (with about 7 %) relative to the ash catalyst. Given the nature of the feedstock and the low carbon content of the samples the results are very promising.

This study demonstrates that steam gasification of CBW-derived biochar can be significantly enhanced by using ash-based catalysts. Pure CBW ash increases the overall gas yield, while Ni impregnation increases hydrogen concentration up to 42% in the syngas. The process output consists of syngas rich in H2 and inert solid fraction that can be disposed off safely. Therefore, the closed loop conversion process can be a solution for energy recovery from organic residues.

Keywords: organic residues, steam gasification, pyrolysis, bio-based catalyst, hydrogen

HEALTCHARE WASTE

64. Understanding knowledge, attitudes and behaviour on sustainable healthcare waste management practices in selected National Health Service (NHS) Trusts in the Northwest of England.

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Of the carbon emissions that the NHS directly produces, waste and water currently make up about 21%, only second to building energy. This study set out to evaluate current knowledge, attitudes and behaviour on sustainable healthcare waste management (SHCWM) practices within selected NHS Trusts in Northwest England. This is part of a wider research to develop a resilient assessment tool for SHCWM implementation within NHS Trusts in the UK. The study utilised a questionnaire survey of hospital staff across 3 NHS Trusts. A total of 54 respondents ranging from doctors to clinical support and administrative staff were analysed. The results showed that none of the respondents had periodic training on either health/environmental risks of HCWM or sustainable healthcare waste management. Majority of the respondents, 78% and 81% said they had no training at all on health/environmental risks of HCWM and SHCWM respectively. Regarding knowledge, majority of the respondents indicated they had very low to moderate knowledge on health/environmental risks of HCWM (85%), SHCWM practices (67%), and HCWM legislation in the UK (62%). However, they showed willingness to attend voluntary programmes to update their knowledge on SHCWM (90%). Only 7%, 10%, and 5% indicated they had high knowledge of health/environmental risk of HCWM, SHCWM practices, and HCWM legislation respectively. Where deemed safe, majority of the respondents indicated they would reuse materials (98%), devices and equipment (100%) and did not consider all waste generated to be infectious (77%). Regarding attitude towards segregation, 81% agreed they thought carefully before discarding waste items in bins, although 62% indicated to have at least once put waste in the wrong bin. The respondents generally disagreed that segregation at source was extra work/time consuming (75%). They agreed that it improved recycle/reuse potential (93%) and reduced volume of hazardous/infectious waste (83%). Most of the respondents believed that SHCWM could enhance effective delivery of care (72%) and overall sustainability of their Trust/healthcare sector (93%). They also showed overwhelming willingness to get involved and participate in SCHWM initiatives (95%). While the findings demonstrate a lack of periodic training on SHCWM, there appear to be a generally positive perception, attitude and behaviour towards SHCWM practices. Where SHCWM initiatives are introduced, the findings suggest that staff would be willing to engage and participate. There is, however, the need for those leading sustainability efforts at NHS Trusts to develop periodic training programmes to improve staff knowledge on SHCWM.

Keywords: attitude, healthcare waste, knowledge, NHS, perception, SHCWM, training, United Kingdom

65. Decoding Diaper Waste: A Comprehensive Study in Nursing Homes.

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Every year 30 million tons of diapers are produced. Because of their complex nature, pathogens and odor as well as strict hygiene requirements, most of these diapers end up in landfills and incineration where all materials are lost. It is estimated that diapers take up 7.5% of municipal waste in OECD countries, of which 4.8% are continence care products for adults. Besides the resource loss and waste accumulation, diapers also pose a significant impact on the environment. The Global Warming Potential (GWP) of diapers throughout their whole life cycle in the EU can be estimated to around 3.6 million t CO2e/year. However, most waste estimations and environmental assessments of diapers only focus on the diaper itself, neglecting the use of auxiliary products needed during continence care. Especially in the elder care, a multitude of additional products are involved when changing a diaper. Besides diapers, products such as gloves, single-use and multi-use cloths are used during a diaper change.

This work aims to assess the environmental impact and characterize the waste associated with continence care, including the use of diapers and all auxiliary products and activities consumed. Primary data was collected in a field test which took place in nursing homes for the elderly in Denmark in May 2025 to, inter alia, collect data on auxiliary products, occurring leakages and accumulated waste. Integral part of the data collection was the characterization of the waste related to continence care. The waste generated by 35 nursing home residents was collected separately and analyzed over the duration of one week. The characterization gives an overview of the total waste generated and the products used in continence care, providing a clearer picture of the amount and different fractions of waste occurring for different levels of incontinence. The current work is part of a larger project which addresses socio-technical transition scenarios towards sustainable continence care.

The waste characterization revealed that a typical diaper change requires 3 pairs of gloves, 7 single-use cloths, 0.25 aprons and 1.5 garbage bags, making up around 25 % of the total amount of the waste associated with a diaper change and contributing to up to 60% to the global warming potential. The results indicate that the environmental impact as well as occurring waste estimations associated with continence care, especially in nursing homes, are significantly underestimated. Auxiliary products have a significant contribution to the environmental impact of continence care, emphasizing the importance of the assessment of the full system rather than the product alone.

Keywords: waste characterization, continence care, environmental impact

66. Hospital waste management: a circular approach for waste reduction and valorization. Magrini, G (1)

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Hospital waste is an emerging issue, particularly after the recent COVID-19 health crisis. According to the Regulatory Services at the British Standards Institution “BSI,” the most recent data indicate almost six million tons of medical waste are generated every year. A closer look at these six million tons of waste reveals that nearly 25% is plastic, and less than 1% is recycled annually.

International organizations and governmental institutions are increasingly recognizing this challenge through a circular approach aimed at minimizing the amount of waste destined for incineration and/or sporadic uncontrolled landfilling. One of the main challenges of infectious waste lies in its highly heterogeneous composition, which, despite variations between industrialized and emerging nations, remains relatively constant and homogeneous within the same country, based on the local availability and quality of medical devices. For now, Europe leads the way in producing regulations related to plastics and waste. These regulations mostly relate to the consumer sphere, but they will also impact medical devices and then hospital waste (The United Kingdom’s Waste Separation Regulation, effective March 31, 2025 - The European Union’s Single-Use Plastics Directive 2019/904, effective January 2025 - Spain Textile Waste Disposal Law 7/2022: 2025). In the meantime, sterilization and sterility assurance professionals can apply their skills to treat healthcare waste and even use waste as a resource when feasible.

A key step in hospital waste management is proper decontamination ensuring uniformity in particle size after shredding and low residual moisture content. Based on the difference in density, an aeraulic separator extracts light materials such as textiles and paper, accounting for approximately 25-30% of the total weight. The high calorific value, combined with a moisture content below 50% and high removal rate of PVC, allows compliance with the technical standards for Solid Recovered Fuel (SRF). The remaining heavy fraction undergoes an advanced sorting process using VIS and NIR sensors to recognize and recover specific plastic materials as secondary raw materials. The plastic fraction in hospital waste primarily consists of PP, PE, PET, PVC, PC, and PS. A combination of "positive" and "negative" selection methods enables progressive material separation based on the predominant and valuable fraction.

Sorting centers like R-Steryl can achieve a total reduction of up to 80% in the amount of hospital waste sent for disposal, based on local regulations and availability of raw materials. Considering that recycling one ton of plastic can reduce CO2 emissions by 1.5 to 3.2 tons of CO2eq, waste management systems that integrate disinfection and sorting in accordance with the Stockholm Convention significantly contribute to achieving the sustainability goals outlined by COP15 and reaffirmed at COP29 in Baku.

Keywords: Recycling, Circularity, Innovation

TEXTILE WASTE MANAGEMENT

67. Textile Waste Management: Inspiring Best Practices from Flanders.

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Vervinckt, Pieter

VVSG, the association of Flemish cities and municipalities, OVAM, the Public Waste Agency in the region of Flanders.

As of January 1, 2025, all EU member states must separately collect textile waste. Flanders has been ahead of this requirement for years, with a well-established mandatory selective collection system for both households and companies. On average, 7 kg of textile waste per capita is collected annually through door-to-door collection, textile containers, and civic amenity sites. Additionally, an estimated 4.3 kg per capita of reusable textiles is redirected to reuse shops and private initiatives, contributing to a local reuse rate of 11%.

Textile waste is one of eight streams that municipalities are legally required to collect. Most municipalities outsource collection to certified private collectors and social economy enterprises, ensuring both high collection standards and employment opportunities. However, textile containers—while effective—are prone to illegal dumping. Over the years, municipalities and collectors have optimized collection strategies to improve site cleanliness and prevent unauthorized placement of containers. Regulations now enforce that only designated collectors may collect household textile waste.

Collected textiles are sorted in specialized facilities, with around 50% deemed suitable for reuse and sold locally and internationally. The remaining textiles are largely recycled—mainly through downcycling into rags and fibers—while a small fraction is incinerated. Landfilling of textiles is banned, making reuse and recycling the only viable pathways.

Despite these efforts, sorting analyses indicate that 5.2 kg of textiles per capita still ends up in residual waste annually. To address this, Flanders is increasing awareness, improving collection efficiency, and developing a new Extended Producer Responsibility (EPR) scheme for textiles. With extensive experience in EPR systems across multiple waste streams, Flanders is well-positioned to implement an effective textile EPR, which is expected to halve textile waste in residual waste. The Flemish waste policy plan 2023-2030 has prioritized this development, with stakeholders actively shaping the framework.

Additionally, Flanders is exploring innovative solutions to support textile companies in navigating waste legislation and optimizing circular textile flows. Within the EU-funded RegioGreenTex project, an AI-powered tool is being tested to provide intelligent matchmaking between textile waste streams and actors for reuse and recycling, further driving the transition toward a circular textile economy.

Keywords: textile, household waste management, awareness campaigns, reuse, textile collection

68. Problems with waste from the textile industry and opportunities for process circularity in the Gamarra Commercial Emporium in Peru.

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Peru Waste Innovation S.A.C.

The research analyzes the solid waste management in the Gamarra Commercial Emporium (ECG), the main center of the textile industry in Peru, with nearly 40,000 establishments and more than 80,000 workers in 20 blocks of the La Victoria District, Lima. The objective is to evaluate the waste management problem in the ECG, identifying opportunities for circularity in key processes.

The First Waste Characterization Study was carried out in shopping centers in the textile sector, to be held for seven consecutive days from 6:00 p.m. to 9:00 p.m. The work included field and office analysis, evaluating the conditions of the cleaning service to propose improvement strategies. Seven sampling points were selected using a simple random method for convenience, considering the resistance of gallery representatives to provide information.

Three data collection techniques were used: (1) Interviews, (2) Surveys, (3) Observations.

The results obtained refer to:

- 15 containers with maintenance problems have been identified. There is non-compliance with technical criteria and lack of supervision by public entities.
- The District Municipality of La Victoria (MDLV) does not deliver protective equipment on time, attributing this responsibility to the worker.
- The ECG has a daily production ranging from 2 to 6 tons.
- There is non-compliance in the use of protective equipment by recyclers.

To initiate a process towards circularity in the ECG, it is imperative to consider the following:

- It is a priority to start registering informal recyclers to invite them to formalize.
- Each gallery must invest in generating clean waste separation points, training sellers and creating signage.
- Due to the conditioning of fabric scraps in places that affect their quality, it is suggested to implement a waste control committee under the product and services axes.
- In the Peruvian context, fabric distributors should be considered key actors in waste management under the approach of extended producer responsibility.
- Because the ECG is characterized by its high levels of informality, it is necessary to install a Supervision, Inspection and Sanction system.
- The central government must manage financing measures for projects that optimize waste management.
- Given the lack of awareness among producers and generators, it is important to increase the MDLV budget to work on formal waste management processes.

The ECG generates between 2 and 6 tons of waste per day, mainly general waste and textile scraps, whose low profitability limits its formal collection. Informal marketing, carried out by public cleaning workers, distorts the flow of waste and makes its precise quantification difficult. This hierarchical system, which includes collectors, collection centers and large companies, exposes the actors at the initial levels to serious risks of health and occupational safety, aggravated by the lack of adequate conditions.

Keywords: Gamarra Commercial Emporium, La Victoria, textile waste, recovery

69. Material Flow and Carbon Emission Reduction Potential of MSW Recycling System in an Eastern China Metropolis.

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Recyclables are a significant component of municipal solid waste and possess notable potential for resource utilization and greenhouse gas (GHG) reduction. They are expected to make substantial contributions to the goals of peaking GHG emissions and achieving carbon neutrality. However, the diversity of recyclable waste and the fragmentation of recycling entities, coupled with a lack of scientifically standardized data especially for devoloping countries, leave the systematic material flows of recyclables unclear. Additionally, there is no specialized accounting method yet developed that fits the unique characteristics of recyclables for assessing their GHG reduction potential. A crucial issue in recyclable management is how to quantitatively evaluate and fully utilize the potential for greenhouse gas reduction of various recyclables.

In response to these needs and challenges, this study employs a combined approach of Material Flow Analysis (MFA) and Life Cycle Assessment (LCA). Through field research, detailed material flow data for recyclable systems were collected. The representative GHG emission factors for various types of recyclables were calculated under unified life cycle assumptions and boundary conditions. Especially, the textile wastes were further classified and seperatedly quantified. With clear material flow data and reliable GHG emission factors, the intensity of GHG emissions and key influencing factors of the urban-scale recyclable system under different management strategies were further assessed.

The Material flow analysis results indicate that in the studied city, only 34.7% of recyclable components enter the recyclables system, while the rest are present in the dry waste to be incinerated, which is mainly attributed to the low recovery rate of some low-value recyclables. Of the recyclables that were recovered, 77.2% were converted into secondary materials, while the remaining 22.8% were lost due to unavoidable yield problems and quality degradation in the recycling process.

Life cycle assessment results show a wide range of GHG emission factors, from -13181 to -18 kg CO2-eq/t of recyclables. This suggests that recycling leads to net GHG reductions even in the unfavorable conditions, while recyclables incineration leads to net GHG emissions.

The results of the sensitivity analyses carried out on the 41 model parameters showed that the total recyclables recovery and the secondary material yield were the most sensitive factors, and that an increase in these two parameters could significantly reduce the GHG emissions of the city's recyclables system. In addition, the global warming potential of the recyclables system rather rises as the electricity emission factor decreases.

Keywords: municipal recyclables, textile waste, material flow analysis, mega-city scale

70. The potential re-entry stages for recycled material into the textile production chain are defined and explained, and the key technologies are presented.

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The textile industry is one of the most polluting industries worldwide regarding CO2 emissions, waste production and toxic by-products, which is why textile recycling is a key factor in achieving a more sustainable future with fewer emissions and reduced resource consumption. The recirculation of post-consumer textiles is possible at various re-entry points in the production line, but energy consumption rises as the production chain lengthens due to repeated processes needed to create a new product. Since post-consumer textiles consist of a complex and variable composition of mixed materials, including both biogenic and synthetic components, a combination of multiple recycling technologies on all re-entry stages is necessary to efficiently achieve a high recycling rate. On re-entry stage 0, recycling is performed on a textile level, repurposing textiles like truck tarpaulins to preserve the durability of the material. On re-entry stage 1, recycling is performed on a fibre level, which typically involves shredding and tearing the fabric, breaking it down into fibres. On re-entry stage 2, recycling is performed on a polymer level, which includes natural polymers like cellulose and man-made polymers like PET and PA. On re-entry stage 3, recycling is performed on a monomer level, following either monomer-specific (e.g. isolating ε-caprolactam) or non-specific approaches (e.g. thermochemical cracking). This communication addresses the complex nature of textile waste, highlighting the need for specialized collection and sorting systems, which are currently inadequate for efficient recycling. Different recycling loops are presented, outlining their advantages and disadvantages and discusses several processes based on green chemistry.

Keywords: Recylcing, green chemistry, textile

HAZARDOUS WASTE MANAGEMENT

71. Managing and disposing Used Lead Acid Batteries - ULABs: Experience in MERCOSUR. Corra, Lilian

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Global Alliance on Health and Pollution -GAHP

A Long Journey of Multisectoral Dialogue: After years of multisectoral dialogue led by the Global Alliance on Health and Pollution (GAHP) within the framework of MERCOSUR ’s Subgroup 6 on Environment (SGT 6) , and with the participation of the private sector (including ISWA and ABRABAT), the issues of lead-related disease burden and pollution from informal ULABs management have been successfully brought to the forefront. This sustained effort is now yielding tangible results, with actions identified to overcome barriers and drive necessary reforms.

Recognizing Lead Pollution and Human Toxicity: Addressing lead pollution requires promoting circular economy practices. Lead exposure significantly increases the burden of cardiovascular diseases (e.g., hypertension, stroke, heart attack) and cognitive impairments, resulting in high public health costs and economic losses, impacting gross domestic product in LMICs.

Impact on the Lead-Acid Battery Industry: The GAHP strategy, which combines multisectoral dialogue and data-driven decision-making tools, has increased visibility and prompted voluntary actions from the lead-acid battery industry, particularly in MERCOSUR countries. Under this approach, used lead-acid batteries (ULABs) in “sealed” units should be returned to producers for formal recycling, enabling the recovery of components for new battery production and reducing both production costs and prices. Ensuring the proper return of used sealed units also helps prevent informal dismantling, a significant issue that drives illicit trafficking.

A Step Toward Solving Lead Pollution: Informal management of used lead-acid batteries (ULABs) generates severe lead pollution, with significant Public Health impacts, particularly on cardiovascular and neurodevelopment. ULABs lead-polluted components, such as plastics (often containing over 10,000 ppm of lead, often burned or poorly recycled) and sulfuric acid (which is dumped into the environment or reused as precursor for unregulated purposes), both posing substantial risks. Implementing Extended Producer Responsibility (EPR) strengthens formal recycling chains and infrastructure (BAT/BEP) for sealed ULABs, helping to reduce informal practices and curb illegal trafficking, along with their associated environmental and health consequences.

Cost of Inaction: The World Bank estimates in 2023 that cardiovascular deaths were six times higher than projected in 2019, with the global cost of lead exposure reaching US$6 trillion. Of this, 77% accounted for the welfare costs of cardiovascular disease mortality, while 23% represented the present value of future productivity losses. These impacts are disproportionately felt in lowand middle-income countries (LMICs), with significant consequences for health, productivity, and economic stability.

An important step towards a collaborative solution: On January 7, 2025, a Presidential Decree was published endorsing the Brazilian National Congress's amendment to Article 49 of Law No 12.305 (2010), which governs the National Policy on Solid Waste. This amendment aims to transform hazardous waste management in the country by promoting circular economy principles and comprehensive recycling. This amendment allows Brazilian importers and manufacturers to reintroduce solid waste derived from produced and exported domestic products, including

hazardous waste, strictly for reverse logistics comprehensive recycling. These processes will be overseen by the Ministries of Development, Industry, Commerce and Services, and the Ministry of Environment and Climate Change.

GAHP continues to prioritize multisectoral dialogue, providing platforms and data as decision-making tools to enable informed decisions across sectors. By emphasizing the cost-benefit of circular economy principles and health protection, GAHP advocates for win-win solutions that enhance environmental outcomes while reducing production costs. This work is ongoing and continues to drive positive change across various sectors.

Kewords: ULABs MERCOSUR LEAD POLLUTION

PART 2 – ABSTRACTS IN SPANISH (IBEROAMERICAN SESSION) - RESÚMENES EN ESPAÑOL (SESIÓN IBEROAMERICANA)

GOBERNANZA Y ASUNTOS LEGALES

72. 20 años de Responsabilidad Extendida del Productor en Uruguay: Logros, Desafíos y Oportunidades Futuras.

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Hace más de 20 años, Uruguay fue pionero en la implementación de la Responsabilidad Extendida del Productor (REP), un principio que asigna a fabricantes, importadores y propietarios de marca la responsabilidad económica y operativa sobre la gestión de ciertas corrientes de residuos. Este artículo resume los principales aprendizajes y desafíos de la REP en Uruguay, en relación con la gestión de residuos, la circularidad de materiales y la economía circular.

Se analiza la evolución de la REP a nivel nacional, considerando la experiencia de varios sistemas: baterías plomo-ácido (2003), envases posconsumo (2007), agroquímicos y plaguicidas obsoletos (2013), neumáticos fuera de uso (2015) y aparatos eléctricos y electrónicos (2024). Se abordan los modelos de gestión, el desarrollo de capacidades nacionales y su implementación territorial en coordinación con los gobiernos locales, así como el impacto de la REP en la inclusión socioproductiva de las personas clasificadoras de residuos.

El artículo se basa en un análisis de políticas públicas y marcos jurídicos relacionados con la REP y su implementación a través de planes de gestión operados por el sector privado. También incluye entrevistas con actores clave del sector público, privado, sindicatos y cooperativas de personas clasificadoras de residuos.

El trabajo destaca lecciones aprendidas, como la aceptación de la responsabilidad de gestión y su financiamiento por parte de importadores y fabricantes, la construcción de confianza mediante procesos colaborativos, la definición de modelos de gestión y financiamiento para planes colectivos, así como la integración gradual de la dimensión social. También se analizan los desafíos relacionados con la valorización de materiales y la modulación de tarifas para incentivar el diseño de productos más sostenibles, junto con los mecanismos de control implementados para asegurar la eficacia de las acciones.

Se abordan temas clave como la implicancia de las metas de recuperación en los modelos de gestión y cómo metas desafiantes pueden generar avances estratégicos para lograr la circularidad de materiales y un reciclaje de alta calidad.

La REP en Uruguay se ha constituido en un instrumento clave para lograr la sostenibilidad económica de los sistemas de valorización de residuos, en sinergia con los planes departamentales de residuos, particularmente en el sistema de gestión de envases posconsumo. Dado que la REP es un tema central en el Congreso Mundial de ISWA, este trabajo constituye un aporte a la discusión regional e internacional, promoviendo la REP como un recurso estratégico para la transición hacia un modelo de economía circular.

Palabras clave: Responsabilidad Extendida del Productor (REP), gestión de residuos, economía circular, circularidad de materiales, valorización de residuos, marcos normativos, responsabilidad económica, inclusión social.

73. Planificación Integral de la Gestión de Residuos para el Área Metropolitana de Rosario, Santa Fe.

de la Fuente, Sebastian Rodrigo

Motkoski M. (1), Floriani, H (1)

(1) Ente de Coordinación Metropolitana de Rosario

El Ente de Coordinación Metropolitana Rosario (ECOMR) es una asociación voluntaria de 32 municipios con alrededor de 1.500.000 habitantes. Su administración es ejercida por los gobiernos locales, presidencia de la Municipalidad de Rosario y participación de la Provincia de Santa Fe. Su principal propósito es la coordinación y promoción de políticas públicas de impacto regional que orienten el desarrollo del territorio
metropolitano.

Uno de los principales temas que demanda un abordaje metropolitano son los residuos sólidos urbanos. En la provincia de Santa Fe, aunque las normas promueven una gestión consorciada de las RSU, en la realidad esto se da en muy pocos casos.

Particularmente en el Área Metropolitana de Rosario, mientras que los residuos domiciliarios se envían a alguno de los rellenos sanitarios habilitados, el resto de las corrientes urbanas terminan en muchos casos en basurales a cielo abierto. Además, hay pocos avances en materia de reducción de volumen, separación de la fracción orgánica, reciclables y revalorización de materiales como residuos de demolición y construcción.

Ante este panorama en 2021 el ECOMR inicia la construcción de un Plan Metropolitano GIRSU, trabajando junto a las localidades que lo integran en la elaboración de un diagnóstico ejecutivo sobre la situación de la gestión de residuos en la región. Este documento sirvió de base para trabajar durante el año 2022 en instancias participativas del proceso, y nutrirlo/enriquecerlo con distintas miradas y opiniones sobre aspectos sociales, educativos, infraestructurales y económicos.

El año 2023 dio paso al desarrollo específico del Plan. Se convocó a las principales instituciones académicas de la región desarrollando avances en los siguientes temas:

- Fracción Orgánica de RSU
- Fracción Reciclable de RSU
- Residuos de Construcción y Demolición
- Transporte y logística

Desde el año 2024 se profundizó el estudio de la fracción reciclable trabajando sobre las cadenas de valor de los distintos materiales a nivel regional. Además, se abordó la problemática de los basurales a cielo abierto, desarrollando una caracterización básica y comenzando a trabajar en un plan de acción para su clausura y reconversión en centros regionales de economía circular. Actualmente además se está iniciando el capítulo de Comunicación del Plan y coordinando con el Ministerio de Ambiente y Cambio Climático de la provincia de Santa Fe en una propuesta de tratamiento de restos verdes en municipios del AM.

Si bien se trata de un trabajo en desarrollo, ya es posible concluir que uno de los desafíos principales del proceso consiste en llegar a definir de manera concertada políticas de articulación entre municipios con características muy desiguales en aspectos tales como el tamaño poblacional o los recursos fiscales y financieros. Es preciso desarrollar mecanismos transparentes y dinámicos para coordinar acciones que
trascienden los límites administrativos de cada una de las jurisdicciones.

Palabras clave: gestión de residuos, áreas metropolitanas, cooperación intermunicipal, planeamiento de residuos

74. GOBERNANZA Y CUESTIONES JURÍDICAS MINISTERIO DE AMBIENTE Y ECONOMÍA CIRCULAR (MAyEC) PROVINCIA DE CÓRDOBA- REPÚBLICA ARGENTINA.

Flores, M.V.
Vottero, P.N.

Ministerio de Ambiente y Economía Circular y Secretaría de Economía Circular y Empleo Verde, Provincia de Córdoba, República Argentina

La Provincia de Córdoba se ubica en el centro de la República Argentina, con una superficie de 165.321 Km2 y una población de 3.812.064 habitantes, localizados en 427 municipios y comunas, siendo la Ciudad Capital la de mayor cantidad de habitantes.

En diciembre de 2023, el Gobernador de la Provincia de Córdoba Dr. Martín Llaryora crea el Ministerio de Ambiente y Economía Circular (MAyEC) elevando a rango ministerial la temática ambiental por primera vez, a cargo de la Dra. María Victoria Flores.

Así, fue necesario organizar la nueva estructura ministerial en función a la transición hacia la Economía Circular y el cumplimiento de las ODS. El organigrama quedó compuesto por 5 Secretarías, siendo una de ellas, la Secretaría de Economía Circular y Empleo Verde (SECyEV), a cargo del Sr. Pedro Nicolás Vottero; conformada por: Subsecretaría de Gestión de Residuos, Subsecretaría de Empleo Verde, Dirección de Educación Ambiental y el Grupo de Promoción Ambiental.

Desde la SECyEV se lleva adelante una estrategia provincial para la transformación sostenible de los sistemas de producción y de consumo, en conjunto con CFI y Cepal, entre otros. De manera específica se ejecutan las siguientes acciones:

- Propuestas de nuevas legislaciones, entre ellas la Ley de Economía Circular, además de, numerosos convenios, resoluciones, actas, pliegos, etc.

- Desarrollo de programas, tales como: Fortalecimiento de Buenas Prácticas Circulares con acceso a manuales operativos, Córdoba Mercado Circular y SiGirsu; trazabilidad de materiales circulares y vinculación sectorial, Circulá Industrial dirigido a Parques Industriales, Hacelo Girar, gestión institucional de materiales circulares, Gestión Circular de NFU, puntos de acopio regionales y logística, Compostá, compostaje domiciliario, Impulsá para circularidad textil, Eventos sostenibles; entre otros.

- Uso de sistema de información geográfica para diversas georreferenciaciones: basurales a cielo abierto (BCA), plantas seleccionadoras, etc.

- Ejecución del Fondo de Financiamiento Ambiental para prácticas circulares.

- Rellenos sanitarios: a la fecha se encuentran 11 operativos, proyectados 4, más 6 estaciones de transferencia, con el cierre y cicatrización de BCA.

Todo lo antedicho es acompañado por: la creación del Registro de actores de la Economía Circular (EC).

La Dirección de Educación Ambiental brinda capacitaciones sobre Ley Yolanda y gestión de residuos, tanto virtuales, como presenciales e híbridas. El trabajo territorial es realizado por el cuerpo de Promotores Ambientales.

El control y la fiscalización es realizada por la Policía Ambiental. Además, se creó el Tribunal Administrativo Ambiental y de manera transversal, la Autoridad de Cuenca.

Palabras clave: circularidad, gobernanza, estrategia, Córdoba

75. La cooperación intermunicipal: Una herramienta territorial para la gestión de los residuos sólidos en México.

GALVAN MERAZ, FRANCISCO JAVIER
DS LATAM ISWA MEXICO

En el municipio suceden, día con día, dinámicas de producción y distribución de bienes y servicios que contribuyen al desarrollo personal y comunitario de su población. Los ayuntamientos asumen así la responsabilidad de tomar decisiones con la mayor eficiencia de sus procesos, y la mayor eficacia en la coordinación con otros gobiernos (estatal y municipales) en aras de alcanzar la sustentabilidad de sus proyectos y una buena gestión de la administración local.

Este panorama caracteriza en gran medida a la mayoría de los gobiernos municipales, que se agudiza cuando se carece de organización eficiente, políticas claras en la gestión integral de residuos en su territorio e incluso omisiones en el cumplimiento del marco legal por parte de las autoridades estatales, lo que impacta en el ritmo integral de su desarrollo y mejoramiento.

Las grandes inversiones de recursos económicos que se requiere para la construcción y operación de infraestructura, especialmente para su tratamiento y disposición final, y lo técnico para el cumplimento del marco legal ambiental vigente, hace difícil que los municipios de forma individual, puedan atender una visión sostenible de los servicios y cuidado del ambiente.

Con lo complejo del tema, es viable establecer nuevos modelos colaboración surgiendo la figura de «gestión asociativa entre municipios» a través de la intermunicipalidad para la prestación coordinada entre gobiernos locales (colindantes o no) de un mismo estado o dos, para unir esfuerzos, recursos materiales y humanos, financieros, técnicos, administrativos y de gestión, datos e información, entre otros, que permita planear, ejecutar y administrar obras y gestión de infraestructura común para la prestación del servicio público de limpia, recolección, traslado, tratamiento y disposición final de residuos sólidos, en donde sociedad y autoridades locales definan acciones que busquen reducir los efectos nocivos a la salud y los ecosistemas que conoce sobre los límites territoriales.

Así, la intermunicipalidad se constituye como un mecanismo eficaz de trabajo de coordinación para resolver problemas en común entre sus integrantes. Son parte de las atribuciones y facultades que la Constitución Política de los Estados Unidos Mexicanos, en su artículo 115, le reserva en exclusiva al Municipio. Dicha figura faculta al Municipio para coordinarse y asociarse para la más eficaz prestación de los servicios públicos o el mejor ejercicio de las funciones

Esto a través de la creación mediante convenio de coordinación y asociación de un organismo público descentralizado de naturaleza intermunicipal con vocacionamiento único para la gestión integral de residuos sólidos urbanos ofrece la posibilidad de diseñar e implementar políticas públicas para la gestión integral de residuos, la continuidad de la política en los cambios de administraciones municipales, profesionaliza los recursos humanos gerenciales, técnicos y operativos, internacionalizar la experiencia.

Palabras clave: cooperación intermunicipal, mancomunidad, asociacionismo intermunicipal, organismos operadores

76. Playas sustentables: más que actividades de limpieza y normatividad, un asunto de estrategias locales de acción.

Hernández Barrios, Claudia Patricia

Argüello Dávila, D.M. (2), Terán Guerrero, T.D. (2), Calderín Romero, M.L. (2)

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Las regiones costeras de México experimentan un aumento irregular de la población caracterizado por una economía basada en el turismo, el desarrollo portuario, la agricultura y las industrias de hidrocarburos. México ocupa el sexto lugar en el mundo en términos de turismo; tan sólo en el primer trimestre de 2023, el Producto Interno Bruto Turístico (PIBT) representó el 8.4% del Producto Interno Bruto (PIB) y empleó a poco más de 2 millones de personas.

El turismo no regulado impacta al ambiente en el cambio de uso del suelo, la destrucción de entornos terrestres y acuáticos, la generación acelerada de residuos sólidos y el uso excesivo de los recursos hídricos. La mala gestión de los residuos incluye servicios de recogida deficientes, falta de infraestructuras y equipamiento, eliminación inadecuada en barrancos y cauces de ríos y quema indiscriminada, pero también falta de educación ambiental.

En 2023, bajo la coordinación de la Secretaría de Medio Ambiente y Recursos Naturales de México, se organizó un grupo de trabajo multisectorial para actualizar la norma técnica NMX-AA-120-SCFI-2016 “Que Establece los Requisitos y Especificaciones de Calidad de las Playas para su Desarrollo Sustentable”, con el fin de establecer especificaciones y requisitos para la calidad de agua del mar, para el manejo adecuado de residuos sólidos en la playa, estrategias de prevención/reducción de productos plásticos y la cuantificación e identificación de los residuos sólidos urbanos generados.

Las autoras, como parte del grupo de trabajo de la Cooperación Técnica Alemana (GIZ) en México, aportaron insumos relacionados con la gestión y manejo de residuos generados por actividades en playas recreativas y de conservación.

El Programa de Manejo de Residuos en Playas (PMRP) es un requisito para la certificación de cualquier playa que establece: a) objetivos, metas e indicadores; b) documentos que acreditan su implementación; c) límites de la playa; d) posibles riesgos que incrementan la generación de residuos; e) tipo de recolección de residuos, condiciones ambientales, afluencia turística y disponibilidad de recursos; y f) frecuencia del servicio de limpieza, con base en la generación diaria de residuos y afluencia de visitantes. Para ello, se ha elaborado un manual cuyo contenido, metodología y recomendaciones pueden ser adaptados para su implementación por los Comités de Playas Limpias o Promotores privados, incluyendo herramientas y formatos de apoyo.

Los PMRP se complementan con la documentación de las acciones llevadas a cabo entre los diferentes actores participantes, como son los programas de limpieza de playas. Para facilitar esto se desarrolló el Sistema de Limpieza de Playas, una herramienta práctica que permite sistematizar los datos recolectados para generar información, obtener fichas técnicas para informes de actividades, actualizar datos y agregar información para apoyar políticas públicas que reduzcan la generación de residuos y eviten su ingreso al mar.

Palabras clave: Playas sustentables, residuos sólidos, programa de manejo

77. MEJORES PRACTICAS PARA GESTION DE EWASTE Y NORMATIVAS REP EN LATAM.

ROSALES, JHOANNA
MENDES HENRIQUE

EWASTELATAM

Este documento presenta un conjunto de recomendaciones regionales sobre mejores prácticas para la gestión de residuos de aparatos eléctricos y electrónicos (RAEE) en América Latina, con foco en el diseño e implementación de esquemas de Responsabilidad Extendida del Productor (REP).

El objetivo es contribuir al fortalecimiento de políticas públicas que impulsen una gestión más eficiente, trazable y controlada de los RAEE en la región.

Las recomendaciones se organizan en cuatro ejes principales:

Hacia la gestión tecnificada de RAEE: Se propone establecer licencias específicas para gestores, crear un registro oficial de empresas gestoras y elaborar una guía regional de buenas prácticas. También se recomienda prohibir el envío de RAEE sin procesar a vertederos, incentivando el tratamiento previo y el aprovechamiento de materiales secundarios.

El Estado como generador de RAEE: Se plantea que las instituciones públicas entreguen sus RAEE exclusivamente a sistemas colectivos autorizados y que se eliminen las subastas de estos residuos. Además, se sugiere que ser parte de un sistema REP sea un requisito para proveedores de equipos electrónicos del Estado.

Control y trazabilidad: Se destaca la importancia de definir sanciones claras por incumplimientos, fortalecer la supervisión, asegurar la trazabilidad desde los generadores hasta los gestores y establecer controles a la importación de RAEE. También se propone simplificar el procedimiento de notificación previa (PIC) bajo el Convenio de Basilea.

Actores de la REP y Metas: Se recomienda incluir a comercializadores y distribuidores en los sistemas de gestión, así como definir metas específicas por categoría de producto, basadas en información histórica de los últimos tres años.

Estas propuestas nacen del trabajo y análisis conjunto de los miembros de EWASTELATAM, 12 plantas de gestión de RAEE en 10 países de la región, y buscan facilitar la adopción de criterios comunes que fortalezcan los marcos regulatorios, promuevan la circularidad de los materiales y generen condiciones más equitativas y transparentes en el manejo de los RAEE.

Palabras clave: residuos, RAEE, REP, ewaste, LATAM, sostenibilidad, gestión

78. Software especializado para el cálculo de la muestra de usuarios en la caracterización de residuos sólidos.

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La gestión integral de residuos sólidos (GIRS) es un desafío complejo que enfrentan las ciudades a nivel global. Para ello es imprescindible contar con información precisa y detallada sobre la composición y cantidad de los residuos generados, por tal motivo el punto de partida para una buena GIRS, se debe conocer lo que genera la población y esto se consigue por medio de una caracterización de residuos sólidos, la cual da como resultado las propiedades cualitativas y cuantitativas de los residuos. Para ello se hace necesario tomar una muestra representativa de los usuarios que generan los residuos. El proceso tradicional de selección de la muestra, a menudo se basa en métodos simplificados estadísticos o criterios subjetivos, lo que puede resultar en una representación inadecuada de la heterogeneidad de la población y sus patrones de generación. Esta limitación puede conducir a errores significativos en la estimación de la composición y cantidad total de residuos, afectando negativamente la planificación. En Colombia no se tiene una normatividad especifica, sobre de cuanto debe ser el mínimo de usuarios a caracterizar según el número de generadores. Aunado a que tampoco se cuenta con una guía reglamentada para efectuar la caracterización, la cual se hace necesaria dado a que según la resolución 754 de 2014, se deben actualizar PGIRS cada cuatro años, lo que implica caracterizar los residuos. Ante esta problemática, docentes investigadores y estudiantes de la facultad de Ingeniería del Tecnológico de Antioquia, desarrollaron un software especializado que automatiza y optimiza el proceso de determinación de la muestra de usuarios a caracterizar. Esta herramienta, permite integrar y analizar múltiples variables relevantes, garantizando una selección de muestra más representativa, eficiente y con menor margen de error, que es lo que buscan las ciudades al momento de realizar la caracterización de sus residuos sólidos. Con este software se pretende promover la estandarización de la metodología de selección de la muestra, lo que facilita la comparación de los resultados de caracterización entre diferentes estudios y ciudades, contribuyendo al desarrollo de mejores prácticas a nivel regional e internacional y porque no convertirse esta en una política pública. Implementa algoritmos estadísticos para la determinación de la muestra dentro de cada nivel socioeconómico de la población, como también por tipo de generador, considerando el nivel de confianza y un margen de error mínimo, además contiene el diseño de una interfaz gráfica intuitiva de fácil uso, que permite superar las limitaciones de los métodos tradicionales, mejorando significativamente la representatividad de la muestra, optimizando los recursos, incrementando la precisión de los resultados y facilitando la adaptación a las dinámicas urbanas cambiantes, lo que representa un avance significativo hacia una gestión de residuos más eficiente, sostenible y basada en datos confiables.

Palabras clave: Caracterización, Software, Muestra, Residuos sólidos, legislación

79. Cómo ordenar el financiamiento de la gestión de residuos municipal.

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Uno de los grandes desafíos de los municipios de América Latina y el Caribe en materia de gestión de residuos sólidos es fortalecer su situación económico financiera, ordenando y clarificando la información de ingresos y gastos para avanzar en la mejora de la sostenibilidad de los programas.

El trabajo que se va a presentar explica cómo se ha hecho en más de 400 municipios de Argentina para ordenar la estructura de costos de los programas de gestión de residuos, mejorar el financiamiento mediante tasas específicas y desarrollar indicadores económico financieros.

En la mayor parte de los casos, los municipios de ALC no conocen los costos totales de la gestión de RSU. No lo saben, entre otras cosas, por el modo de organización de la gestión entre las áreas municipales y el grado de dispersión en que trabajan. Además de ello, no se cuenta con un sistema único e integral de contabilidad, ejecución de gastos y análisis del financiamiento GIRSU, por lo que hay múltiples partidas de gastos e ingresos que no se integran, relacionan ni vinculan.

Al no conocerse los costos totales de la gestión anual, no se sabe cuánto se gasta ni qué parte del financiamiento se cubre con tasas específicas, no se pueden calcular las tasas de equilibrio para mejorar el balance de ingresos y gastos, no se puede preparar un presupuesto completo de toda la gestión integral, ni calcularse indicadores para medir la eficiencia de la gestión.

Es un hecho reconocido que los gobiernos locales no recaudan lo suficiente en concepto de tasas y tarifas específicas para financiar todos los gastos de la gestión. Son excepcionales los casos de gobiernos locales que cubren con recursos genuinos más del 80% de los costos de la GIRSU. Esta imposibilidad de medir el gasto y los ingresos, dificulta el ordenamiento y el trabajo en pos de un avance en el equilibrio de la gestión financiera.

La gestión de residuos sólidos municipal implica el trabajo de diferentes áreas municipales, que en muy raras excepciones se encuentran unificadas, integradas o coordinadas, ni acostumbran a trabajar regularmente en forma conjunta. Por ello, no se tiene la información del total del trabajo, lo que lleva a la pérdida de la perspectiva global del manejo de los residuos.

Para resolver estas cuestiones se ha desarrollado la Matriz Económico Financiero GIRSU, con el propósito de registrar y ordenar la situación financiera de los programas GIRSU de los municipios, calcular los costos de la gestión y desarrollar indicadores económico financieros para la gestión. La realización de talleres de fortalecimiento donde se carga de esta matriz ha permitido a los municipios conocer el costo anual de la gestión de residuos y saber en qué están invirtiendo los recursos municipales: en qué fases de la gestión, en qué áreas de gasto y en qué programas. También ha permitido evaluar con precisión la sustentabilidad entre ingresos y gastos, y calcular las tasas de equilibrio de los diferentes generadores para intentar cubrir los costos de la gestión.

Estos talleres presenciales implican 3 o 4 días de trabajo con los equipos de las diferentes áreas de la municipalidad en las que éstos aprenden a analizar y cargar la información de ingresos y gastos de su localidad, obtener indicadores técnicos para la eficiencia de los servicios y calcular las brechas financieras la mejora del financiamiento de los programas GIRSU.

Palabras clave: Financiamiento GIRSU, Costos GIRSU, aspectos económico financieros GIRSU, sostenibilidad económica

80. Desarrollo y validación de indicadores para la medición de la circularidad en la gestión de residuos sólidos urbanos.

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La adopción de la economía circular en la gestión de residuos sólidos urbanos (RSU) requiere herramientas de medición estandarizadas para evaluar el progreso y la efectividad de las políticas públicas. Sin embargo, en muchos países, especialmente en economías emergentes, la falta de indicadores claros y metodologías comparables dificulta la transición desde modelos lineales de gestión. Este estudio desarrolla y valida un conjunto de indicadores para medir la circularidad en la gestión de RSU, permitiendo su aplicación en distintos contextos urbanos y geográficos. Se utilizó el método Delphi para construir una matriz de indicadores basada en diez dimensiones clave: prevención de residuos, eficiencia de recolección y separación, infraestructura para valorización, impacto social y económico, inversión y sostenibilidad financiera, educación y participación ciudadana, cooperación intermunicipal, marco regulador, asociaciones estratégicas y disposición final de residuos. La validación se realizó en cinco municipios de Brasil con menos de 20.000 habitantes, aplicando técnicas de análisis estadístico y ponderación para determinar la confiabilidad y relevancia de cada indicador. Los resultados evidencian que la ausencia de métricas estandarizadas impide la comparación entre diferentes ciudades y regiones, limitando la identificación de buenas prácticas y la optimización de estrategias de gestión de residuos. Se observó que la mayoría de los municipios carecen de indicadores cuantificables para medir la efectividad de sus sistemas de RSU y la integración de principios de economía circular. Además, las limitaciones en infraestructura y financiamiento impactan negativamente la implementación de políticas efectivas de reciclaje y valorización de residuos. Como contribución, este estudio propone un marco metodológico replicable internacionalmente, proporcionando a los gestores públicos y responsables de políticas ambientales una herramienta para monitorear la circularidad de la gestión de RSU, identificar áreas críticas y establecer estrategias de mejora basadas en datos empíricos. Se recomienda su aplicación en países de América Latina, África y Asia, donde los desafíos estructurales y regulatorios presentan similitudes. La implementación de indicadores validados contribuirá a la creación de un sistema global de referencia para la medición del desempeño en economía circular en la gestión de residuos sólidos urbanos, facilitando la cooperación internacional y la integración de estrategias basadas en evidencia científica.

Palabras clave: indicadores, circularidad, evaluación, políticas públicas

81. Argentina Recicla - Modelo de gobernanza local hacia una Ley REP con transición justa. Tarando, Matias

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El Programa "Argentina Recicla" fue creado en 2021 con el objetivo de consolidar un modelo de gestión de residuos con inclusión social. Implementado por el Ministerio de Desarrollo Social, el programa busca mejorar las condiciones laborales de los recicladores urbanos, fortalecer la cadena de valor del reciclado y promover la economía circular a nivel local.

Argentina genera más de 45.000 t/día residuos y solo el 6% se recicla formalmente mientras el resto se dispone en más de 5.000 basurales a cielo abierto. Por su parte, existen más de 150.000 recuperadores que valorizan 10.000 t/día de materiales reciclables, evitando su disposición en BCA. Sin embargo, solo el 10% de ellos accede a condiciones laborales formales.

Para abordar estos desafíos, Argentina Recicla a estructurado acciones referidas a una Economía Circular Humanista, enfocada en el desarrollo humano integral a través de acciones respecto al fortalecimiento de recicladores de base, implementación de sistemas locales de reciclado de cogestión, redes de comercialización y valor agregado de residuos. También realizó acciones en ejes transversales como la educación ambiental, mediante el manual pedagógico "Aprender de los Residuos", cambio climático (calculadora de GEI para medir el impacto de los recuperadores), sistemas de información geográfica (Mapa Federal de Reciclado), TICs (videojuego Argentina Recicla), trazabilidad de residuos (índice SLR), género, salud, higiene y seguridad, entre otros.

Uno de los principales aportes metodológicos del programa a la Economía Circular y los gobiernos locales, ha sido la Guía para la Implementación de una Gestión Integral e Inclusiva de Residuos Sólidos Urbanos (GIIRSU), desarrollada en articulación con el Ministerio de Ambiente y Desarrollo Sostenible en 2022. Esta guía con más de 30 anexos técnicos, también traducida al inglés, constituye una hoja de ruta con herramientas claves para diseñar e implementar proyectos de gestión de residuos inclusivos en gobiernos locales, con un enfoque circular, territorial, federal y progresivo.

El impacto del programa se refleja en la mejora de las condiciones laborales de más de 70.000 recicladores, la formación de más de 25.000 docentes y trabajadores con una inversión social de $2.542 millones. Gracias a la cogestión con municipios y recuperadores, se han implementado y fortalecido más de 300 sistemas locales de reciclado en todo el país, optimizando la cadena de valor del reciclado, incrementando la capacidad de procesamiento de reciclables, generando empleos verdes de calidad, con economía regionales fortalecidas a través del desarrollo sostenible.

Argentina Recicla ha generado alianzas estratégicas nacionales e internacionales, participando en el Tratado Internacional de Plásticos INC 3 en Nairobi Kenia, como modelo de gobernanza local hacia una ley REP. Este modelo de gobernanza demuestra que la GIIRSU y la REP son fundamentales para una transición justa hacia una economía circular humanista.

Palabras clave: Economía Circular Humanista, Responsabilidad Extendida del Productor, Gobiernos Locales, Recuperadores Urbanos, Argentina Recicla, Gestión Integral e Inclusiva de Residuos (GIIRSU), Transición Justa, Empleo Verde, Desarrollo Sostenible,

CAMBIO CLIMÁTICO Y GESTIÓN DE RESIDUOS

82. Re-imaginando la agricultura: Fortalecimiento de la economía circular a través de la valorización de subproductos agrícolas en los departamentos de Córdoba y Sucre (Colombia).

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Este proyecto de investigación se desarrolla en los departamentos de Córdoba y Sucre, regiones con gran potencial agrícola pero también afectadas por prácticas de manejo inadecuado de residuos y problemáticas ambientales derivadas de la actividad minera. En este contexto, el estudio propone un enfoque integral de economía circular centrado en la valorización de subproductos agrícolas provenientes de cultivos ampliamente presentes en la región: plátano, arroz, coco y marañón.

La iniciativa identificó, caracterizó y transformó los residuos derivados de estos cultivos en productos con alto valor agregado y aplicaciones industriales. A partir de las fibras naturales extraídas del plátano y el coco, se desarrollaron materiales compuestos biodegradables con potencial uso en sectores como la construcción, la fabricación de empaques sostenibles y la producción de bienes de consumo con bajo impacto ambiental.

Paralelamente, se implementaron procesos de compostaje enriquecido para el tratamiento de lodos orgánicos y la rehabilitación de suelos deteriorados por la actividad minera, fomentando prácticas agrícolas regenerativas que restauran la fertilidad del suelo y mitigan impactos ambientales. De manera innovadora, se logró la extracción de ácido anarcárdico a partir de residuos del marañón, con aplicaciones potenciales en las industrias farmacéutica y química, así como la obtención de grafeno a partir de residuos de cáscara de coco, con posibles usos en tecnologías electrónicas y energéticas.

Estos desarrollos no solo aportan soluciones sostenibles para la gestión de residuos, sino que también abren nuevas oportunidades económicas para los agricultores locales, al incorporar alternativas productivas de alto valor que pueden ser integradas en cadenas cortas y modelos asociativos rurales. La transferencia de conocimiento y tecnologías adaptadas al contexto territorial ha sido clave para impulsar una visión de agricultura circular donde los residuos se reconfiguran como recursos estratégicos para el desarrollo sostenible.

En línea con la misión de ISWA y los principios de la economía circular, esta experiencia demuestra que es posible reimaginar el papel del agricultor como innovador y gestor de recursos, promoviendo una transición agroecológica capaz de dinamizar economías rurales, regenerar ecosistemas y construir territorios más resilientes.

Palabras clave: Gestión de Residuos; Valorización de residuos; Desarrollo sostenible; Economía Circular

83. Gestión Integral de Residuos en Jujuy, Argentina. Modelo de innovación institucional, técnica, financiera y social.

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Zigarán, M. I. (1,3)Amador S. B. (2,3)Dorvil P. L. (4)

(1) Ministerio de Ambiente y Cambio Climático/Ministra, Jujuy/Argentina(2) Ministerio de Ambiente y Cambio Climático/Secretaría de Ordenamiento Ambiental y Territorial, Jujuy/Argentina(3) Gobierno de la Provincia de Jujuy, Argentina(4) Banco Europeo de

La Gestión de Residuos Sólidos (GRS) en economías emergentes presenta desafíos, siendo el financiamiento limitado uno de los factores que lleva a los tomadores de decisiones a ver tales inversiones como cargas en lugar de oportunidades de crecimiento. El programa GIRSU Jujuy representa un modelo innovador que aborda la GRS integralmente, combinando tecnología, estructura institucional eficiente y financiamiento sustentable, con respaldo internacional.

Impactos y beneficios

- Formalización de 224+ recuperadores
- Recuperación de medios de vida para familias trabajando en vertederos
- Contribución a los Objetivos de Desarrollo Sostenible.
- Incorporación de las perspectivas interculturales e indígenas a la GRS
- Beneficios sanitarios para más de 300.000 habitantes
- Creación de 200 empleos permanentes a través de cooperativas y programas de capacitación
- Tasa Interna de Retorno Financiera del 9% y Tasa Interna de Retorno Económico del 15% a 20 años

Antecedentes

Jujuy, ubicada al noroeste de Argentina, con 810.000 habitantes, ha sufrido durante décadas deficiencias graves en los servicios de GRS, con tasas de recolección de residuos inferiores al 15%. Muchos recicladores informales dependían de los vertederos para su sustento. Se estimaba que los impactos en la salud pública y el ambiente en la región costaban entre el 5% y el 10% del PIB anual. El proyecto forma parte de la iniciativa "Jujuy Verde Carbono Neutral 2030".

Estructura Institucional

Establece un marco normativo centrado en el paradigma de responsabilidad compartida donde los municipios mantienen la recolección de los residuos y la provincia gestiona hasta la disposición final. Esta política integral ha logrado:

- Regionalización de la gestión
- Promoción de la economía circular
- Participación ciudadana y educación ambiental
- Solución Técnica

La infraestructura incluye:

- Centro Ambiental Jujuy (CAJ): clasificación, compostaje, captura de biogás y disposición con control de lixiviados
- Plantas de Clasificación y Transferencia en San Pedro y Libertador General de San Martín
- Estaciones de Transferencia y Puntos de Acopio para optimizar logística
- Planta de Biogás: 0,5 MW de energía renovable

Esta política permite cerrar basurales a cielo abierto en la provincia, logrando un cambio estructural en la GRS.

Inversión

La inversión del proyecto es de 120 millones de dólares siendo 45% contrapartida, 40% financiamiento del Banco Europeo de Inversiones, 12% del Banco Interamericano de Desarrollo y 3% subvención de la Comisión Europea. El financiamiento tiene una estructura de garantías soberana y sub-soberana; y se prevé la implementación de una tasa GIRSU y aportes provinciales para solventar la operación.

GIRSU Jujuy representa un modelo replicable para Latinoamérica, demostrando como los desafíos ambientales pueden transformarse en oportunidades de negocio sostenibles mediante la colaboración institucional, la valorización de residuos y políticas de inclusión social.

Palabras clave: Residuos, medio ambiente, gestión integral, biogás, economía circular

84. IBERA Basura cero y Economía Circular frente al Cambio Climático.

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La región del Litoral, y en particular la provincia de Corrientes, presenta hoy una oportunidad para desarrollar un modelo regional de ecoturismo. En este contexto, la gestión de residuos adquiere especial relevancia. La crisis ambiental, propia de un país en desarrollo, pero inserto en una región privilegiada en términos ambientales, pero con indicadores socioeconómicos desfavorecidos, contrasta con la oportunidad única de avanzar en el desarrollo ambiental y ecoturístico regional, hacia un sitio caracterizado por una gestión ambiental con una clara misión de integración ambiental con las actividades humanas, resolviendo adecuadamente, y en función de los recursos disponibles, los problemas generados.

En este contexto, las contribuciones al Plan de Gestión de Residuos adquieren un papel relevante en las posibilidades de acción de los gobiernos locales, donde se destaca la sinergia de acciones y políticas en un contexto ambiental e institucional tan importante para superar las debilidades a corto plazo. La región IBERA constituye un área de alto valor paisajístico y estratégico de desarrollo eco turístico de la provincia de Corrientes, por lo cual no solo debe ser entendida como una Unidad Ecológica, sino como una Unidad de Planificación y Gestión respecto al cuidado de sus ecosistemas por su importancia ecológica-ambiental y calidad de vida de los habitantes (salud, recreación, etc.) actividades económicas y de interrelaciones.

En función de ello, el Gobierno de la Provincia de Corrientes, a través del Comité Ibera e impulsado por el Ministerio de Turismo provincial, convocó a la elaboración de propuestas para el Plan de Gestión Integral de RSU (PGIRSU) en la Micro Región Ibera Oeste, reconociendo la importancia minimizar los impactos ambientales derivados de gestionar inadecuadamente los RSU, a través de un proyecto que inicie el proceso de implementar soluciones integrales a la problemática de los residuos.

La metodología considera una estrategia de abordaje regional sobre la unidad de gestión que conforma el Circuito turístico provincial “Solar de las Huellas” abarcando las localidades de Saladas, Colonia Santa Rosa, Mburucuyá, Concepción del Yaguareté Corá, San Miguel, Caá Catí y Loreto, denominada como MICRO REGIÓN IBERA-OESTE (MRI-O), configurando el resultado de un proceso de participación y colaboración de los citados Municipios para la elaboración del Plan. Estos trabajos deben desarrollarse en el marco de una perspectiva integradora, con la participación de todos los sectores comprometidos e involucrados en un proceso dinámico y con ajustes periódicos, conducidos por una decisión política clara por los derechos de todos los ciudadanos y el concepto de que la calidad de vida es una obra de todos.

Estas ciudades pueden y deben desempeñar un papel más activo frente al proceso de urbanización y concentración, equilibrando los procesos. Esta función de re-equilibrio territorial debe tener en cuenta la diversidad de patrones de urbanización y funcionamiento de los sistemas urbanos, así como las potencialidades y roles que juegan las diferentes ciudades/municipios en cada contexto territorial regional. El aporte de esta propuesta a las pequeñas ciudades de la región en momentos de revisión y cambio de la concepción estratégica de las ciudades en función de su desarrollo sustentable, contribuirá a gestar cambios estructurales en un tema largamente postergado y sobre el cual la ciudadanía como sus dirigentes, tienen una deuda consigo mismos.

Palabras clave: Nueva Agenda Urbana, ODS2030, GIRSU, Economía Circular, Tecnología de Gestión

85. Rediseñando la recuperación de orgánicos en la Ciudad de Buenos Aidel piloto a un sistema escalable.

Boix, Catalina

Julieta Vallejos – Mariela Pascua

Delterra

Los residuos orgánicos representan casi un tercio de los residuos municipales de la Ciudad de Buenos Aires, pero menos del 3% se separa en origen y se recupera efectivamente. La mayor parte termina en el relleno sanitario Norte III, uno de los mayores emisores de gases de efecto invernadero de la ciudad. La ciudad opera un servicio específico de recolección para grandes generadores y una planta de compostaje de orgánicos, pero la capacidad de ambos sistemas se encontraba subutilizada. Esto evidenciaba una brecha entre la infraestructura disponible y la recuperación real.

Para abordar esta situación, Delterra se asoció con la ciudad para lanzar un piloto en el barrio de Caballito. El enfoque combinó tres elementos: el rediseño de las rutas de recolección utilizando datos de GPS, la implementación de un programa de cambio de comportamiento adaptado a grandes generadores y la introducción de una aplicación digital para reemplazar los remitos manuales y contar con datos operativos en tiempo real.

En Caballito, donde el rediseño operativo se combinó con el cambio de comportamiento y la aplicación digital, la recuperación aumentó un 45%, la calidad de la separación mejoró del 68% a casi el 100% y el tiempo de recolección por punto se redujo en un 24%.

Más allá de las mejoras operativas, el piloto proporcionó aprendizajes clave. Un servicio confiable debe preceder al trabajo de cambio de comportamiento para no perder la confianza de los generadores. Las herramientas de comunicación deben adaptarse al tipo de negocio. La confirmación digital ayuda a generar responsabilidad y a sostener la participación. Estos aprendizajes fueron co-desarrollados con los equipos de la Ciudad, quienes también crearon sus propios tableros de control e indicadores clave de desempeño, fortaleciendo capacidades institucionales de largo plazo.

El impacto se expandió rápidamente. A partir de una línea de base de siete rutas, la ciudad ya incorporó seis adicionales, alcanzando trece. Una vez validada la metodología, esta se escaló en las rutas de los barrios de Palermo y Belgrano, y la ciudad tiene planes de continuar agregando rutas y escalando la metodología, alcanzando 15 rutas para 2027.

Este caso demuestra cómo un piloto focalizado con grandes generadores puede generar un efecto multiplicador, fortalecer la apropiación por parte de la Ciudad y escalar hacia una hoja de ruta, con el potencial de recuperar más de 32.000 toneladas anuales de residuos orgánicos y evitar 14.300 toneladas de CO_2e por año.

Palabras clave: Orgánicos, residuos alimentarios, metano, cambio climático, residuos, Argentina, economía circular, grandes generadores, trazabilidad, cambio de comportamiento.

86. Más allá de la mitigación: Manejo de residuos orgánicos de Uganda como vía para adaptación y resiliencia.

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Okello G (2) , Nyamurungi K (2), Dell'Orto A (3), Kiguli D (4), Trois C (3)

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Las estrategias de mitigación del cambio climático requieren acciones coordinadas que aborden tanto el dióxido de carbono (CO_2) como los Contaminantes Climáticos de Vida Corta (SLCPs, por sus siglas en inglés), tales como el metano (CH_4), el carbono negro (BC), el ozono troposférico (O_3) y los hidrofluorocarbonos (HFCs). El sector de los residuos, en particular, desempeña un papel significativo en la mitigación climática, ya que las acciones en este ámbito reducen tanto los contaminantes climáticos de corto como de largo plazo, contribuyendo así a la lucha contra el cambio climático. Sin embargo, el principal objetivo de un sistema de gestión de residuos debe ser garantizar el bienestar de las comunidades, mejorar la eficiencia en el uso de los recursos y fomentar el desarrollo sostenible.

En ese contexto, el Sur Global ofrece una oportunidad para cambiar el paradigma, pasando de adoptar exclusivamente sistemas de gestión de residuos centralizados a un enfoque que combine sistemas centralizados y descentralizados, colocando a las comunidades en el centro de las estrategias de gestión de residuos. Aquí sostenemos que, para desarrollar intervenciones y políticas eficaces, equitativas y viables, es crucial adoptar un enfoque centrado en las realidades y necesidades de la población. Las personas deben tener el derecho de participar en el diseño de las intervenciones, para que puedan adoptarlas, responder a ellas y beneficiarse de manera efectiva. Adoptamos una metodología de co-desarrollo, un enfoque que combina métodos participativos y cualitativos, para formular la Estrategia Nacional de Uganda para la Reducción de Emisiones de SLCPs del Sector de Residuos Orgánicos, al tiempo que exploramos y cuantificamos oportunidades para mejorar la adaptación, la resiliencia y promover comunidades más equitativas en todo el país.

Estimamos las emisiones de metano (CH_4) y los potenciales de mitigación del sector de residuos orgánicos en Uganda bajo un Escenario de Referencia, un Escenario con Medidas Existentes y tres escenarios de mitigación co-desarrollados durante talleres con partes interesadas. Estos escenarios incorporan una revisión exhaustiva del estado actual de la generación y gestión de residuos orgánicos en Uganda, una evaluación del marco normativo vigente y reflejan un enfoque colaborativo para identificar estrategias viables para la reducción de emisiones en el sector de residuos del país. Usando el año 2020 como año base, la evaluación cubre el período de 2005 a 2050. Los escenarios tienen como objetivo no solo capturar el potencial de mitigación del metano, sino también responder a las necesidades de las comunidades —como el suministro de fertilizantes, energía para cocinar e iluminar y alimento para animales— a través de estrategias sostenibles de gestión de residuos.

Este Proyecto es financiado por Climate and Clean Air Coalition – CCAC

Palabras clave: Cambio climático, residuos orgánicos, comunidad, estrátegia, co-diseno

87. Evaluación de la factibilidad técnica para valorizar restos de poda, FORSU y bioestabilizado mediante producción de biochar: caracterización de sustratos, productos y potencial de aplicación.

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Se presenta un análisis sobre la potencialidad de producción de biochar a partir de residuos orgánicos que generalmente tienen destino de relleno sanitario en Latinoamérica: el rechazo fino de una planta de compostaje de restos de poda (RFC), la fracción orgánica de residuos sólidos urbanos (FORSU) y su bioestabilizado (BioFORSU).

A través de un proceso de pirólisis controlada, se busca transformar estos materiales en un producto estable y con alto potencial de adsorción, capaz de retener agua, nutrientes, contaminantes y con una importante capacidad de reducir las emisiones de gases de efecto invernadero.

Para poder comparar sus características se realizó un proceso de caracterización fisicoquímica de sustratos, síntesis de biochar y posterior caracterización de los productos obtenidos.

Se detectó que el RFC presenta las mejores condiciones para la producción de biochar, destacándose por su bajo contenido de materiales impropios (vidrio, piedra, metales, plásticos) que no supera el 1,5% frente al 32% de la FORSU y un 27,5% del BioFORSU. Este resultado es muy importante ya que determina la necesidad de tratamientos previos a la pirólisis. En parámetros como humedad, metales pesados, cenizas y carbono orgánico, el RFC también presentó los valores más adecuados destacando su alto contenido de carbono orgánico.

En lo que comprende al rendimiento del proceso de pirólisis, el RFC mostró el menor valor de biocarbón resultante (36,2%) en comparación con la FORSU (55,7%) y el BioFORSU (53,4%), posiblemente debido al elevado contenido de ceniza de estos últimos, la cual permanece durante la pirólisis y aumenta la masa de biochar, pero reduce su contenido de carbono fijo. Para verificar esta suposición y poder comparar los biocarbones obtenidos, se realizó una caracterización fisicoquímica, incluyendo parámetros como pH, NTK, P, HAP, metales pesados, %Ceniza y %C fijo. Se observó que, según lo supuesto, el biochar de RFC contiene un 81,4% de carbono, frente a 35,8% y 23,3% de la FORSU y el BioFORSU.

Al comparar los resultados obtenidos con los estándares internacionales surge que la FORSU y el BioFORSU podrían tener potencial para producir biochar de aplicación en la industria de los materiales, siempre que se supere la problemática de la separación de los impropios, mientras que el RFC aparece como el material más adecuado, tanto desde el punto de vista técnico como ambiental, para la valorización mediante la producción de un biochar de grado agronómico. Adicionalmente, el alto contenido de carbono fijado en el biochar derivado de RFC sugiere un potencial económico asociado a la comercialización de bonos de carbono, incrementando el atractivo y la viabilidad económica del proceso como estrategia de valorización integral de residuos. Posteriores análisis sobre el biochar producido de forma industrial son recomendables.

Palabras clave: Biochar, compostaje, pirólisis, residuos de poda, emisiones, captura de carbono

TRATAMIENTO BIOLÓGICO DE RESIDUOS

88. Gestión local de residuos orgánicos mediante compostaje in-situ, estrategia para la disminución de costes e impactos, y la generación de beneficios. Experiencias, aprendizajes y desafíos.

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El presente trabajo sintetiza aspectos clave para una gestión local de los residuos orgánicos, tomando como referencia experiencias europea, con especial foco desde experiencias en Italia, que han impulsado soluciones descentralizadas, diversas y complementarias. Estas prácticas permiten reducir significativamente los costos y los impactos socioambientales, al tiempo que generan beneficios locales directos a personas, comunidades y municipios.

En este marco, el compostaje de in-situ y proximidad se define como aquel desarrollado en la misma comuna o zonas cercanas, e incluye variantes como el auto-compostaje, el compostaje comunitario y el local. A diferencia de los sistemas industriales centralizados, nos permite lograr un abono natural que revitaliza suelos, desarrollar formas de economía circular, huertos y de mejoramiento ambiental en las distintas zonas donde se realiza

En Santiago de Chile, estas ideas han sido llevadas a la práctica mediante experiencia pilotos desde "Ecología en tu Barrio", con la instalación de estaciones de compostaje comunitario en plazas y privados. Permitiendo que estas experiencias, de escala menor a 36 toneladas al año, sean una demostración concreta que es posible gestionar residuos de manera eficiente, cercana y regenerativa, evitando su traslado y disposición final, disminuyendo la huella ecológica y generando un compost de calidad para uso local.

Cada estación puede recibir hasta 100 kg diarios, involucrando activamente vecinos, estudiantes y organizaciones locales mediante campañas de educación ambiental, participación ciudadana y un trabajo articulado con las autoridades locales.

El compostaje de proximidad no solo reduce emisiones de CO_2, sino que también potencia encadenamientos con la agricultura urbana, mejora la salud del suelo, conecta a las personas y organizaciones en un territorio, y fortalece la economía circular a nivel local. Además, puede integrarse con incentivos como la reducción de tasas de recolección, generando un marco favorable para su expansión.

Estas experiencias nos invitan a reimaginar la gestión de residuos desde lo local, como una acción climática concreta, socialmente justa y ecológicamente restauradora.

El marco normativo en Chile se encuentra en transición, con la Ley REP y la Ley Orgánica de Municipios como puntos de apoyo, aunque aún sin una reglamentación específica para compostaje descentralizado al día de hoy. En este vacío, los municipios y organizaciones civiles han jugado un rol clave en la innovación local, generando manuales técnicos, protocolos operacionales y criterios de replicabilidad.

En conclusión, el compostaje in-situ y de proximidad se consolida como una estrategia técnica, social y climáticamente efectiva, que permite reducir impactos, regenerar suelos y fortalecer comunidades urbanas resilientes.

Palabras clave: Compostaje, acelerado, electromecánico, local, in-situ, colaborativo, innovación, economía circular, regeneración, cambio, nuevas prácticas, cultura organizacional, transformación, basura cero.

RESIDUOS PELIGROSOS

89. Trazabilidad de Residuos Industriales. Guerguerian, G. (1)

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En el marco de la política de gestión de residuos que Uruguay viene impulsando, es fundamental contar con herramientas que permitan facilitar y optimizar el control y seguimiento de residuos en tiempo real, facilitando su valorización y reduciendo la informalidad. Actualmente, los procesos de reciclado y valorización son incipientes y se realizan en gran medida a través de canales informales, con clasificadores que realizan la tarea en condiciones de alta vulnerabilidad y exclusión. La información sobre residuos es fragmentada e incierta, dificultando su gestión eficiente. En línea con la Ley N.º 19.829 y el Plan Nacional de Gestión de Residuos, el sistema de trazabilidad de residuos industriales busca un manejo ambiental adecuado, promoviendo la conversión de residuos en recursos.

El presente artículo expone el diseño e implementación del Sistema de Trazabilidad de Residuos Sólidos Industriales de Uruguay, una herramienta clave para mejorar el control y la información. Adicionalmente, se describen las características técnicas del sistema, y se abordan las estrategias implementadas para involucrar a los generadores de residuos, transportistas y gestores autorizados en el uso del sistema, destacando la importancia de la colaboración público-privada y el fortalecimiento de capacidades. Finalmente, se evalúan los desafíos de su implementación, así como también las lecciones aprendidas y las oportunidades para replicar y mejorar este modelo, ya sea para otras corrientes de residuos a nivel nacional, así como en otros países interesados en la gestión sostenible de residuos industriales.

La trazabilidad de residuos, implementada a través de una plataforma digital interoperable, constituye una herramienta efectiva para fortalecer el control de la gestión, asegurando el tratamiento adecuado y reduciendo la informalidad. El seguimiento desde la generación hasta la disposición final garantiza operaciones dentro del marco normativo, evitando prácticas inadecuadas. Su implementación mejora la toma de decisiones basada en datos y fomenta prácticas sostenibles.

El desarrollo de soluciones tecnológicas a medida permitió adaptar herramientas digitales a las necesidades específicas del sector, garantizando su funcionalidad y eficiencia. Uruguay ha impulsado la innovación mediante el sistema de trazabilidad específico para residuos industriales, con el objetivo de ampliar su alcance a otras corrientes.

Extender la trazabilidad a todas las corrientes de residuos contribuirá a la consolidación de un sistema unificado de gestión. Esto facilitará la recolección de datos precisos para mejorar la planificación, optimizar recursos y fortalecer el cumplimiento normativo, asegurando un impacto positivo en la reducción de residuos mal gestionados y en la promoción de la valorización de materiales. La implementación progresiva y escalonada permitirá identificar y superar desafíos técnicos, operativos y económicos, garantizando la viabilidad del sistema a largo plazo.

Palabras clave: trazabilidad, gestión de residuos, residuos industriales, valorización, plataforma digital

90. Gestión circular de disolventes industriales: innovación sostenible en la recuperación y valorización de residuos peligrosos.

Villar, Alejandro

Chifflier, G., Nupieri, P.

Veolia

La gestión de residuos peligrosos implementada en Veolia constituye un paradigma significativo en la implementación de principios de economía circular y gestión ambiental sostenible. Uno de los servicios brindados en Argentina presta una relevante solución para el manejo y recuperación de solventes provenientes de procesos de pintura industrial. Esta unidad operativa se especializa en el procesamiento y revalorización de residuos solventes, brindando servicios principalmente a los sectores automotriz, autopartista y metalmecánico, estableciendo así un modelo de excelencia en la gestión integral de residuos industriales y la optimización de recursos en procesos productivos.

Los solventes son utilizados en diversos procesos de aplicación de pinturas. El proceso de limpieza de estos sistemas genera solventes sucios con pintura, que son recolectados en recipientes metálicos o plásticos (tambores o contenedores). Posteriormente a su utilización, los recipientes que albergan residuos de solvente son trasladados a las instalaciones de Veolia, donde se someten a un proceso de destilación en batch con anhidración física en destiladores. Esta metodología facilita la separación térmica del solvente, que subsecuentemente es reintegrado a los usuarios originales, lo cual resulta en una reducción sustancial en la demanda de solvente virgen. Los residuos semisólidos resultantes son utilizados como combustible alternativo, mientras que los contenedores son sometidos a procesos de lavado bajo rigurosos protocolos de control de calidad para, en el caso de los recipientes metálicos, su reutilización, y en caso de los plásticos, su reciclado.

En 2024, se recuperaron 947 toneladas de solventes y 990,1 toneladas de plásticos. La compañía atiende al 100% del mercado automotriz y autopartista de piezas pintadas del país.

Esta iniciativa genera múltiples externalidades positivas tanto ambientales como económicas. Desde la perspectiva ambiental, se logra una significativa mitigación de la contaminación mediante la reducción en la emisión de compuestos orgánicos volátiles a la atmósfera, litósfera e hidrósfera. La recuperación de solventes contribuye sustancialmente a la preservación de recursos naturales al disminuir la demanda de producción de nuevos solventes, lo que implica una optimización en el consumo de materias primas y una reducción en la huella de carbono asociada a su producción, además de la reducción de residuos generados.

En el ámbito económico, las organizaciones participantes obtienen beneficios cuantificables mediante la recuperación de sus residuos, optimizando costos operativos y reduciendo volúmenes de residuos peligrosos. Este sistema maximiza la eficiencia en el uso de recursos mientras fortalece el cumplimiento normativo y el perfil de sostenibilidad corporativa.

Se materializa la circularidad del proceso en la recirculación sistemática tanto de los solventes como de sus contenedores, permitiendo múltiples ciclos de utilización. Este modelo de gestión ejemplifica la implementación efectiva de principios de economía circular en procesos industriales, generando sinergias positivas entre el desempeño ambiental y la eficiencia económica, mientras se contribuye al desarrollo sostenible.

Palabras clave: Circularity, Solvents, Circular economy, Environmental performance, Economic efficiency, Sustainable development, Hazardous waste, Recovery, Valorisation

RESIDUOS DE ESTABLECIMIENTOS DE SALUD

91. Determinación de tasas de generación de Residuos de Atención a la Salud en Uruguay. Ramírez, Carolina

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Determinación de tasas de generación de Residuos de Atención a la Salud en Uruguay

La cantidad de residuos que se genera en un Centro de Atención a la Salud (CAS) está relacionada entre otros factores, de la cantidad de servicios médicos ofrecidos, del grado de complejidad de la atención prestada, del tamaño del establecimiento, de la proporción de pacientes atendidos y de la dotación de personal (Sánchez y Ortunio, 2017)). Esto ha llevado a que, se opte por relacionar la cantidad promedio de residuos sólidos generados diariamente con el número de camas de CAS, obteniéndose cifras, que, si bien están sujetas a cierto grado de imprecisión, son sencillas de manejar (Ramírez et al., 2017).

En cuanto a las tasas de generación de Residuos de Atención a la Salud en América Latina, OMS (1997) indica que los valores del rango promedio de generación de HCW de América Latina son de 1,00 a 4,50 kg/cama/día. De acuerdo con Ramírez et al. (2017), no se conocen muchos estudios referidos a la determinación de tasas de generación de HCW en Uruguay, lo que conlleva a que las tasas de generación empleadas se correspondieran a datos bibliográficos, sin tener información clara de cómo se obtuvieron. Actualmente en Uruguay, los estudios referentes a determinación de tasas de generación de HCW en el país son los desarrollados por el Departamento de Ingeniería Ambiental del Instituto de Mecánica de los Fluidos e Ingeniería Ambiental de Facultad de Ingeniería de Udelar: (González et al., 2009), (González et al., 2011) y (Ramírez, 2022).

En González et al. (2009), se obtuvieron valores de tasa de generación media de HCW de 3,6 kg/cama/día, correspondiendo 1,9 kg/cama/día a Residuos Comunes y 1,7 kg/cama/día a Residuos Contaminados. En promedio, por cada kg de residuos totales se generan 0,5 kg de Residuos Contaminados. En González et al. (2011), se obtuvo que el promedio diario teórico de generación de HCW resultó de 2,7 kg/cama/día. El análisis de los datos obtenidos por Ramírez (2022), arroja que las tasas de generación promedio de HCW Comunes y HCW Contaminados obtenidas fueron de 1,8 kg/cama/día y 2,1 kg/cama/día respectivamente. Además, por cada kg de HCW totales se generan 0,5 kg de Residuos Contaminados. Del análisis de los datos resultantes de otra campaña de pesaje también presentados en Ramírez (2022), se concluye que las tasas de generación promedio de HCW Comunes y HCW Contaminados obtenidas fueron de 0,8 kg/cama/día y 1,7 kg/cama/día respectivamente y que, en promedio, por cada kg de HCW totales se generaron 0,7 kg de HCW contaminados.

Con base en los estudios realizados, se pueden constatar ciertas relaciones de interés, siendo esperable que las tasas de generación de HCW en Uruguay se sitúen entre 3 y 4 kg/cama/día. Sin embargo, prácticas relevadas vinculadas con la clasificación incorrecta de HCW en los CAS impiden proponer tasas nacionales.

Palabras clave: Residuos de atención a la salud, Gestión de Residuos, Tasas de generación

CIERRE Y MEJORA DE BASURALES A CIELO ABIERTO

92. La radiografía de los tiraderos a cielo abierto en México. Un tema relegado en la agenda pública nacional y su posible erradicación mediante sistemas intermunicipales.

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El Atlas Nacional de Residuos Sólidos Urbanos publicado por la autoridad federal ambiental en México llega a un resultado alarmante, del total de sitios de disposición final el 86% son tiraderos a cielo abierto, el 10% son sitios controlados y únicamente el 4% son rellenos sanitarios. Estas cifras revelan un preocupante problema público de insostenibilidad. El documento citado señala que el país tiene 2,227 sitios de disposición final, cifra que es absoluta y técnicamente irracional.

Esta radiografía por sus implicaciones ambientales es contraria al cumplimiento de todos los preceptos del marco legal nacional. La transgresión resultante del derecho ciudadano a gozar de un ambiente sano sobresale como la primera ruptura en el tema entre gobernantes y gobernados, a partir de no contar con la infraestructura suficiente para poder tener un manejo adecuado de los residuos sólidos generados en 32 estados y 2,473 municipios.

Desde 2018, la Ley General de Cambio Climático obligaba a los municipios en coordinación con los niveles de gobierno estatal y federal a desarrollar infraestructura en centros urbanos de más de 50,000 habitantes para el adecuado manejo de los residuos sólidos a fin de que, en su disposición final, no contribuyeran con emisiones contaminantes a la atmósfera. El tema no tuvo seguimiento en la agenda pública, menos aún recursos asignados y quedó en total olvido. En este contexto, las malas prácticas derivadas de la falta o insuficiencia de servicios, infraestructura e instalaciones abonan con creces a la triple crisis planetaria en tanto el cambio climático, la contaminación y la pérdida de biodiversidad, ya sea por la acumulación de residuos al aire libre y/o por la quema sistemática de estos.

Con el desarrollo de sistemas intermunicipales estratégicamente localizados y donde exista una correcta coordinación entre los niveles de gobierno, puede avanzarse significativamente en la lucha contra la multiplicación de tiraderos a cielo abierto. En la ponencia se abordarán los resultados de una investigación de tesis doctoral que analiza las experiencias revisadas de estudios de caso, que demuestran que los sistemas intermunicipales en México son más efectivos en la cadena de manejo, que los municipios que no pertenecen a alguno. El indicador que revela la afirmación anterior es la menor presencia de fuentes de contaminación ambiental al suelo, aire y cuerpos de agua, así como la reducida o nula incidencia de tiraderos a cielo abierto. También, como parte de los resultados de la investigación, se ha procesado una herramienta para el reconocimiento georreferenciado de los sitios de disposición final y, paralelamente, para la territorialización, conformación y modelación de los sistemas intermunicipales en todo el país, a efecto de que este conjunto de bases de datos y proyecciones fortalezcan los elementos de la gestión ambiental en la toma de decisiones público-privadas.

Palabras clave: sitios de disposición final, tiraderos a cielo abierto, municipios, sistemas intermunicipales, gobierno, infraestructura

93. ¿Cómo transformar la basura en parques?: El caso del ex tiradero La Reserva, del Sistema Integral de Aseo Público de León, México.

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El Sistema Integral de Aseo Público de León (SIAP) es un organismo operador descentralizado del gobierno municipal (Municipio de León en México), cuya misión es ser vanguardista en el manejo de los residuos sólidos urbanos (desde la recolección hasta su disposición final), promoviendo además la participación ciudadana para conservar un municipio limpio. Uno de los proyectos más emblemáticos impulsados por el SIAP es el saneamiento y reinserción del ex tiradero de residuos "La Reserva". En el presente trabajo se describen las etapas y evolución para transformar este ex tiradero a un parque urbano. Este sitio, que funcionó de 1985 a 2001, se estima que tiene unos 6,000,000 de toneladas confinadas. La descripción de este caso tiene mucho valor, dado que las experiencias en México y América Latina sobre la recuperación de estos espacios han sido poco documentadas y los ejemplos de éxito son escasos. Se realizó la recopilación de los estudios, metodologías y estrategias que han formado parte de esta conversión, así como la intervención de las distintas dependencias municipales y otras entidades que son necesarias para lograr un proyecto como este. Actualmente, el proyecto se encuentra en la fase final de construcción de la Primera etapa del parque, que incluye una zona infantil, un área educadora (preparada para un museo y actividades lúdicas), así como zonas deportivas y de esparcimiento. Los impactos positivos de este proyecto se pueden agrupar en un binomio de beneficios: no sólo se recupera la zona a un nivel ambiental, sino que ayuda a solucionar la necesidad de índole social que existe de espacios dignos para el esparcimiento de las familias. Entre las principales limitaciones que se enfrentan este tipo de proyectos es la escasa información técnica sobre algunos aspectos referentes al saneamiento y falta de fuentes de financiamiento para poder ejecutar este tipo de obras. Se puede concluir, que los proyectos como este son complejos, por lo que se requiere de una participación multidisciplinaria de especialistas, así como el compromiso de diversas instituciones municipales y de otras entidades para poder llevarlo a cabo, así como de un firme compromiso político y de la participación activa de la sociedad, para poder concretarlo y que sus resultados puedan mantenerse a través del tiempo.

Finalmente, el avance de este proyecto también da testimonio del impacto positivo de organismos operadores como el SIAP, en la gestión integrada y sostenible de los residuos, dada su madurez a nivel operativo y técnico, le permite liderar un proyecto tan complejo como este, y a la vez, seguir generando ejemplos de buenas prácticas y casos de éxito, que tanta falta hacen en México y en la región de América Latina y el Caribe.

Palabras clave: Organismos operadores, parques, saneamiento de vertederos, trabajo multidisciplinario, vertederos a cielo abierto.

RELLENOS SANITARIOS

94. Utilización de geosintéticos en celdas de disposición de residuos.

Calderon, Javier

NAUE

Utilización de geosintéticos en celdas de disposición de residuos

Los botaderos de basura a cielo abierto son sitios utilizados para la disposición final de residuos sólidos sin el tratamiento adecuado, lo que genera un impacto ambiental y social considerable. El incremento poblacional y el crecimiento urbano han aumentado el volumen de residuos generados.

El diseño de rellenos sanitarios ha evolucionado significativamente a lo largo de las últimas décadas, respondiendo a las crecientes demandas de las zonas urbanas y a la necesidad de gestionar de manera sostenible los residuos sólidos. A medida que las poblaciones se concentran en las ciudades, la generación de residuos se incrementa, lo que exige soluciones cada vez más eficientes y seguras para su disposición final.

Los rellenos sanitarios controlados hoy representan un área de interés social y económico significativo. Todo tipo de residuos deben mantenerse aislados en el tiempo para proteger el medio ambiente y la salud de las personas. El uso de geosintéticos en rellenos sanitarios viene desde hace mas de 4 décadas donde todo comenzó con la necesidad de utilización de un material impermeabilizante para evitar fugas de lixiviados. Hoy en día son muchos los diferentes tipos de geosintéticos que se usan en los rellenos sanitarios tanto en la base como en el cierre de las celdas como son los geotextiles, geomembranas, geoceldas, GCL, geomallas así como los productos de control de erosión utilizados en los cierres de los rellenos sanitarios y en la protección de taludes.

En Estados Unidos la creación de la“ Environmental Protection Agency”(EPA) y el desarrollo de criterios estrictos para la construcción y mantenimiento de los rellenos sanitarios así como la Ley de Conservación y Recuperación de Recursos de 1976 (“Resource Conservation and Recovery Act” (RCRA), obligó al cierre de tiraderos a cielo abierto en todo el país y desarrolló la regulación que dicta las normas mínimas para la construcción y mantenimiento de rellenos sanitarios (“TrashTimeline”,1998).

Los rellenos sanitarios actualmente requieren de:

• Un sistema de revestimiento de arcilla compactada o polietileno de alta densidad.

• Un sistema de recolección de lixiviados para poder extraer estos líquidos desde el fondo del depósito.

• Pozos de captación de gas metano.

En Centro América y Sur América se siguieron en la mayoría de los países las normas Norteamericanas, en algunos casos con algunas particularidades de los países adoptantes.

SISTEMA DE REVESTIMIENTOS EN USA Y EUROPA

Particularidades de la arcilla compactada

Las arcillas compactadas tienen las dificultades principalmente que pueden tener perdida de humedad en el proceso constructivo, además de las dificultades de compactación en taludes pronunciados y poder hacer los métodos de ensayo insitu de la calidad de la arcilla compactada.

Geomembranas y GCL

Geomembrana es el nombre generico que recibe la lámina impermeable hecha a partir de diferentes resinas Plásticas, con diferentes espesores fabricado con diferentes materiales

sinteticos con cualidades físicas y químicas distintas que las hacen sutilmente diferente pudiendo ser de PE, PVC y otras
Igualmente pudiendo ser de alta densidad, baja, reforzado, lisa, corrugada y otras

Sin embargo, las Geomembranas (actuando solas) son vulnerables a daños por punzonamiento (rocas grandes + altas cargas)
-Punzonamiento actua como un camino de entrada a la pérdida de Soluciones de lixiviados, para reducir las fugas, se puede usar una geomembrana sobre una capa de suelo de baja permeabilidad como parte de un sistema de revestimiento compuesto:
-Arcilla compactada con k = 1 x 10-8 m/s o 1 x10-9 m/s (según requisitos normativos)
-Revestimientos de arcilla geosintética (GCL), revestimientos a base de bentonita de sodio con k = 5 x 10-11 m/s
Un GCL debajo de la geomembrana tenderá a "tapar" los defectos o perforaciones en la geomembrana, lo que reducirá las fugas generales.

Palabras clave: Geosinteticos, residuos, medio ambiente

95. Influencia de la composición de residuos sólidos municipales en las características de lixiviado generado bajo el método de biorreactores semiaerobios.

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La gestión inadecuada de residuos sólidos es un problema global que exige soluciones sostenibles y adaptables al cambio climático. En el Perú, la escasez de sitios de disposición final dificulta el manejo adecuado de los residuos, representando un desafío creciente para satisfacer la demanda poblacional. Para abordar esta problemática y mitigar su impacto ambiental, el país ha impulsado la implementación de infraestructuras de disposición final con tecnología semiaerobia, basada en el Método Fukuoka. Este esfuerzo, financiado por organismos internacionales, busca optimizar la disposición de residuos y reducir las emisiones de gases de efecto invernadero. Sin embargo, para garantizar su efectividad a largo plazo, es necesario adaptar esta tecnología al contexto climático y a las políticas de segregación de residuos del país.

Se evaluó el comportamiento de tres biorreactores de polietileno, diseñados para simular rellenos sanitarios según el Método Fukuoka, y su influencia en las características del lixiviado generado por la descomposición de residuos. Se analizó el efecto de la segregación de residuos orgánicos e inorgánicos aprovechables, variando el aprovechamiento al 0%, 25% y 50%. La composición de los residuos colocados en los biorreactores se basó en el Estudio de Caracterización de Residuos Sólidos de la Municipalidad Metropolitana de Lima (2019-2022). Los parámetros iniciales evaluados para los residuos sólidos fueron peso, volumen, altura, sólidos volátiles, sólidos totales, densidad de compactación, temperatura y tasa de asentamiento, en cuanto a los parámetros del lixiviado se realizó mediciones en pH, conductividad eléctrica, turbiedad, sólidos totales, sólidos volátiles, demanda bioquímica de oxígeno (DBO5) y demanda química de oxígeno (DQO). El análisis estadístico se realizó con StatsDirect, aplicando ANOVA de un factor (significancia del 5%) y la prueba de Pearson

Durante el periodo de investigación de 5 meses, se evidencio la variabilidad de las características fisicoquímicas en los lixiviados, desde la fase acidogénesis hasta la metanogénesis, lo que permitió evaluar el ciclo de vida de los rellenos sanitarios. Los resultados promedio de los 3 lixiviados de los biorreactores presentaron pH entre 6,41 y 9,45, conductividad eléctrica de 4867 a 86027 uS/cm, DBO5 de 77,4 a 635,3 mg/L y DQO de 3590 a 23334 mg/L. Cabe precisar que no se encontraron diferencias significativas en pH, conductividad eléctrica, sólidos totales, sólidos volátiles, DBO5 y DQO entre los lixiviados con distintos porcentajes de segregación, lo que sugiere la influencia de residuos inorgánicos altamente estables que dificultan la biodegradación natural. Sin embargo, el lixiviado con menor segregación presentó las concentraciones más elevadas de materia orgánica en términos de DBO5 y DQO. Este estudio piloto con biorreactores semiaerobios permitió comprender el comportamiento de los subproductos generados.

Palabras clave: residuos sólidos municipales, biorreactores semiaerobios, lixiviados

RECICLAJE Y MINIMIZACIÓN DE RESIDUOS

96. Marco Global Sistemas Digitales de Producto – Pasaporte digital de producto.

Capra, Alberto
Devia, Leila

El desarrollo del Marco Global de Sistemas Digitales de Producto (DPIS), liderado por el PNUMA a través de la One Planet Network, representa un paso decisivo hacia la construcción de economías más circulares, transparentes y sostenibles. Estos sistemas integran información verificable sobre el ciclo de vida de los bienes —desde la producción hasta su disposición final— y la ponen a disposición de consumidores, empresas y autoridades a través de tecnologías digitales accesibles. Entre sus aplicaciones más relevantes se encuentra el Pasaporte Digital de Producto (DPP), que facilita la trazabilidad de materiales, garantiza el cumplimiento normativo y promueve decisiones de compra más responsables.

La experiencia europea anticipa la obligatoriedad del DPP en 2027, comenzando por sectores como baterías, plásticos, textiles, calzado y envases. Paralelamente, en América del Sur se desarrollan pilotos que exploran su aplicabilidad: en Argentina se avanza en textiles y en Uruguay en la gestión de baterías ácido-plomo usadas, constituyendo ejemplos que pueden ser replicados regionalmente. Estos ensayos muestran tanto el potencial de los DPP para aumentar la transparencia y reducir residuos, como los retos de infraestructura digital, armonización normativa y estandarización de datos que enfrenta la región.

El Marco Global DPIS busca justamente responder a estos desafíos mediante principios comunes de accesibilidad, interoperabilidad, trazabilidad y uso de tecnologías abiertas. A través de consultas internacionales y pilotos sectoriales, se construye una base para la implementación inclusiva, con especial atención a las necesidades del Sur Global y de las pequeñas y medianas empresas. Para América Latina y el Caribe, la alineación temprana con este marco ofrece oportunidades de acceso a nuevos mercados, fortalecimiento de la competitividad y consolidación de la economía circular en sectores estratégicos. El Pasaporte Digital de Producto se perfila así no solo como una herramienta tecnológica, sino como un eje transformador para la gestión ambientalmente adecuada de los productos y residuos en un contexto global en transición.

97. ¿Qué harán los parques eólicos, con las palas, cuando cumplan con su vida útil?.

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Como expertos en recuperación de residuos no convencionales, consideramos que los futuros residuos de palas de aerogeneradores, generaran un gran problema, tanto al parque eólico, como a la zona donde se encuentra el mismo. Debido a su tamaño y su composición, no es viable destinarlo en rellenos sanitarios. Al observar el crecimiento de la energía eólica hemos identificado una oportunidad para ofrecer una solución sostenible que transforme estos residuos en algo útil y valioso para la comunidad, transformándolos en mobiliario urbano (por ejemplo, garitas para bicicletas o colectivos, entre otras tantas alternativas), fomentando la economía circular, de un residuo complejo.

Nuestra propuesta consiste en brindar una alternativa innovadora para dar un nuevo propósito a las palas de los aerogeneradores una vez que ya no puedan ser utilizadas para generar energía. A través de un proceso que optimiza la reutilización de estos materiales, podemos asegurar que estos residuos pueden ser aprovechados dentro de un ciclo productivo que contribuye a la economía circular y reduce el impacto ambiental de la actividad.

Beneficios para los operadores de parques eólicos:

Sostenibilidad y reducción de residuos: implementar nuestra propuesta contribuirá a la gestión responsable de los residuos generados por los aerogeneradores, evitando la acumulación de materiales difíciles de procesar.

Posicionamiento como lideres verdes: Al adoptar esta solución innovadora, los operadores no solo fortalecerán su reputación como empresas comprometidas con la energía limpia, sino que también serán pioneras en la gestión ecológica de los residuos generados por su propia actividad.

Cumplimiento con normativas ambientales: Con el tratamiento y reciclaje de las palas al final de su vida útil, estarán alineados con las regulaciones más exigentes sobre gestión de residuos y sostenibilidad.

Aprovechamiento de materiales reciclados: Las palas de los aerogeneradores, pueden ser transformadas en nuevos productos de valor, minimizando el impacto ambiental y generando beneficios económicos adicionales.

Conclusión:

Consideramos una oportunidad para resolver un problema de un residuo no convencional, para transformarlo en la solución de problemas urbanos y arquitectónicos, generando mobiliario urbano a través de la responsabilidad social empresarial a las comunidades, fomentando la economía circular.

Palabras clave: reciclaje, aerogeneradores, turbinas

GESTIÓN DE RESIDUOS TEXTILES

98. Fortalecimiento de cadenas productivas para la gestión de residuos textiles en Bogotá - región.

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El fortalecimiento de cadenas productivas para la gestión de residuos textiles en Bogotá-Región ha sido clave para consolidar soluciones innovadoras y sostenibles en el sector. A partir del trabajo articulado con actores clave, se ha impulsado la transformación de desechos textiles en nuevos productos con alto valor agregado, fomentando el encadenamiento productivo como estrategia para la circularidad.

El proyecto ha permitido el desarrollo de iniciativas en múltiples frentes: confección de prendas con alto contenido creativo, producción de accesorios de moda, fabricación de materiales para aislamiento térmico y acústico, creación de baldosas y aglomerados, así como la valorización de residuos textiles para la generación de combustibles alternativos. A través de un enfoque integral, se han identificado y fortalecido sinergias entre diseñadores, recicladores, empresarios y organizaciones, promoviendo modelos de negocio sostenibles y escalables, de cara a la consolidación de productos como nuevas prendas de vestir con alto contenido creativo, accesorios de moda, productos para aislamiento térmico o acústico a partir de desechos textiles, baldosas y aglomerados, o para la generación de combustible derivado de residuos textiles; además, se está reduciendo la cantidad de residuos textiles dispuestos en el relleno sanitario regional de Doña Juana (que recibe más de 7000 ton/día de residuos sólidos urbanos) o en el relleno regional de nuevo mondoñedo (más de 2000 ton/día de residuos sólidos urbanos)

Los resultados reflejan un impacto positivo tanto ambiental como económico. Se ha reducido la cantidad de residuos textiles enviados a disposición final, disminuyendo la presión sobre los rellenos sanitarios y reduciendo la huella de carbono del sector. Al mismo tiempo, se ha potenciado la generación de empleo verde y el fortalecimiento de capacidades en comunidades vulnerables, evidenciando que la economía circular aplicada a la industria textil puede convertirse en un motor de desarrollo inclusivo y resiliente.

Esta experiencia demuestra la viabilidad de transformar residuos en recursos de alto valor mediante la articulación de actores y la innovación. La consolidación de encadenamientos productivos es fundamental para la transición hacia una industria textil más sostenible y regenerativa, alineada con los principios de la economía circular y la acción climática

Palabras clave: Economía Circular, textiles, cadena productiva, aperovechamiento

RECUPERACIÓN DE ENERGÍA

99. Uso innovador de los gases de escape de motores para tratar el concentrado de ósmosis inversa.

Panelo, Martin
SWANA, Usa

La misión de la Autoridad de Mejoras del Condado de Cumberland ("La Autoridad") es desarrollar proyectos integrales para la sostenibilidad económica y ambiental del Condado de Cumberland. Para promover este objetivo, en 2018, Energy Power Partners (EPP) identificó la oportunidad de aprovechar el calor residual de su planta de biogás para evaporar el concentrado de lixiviados de un sistema de ósmosis inversa ("OI") existente, utilizando el concentrador LM-HT® de Heartland Water Technology.

Antes del proyecto, el complejo de residuos sólidos transportaba 25 camiones semanales de líquido altamente concentrado a una planta de tratamiento de aguas residuales. Al evaporar el concentrado de OI in situ, EPP mejoró significativamente la eficiencia de sus motores eléctricos Caterpillar 3520, a la vez que redujo los costos operativos del complejo y ofreció una solución más sostenible desde el punto de vista ambiental. En la presentación, los miembros del equipo del proyecto analizarán las mejoras demostradas en la eficiencia del motor, la reducción del volumen de lixiviados que se puede lograr mediante la evaporación del concentrado de ósmosis inversa y los beneficios económicos y ambientales que ofrece el tratamiento in situ del concentrado de ósmosis inversa.

Palabras clave: lixiviado, concentrado, osmosis inversa, generacion de energia, evaporacion, efluentes, relleno sanitario, co-generacion, CHP, eficiencia, biogas, calor de escape

100. La oportunidad de generar energía renovable a partir de aceite lubricante usado. Sassone, Facundo

Belardinelli, Osvaldo

Grupo Quimiguay

REVERT/NOVERGY

Queremos hablar de la gestión responsable del aceite lubricante usado (ALU), enfocados en la recolección y revalorización, bajo el paraguas del concepto de Economía Circular.

En un mundo donde la sostenibilidad se ha vuelto una prioridad, la revalorización de aceites usados aporta beneficios tanto económicos como ambientales. Hoy sabemos mucho de la revalorización de aceite vegetal usado (AVU), pero muy poco de lo que pasa con el aceite de los motores que mueven el mundo.

Utilizando tecnología de vanguardia, la revalorización de ALU permite minimizar el impacto ambiental en cada etapa del proceso. Por ejemplo, al recolectar y reutilizar el aceite, se logra un 100% de recuperación y se evita que este residuo peligroso termine en lugares no deseados como basurales a cielo abierto, cursos de agua o quemado en forma directa en calderas industriales.

Los resultados son impactantes: se logra reducir las emisiones de partículas finas en un 90% y las emisiones de CO_2 en un 80%. Además, el impacto ambiental se reduce hasta en un 87% en comparación con la producción de aceites base vírgenes. Esto no solo representa un ahorro significativo en divisas para el país, al sustituir importaciones, sino que también ayuda a preservar nuestros recursos naturales al evitar el uso de petróleo crudo. Además, los aceites pueden ser revalorizados indefinidamente sin perder calidad, lo que garantiza una sostenibilidad a largo plazo.

Las bases y combustibles revalorizados ofrecen características y ventajas notables; por ejemplo, superan en calidad a las vírgenes en aspectos como viscosidad, resistencia térmica y estabilidad a la oxidación, lo que se traduce en una mayor vida útil.

Sin embargo, aún queda un camino por recorrer. Es fundamental el compromiso de los distintos actores (productores, recolectores informales, talleres y concesionarias, lubricentros, industria, etc.) y de los organismos gubernamentales a través de normativas y controles. Es esencial incentivar a los recolectores informales a integrarse en redes formales, con buenas prácticas, mejorando sus condiciones laborales y su inclusión en la cadena de valor.

En este contexto, conformamos REVERT como un sello de calidad de las empresas recolectoras del sector garantizando trazabilidad y NOVERGY, una empresa abocada a la revalorización de ALU a partir de la utilización de nuevas tecnologías y logrando productos de altísima calidad.

En conclusión, creemos firmemente que abordar estos desafíos contribuye a un futuro más sostenible. Hay muchas oportunidades para seguir impulsando cambios y así construir un mundo mejor.

Palabras clave: Economía Circular, Energía, Revalorización

TECNOLOGÍA DE RECOLECCIÓN Y TRANSPORTE

101. Implementación de Sistema Integral de Trazabilidad en la Gestión de Residuos Sólidos Urbanos: Optimización Operativa y Contribución a la Economía Circular.

Diaz, Emiliano
AESA Buenos Aires, Grupo Veolia

Este sistema se implementa en la Zona 1 de la Ciudad Autónoma de Buenos Aires, cubriendo a 223.282 residentes más un millón de personas en tránsito diario, bajo un contrato vigente hasta 2028.

Los servicios incluyen recolección 100% contenerizada, barrido manual, mecánico, servicios de lavado, servicios en zonas vulnerables y otros servicios complementarios, con una flota de 221 unidades y gestión de 10.500 toneladas promedio por mes.

La operación se planifica mediante la confección de 1.000 rutas mensuales, mas de 135.000 km de recolección, 45.000km de limpieza mecanizada y 30.000km de barrido manual.

Se monitorean de forma diaria 180 rutas, mediante el uso de sensores obtenemos más de 8.000 alertas, que nos envían los equipos, para poder asegurar la calidad del servicio desde las herramientas tecnológicas.

Implementamos tres metodologías de control principales: la primera, mediante la asignación de vehículos, se centra en el monitoreo de los tiempos en ruta. La segunda, a través del trazado, verifica el cumplimiento de los recorridos establecidos. Finalmente, en los servicios de recolección, utilizamos sensores RFID para validar diariamente 3.100 operaciones de vaciado de contenedores.

Además, el sistema atiende 1.800 solicitudes diarias de usuarios. Estos datos nos permiten realizar análisis a mediano plazo mediante uso de Mapas de Calor de nuestras zonas por tipo de servicio.

A futuro, la innovación se centra en el uso de Inteligencia Artificial, con 160 cámaras en 80 equipos para entrenar la IA en la detección de diseminados y mejorar la eficiencia en el diseño de recorridos.

Palabras clave: trazabilidad, residuos sólidos urbanos, economía circular, huella de carbono, Veolia, monitoreo, control, recolección, GPS, algoritmos, optimización, logística, emisiones CO2, planificación de rutas, control de calidad, georreferenciación, sostenibilidad,

COMUNICACIÓN Y ASPECTOS SOCIALES

102. Usa la basura: Un programa de Educación Ambiental y Gestión Integral de los Residuos Sólidos Urbanos implementado desde el 2009 en colegios públicos y privados de Argentina.

Boehme, Verena
Lillo, Agostina Laura

Fundación Manos Verdes, Buenos Aires, Argentina

Usa la Basura es un programa de Educación ambiental y gestión integral de Residuos, impulsado por la Fundación Manos Verdes a través de un proyecto de cooperación argentino-alemán en 2009. El programa nació de la convicción de que todas las personas pueden ser agentes de cambio positivo en la sociedad. A través de la difusión de buenas prácticas ambientales en las escuelas, se busca generar un cambio en los hábitos cotidianos, mejorar la calidad de vida de toda la comunidad educativa y recuperar los residuos como recursos valiosos. El programa tiene como objetivo concientizar a todos los actores escolares (directivos, equipo docentes y no docentes, estudiantes y familias) para reducir progresivamente la generación de basura, aumentar la reutilización de los residuos y generar las condiciones necesarias para la separación, recolección y el reciclaje en la industria.

El programa se articula en cinco ejes temáticos: Educación, Gestión, Comunicación, Monitoreo y Certificación. A su vez, se implementa en cuatro etapas interrelacionadas.

Su funcionamiento es conectado y transversal, abarcando a todos los actores y niveles educativos de la escuela, involucrando así a toda la comunidad escolar.

La primera etapa de implementación es, la "Concientización y diagnóstico de la situación inicial" permitiendo analizar la gestión de residuos en la escuela. Este diagnóstico inicial proporciona una base para la planificación. Luego, se procede al "Desarrollo de ideas y planificación del proyecto" donde se elabora un plan de acción con metas claras, actores responsables y criterios de evaluación basado en contenidos curriculares. En tercer lugar, se implementa la "Puesta en marcha" que implica la ejecución del plan de acción, promoviendo la separación de residuos en origen y su reciclaje o reutilización. Además se generan alianzas con otras entidades clave. Finalmente, se procede a la "Evaluación y monitoreo" que permite analizar los resultados del proyecto mediante herramientas e indicadores predefinidos así como planificar futuras mejoras.

Hasta el año 2024 se capacitaron a más de 3.000 docentes y participaron más de 20.000 estudiantes de la Ciudad de Buenos Aires, el Conurbano Bonaerense, de la provincia de Córdoba y de Corrientes. Usa la Basura se ha consolidado como una herramienta de consenso en la comunidad escolar sobre los desafíos de la gestión de residuos. El éxito del programa se encuentra ligado tanto al compromiso de los responsables y representantes de la institución educativa como la relación y conexión con los sectores responsables de la gestión pública. Usa la Basura ofrece una visión compartida para movilizar la acción colectiva para hacer frente a la problemática del consumo y la generación de residuos. Durante más de 10 años el programa puso a prueba la creatividad y el grado de involucramiento de los alumnos y todos los participantes logrando la continuidad de la ejecución y el seguimiento del mismo a mediano y largo plazo.

Palabras clave: educacion, residuos, ambiente, separacion, conciencia

SECTION II – ABSTRACTS SELECTED FOR POSTER PRESENTATIONS

II. PART 1 - POSTERS IN ENGLISH

BIOLOGICAL TEATMENT OF WASTE

103. Preliminary assessment of sludge management strategies in an industrial wastewater treatment facility.
Andrés, A

Galán, B (1), Cifrián, E (1), Viguri, JR (1), Andrés, A

(1) Department of Chemistry and Process & Resources Engineering – ETSIIT, University of Cantabria, Santander, Spain

Industrial sludge and leachate treatment plants generate a significant amount of sludge as a final waste of their processes. The most commonly employed operations in these facilities include pretreatment, physicochemical treatment, settling and thickening, as well as filtration and pressing. These stages result in a solid waste, identified as sludge from the treatment of industrial wastewater, and a liquid stream which, after undergoing biological treatment, in turn produces a treated effluent and a new solid residue, referred to as sludge derived from the biological treatment of industrial wastewater. Both solid residues, classified separately in the European List of Waste, require environmentally sound and technically feasible management.

The aim of this study is to carry out a synthesis, analysis, and preliminary evaluation of management alternatives for the sludge generated in an industrial wastewater treatment plant. Among the options considered are the application of sludge to soils through composting processes, energy recovery from waste (Waste-to-Energy, WtE) through various processes that allow for the generation of energy and by-products, stabilization through lime addition, landfilling, as well as other innovative alternatives.

Given that both types of sludge analyzed are classified as non-hazardous waste, particular attention is paid to management alternatives that facilitate their reintegration into production processes, in line with the principles of the circular economy, with the aim of minimizing their final disposal in landfills. Additionally, a conceptual approach is proposed in which the industrial sludge and leachate treatment plant is envisioned as a resource biorefinery, aimed at the integral recovery and valorization of the waste generated.

Keywords: Industrial sludge, valorization, circular economy

104. OPTIMISATION OF THE CONDITIONS FOR DIGESTATE STABILISATION BY COMPOSTING IN AN INDUSTRIAL PLANT.

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Luengos Coello, A. (1)

(1) IDOM Consulting and Engineering, SPAIN.

Given the energy needs of the world nowadays and the existing boom in green energy, there is a recent trend towards the management of organic waste through anaerobic digestion. Anaerobic digestion (AD) is a biological process that is widely used as a technology dedicated to convert various organic wastes into bioenergy. In addition to bioenergy production, AD produces large quantities of a solid known as digestate (DG) as a by-product of the process.

Traditionally this DG has been used directly in agricultural applications without any treatment, posing potential health and environmental risks. Despite its good fertilising properties, the direct application of this by-product can have some drawbacks. These drawbacks make post-treatment recommended before land application. Composting is considered a good option for post-treatment of DG as it offers a sustainable option to produce nutrient-rich and pathogen-free organic fertilisers while also reducing the storage volumes and completing the cycle of nutrients and organic matter.

The present study identifies, through in-plant trials, the optimal mixtures, handling, fermentation and maturation times for the aerobic stabilisation process to produce a hygienic compost of the highest quality, marketable as fertiliser according to European Standards (RD 506/2013).

As a conclusion of the present study, a 3:1 mixture is recommended, the choice of a good bulking agent and a good mixing process are of crucial importance, as they determine the final product. Therefore, this end product of high-quality compost would be suitable for marketing in Europe.

Keywords: Anaerobic digestion, digestate, biowaste, composting

105. Sustainable Organic Waste Management through Community Biodigesters in the Agro-Livestock Community of Mamiña Chile.

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The increasing growth of the world's population has generated various negative effects on society and the environment. The increase in the generation of organic waste, at the domestic, commercial, and industrial levels, represents a major environmental challenge. Specifically, in 2017 in Chile, 7.9 million tons of municipal solid waste was generated, of which 58% corresponded to organic waste; however, only 1% of this waste was recovered. Poor final disposal of this waste contributes to the emission of greenhouse gases such as methane and the generation of leachates and odors.

A sustainable long-term solution to this problem is the use of biodigesters, which enable the anaerobic degradation of organic waste to produce biogas, which can be used for energy generation, and digestate, a biodegradable material that can be used as fertilizer because of its nitrogen (N), phosphorus (P), and potassium (K) contents, improving soil quality.

The production of fertilizers from the digestate generated in biodigesters presents an alternative to the instability in the global market for agricultural supplies. In 2021 and 2022, fertilizer prices increased by 30% and 80%, respectively. This increase was driven by a rise in the prices of natural gas, coal, ammonia, and sulfur, which was influenced by political factors. The price of essential products, such as urea and DAP, exceeded USD 1 000/tonne, more than three times higher than their historical 10-year averages.

The present study addresses waste management in the indigenous agro-livestock community of Mamiña, where it was identified that most waste originated from agricultural and livestock activities, as well as from the HoReCa sector (hotels, restaurants, and catering services), with the majority being organic in nature. The proposed solution was a communitary biodigester for the treatment of agro-livestock residues.

The Mamiña community actively participated in the installation of the biodigester, and a governance plan was established in which each participant was trained and assigned a role. This served as a guarantee that the community biodigester would remain functional for years.

The fertilizer exhibited an electrical conductivity (EC) of 4500 µS/cm, allowing for up to a 10-fold dilution for fertigation. Meanwhile, microbiological analysis revealed a 92% reduction in total coliforms, fecal coliforms, and E. coli after 50 days of treatment at 15–25°C, with the expectation of achieving 100% removal at temperatures of 25–35°C. The fertilizer demonstrated adequate concentrations (ppm) of calcium (34), potassium (37.2), and phosphorus (23.3), although supplementation with nitrogen is recommended to optimize its nutritional balance. Additionally, a decrease in the sulfur concentration was observed, making it suitable for crops. The levels of heavy metals, such as zinc and nickel, were within regulatory standards, ensuring their safety for agricultural use.

Keywords: Anaerobic digestion, rural waste management, Organic waste, Digestate fertilizer, Agro-livestock residues

106. Leachate Generated at Urban Solid Waste Transfer Stations: Impact Assessment.

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The sustainable management of urban solid waste (USW) is an increasing challenge due to population growth and the expansion of human activities. Improper waste management leads to soil, water, and air contamination, as well as greenhouse gas emissions. To optimize transportation logistics and final disposal, many cities implement waste transfer stations (WTS). However, a commonly overlooked issue in these facilities is the management of the leachate generated, which can pose a significant environmental threat if not properly treated.

This study investigates pollution indicators in fresh leachate from compacting trucks used for USW and evaluates the effectiveness of coagulation/flocculation as a pre-treatment method. The research was conducted at the Jacarepaguá Waste Transfer Station, located within the Jacarepaguá Recycling and Composting Plant in Rio de Janeiro, Brazil. The facility handles waste from approximately 900,000 residents, making it a strategic location to assess the composition and environmental impacts of the generated leachate.

Samples were analyzed at the COMLURB and UFRJ laboratories, following the standards set by the Standard Methods for the Examination of Water & Wastewater (2012) and the Brazilian Association of Technical Standards (ABNT). The results indicated a high pollution load in the leachate, with an average pH of 4.79, an average ammoniacal nitrogen concentration of 375.09 mg/L, and an average turbidity of 6,500 NTU. The chemical oxygen demand (COD) averaged 43,458 mg/L, and the total organic carbon was also 43,458 mg/L, indicating a high contamination potential.

Microbiological analysis revealed significant densities of total coliforms (8.4×10^9 CFU/100mL) and E. coli (5.4×10^9 CFU/100mL), as well as the presence of sanitary-relevant bacteria such as Escherichia coli, Proteus mirabilis, and Klebsiella pneumoniae, confirming fecal contamination.

The findings highlight the high pollution potential of fresh leachate generated at transfer stations and emphasize the need for effective leachate treatment strategies to mitigate environmental impacts and public health risks. The coagulation/flocculation pre-treatment demonstrated potential in reducing pollutant loads, offering a viable approach to improve effluent quality before further treatment at WTS. The implementation of appropriate treatment technologies at transfer stations is essential to ensuring the sustainability of urban waste management systems.

Keywords: Urban solid waste, leachate, transfer stations, coagulation/flocculation, environmental impact

107. Assessment of Reduction of E. coli in Livestock Waste using Advanced Ozone Wastewater Treatment Method and Anaerobic Digester.

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Recently substantial emphasis has been given to identify and discover novel waste treatment methods capable of reducing greenhouse gas (GHG) emissions from livestock waste because previous studies including IPCC estimates showed that livestock waste is a significant sources of GHG emission (livestock accounted >14% of global GHG emissions), and controlling it requires identifying the cost-effective, and simple strategies which are adaptable in on-farm environment. While anaerobic digestion is a well-studied treatment method for trapping GHG emissions from livestock waste, the reduction of pathogenic organisms in anaerobic digestion process is often uncertain. One of the major issues related with livestock waste is pathogens, which poses risks to food security and human health. In this research, we evaluated pathogen indicator such as E. coli reduction in anaerobic reactors, which were used for GHG capture from animal waste. In addition, we developed a novel waste treatment system using ozone, which was also tested for E. coli reduction in livestock waste. Further, we performed a comparative analysis to understand the impacts and feasibility of ozone system in tandem with anaerobic digestion for reducing the risk of pathogens in livestock.

Keywords: Livestock waste, anaerobic digestion, ozone treatment, human pathogen, public health

108. Circular Economy from waste of Theobroma cacao L. for the Gold Beneficiation as a Sustainable Alternative to Mercury.

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The widespread use of mercury in artisanal and small-scale gold mining (ASGM) in Colombia has led to severe environmental and health hazards, including contamination of water bodies, soil, and air, as well as bioaccumulation in food chains. As part of the transition to sustainable and mercury-free gold extraction, this study investigates the potential of mucilage derived from waste of Theobroma cacao L. as an alternative coagulant agent. The research highlights a novel approach within the framework of a circular economy by repurposing agricultural waste for mineral beneficiation. The mucilage, obtained through simple extraction and thermal treatment processes, acts as a highly effective natural coagulant, enabling the separation of gold from mining sediments with a recovery efficiency of 95%. This method surpasses conventional techniques such as cyanide leaching, borax, and gravity separation, offering a scalable and environmentally responsible alternative for ASGM communities. By integrating agricultural waste into mining processes, this approach embodies circular economy principles, reducing waste accumulation, enhancing resource efficiency, and creating added value from discarded biomass. Also, the reuse of cocoa waste, a byproduct of chocolate production, contributes to sustainable waste management while providing a cost-effective, non-toxic solution for gold beneficiation. Unlike mercury-based methods, which pose long-term ecological and health risks, this bio-coagulant enables cleaner mining practices, fostering economic resilience in mining-dependent communities. The study underscores the potential of bio-coagulants in promoting environmentally friendly mining, reducing dependency on hazardous substances, and advancing policies aligned with global mercury reduction initiatives such as the Minamata Convention. This innovation represents a significant step toward integrating sustainable mining practices with agro-industrial waste valorization, demonstrating how circular economy strategies can be effectively applied in the extractive industries. By shifting toward greener, resource-efficient methodologies, this study provides a model for sustainable development in the mining sector in Colombia, ensuring both environmental protection and economic benefits for local communities.

Keywords: Circular economy, agricultal waste. cocoa, gold beneficiation.

109. Stabilization of organic amendments and remediation of pesticide-contaminated soils through microbial inoculation and complementary techniques.

Moreno, V.R

Miño, D., Ochoa, A., Byun, A., Rangel, L., Suquilanda, J

Universidad de Las Américas

Soil contamination by pesticides is a growing environmental concern due to its adverse effects on ecosystems and human health. This study seeks to address the remediation of pesticide-contaminated soil by stabilizing organic amendments and applying microbial inoculation. The experiment was conducted in four phases: (1) stabilization and conditioning of the organic amendment, (2) analysis of the eroded soil, (3) contamination of the eroded soil with pesticides, and (4) remediation of the contaminated soil using microbial inoculant and complementary techniques such as palm biochar, zeolite, and clay soil. The results indicate that the application of organic amendments and microbial inoculants significantly improved soil parameters including organic matter content, carbon and nitrogen levels, and porosity. The remediation process also demonstrated a reduction in pesticide concentration and an increase in soil fertility. This study highlights the effectiveness of organic amendments in remediation processes and microbial inoculation as sustainable techniques for soil remediation, offering a viable solution for the recovery of pesticide-contaminated soils.

Keywords: soil remediation, pesticides, organic amendments, microbial inoculation, soil fertility.

110. THE IMPACT OF AMENDMENT ON THE REMEDIATION OF HYDROCARBON CONTAMINATED SOILS: AN EXPERIMENTAL APPROACH.

Ochoa, S.A.

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This study investigates the effectiveness of organic amendments and microbial inoculants in the remediation of hydrocarbon-contaminated soils. Hydrocarbon pollution, resulting from industrial spills and improper waste management, poses significant risks to soil ecosystems, human health, and water quality. The research focuses on the application of organic materials such as compost, stabilized sludge, zeolite, and clay, which enhance microbial activity and improve soil structure. These amendments, combined with specific bacterial and fungal species capable of metabolizing hydrocarbons, accelerate the degradation process. The study evaluates key physical and chemical properties, including moisture content, organic matter, pH, and porosity, under controlled experimental conditions. The findings demonstrate that the synergistic effects of organic amendments and microbial inoculants offer a cost-effective and sustainable method for rehabilitating hydrocarbon-contaminated soils, contributing to the development of eco-friendly remediation strategies.

Keywords: Hydrocarbon contamination, soil remediation, organic amendments, microbial inoculants, zeolite, clay.

111. Food Waste Valorization and Emissions Reduction: LIPOR's Local Anaerobic Digestion Experience.

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The separate collection and treatment of biowaste is a key pillar of sustainable waste management and a requirement under EU legislation, notably the Waste Framework Directive (Directive 2008/98/EC) and the EU Circular Economy Action Plan (EC, 2020). Anaerobic digestion (AD) has been recognized as an effective technology for food waste treatment, enabling both energy recovery and the production of biofertilizers (Zhang et al., 2014). However, most AD infrastructures are large-scale and centralized, which can limit accessibility and increase environmental burdens related to transport. In this context, small-scale, decentralized AD offers promising opportunities for local food waste valorization, emissions reduction, and community engagement.

LIPOR – Municipalities Association for Sustainable Waste Management of Greater Porto – implemented a small-scale AD plant, co-financed by the POSEUR Programme (Operational Programme for Sustainability and Efficient Use of Resources), as a demonstration project. With a nominal capacity of 900 tonnes/year, the plant treats source-separated food waste from households in the municipality of Póvoa de Varzim. It can produce up to 30 kWh of electricity, contributing directly to renewable energy generation onsite.

Although AD is well-established, it still faces technical and economic challenges, such as foaming, acidification, and ammonia nitrogen (NH4+-N) inhibition, which can result in low biogas yield. A better understanding of these barriers can enhance energy recovery and promote more stable operations. One of the project's main goal was to gain hands-on experience with AD, as LIPOR's previous biowaste strategy relied solely on composting. The plant is modular and adaptable, functioning both as a treatment unit and a learning tool to guide future decisions on biowaste valorization.

A key advantage of the project lies in its decentralized model, which significantly reduces the environmental impact associated with waste transport. While LIPOR's main composting facility typically requires round trips of over 100 km, the AD plant's location, in Póvoa de Varzim, cuts this distance to about 50 km per round. This halving of travel reduces fuel use and associated greenhouse gas emissions, supporting climate action goals.

The digestate produced is undergoing laboratory analysis to assess its agronomic value and potential for safe agricultural use, in line with circular economy principles.

In conclusion, a small-scale, decentralized AD system can complement traditional composting, particularly in urban and peri-urban areas seeking sustainable biowaste management. It also serves as a valuable platform for gaining technical knowledge in anaerobic digestion and advancing the development of new biobased products.

Keywords: Anaerobic digestion; Food waste valorization; Decentralized systems; Circular economy; Emissions reduction

112. IMPLEMENTATION OF HOME COMPOSTING IN 1.000 FAMILIES FROM THE CITY OF PAPUDO, USING A DIGITAL PLATFORM.

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Papudo is a city on the central coast of Chile, located in the province of Petorca, Valparaíso Region. Its main town is the tourist beach of the same name. It has 6,331 inhabitants and 6,817 houses, many of them summer homes. In 2022, the municipality declared 4,898 tons of household solid waste, which were disposed of in the Lomas de los Colorados landfill located 78 km away.

In 2023, a pilot program for home composting of organic waste was implemented in 1,000 homes in the city, considering training, delivery of equipment for home composting, monitoring visits and evaluation of the process. As a result, it was expected to considerably reduce the amount of waste sent to landfill.

As a first activity, a characterization of the waste of 44 homes was carried out, collecting 120 samples during a week, to determine its composition. According to the study, organic waste represents 51% of total waste, with 7.6% of this organic waste coming from animal origin or cooked food. Although these last types of waste could be recycled in industrial composting plants, it is not compostable at home, which is why the target value is to reduce household solid waste by 47%.

A wide call was made within the different sectors of the city, to call for voluntary registration in the project. The composting set was delivered in a personalized way to each home of the registered beneficiaries. The equipment delivered consists of a 310 liters compost bin with a municipal logo printed on the lid, an aerator stick, a 7-liter container and a user manual.

To ensure the success of a waste minimization program through home composting, is essential to support beneficiaries during the process. For this, 4 follow-up visits were made door to door to the beneficiaries. The objective of the visits was to maintain adequate control of the process, providing advice and answering doubts that the beneficiaries may have during the use of the equipment, giving information about what can be recicle in the compost bin, how hold the process of composting and how use the compost.

A specialized software was used for the systematization of information and georeferencing of beneficiaries, which provides information and results of the process in real time.

Finally, a new characterization of waste was developed, in the same sectors in which it was previously carried out, with which a decrease in the fraction of organic waste of 84,6% was verified. This result indicates the impact of the program, which could also be verified with a decrease in the tons disposed of in landfills after the project was implemented.

The project allowed 1,000 families to reduce their total waste by 43%, demonstrating the effectiveness of home composting, but also made it possible to verify that the use of a digital platform for project management brings important benefits, allowing information to be managed more efficiently and transparently, facilitating control, measurement of results and communication with users

Keywords: home-composting, organic waste, composting, recycling,

113. ***HOME COMPOSTING PROGRAM USING A DIGITAL PLATFORM.***

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Cochamó is a city in southern Chile, in the Llanquihue Province, Los Lagos Region. Its name comes from the Mapudungun "Kocha-mo," which means "where the waters meet," referring to the meeting point between the Reloncaví estuary and the sea.

Classified as an extreme zone, the city has a population of 3,976 and 2,240 homes. In 2022, Cochamó generated 1,157 tons of household solid waste, which was transported and disposed of at the La Laja landfill in Puerto Varas, located 101.7 km away, a journey that takes approximately two hours, just one way.

Between November 2023 and January 2025, an organic waste recycling program was carried out in 400 households in the town. Of these, 200 implemented composting and the other 200 used vermicomposting. The program included training, equipment distribution, and follow-up visits. Its main objective was to reduce the amount of waste sent to landfills.

As a first step, a week-long study of characterization of the waste was made in 30 homes to determine its composition. It was found that organic waste accounted for 58.45% of the total.

To encourage community participation, various communicational strategies were implemented, including radio announcements, door-to-door visits, social media posts, poster installation in key locations, and meetings in various sectors.

Beneficiaries received the organic recycling kits at their homes. The composting kit included a 310 L compost bin, a 10 L kitchen waste container, an aerator stick, and a user manual. The vermicomposting kit included a vermicompost bin with five trays (four 33 L trays each for organic vegetable waste and one tray for liquid collection), a tap for extracting liquid humus, a pack of live worms, a 10 L kitchen waste container, a coconut fiber block, and a user manual. A digital platform, specially designed to efficiently execute composting programs, was also implemented. This software allowed to systematize beneficiary data, to georeference the equipment, to record the results, generating indicators and enabling real-time monitoring. It also improved the communication between the beneficiaries and the consulting team.

The success of the program depended largely on the support provided to the beneficiaries. For this reason, the team carried out three follow-up visits, during which provided advice and support, answering the questions, and verifying the correct use of the equipment

At the end of the program, a new waste characterization was made in the same areas previously assessed. The results showed a 77% reduction in the total organic waste fraction and a 30% decrease was observed in the total tons sent to the La Laja landfill.

The use of the digital platform allowed for reliable data collection and systematization, becoming a perfect complement to home composting, enabling its use not only as a waste prevention strategy but also as a recycling strategy, even in extreme zones as Cochamó.

Keywords: Home Composting, organics, climate change, recycling

114. Soil Respiration and Estimation of C-CO2 Flux from Household Organic Solid Waste Compost in the City of Rio de Janeiro.

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Composting of household organic waste can be a tool to improve soil properties. This study aimed to estimate soil respiration and C-CO2 flux through the use of compost produced from household organic solid waste composting in the city of Rio de Janeiro, in order to assess its applicability, effect on the soil, and optimal usage methods. The methodology involved the collection of household waste from four representative areas of the city, gravimetric characterization, thermal analyses, and physicochemical analyses. Composting was carried out in static piles with passive aeration. The soil respiration test, using static chambers with hydrated lime, was employed to capture CO2 for estimation and comparison across soil management types, time intervals, and compost samples from triplicates, in different proportions. It was found that household organic waste was predominantly composed of fruits, vegetables, and legumes, representing approximately 58.75% of the total mass. Fine aggregates contributed 22.50%, while masses accounted for 4.78%, among other components. This set of organic waste had an average of 38.67% organic carbon and a C/N ratio of 17.5/1, while the compost produced from these wastes had 29.56% organic carbon and a C/N ratio of 14.7/1. Thermal analyses indicated that the compost reached a maturity index, due to the relationship between the relative amount of the thermally less stable and more stable organic fractions, which reached a value greater than 0.89. Regarding the use of compost, different soil preparation methods impacted microbial activity, resulting in significant differences in the investigated parameters, both in terms of soil preparation type and incubation periods. When the soil was prepared with compost, respiration response and CO2 flux were significantly higher ($p<0.0001$) compared to methods without compost, whether or not the soil was tilled, during the same incubation period. Most differences between the produced composts were not significant, indicating uniformity in these bioinputs. With increased incubation period, there was a significant decrease ($p<0.0001$) in CO2 flux in both the compost-treated soil and the tilled soil (without compost). On the other hand, non-tilled soil showed no significant change in its flux during the same period, which was expected given the lack of intervention. Finally, it was observed that applying compost superficially to the soil, due to the higher organic matter content and increased oxygen contact, resulted in greater biological activity.

Keywords: Organic waste, Food Waste, Composting, Soil respiration

115. Waste Utilization in the Construction Sector: Environmental Assessment in Marine Ecosystems using Aquatic Toxicity Bioassays.

Andrés, A

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The increasing use of construction materials incorporating waste requires a comprehensive understanding of their impacts on marine and terrestrial environments in order to accurately assess their effects on ecosystems. Ecotoxicology, an integrative discipline, is increasing in importance in the environmental assessment of conventional and alternative construction materials throughout their life cycle phases using chemical and biological methods. The majority of internationally harmonised ecotoxicity tests were initially developed to assess the ecotoxic potential of chemicals, wastewater or contaminated soil. These tests have been successfully applied to waste and waste eluates and, recently, with some modifications, they can be used for the ecotoxicological characterisation of construction products and their eluates. These methods are compiled in the CEN/TR 17105 technical report, which forms part of a European standardisation process, giving them a normative status.

The scientific community is addressing the sustainability of cement from various perspectives, but the 'ecotoxicological aspect' is not yet sufficiently integrated into sustainability issues within the cement industry. This study evaluates the ecotoxicity of different cements on marine biological life. Two types of cement are considered: CEM II/B-V with a strength class of 42.5, composed of 70% clinker and 30% fly ash, and an alternative hybrid alkaline cement based on 40% CEM II/B-V and Actiiflash (60%), a blend of fly ash (57%), sodium sulphate (3%) and gypsum (2%). The leaching test UNE-EN 12457-4 was carried out, together with three different toxicity bioassays using living model organisms from different taxonomic groups: the reduction of luminosity with the marine bacterium Vibrio fischeri UNE-EN 11348-3, the mortality of brine shrimp (Artemia salina) larvae and the successful embryonic-larval development of the sea urchin Paracentrotus lividus.

From a leaching perspective, it was found that the mobility of all trace elements complied with inert landfill limits. The responses of the luminescent bacteria and the Artemia salina species did not show significant toxicity within the concentration range indicated by the standard. However, the greater sensitivity of sea urchin larvae compared to the other two organisms was evident during contact with both products. The implementation of this battery of bioassays can lead to the development of statistical tools based on toxicity criteria to determine the degree of toxicity associated with the leaching behaviour of specific construction products, through various end points compared to the control. This approach provides valuable information during the material formulation process. Consequently, the concept of ecotoxicity will allow environmental authorities to better estimate the real impact of construction materials incorporating waste on marine ecosystems.

Keywords: leaching, ecotoxicity, hybrid cement

116. Valorization of olive oil production solid residues. Synthesis and characterization of recycled high-density polyethylene composites with olive stone filler.
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The valorization of solid residues generated from olive oil production is a challenging issue for olive oil-producing countries such as Greece, Italy, Spain, etc. Olive stone waste is a type of lignocellulosic biomass with potential use as a natural additive in polymeric composites. In the present study, recycled high-density polyethylene (rHDPE) composites with olive stone (OS) fillers were prepared, in the presence of two different compatibilizers like polyethylene-g-maleic anhydride (PE-g-MA) and Joncryl. Compatibilizers are connecting different reactive groups like maleic anhydride moieties and epoxide groups, respectively, and can enhance the interactions between polymer matrix and filler. The aim was to valorize olive oil solid waste as a filler in HDPE. rHDPE/olive stone composites have been prepared via melt mixing containing 5, 10 and 20 wt% waste filler. The chemical structure of the composites was examined by infrared spectroscopy, and their thermal properties by differential scanning calorimetry. In addition, the mechanical properties, biodegradability and antioxidant activity of the composites were further studied. Scanning electron microscopy showed good dispersion of the filler for all composites, while in the compatibilized samples a markedly better adhesion was observed. JC was identified as the compatibilizer that resulted in the best adhesion between the OS filler and the polymer matrix. Tensile tests revealed an increase in the elastic modulus for the composite with 10 % wt. olive stone. Furthermore, all materials demonstrated strong antioxidant activity, rendering them interesting for active packaging applications. Overall, the solid residue from olive processing can enhance the properties of rHDPE, paving the way to promote circular economy.

Keywords: Recycling, valorization of organic solid residues, high density polyethylene, olive oil stone residues, composites,

117. Microwave-assisted chemical recycling of PLA-PEAz copolymers as sustainable substrates for Printed Electronics.
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Printed electronics (PE) technologies have undergone substantial growth over the past few decades. By 2020, an estimated 30 billion devices were connected to the Internet, spanning applications from smart cities to wearable technology and ranging from household settings to industrial environments. This expansion has been driven by advancements in electronics, polymer processing, and printing techniques [1]. Currently, PE is transitioning into its commercial phase, prompting academic research teams to tackle newly emerging challenges [2]. Flexible hybrid electronic devices are commonly fabricated on substrates made from thermoplastic polymers such as poly(ethylene terephthalate) (PET), poly(ethylene naphthalate) (PEN), and thermoplastic polyurethane (TPU). These traditional plastics offer advantages like high flexibility and low cost. However, they are derived from finite petroleum-based resources and are often disposed of through incineration or landfill at the end of their lifespan [3]. Adopting more sustainable materials and manufacturing processes aligns with the Eco-design directive regulations and the goals of the European Green Deal. Among bio-based polymers, poly(lactic acid) (PLA) has recently been investigated as a potential material for thin-film printed electronics [4]. However, commercial PLA has limitations, including low heat resistance and inherent brittleness. These drawbacks may be mitigated through copolymerization with biobased aliphatic monomers. One such example is poly(ethylene azelate) (PEAz), synthesized from biobased ethylene glycol and azelaic acid, which offers improved material properties.

In the current work a series of biobased and recyclable PLA-PEAz flexible copolymers were successfully synthesized by a combination of the two-stage melt polycondensation procedure for PEAz synthesis, followed by a ring opening polymerization (ROP) reaction in the presence of lactide. The recyclability of the prepared polymeric substrates was evaluated using a microwave assisted hydrolysis and 1H NMR spectroscopy. Enzymatic hydrolysis and UV degradation were also tested for the evaluation of the polymers degradability in the environment.

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Keywords: PLA, copolymers, chemical recycling, alcoholysis, microwave irradiation, sustainability, printed electronics

118. Thermochemical decomposition of nylon-6 textiles in a microwave reactor, for clothe waste diminution.

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The aim of this work is the degradation of nylon-6 textile wastes in the presence of solvents and phase transfer catalysts through microwaves, with the goal of increasing the reaction rate. Polyamides are produced in large quantities worldwide and the requirements for their "end of life" waste management are correspondingly high. The most abundant source for polyamides in form of fibres is the carpet industry. According to the U.S. Department of Energy, approximately 3.5 billion pounds of carpet waste is disposed of each year in the United States, about 30% of which is made from nylon-6. The purpose of the experiments is to find the optimum conditions to achieve the most efficient thermochemical degradation of nylon-6 by using cheap and more environmentally friendly solvents. The use of microwave radiation results in lower energy consumption and higher degradation efficiency (due to the immediate and fast energy supply). Unlike other ways, thermal degradation requires high amounts of energy and strong solvents. Using microwaves saves time, energy and is a potentially "green" process. The advantage of the polycondensation plastics is that their monomers may be “reproduced” via chemical reactions, that is not the case for the addition polymers. Certainly, whether this is an ease process, or not, depends on the conditions tested and the clarification needed for the products. It was concluded that the neutral or alkali solution do not facilitate the reactions, thus only the acidic environment decomposes the polyamide. The too low or too high acid concentrations do not present the desirable results, while the working temperature should be above 130 oC. The 20-30 %v/v H3PO4 solutions were efficient for the decomposition of PA-6. From the phosphoric and alkyl ammonium salts tested 2-Dimethylaminoethyl(-triphenylphosphonium bromide) was proved to be the most effective as phase transfer catalyst. The aquatic phase of the mix after reaction contains oligomers and monomer ingredients. Thus, it is a depolymerization reaction and monomer may be reused. The precipitate gathered after filtration is ε-caprolactam, truly helpful for further industrial uses.

Keywords: polyamides, microwaves, acidic hydrolysis, waste textiles management, phase transfer catalyst

119. Microplastics in aquatic environments: distribution, characterization, and strategies for plastic waste minimization.

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The increasing presence of microplastics (MPs) in aquatic ecosystems highlights structural failures in plastic waste management systems, with significant environmental repercussions. Defined as polymeric particles smaller than 5 mm, MPs may originate from primary sources or result from the fragmentation of improperly discarded waste. In Brazil, where only 4.5% of plastic packaging is recycled and the country ranks seventh globally in plastic discharge into the oceans via rivers (Meijer et al., 2021; Sodré et al., 2023), understanding the dynamics of these pollutants is urgent. This study assessed the spatial distribution, morphology, and chemical composition of MPs. Sampling was conducted at 10 locations in the Middle Paraíba do Sul River Basin (RJ-Brazil), covering areas with varying levels of urbanization. Samples underwent digestion with H_2O_2 (30%) and were analyzed using optical and fluorescence microscopy (EVOS). Chemical characterization was performed via µFTIR spectroscopy, focusing on particles >25 µm. Among the particles manually extracted for µFTIR analysis, 27.9% (n=22) measured between 25 and 100 µm—a critical range due to their high ingestion potential by aquatic organisms. Most particles (n=35) ranged from 101 to 500 µm, a size that facilitated handling and removal from filtration membranes. Irregular fragments (68.2%) and fibers (20.7%) predominated. Stations 6 and 10, under strong urban influence, exhibited the highest concentrations (230 and 205 particles, respectively). Transparent (67.7%) and black (20.1%) particles were the most frequent. µFTIR analysis confirmed the presence of polymers such as PE, PP, PS, and PET in the most impacted areas, whereas cellulose fibers—likely derived from plant organic matter such as tree or leaf fragments—were predominant in less urbanized regions. The use of Nile Red dye enabled selective visualization of MPs under fluorescence, representing a promising alternative for semi-automated quantitative analysis of these particles. The heterogeneous distribution of MPs reflects the multiplicity of sources, including diffuse urban discharge. The predominance of particles <500 µm, often overlooked, reinforces the methodological challenges in detecting and remediating these contaminants. As mitigation strategies, the development of biodegradable materials, improvements in effluent filtration, and expansion of selective waste collection are recommended. Educational initiatives and public policies focused on circular economy—such as taxation of virgin plastics and incentives for recycling—are also essential. The findings contribute to the advancement of SDGs 6, 12, and 14. Transitioning toward efficient plastic waste management requires integrated approaches that combine science, governance, and community engagement.

Keywords: Microplastics, plastic waste, enviroment monitoring, chemical characterization, µFTIR spectroscopy

120. Chromatic Clues: A Review of Microplastic Contamination in Beach, Estuarine, and Mangrove Sediments in South America.

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Microplastics (MPs) studies usually assess particle characteristics such as size, color, type, and shape to obtain information regarding sources, fate and risk posed by MPs to organisms. This review aims to compile data and findings obtained from the analysis of MP color in articles that analyzed the abundance of MPs on beaches, in mangroves and in estuaries in South America. To this end, a systematic review was conducted on the Scopus platform using the terms “microplastics” and “sediments,” along with the names of each South American country. In March 2025, 102 articles were retrieved, 46 of which focused on sediments from the environments of interest: beaches, estuaries, and mangroves. Among these 46 articles, 25 researched on beaches, 11 on estuaries, and 10 on mangroves. These environments are greatly affected by MPs pollution from different sources that cause direct and indirect pollution, besides the proximity of urban areas and hydrodynamic conditions that can favor the accumulation of MPs in these environments. Focusing on color, 36 (80%) articles analyzed the color of MPs. Most studies categorized them into 5 colors (17%), followed by 7 colors (11%), with classification ranging from 5 to 16 colors. Regarding the countries where the studies were conducted, Brazil was represented in 57% of the articles, followed by Argentina in 22%. The most abundant colors found in sediments were blue (37%) and transparent (21%), followed by white (15%). A few articles used a category referred to as yellowing or yellowish, to classify particles that had undergone weathering processes. White and transparent particles may also have been subjected to weather. In this context, some authors note that if the predominant color is not white or transparent, it suggests that the particles have remained stable or were recently introduced into the area. However, regarding these observations on the duration of the particles' presence in the environment, no time scale is provided for these measurements. The occurrence of blue, which was the most abundant color among the selected articles, may indicate fishing nets. If the particles are fibers, it may also suggest laundry washing. The black color represents a significant percentage of the waste produced in residential areas, with a large portion consisting of single-use plastics. Its presence in the environment is also due to black plastics' low rate of recycling. It was observed as the predominant color in two environments in Brazil. In conclusion, the characterization of color lacks standardized methodology, varying a lot between the number of colors and the criteria used for their categorization. In most cases, color data was mainly utilized to assess potential sources of contamination and the span of time they have been in the environment. Microplastics studies also emphasize the need to reduce and recycle waste to minimize MPs pollution in coastal environments.

Keywords: Microplastics, Sediments, Coastal environments, South America, Pollution sources

121. Use of polymer waste on construction materials: contributions and barriers for enhancing material circularity.

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Global plastics production has doubled between 2000 and 2019, and over 20% of it is directly sent to inadequate sites such as dumps, burned without any control, or leaked to the environment, affecting marine and terrestrial ecosystems. At the same time, Waste Electric and Electronic Equipment (WEEE) generation keeps growing at an approximate rate of 0.5 billion kg per year. It is one of the fastest growing waste streams worldwide, and yet less than 20% of it is formally collected and recycled. Polymers are the second most prevalent element in WEEE; thermoplastics such as acrylonitrile-butadiene-styrene (ABS), a mixture of ABS and polycarbonate (ABS/PC) and high-impact polystyrene (HIPS) are found in equipment such as computer monitors and printers. Among the main strategies aligned to circular economy principles for managing polymer-based WEEE are mechanical recycling and use as recycled aggregates. Indeed, previous research on articles addressing ABS and circular economy resulted in 36 articles; 23 of them indicated the specific origin of the material, which in almost half of the cases was WEEE. The research reported here is part of a project that has investigated possible uses for recycled ABS from WEEE as replacement for commercially available materials on concrete and mortar production. ABS-based parts were collected from WEEE such as out-of-use monitors and printers, cut into smaller pieces with an electric saw, and went through comminution, processed in two consecutive steps on different grinders. Granulometry, specific mass and water absorption were determined for both conventional and ABS-based materials. Commercially available materials were found to be outside the desirable values, so assess if recycled aggregate might compensate for that became an additional objective. Leaching tests, which have not been reported in previous approaches, were also performed. Research methodology Concrete and mortar specimens were prepared with different percentages of ABS (0%; 2,5%; 5%; 7,5%) for compressive strength, porosity and density analyses. During material collection and processing, significant quantities of flame-retardant materials were found in WEEE components, and that is one of the main points of concern when considering circular strategies such as recycling. Expected results include confirmation of recycled aggregate use in smaller substitution percentages as a viable, more circular strategy for ABS recovery while yielding products with added value.

Keywords: Waste Electric and Electronic Equipment, polymer waste, Acrylonitrile Butadiene Styrene (ABS), recycled aggregate

122. Efficient Removal of Basic Dyes from Wastewater Using Sorption onto Low-Cost Natural Textile Fibers.

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Natural fibers such as cotton, hemp, and flax are widely utilized in industrial applications, including textiles additives, to enhance biodegradability and absorbency. After use, these materials are regarded as waste, necessitating appropriate disposal or repurposing methods. One promising application is their use as low-cost adsorbents for wastewater treatment. Due to their affordability and ease of use, natural fibers present an attractive alternative to conventional adsorbents (e.g., activated carbon, chitosan, zeolite, and clay), which, despite their high adsorption capacity, remain relatively expensive. The increasing demand for cost-effective and efficient adsorbents has led to extensive research on low-cost and zero-cost materials for pollutant removal. Plant fibers are classified into seed, leaf, bast, or core fibers. Flax (Linum usitatissimum), ramie (Urticaceae family), and kenaf (Hibiscus cannabinus L.) are bast fibers composed primarily of cellulose, hemicellulose, and lignin, along with proteins, minerals, and other extractives. Among these components, cellulose has been widely recognized as an efficient adsorbent due to its high surface activity, supramolecular structure, and semicrystalline nature, which facilitate the adsorption of dye molecules.

The present study aims to investigate and quantify the adsorption capacity of these three fibers for removing a cationic dye (basic yellow 37, BY37) from aqueous solutions. The work was developed in four parts: (i) fiber characterization using Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and X-ray diffraction (XRD); (ii) adsorption experiments employing BY37 as a model pollutant; (iii) evaluation of adsorption efficiency by analyzing key parameters such as pH, initial dye concentration, temperature, and adsorbent dosage; and (iv) investigation of fiber reusability through desorption experiments using deionized water at different pH levels, followed by adsorption-desorption cycles. The findings suggest that the tested fibers have significant potential as low-cost adsorbents for the basic-dye removal from wastewater and can contribute to the development of sustainable remediation technologies by reducing both water pollution and fiber waste accumulation.

Keywords: wastewater treatment, natural textile fibers, dye adsorption, low-cost adsorbents

123. Food Waste in Household Solid Waste: Insights from Rio de Janeiro's 2024 Waste Survey.

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Food waste constitutes a major component of household solid waste, posing significant environmental, economic, and social challenges. In many urban areas, a substantial portion of discarded waste comprises both edible and inedible food scraps, reflecting inefficiencies in consumption, storage, and disposal practices. Understanding the extent and composition of food waste in household solid waste is essential for developing targeted waste management strategies, promoting sustainability, and mitigating resource depletion. Food waste consists of rapidly degradable organic material, which increases leachate production and biogas emissions when disposed of in landfills, thereby exacerbating pollution and complicating waste treatment processes, ultimately raising associated costs. This study analyzes food waste generated in households across Rio de Janeiro in 2024, assessing its contribution to overall waste composition and exploring potential reduction strategies through public awareness campaigns, policy interventions, and sustainable waste management practices. A total of 388 samples were gravimetrically analyzed, covering all 157 districts of the city. The number of samples collected in each district was proportional to its population and the volume of household solid waste (HSW) collected in the previous year. The samples underwent laboratory-based gravimetric analysis, where they were segregated into major categories (recyclables, organics, and others). Subsequently, the organic fraction was further separated to differentiate between edible and inedible food components and categorized according to their origin, quantifying the actual amount of food waste. The study analyzed a total of 16,544.4 kg of household solid waste, of which 7,003.6 kg (42.3%) corresponded to food waste. This fraction comprised 4,014.2 kg (57.3%) of edible food waste and 2,989.4 kg (42.7%) of inedible food waste. Among edible waste, Mixed and Cooked Food Residues represented the predominant category (80.7%), consisting mainly of small mixed food scraps from plates and pans, particularly cooked grains such as rice and beans. Other categories included Fruits and Vegetables (10.1%), Bakery and Pasta (5.6%), Meats (1.9%), Dairy (0.7%), Uncooked Grains (0.5%), Candies and Sweets (0.3%), and Spices (0.2%). Regarding the level of food processing, fresh or minimally processed foods constituted the largest fraction (93.1%) compared to processed and ultra-processed foods (6.9%). The findings highlight a substantial level of food waste among Rio de Janeiro's population, underscoring the urgent need for public awareness initiatives, improved food utilization practices, and effective waste management policies. Reducing food waste is crucial for conserving natural resources, generating economic value, and mitigating the environmental impact of waste disposal.

Keywords: Household Solid Waste, Food Waste, Composition, Rio de Janeiro

124. Monitoring of a transfer and sorting area for construction and bulky waste: case study of waste from Belo Horizonte-MG, Brasil.

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Construction & Demolition Waste

Construction and demolition(C&D) waste is defined as the material originated from new construction, renovation, repair and demolition, as well as from land excavation. (C&D) waste, especially when improperly disposed, has a detrimental impact on both the community and environmental quality. The function of the Sorting and Transfer Area (STA) for construction and bulky waste is to receive, sort, and temporarily store segregated materials, before their removal for appropriate disposal. In order to avoid damage or health risks, it is vital that specific operational standards are followed. The article presents the flow of the STA operation process for waste from the municipality of Belo Horizonte, state of Minas Gerais, during the year 2024. The flow is divided into two phases. In the first phase, the technical and operational aspects of the process are delineated. This phase encompasses the sorting of (C&D) waste, the separation and storage of recyclables, hazardous materials, prunings and rejects. This sorting is conducted manually by operators subsequent to the process of spreading, which is undertaken by trucks and with the support of loader shovels. The material is subsequently conveyed to a temporary area (“roll-on roll-off” dumpsters). The bulky waste is to remove and comminution the wood.The second phase presents the gravimetric composition of the(C&D) waste and the reuse and disposal of waste of different natures in a sustainable manner. STA has a licensed processing capacity of 1,000 m^3/day, which is designed to receive(C&D)and bulky materials from the network of reception units of the city of Belo Horizonte. These reception units are known as “Small Volume Receiving Units” (SLU, 2024). The STA processes approximately 20,000 t/month of(C&D)waste. The facility is equipped with an unloading and sorting yard, a material storage area, a dismantling area for bulky materials, a wood crusher, as well as support units comprising an office and a toilet. A total of 3,700 tons of wood chips were sent to a blast furnace for co-processing as an energy source, while 355 tons of recyclable waste were donated to waste picker cooperatives in Belo Horizonte, 234 tons of pneumatic waste were sent for reuse, and 16 tons of hazardous waste were properly treated by a specialized company. In 2024, on average, 85% of the total waste received at STA was reused, with only 15% of waste being sent for final disposal, consciously contributing to extending the useful life of the waste treatment center.STAisan integral partof the Solid Waste Policy which aims to utilise all possible solid waste, thereby generating both environmental and social benefits. These benefits include the implementation of actions focused on reverse logistics through the appropriate disposal of pneumatic and hazardous waste, with a further aim of generating income for recyclers. STA operation has also generates new energy sources and concomitantly reduces the use of mineral material.

Keywords: Construction and demolition(C&D) waste is defined as the material originated from new construction, renovation, repair and demolition, as well as from land excavation. (C&D) waste, especially when improperly disposed, has a detrimental impact on both the

125. Plastic Waste and The Failure of Circular Ambitions.

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Despite ambitious circular economic initiatives material systems seem to remain in a linear economy (Korhonen et al., 2018). The case of Denmark represent this paradox: despite being a frontrunner on sustainability policy, only 4% of its economy is circular according to the Circularity Gap (2024). The low level of circularity exemplifies in the waste management sector, where recent data from a regional Waste-to-Energy (WtE) plant in Denmark reveal a 22.69% rise in fossil fuel input since 2019—primarily derived from plastic waste. This raises a critical question for waste management networks and policymakewhy do circular economy frameworks fail to prevent linear outcomes?

This work aims to investigate why circular frameworks fail to succeed in contexts where the network sustainability paradigm, institutional logics and dependencies undermine the goals that policy makers seek to achieve. The study focuses specifically on plastics within waste flows, by identifying industries that contributes to this while trying to understand why waste management networks struggle to remove plastic from waste directed to WtE plants.

The study combines Material Flow Analysis (MFA) with Industrial Business Network Theory, which offers quantitative and qualitative perspective on waste network behavior. The MFA is based on Denmark's national waste data system for the Region of Funen in Denmark and identify how waste flow from industry sectors to waste-to-energy plants. To deepen the understanding of waste flow, semi structured interviews were performed with key actors across the regional waste management network, ranging from waste generators, collectors, processors and governmental actors. These interviews outline how institutional structures and dependencies shape-decision making. Using industrial network theory, these insights were analyzed to illustrate how actors network pictures and sense-making reinforce linear outcomes.

The preliminary conclusions outline that 19% of all waste directed at the regional WtE plant consisted of plastics, but most importantly that 49% of this was recyclable. Drawing on the interviews, the study revealed that even when actors express circular ambitions, their ability to act is constrained by transactional logic, fragmented execution, and deeply institutionalized expectations, which hinder a system-wide transformation. Revealing that reaching circularity is not simply a matter of intensions or technological readiness, rather it is embedded in institutional logic, relational dynamics, and historical routines

Keywords: Plastic Waste, Circular Economy, Systemic Barriers

126. Sustainable waste management in Brunei: A pilot proposal for material recovery and composting to achieve landfill diversion and circular economy goals.

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This pilot proposal outlines a comprehensive plan for improving waste management in Brunei Darussalam through the development of a Material Recovery Facility (MRF) and a composting plant. Brunei faces significant waste management challenges, including high per capita waste generation, limited landfill capacity, and low recycling rates. In 2023, Brunei generated approximately 191,482 tonnes of municipal solid waste (MSW), with a recycling rate of only 2.39% for MSW. The country's primary landfill, Sungai Paku, is expected to reach capacity by 2030, raising concerns about the future of waste disposal.

To address these issues, the pilot proposal aims to divert up to 80% of MSW from landfills by implementing advanced sorting and composting technologies. The MRF will focus on recovering recyclable materials such as plastics, paper, metal, and glass, while the composting plant will process organic waste, producing valuable compost for agricultural and landscaping use. The facility will be designed to process 100 metric tonnes of MSW per day, significantly improving recycling rates, reducing greenhouse gas emissions, and fostering a circular economy.

The success of this initiative depends on strong collaboration between government bodies, private sector entities, and the public. Public awareness campaigns will be crucial in encouraging waste segregation at the source, while the establishment of local recycling infrastructure will reduce Brunei's reliance on exporting recyclables. Additionally, the project will create green jobs and contribute to long-term environmental and economic sustainability. By aligning with Brunei's Wawasan 2035 goals of sustainability, this pilot project represents a pivotal step towards reducing Brunei's environmental footprint and supporting a clean, green, and sustainable future. The proposed MRF and composting plant will enhance resource recovery, reduce landfill dependency, and contribute to Brunei's aspirations of becoming a sustainable, circular economy.

Keywords: Material Recovery Facility (MRF), Composting Plant; Municipal Solid Waste (MSW), Recycling, Circular Economy.

127. Assessment of the Polluting Potential of Leachate from Construction and Demolition Waste.

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Leachate from construction and demolition waste (CDW) is a percolating liquid generated by water passing through construction and demolition debris, potentially containing pollutant compounds. This study evaluates the polluting potential of leachate generated in experimental cells of Class A CDW landfills, assessing its compliance with environmental standards and its potential for reuse.

The methodology was divided into two stages: (i) leaching test of CDW samples according to ABNT NBR 10006, and (ii) construction of experimental cells in triplicate for the physical-chemical, biological, and toxicological monitoring of the leachate. The data were statistically analyzed using the Shapiro-Wilk test for normality and ANOVA, comparing them with the limits set by CONAMA resolutions 357/05, 431/11, and NOP-INEA 08.

Out of the 38 parameters analyzed, 21 showed no significant differences, including pH, alkalinity, conductivity, and metals such as sodium, potassium, and calcium. However, turbidity and metals such as silicon, copper, vanadium, and boron showed significant variation. Only chloride exceeded the regulatory limits during the initial sampling. No total coliforms or Escherichia coli were detected, and the leachate was not toxic to Vibrio fischeri, except for one sample. However, it did show toxicity to Daphnia similis.

Statistical analysis revealed that 12 metals were below the detection limit, preventing further evaluation. The evolution of results was monitored throughout the leachate confinement period and represented by boxplot diagrams.

The results indicate that the polluting potential of the leachate depends on the composition of the CDW. The study suggests that controlled reuse of this effluent in industrial processes or for dust control on construction sites could be viable, provided it meets the required environmental standards. These strategies may contribute to the sustainable management of CDW, reducing environmental impacts and promoting the circular economy in the sector.

Keywords: construction and demolition waste, leachate, environmental impact, toxicity, reuse.

128. Analysis of Residuals from Recycling Cooperatives in Rio de Janeiro: Challenges and Opportunities for the Circular Economy.

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Recycling is a crucial strategy for mitigating the solid waste crisis; however, it does not completely eliminate the challenges associated with improper disposal. This study analyzed the composition and environmental and socioeconomic impacts of residuals generated by recycling cooperatives that process waste selectively collected by COMLURB in Rio de Janeiro. Four cooperatives were selected, and samples of their residuals were characterized in three phases: (1) general gravimetric characterization, (2) specific analysis of plastics, and (3) identification of the companies generating the waste.

A total of 138 kg of residuals were examined, revealing that 75.64% were potentially recyclable materials, while 24.36% consisted of contaminants that should not have been included in the selective collection. Among the plastics, polystyrene (PS), a resin of low commercial value, predominated, along with unidentified resins, which hinder the sorting process due to a lack of information. The business characterization identified 462 companies generating these residuals, with notable contributions from Nestlé Brasil LTDA, Valgroup RJ Indústria R-PET LTDA, Mantiqueira Alimentos LTDA, and Laticínios Bela Vista S.A.

The results highlight the need for more effective waste management policies, emphasizing shared responsibility among the public sector, businesses, and society. Cooperatives play a crucial role in the circular economy by reducing pressure on landfills and promoting social inclusion. However, they face challenges such as poor-quality sorting at the source and inadequate infrastructure.

The study concludes that strengthening the circular economy requires investments in environmental education, improvements in reverse logistics, and greater corporate responsibility in managing the product lifecycle. This study underscores the urgency of a more efficient waste management model, where all stakeholders assume responsibility for building a sustainable future.

Keywords: Recycling, circular economy, solid waste management, recycling cooperatives

129. Estimating Environmental Impact in Urban Waste Management.

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Luca Moretti, Gianluca Tapparini, Andrea Pavan, Marco Bavastrelli

Fondazione Operate

Background

Urban waste management represents today one of the most significant challenges, particularly due to climate change. The increase in urban populations and the consequent rise in waste production raise questions about the sustainability of current practices and the environmental impact of daily choices.

Framework in ISWA

Following the presentation of the Carbon WastePrint® method at ISWA 2024, we are now introducing how the model has been adopted by some governance authorities within the Italian context. This initiative is replicable in both European and non-European contexts that choose to adopt PAYT, supported by RFID, IoT, and AI tools to optimize system implementation, improve waste tracking, and simplify processes.

Methodology

The methodology adopted was participatory, involving some institutional stakeholders representing approximately 14% of the Italian population and about 11% of Italian municipalities. These stakeholders joined a voluntary Technical Committee to study the environmental impact of urban waste management and actively contributed to developing the guidelines titled "Estimating Environmental Impact in Waste Management Based on CO2 Equivalent Emissions”.

Value Proposition

The guidelines, developed through a participatory approach with governance bodies, represent a significant step forward in estimating environmental impacts in urban waste management. The creation of an environmental impact database and the active participation of national stakeholders are essential to fostering continuous debate on this topic and identifying effective mitigation actions.

Challenges

The guidelines include a model for estimating environmental impacts in urban waste management, with reference indicators that allow for replicability across territorial contexts at national, European, and international levels. The model also outlines a series of actions that can be implemented at municipal or inter-municipal levels

Benefits

The initiative has strengthened research on the environmental impact of urban waste management and encouraged active participation from national stakeholders. It has also laid the groundwork for populating an impact database while continuously stimulating national and international debate on the subject. The authorities participating in the Committee are adopting the guidelines within their respective territories and will begin estimating the environmental impacts of waste management in certain municipalities. Additionally, they will identify some mitigation actions and populate a database for their territory.

Participation and involvement for sustainable waste management

The guidelines represent an important step forward in estimating environmental impacts in urban waste management, enabling replicability across different contexts. The combination of advanced technologies and shared commitment among institutions, businesses, and citizens is crucial to building a more sustainable respectful future.

Keywords: participation, involvement, waste management, environmental impacts, GHG emissions

130. Advancing Pilot Solutions for Marine Litter Prevention in Caribbean SIDS – Phase II of the PROMAR Project.

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adelphi, Berlin, Germany

Marine litter, particularly plastic waste, poses a significant challenge to Small Island Developing States (SIDS), where limited waste infrastructure and geographic isolation worsen the impacts of climate change on marine ecosystems, coastal communities, and waste management systems. The PROMAR project, funded by the German Federal Ministry for the Environment, addresses these interconnected issues by promoting innovative waste management and circular economy solutions that contribute to climate resilience. Building on the successes of Phase I, Phase II (2025–2026) focuses on piloting tailored interventions in five Caribbean SIDS: Suriname, the British Virgin Islands (BVI), Trinidad and Tobago, St. Kitts and Nevis, and Guyana. In Phase I, demonstration sites in the Dominican Republic, Costa Rica, and Colombia provided critical insights into marine litter sources and composition through waste sampling and monitoring activities. For example, in Costa Rica, waste flow mapping and beach sampling identified plastic bottles, Styrofoam fragments, and other single-use plastics as the most critical litter types. These findings informed pilot interventions such as floating river booms to capture waste, community awareness campaigns, and the integration of marine litter prevention into municipal waste management plans. In Colombia, circular economy pilots strengthened recycling systems by empowering waste picker associations, introducing selective collection routes, and linking recyclers directly with material processors. These efforts prevented thousands of tons of plastic pollution while creating scalable models and cutting carbon emissions. In Phase II, PROMAR expands to the aforementioned five countries, where demonstration sites have been identified, and waste sampling and material flow analysis (MFA) are underway. Innovative methods, such as weekly sampling from river booms, complement traditional approaches like beach cleanups to establish baseline data. This will inform pilot solutions, ranging from upstream measures like reusable packaging systems to downstream interventions such as waste capture technologies, household segregation programs, and community sensitization campaigns. Tailored to each SIDS’s unique context, these pilots address waste composition, infrastructure gaps, and community needs, with Extended Producer Responsibility (EPR) as a potential complementary policy tool. The PROMAR project demonstrates how innovative waste management solutions can address the dual crises of marine litter and climate change in SIDS. By combining upstream and downstream interventions with community engagement and capacity building, Phase II aims to create scalable models that prevent marine litter and enhance climate resilience. The ISWA 2025 PROMAR poster will provide an up-to-date snapshot of these pilot interventions, showcasing their progress and potential for replication across the Caribbean and beyond.

Keywords: Marine, Litter, Plastic, SIDS, Climate, Waste, Pilot, Innovations, Infrastructure, Awareness, Baseline, Sampling, EPR

131. TECHNOLOGICAL TOOL RESCOL FOR THE DESIGN OF A COLLABORATIVE HOUSEHOLD SOLID WASTE COLLECTION SYSTEM IN URBAN AREAS.

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In Chile, decisions on household solid waste collection (HSSW) are usually based on intuition or field experiences through trial and error. This leads to inadequate design of HSSW routes and itineraries, which generate negative impacts on the population and the environment. Thus, municipalities must incur additional expenses to mitigate these negative externalities, which is relevant, as available resources are scarce. Therefore, municipalities face the challenge of conceiving an efficient collection design considering economic, environmental, logistical and territorial aspects. The HSSW is one of the most important allocations of municipal public resources. In Chile, 5-20% of the municipal budget is allocated to HSSW management. An efficient HSSW becomes even more necessary as the generation of RSD grows with the increase in population. In this context, technical advances present opportunities to reduce the costs of design and implementation of HSSW. Studies have shown that these costs decrease when municipalities work collaboratively and share resources (vehicles and personnel) in the HSSW. This joint work allows the HSSW to be designed without responding to communal boundaries and the costs of the HSSW are allocated fairly according to each municipality's contribution. The municipalities can benefit from the consequent economies of scale resulting from the better use of their resources. As a result of this collaboration, vehicular congestion is reduced, environmental pollution is reduced and social inequality is reduced, since workers' salaries and safety are improved, working hours are shortened, etc. Thus, we developed technological tool named “RESCOL” for the design of a collaborative HSSW between municipalities that optimizes HSSW routes while minimizing HSSW costs and improving the level of HSSW service in the participating communes. Through the use of spatial analysis and sophisticated algorithms, RESCOL is able to simulate different scenarios that will support local authorities in the decision-making process on HSSW design. In addition, the results will ensure that participating municipalities will benefit from collaborating as they will perceive a significant reduction in the total cost of HSSW logistics with an equitable distribution of the cost.

Keywords: collaborative collection, waste management, household solid waste, Chile

132. Closing the Gap: Satellite-based observations to improve methane emission estimates. A Case Study on European Landfills.

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Reducing methane emissions is a top priority for curbing climate change; in particular, the waste sector contributes with around 20% of the global anthropogenic methane emissions, mostly through the decay of the organic fraction in facilities such as landfills and open dumpsites.

One of the most important challenges in landfill methane monitoring is raised by the dynamic nature of these facilities, both spatially and temporally. Emission sources could be leaks caused by operational issues like soil displacement or fires, to continuous releases from the work-face area, local hotspots and wide diffusive areas. Existing models may fail to represent the actual on-site conditions, while current on-ground methods struggle with spatial and temporal variability, access restrictions, high costs, and complex logistics.

Satellite assets can play a crucial role supporting decision-makers by providing actionable data to improve emission inventories and guide mitigation efforts. Previous studies have revealed major discrepancies between satellite-based emission rates and reported emissions generated by facilities operators-owners. A source of mismatch comes from bottom-up approaches, which rely on inputs that can be far from accurate since they neither precisely reflect on-site conditions nor are regularly updated. As a result, these models can significantly misestimate the methane generated and emitted. Lastly, national inventories are based on annual estimates, so aligning the temporal resolution of satellite data is vital for consistency and comparability. Yet, past studies often oversimplify the dynamic nature of emissions.

These inconsistencies reinforce the need for easier and affordable monitoring strategies that reconcile bottom-up and top-down methods. For this reason, this study aims to contribute to the ongoing efforts to enhance the added value offered by satellite assets in improving the landfill methane emissions monitoring.

Initially, we reviewed the satellite-based landfill methane monitoring state-of-the-art, outlining its capabilities and limitations such as the inability to operate under low-light conditions. Then, we examined some cases in Europe, contrasting the satellite estimates with those values in the national inventories, discussing the prevailing inconsistencies and potential underreporting. We also assessed a empirical model from the literature to predict the methane emissions based on changes in barometric pressure, and investigated how well satellite estimates correlate with key atmospheric parameters recorded near the facilities. Finally, we propose a framework to improve the upscaling of satellite-derived emissions into annual values, addressing current limitations through ground-based and local atmospheric data. It will serve as the basis for a future study to validate its practical application, explore the added value that satellite assets can offer to global methane monitoring and assess its policy relevance.

Keywords: Landfill methane emissions, satellite monitoring, methane emission inventories, climate change mitigation

133. Application of VOCs Emission Reduction Technology in Waste Solvent Concentration and Reuse System.

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As the processes and technologies of the high-tech industry continue to evolve, the organic solvents used in manufacturing have become increasingly complex, leading to the generation of various volatile organic compounds (VOCs). Most VOCs are flammable and have low flash points. When present in the process systems and operating environments, VOCs can create explosive gas atmospheres, posing significant explosion risks. To mitigate these risks, in addition to classifying hazardous areas and installing explosion-proof electrical machinery, appliances, or equipment in appropriate locations, improving the design and performance of air pollution control equipment in process systems to reduce VOC emission concentrations is the fundamental solution. In May 2023, Taiwan revised the "Air Pollution Control and Emission Standards for Semiconductor Manufacturing Industry," significantly strengthening VOC control regulations. Under the previous standards, the total VOC emissions for an entire factory were limited to 0.6 kilograms per hour. The revised standards now mandate that individual emission pipelines meet a VOC concentration limit of less than 14 ppm, with new processes required to achieve concentrations below 10 ppm. These stringent regulations have driven the adoption of environmentally friendly and higher-efficiency control technologies in new factories and processes, effectively reducing VOC emissions to comply with regulatory requirements and minimize environmental risks. ECOVE, leveraging its expertise in the fields of incineration and resource recovery, provides semiconductor plants with the design and construction of waste solvent recycling and reuse systems. These systems address the treatment needs of waste isopropanol (IPA), high-organic-content waste liquids, and waste EBR. By optimizing packing materials and increasing surface area, VOC removal rates are improved to over 90%, ensuring compliance with emission standards. Additionally, for high-concentration IPA solvent storage tanks, condensers are installed for vapor condensation and recovery, effectively reducing VOC emissions and enhancing solvent recycling and reuse efficiency. These technological solutions not only significantly lower overall emission concentrations and improve pollution control efficiency but also assist clients in achieving their goals of resource recovery and reuse, further advancing the principles of the circular economy.

Keywords: VOCs Reduction Technology, Waste IPA Recovery, Scrubber Design, Condensation Technology, Volatile Organic Compounds, Circular Economy, Air Pollution Control Equipment, Resource Reutilization, Carbon Emission Reduction, Filling Material of Scrubber

134. Food Waste in School Institutions: A Case Study in Rio de Janeiro.

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Food Waste in School Institutions: A Case Study in Rio de Janeiro

It is estimated that, in 2022, approximately 1 billion tons of food were wasted globally, according to data from the United Nations Environment Programme (UNEP). Among the sectors responsible for this scenario, food services contributed to 28% of total food waste. School institutions, as part of these services, play a significant role in this context, both due to the environmental impacts resulting from waste generation and their potential as transformative agents in promoting sustainable practices and reducing food waste. However, studies that quantify and analyze food waste in school environments remain scarce and incipient. Given this, the present study aimed to diagnose food waste in 20 schools in the city of Rio de Janeiro. Semi-structured interviews were conducted with school administrators to understand the current scenario and identify initiatives aimed at reducing waste. Simultaneously, solid waste from the schools was collected for physical composition analysis, with a focus on the gravimetric analysis of organic waste produced at different stages of the food flow. The results showed that 70% of school waste consists of food waste. The combination of rice and beans, a staple of the Brazilian diet, as well as fruits such as oranges and apples, were the most wasted foods. The average waste per student/day was 119 g, with 57% of this amount considered avoidable waste. Plate waste per capita was 25.5 g, a value lower than that observed in the literature. It was found that waste in the analyzed schools occurs both during food preparation and meal consumption. Additionally, the research identified several measures to combat food waste adopted by school administrators, which can be replicated and shared with other educational institutions. These initiatives include awareness strategies, menu planning optimization, and the implementation of sustainable waste management practices.

Keywords: food loss and waste; schools; food waste in schools; circular economy.

135. Unlocking GHG Reduction Potential in Southeast Europe through Optimized Organic Waste Management.

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This study, conducted under the Global Methane Initiative (GMI) and funded by Environment and Climate Change Canada, assesses greenhouse gas (GHG) reduction potential in the municipal solid waste (MSW) sector across Serbia, Bosnia and Herzegovina, North Macedonia, and Montenegro. The research applies the EPA's Solid Waste Emissions Estimation Tool (SWEET) to model baseline emissions and evaluate the impact of optimized waste diversion strategies focused on organic waste.

Current waste management practices in the region remain largely dependent on the landfilling of mixed municipal solid waste (MSW), typically disposed of without any form of pretreatment. This approach is particularly problematic given that biodegradable waste accounts for over 40% of the MSW stream. While there are some limited initiatives aimed at introducing separate waste collection to facilitate resource recovery processes like composting or anaerobic digestion (AD), these efforts have yet to achieve meaningful scale or impact. As a result, the region continues to experience high levels of methane emissions from unmanaged organic waste in landfills, representing not only a significant environmental concern but also a missed opportunity to harness valuable resources through more sustainable waste treatment technologies.

In order to define the most appropriate solution for the specific local and regional waste management in the terms of reducing GHG emissions and meeting MSW legal requirement, the SWEET model have been used The analysis focused on three scenarios for diverting biodegradable waste: small-scale composting, large-scale composting, and anaerobic digestion (AD), each modeled at a maximum diversion rate of up to 70%.

Three scenarios of biodegradable waste diversion were assessed: small-scale composting, large-scale composting, and AD at maximum bio-waste diversion rates (up to 70%). Results indicate that by 2050, large-scale composting in Serbia alone could reduce total CO_2e emissions by 47.4% compared to business-as-usual current practice. Similar trends were observed across the region, with cumulative reductions exceeding 40% when waste management strategies are aligned and implemented regionally.

The study highlights systemic barriers such as fragmented governance, insufficient data, and limited institutional and financial capacity. Nevertheless, it demonstrates the transformative potential of investing in separate collection, composting and AD facilities, and enhancing local capacities through public-private partnerships.

By aligning with EU directives and embracing a regionalized approach, SEE countries can significantly reduce GHG emissions while advancing toward circular economy goals. This research offers actionable insights for policy-makers and stakeholders aiming to future-proof waste systems and combat climate change.

Keywords: GHG reduction, biowaste, SWEET, circular economy

136. Circular strategy for green waste management: A climate change and circular economy perspective.

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Cities, as epicenters of human activity and development, are at a critical crossroads. Paradoxically,they are both the main contributors to climate change and its most vulnerable victims. Its effectsthreaten the livability of these urban environments. In response, green architecture is emerging as a strategy to make cities resilient. It is becoming asolution to mitigate the heat island effect, counteract wind waves, and improve rainwater and runoffmanagement in cities. However, the expansion of urban green areas increases with population growth and poses a challenge:the rise of green waste. This flow, resulting from new green infrastructure and the maintenance ofpublic green areas, increases the organic waste ending up in landfills or dumpsites in the worst cases.This contradicts the zero-waste policy, which seeks to reduce waste generation and separately managedifferent waste streams according to their treatment and/or utilization potential. This also prevents thelargest amount of waste from reaching landfills, thereby extending the useful life of existing waste andpreventing the creation of new ones. The article analyzes the problems of green waste management in cities, including information from 21cities in Colombia, exploring sustainable solutions and proposing a circular perspective that contributesto building cities that are more resilient to climate change. This article emphasizes governance andinstitutional management at the municipal level, aiming to harmonize the fight against climate changewith zero-waste policies and the construction of more sustainable and resilient cities, with a visionaligned with the Sustainable Development Goals (SDG).

Keywords: Municipal green waste, public green spaces, municipal green areas, grass cutting and tree pruning waste, organic waste, climate change, green architecture, zero waste, climate resilience, circular economy, urban resilience, Sustainable Development Goals,

137. Antibacterial potential of crude extracts obtained from broccoli stem (Brassica oleracea var. italica) wastes.

Rojas-Avelizapa, N.G.

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Increased antimicrobial resistance has led in the search for bioactive compounds from plant waste. In this context, broccoli stems (Brassica oleracea var. italica), an abundant agro-industrial waste, represent a sustainable source for developing antibacterial agents. In this study, crude extracts were obtained from broccoli stem wastes using deep eutectic solvents (DES) composed of sodium acetate and urea, assisted by ultrasonic sonication. Extracts were characterized by quantifying total protein (Bradford assay), total flavonoids (aluminum chloride colorimetric method), phenolic compounds (Folin-Ciocalteu), reducing power and antioxidant activity using FRAP and ABTS methods, respectively and a Fourier Transform Ion Cyclotron Resonance Mass Spectrometry analysis was performed. Antibacterial activity was evaluated in a liquid medium against Escherichia coli and Staphylococcus aureus using the macro dilution method, with chloramphenicol as the positive control. The extract exhibited 696.50 ± 85.51 μg/mL of total protein, 28.26 ± 5.82 mg/mL of flavonoids, 120.03 ± 9.25 mg/L of phenolic compounds, and antioxidant activity of 2483.55 ± 200.37 (FRAP) and 1899.25 ± 118.33 mg/L (ABTS). Results of antibacterial activity showed no inhibition against E. coli, while a dose-dependent inhibitory effect was observed against S. aureus, with a minimum inhibitory concentration (MIC) of 15 mg/mL and antibacterial activity at 30 mg/mL. These findings demonstrate the selective antibacterial potential of broccoli stem waste against Gram-positive bacteria and support the application of eutectic solvent-assisted sonication as a sustainable method for valorizing vegetable waste into functional bioactive compounds.

Keywords: Biomolecules, ultrasonic sonication, deep eutectic solvents, Gram-positive bacteria

138. Ecotoxicological assessment for proposing landfill leachate treatment strategies.

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Leachate, a type of wastewater generated in sanitary landfills, is produced through the degradation of solid waste and possesses a significant potential for polluting aquatic ecosystems. The ecotoxicological assessment of leachate is crucial for understanding the impact of its various pollutants on water bodies. This study aims to evaluate the acute toxic effects of specific pollutants found in leachates from different landfills in Rio de Janeiro, Brazil.

The primary contributors to the ecotoxicity of leachate identified in this research include organic matter (specifically humic substances), ammonia nitrogen, and chloride (indicative of salinity). Consequently, a treatment system incorporating membrane separation and ammonia stripping has been proposed. This treatment approach facilitates resource recovery, enabling the retrieval of nitrogen, humic substances, water, and salt.

In a resource recovery context, stripping ammonia and recovering it as ammonium sulfate is particularly advantageous. Various studies have examined the operational parameters of this process, noting that temperatures ranging from 40 to 60 oC can facilitate the conversion of ammonia nitrogen into free ammonia.

Humic substances can be effectively removed using membranes with small pore sizes (approximately 500 Da cutoff), such as tight nanofiltration membranes and reverse osmosis systems. For salinity removal, reverse osmosis is preferred to mitigate the toxic effects of the permeate on test organisms; however, tight nanofiltration may also be appropriate under certain conditions.

For best performance, the membrane process should operate in a two-step configuration. The resulting permeate may possess characteristics suitable for reuse in applications such as equipment washing and road wetting at the landfill, among other potential uses. Furthermore, humic substances can be recovered for agricultural purposes through loose nanofiltration.

The initial stage of the proposed process involves utilizing either a forward or reverse osmosis approach or a combination of both for effective water recovery. Suppose the generated stream is characterized by a high organic matter content, wherein humic substances predominate. In that case, it can be further fractionated using tight ultrafiltration or loose nanofiltration to recover organic matter for subsequent utilization as fertilizer. Additionally, salts in saline streams may be recovered via evaporation/crystallization, leveraging the energy produced from biogas generated within the landfill.

Keywords: ecotoxicity, Danio rerio, Vibrio fischeri, Artemia salina, membranes

139. Evaluation of the effects of infiltration of reverse osmosis concentrate into a landfill. CAMPOS, JUACYARA

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The increasing generation of municipal solid waste (MSW) and its management is one of the most pressing environmental challenges the global society faces. In this context, landfills represent the most widely used final disposal solution for waste in Brazil and worldwide. However, leachate generation is an inherent byproduct of landfill operations. It requires proper treatment, as it is a highly pollutant load effluent. Among available technologies, reverse osmosis (RO) is recognized as one of the most efficient methods for leachate treatment, owing to its high removal efficiency of organic matter, salts, and inorganic pollutants. On the other hand, RO generates a liquid reject known as reverse osmosis concentrate (ROC), characterized by high concentrations of leachate pollutants, whose disposal remains a challenge. Among the various technologies used for ROC treatment and disposal, infiltration into the landfill mass is the most widely practiced and disseminated among landfill operators. In this regard, this study aimed to evaluate the effects of ROC infiltration in a large-scale landfill located in northeastern Brazil. The landfill consists of two units: one decommissioned and undergoing post-closure care (Landfill A) and another currently in operation (Landfill B). The RO system is installed in Landfill B, with its ROC directed to Landfill A for infiltration. This study analyzed four years of monitoring data on rainfall, leachate production, infiltrated volume, and the physicochemical characterization of the leachate from Landfill B and its ROC. Additionally, six sampling campaigns were conducted over one year to characterize the physicochemical properties of the leachate from Landfill A and the ROC from Landfill B. The analysis of leachate production data from Landfill A, rainfall patterns, and infiltration volumes indicated that ROC infiltration does not significantly influence leachate generation, which was primarily driven by rainfall. Furthermore, a strong correlation was observed between chloride levels in the leachate and chloride, electrical conductivity, COD, and total nitrogen in the ROC. Similarly, a strong correlation was found between the electrical conductivity of the ROC and the COD, BOD, and total nitrogen in the leachate, based on Pearson's correlation coefficients obtained from one year of monitoring of Landfill A and the ROC. However, the Mann-Kendall trend test applied to leachate parameters indicated no statistically significant increasing trends for any analyzed parameter. Therefore, based on the findings of this study, it was determined that ROC infiltration did not contribute to increased leachate production. Moreover, despite the strong correlation between specific leachate parameters and ROC components, such as chloride, COD, and total nitrogen, no increasing trends were observed in these parameters in the generated leachate.

Keywords: landfill leachate, reverse osmosis, concentrate, infiltration.

140. Treatment of hazardous landfill leachate using sulfate radical-based advanced oxidation process: Suspect and non target screening for exploring degradation of emerging contaminants.

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The generation of landfill leachate as a result of waste disposal poses significant social and environmental challenges due to its complex composition. An increasing presence of artificial and naturally occurring chemicals, classified as emerging contaminants (ECs), has been detected in leachate, posing serious risks to human health and the environment. Landfills act as reservoirs for ECs, including e-waste, industrial chemicals, pharmaceuticals, personal care products, per- and polyfluoroalkyl substances (PFAS), and endocrine-disrupting compounds. Given their ecological risk, especially for aquatic ecosystems, treatment processes must be applied, in order to degrade these highly contaminated fluids. Advanced Oxidation Processes (AOPs) are a particularly attractive choice in leachate treatment as one can see by looking at relevant studies and reviews. This study evaluates the efficiency UV/Fe^{2+}/$S_2O_8^{2-}$ process for the degradation of landfill leachate samples and examines the degradation of ECs and their transformation products (TPs). Based on a suspect screening and literature data, marker compounds are selected from three main categories, namely industrial chemicals, pharmaceuticals and per-and poly- fluoroalkyl substances (PFAS) and their respective concentration was monitored to evaluate the effects of the applied AOPs. Influence of various parameters like UV light, dosing mode and mixing of oxidants have been studied. The performance evaluation was done by measuring basic pollution indicators like chemical oxygen demand (COD), total organic carbon (TOC) and color index(CI). UV/Fe^{2+}/$S_2O_8^{2-}$ process exhibited good performance in terms of degradation (76.34% COD, 71.44% TOC, 88.94% Color Index) in the respective conditions, albeit its efficacy was significantly affected by leachate composition. High-resolution mass spectrometry (HRMS)-based screening utilizing a Q Exactive Focus Orbitrap analyzer, equipped with a heated ESI source operating in switching ionization mode, has been used as a powerful approach to explore the chemical space of these samples and identify compounds present before and after the treatment, including TPs. In total, more than 65 ECs were identified using suspect and non-target screening, with confidence level (CL) 3d or higher, including PPCPs, PFAS, pesticides and their transformation products. Valsartan, pregabalin, propranolol, DEET, PFOA, PFHxA, TPrP, TEP, TMBPF and acesulfame were among the most often detected compounds. ECs on the treated landfill leachate were reduced up to 99% of the initial concentration.

Keywords: landfill, photocatalysis, emerging contaminants, High resolution mass spectrometry

141. Sulfate radical-based enhanced oxidation techniques for the degradation of benzotriazole in leachate.

Rapti, Androniki

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Benzotriazole (BNZ) is a widely used compound and an emerging pollutant frequently detected in leachate due to its extensive application in industrial and commercial products. It is primarily used to prevent photochemical degradation and discoloration, but its high water solubility and strong polarity contribute to its persistence in landfill leachate. These properties make BNZ a challenging contaminant to remove, as it resists conventional wastewater treatment processes. Moreover, its toxic effects, bioaccumulative potential, and resistance to degradation raise concerns regarding its environmental impact, particularly in aquatic ecosystems, where its presence can be detrimental to marine organisms. Therefore, innovative and advanced treatment technologies are urgently needed to ensure its efficient removal from leachate. This study investigates the photolytic degradation of BNZ in leachate utilizing both homogeneous and heterogeneous sulfate-radical-based advanced oxidation processes (SR-AOPs), including UV/$S_2O_8^{2-}$, UV/MOF/$S_2O_8^{2-}$, UV/TiO_2/$S_2O_8^{2-}$, and UV/Fe^{2+}/$S_2O_8^{2-}$. Firstly, all applied processes were tested on BNZ solutions in ultra-pure water, showing significant efficacy in degrading the target compound within one or two hours of treatment. Subsequently, the efficiency of all technologies was assessed in leachate, a complex aqueous matrix, revealing that the presence of organic and inorganic constituents hindered the degradation process. Degradation experiments conducted using only the oxidant showed reduced efficiency, as complete removal of BNZ was not attained within the observed time period. When a suspended catalyst was used without persulfate, TiO_2 exhibited superior photocatalytic performance, whereas the MOF catalyst demonstrated lower efficiency. In contrast, persulfate-assisted photocatalytic processes significantly enhanced degradation rates, particularly for the MOF catalyst, as persulfate effectively suppressed electron-hole recombination. Among the tested processes, the homogeneous UV/Fe^{2+}/$S_2O_8^{2-}$ system exhibited the highest reaction rate, achieving complete BNZ removal within 3 hours. Several key influencing parameters, including catalyst concentration and oxidant dosage, were systematically examined. Total organic carbon (TOC) analysis indicated that complete mineralization even in ultra-pure water necessitated extended irradiation times. However, the UV/TiO_2/$S_2O_8^{2-}$ and UV/Fe^{2+}/$S_2O_8^{2-}$ processes demonstrated the highest mineralization efficiency. TOC removal in leachate using the latter techniques demonstrates effective reduction of the organic load, with homogeneous methods proving to be more efficient since they ensure more uniform distribution and interaction of the treatment agents, leading to better breakdown and removal of organic contaminants

Keywords: Benzotriazole (BNZ); leachate; advanced oxidation processes; photocatalysis

142. Evaluating an Integrated Behavior Change and Waste Audit Approach to Enhance Waste Segregation at a University Campus in Lima, Peru.

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Effective waste segregation at the source is a key strategy for waste recovery; however, in many low- and middle-income countries, a significant portion of waste remains unrecycled. Universities, as centers of learning and innovation, have the potential to model sustainable recycling strategies for their communities. This study assessed the effectiveness of an evidence-based behavior change intervention, combined with waste audits, in improving waste segregation practices at recycling stations on a university campus in Lima, Peru. The intervention employed a systematic methodology integrating psychological frameworks and engineering strategies. Baseline and follow-up data were collected through surveys and waste audits in 2023 (N=472) and 2024 (N=243), respectively. The follow-up waste audit revealed a significant improvement in paper waste segregation, increasing from 18.9% to 30.1%, while the organic waste bin achieved a high segregation rate of 79.7%. Follow-up survey results indicated increased knowledge of segregation practices and a strengthened personal commitment to waste segregation following the behavior change intervention. These findings highlight the effectiveness of evidence-based approaches in driving sustainable behavior change and provide a replicable model for other universities aiming to enhance waste segregation on campus.

Keywords: Behavior change, intervention design, psychological factors, Ranas, segregation rate, waste audit, waste segregation.

143. The influence of environmental behavior on food consumption of the brazilian vulnerable population.

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The growing and unsustainable generation of waste, especially food waste, leads to several lasting environmental problems. This generation is directly linked to the behavior of individuals. Although several studies evaluate the influence of intrinsic motivation, social norms, or heuristics on pro-environmental behaviors, there is a lack of studies that address these issues for the population with social and environmental vulnerability, in an integrated manner. In this scenario, this research aims to understand the influence of the intrinsic pro-environmental motivation of this portion of the population on their decision-making processes, as well as evaluate whether these are influenced by educational processes aimed at environmental preservation and conservation. The research initially has an experimental character. However, to achieve the main objective, exploratory research will also be necessary, as the behavioral gap in food consumption among the vulnerable population in Brazil is evident. To do this, firstly, it will be necessary to observe consumption behavior in popular markets, since part of the population has restricted access to different forms of purchasing (in-person and virtual). Next, an environmental education program will be developed in a virtual environment to evaluate changes in participants' intrinsic motivation and heuristic processes. It will also be conducted application of a real experiment in two stages (before and after the environmental education program). Finally, a statistical analysis using a structural equation model will be conducted to determine the relationship between intrinsic motivation, knowledge about the environmental issue, and heuristic processes. The results of this work may clarify the factors that influence the prevention of food waste, and whether there is a preponderance of one of these factors in the intervention of this behavior. This study may also contribute to the improvement of public policies in the area of urban solid waste to create tools to achieve lasting results.

Keywords: waste prevention, environmental education, pro-environmental behaviour, heuristics

144. Engaging Children in Sustainable Practices: The "Ruta 5Rs" Exhibit at Papalote Children's Museum.

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Environmental education in early childhood is crucial for fostering a sense of responsibility towards our planet and promoting sustainable practices from a young age. Papalote Children's Museum, a leading institution in Mexico dedicated to providing interactive learning experiences for children, developed the "Ruta 5Rs" exhibit based on the "Touch, Play, and Learn" philosophy. This innovative project aims to engage children in a playful and educational journey, raising awareness about the importance of reducing, reusing, readapting, recycling, and reintegrating waste, empowering children to take action in their daily lives. Academics from UAM-Azcapotzalco and UNAM provided scientific advice and ensured the thematic content aligned with the project's objectives.

The exhibit, designed with 80% readapted materials, features interactive experiences that demonstrate the impact of excessive waste and the benefits of sustainable practices. For instance, children can use their bodies and a pulley system to compare the amount of waste generated by disposable and reusable objects. They can also learn about textile repair techniques and the industrial process of PET bottle recycling. Initial results indicate that "Ruta 5Rs" has successfully engaged over 135,000 visitors, with more than 80% expressing intentions to adopt sustainable practices.

This project aligns with several UN Sustainable Development Goals, including those related to sustainable cities and communities, responsible consumption and production, and climate action. Papalote Children's Museum, renowned for its interactive exhibits and commitment to science education, plays a vital role in promoting environmental awareness among children in Mexico. The "Ruta 5Rs" exhibit exemplifies the museum's dedication to fostering sustainable practices through hands-on experiences, encouraging children to become active agents of change in their communities.

Keywords: Environmental Education, Sustainability, Waste Management, Interactive Exhibits, Play-based Learning, UN Sustainable Development Goals, Circular Economy, Community Engagement

145. Role of deflocculation optimization in the consolidation of a low-carbon alkali-activated cement.

Pareuil, P. (3)

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In the context of waste treatment, where cement is central to stabilization and solidification processes, the significant environmental impact of Ordinary Portland Cement (OPC) production prompts the search for alternative solutions. My research at the Ceramic Research Institute (IRCER) focuses on developing alkali-activated binders to replace traditional hydraulic binders, ensuring the desired stabilization and consolidation. The reagents studied are ashes with chemical compositions containing high contents of oxides, SiO_2, Al_2O_3 and CaO. These reagents in the presence of water give rise to CSAH hydrates with slower kinetics than those produced during the hydration of Portland cement. The targeted consolidation mechanism is based on the formation of hydrates, but also and above all on the control of the microstructure, through a densification obtained thanks to an optimization of the dispersion of particles in the Solid/Liquid suspensions. A study of the optimum deflocculation of pastes based on mixtures with different Portland cement/ash proportions was carried out using different dispersants. The optimum deflocculation was noted on the viscosity variation curves as a function of the amount of dispersant added. Subsequently, a correlation study between the efficiency of deflocculation, the microstructure and the consequence on the mechanical resistance was undertaken.

Keywords: waste treatment, alkali-actived binders, deflocculation, microstructure, mechanical resistance

146. PFAS : Significant progress in waste management in response to the global environmental challenge.

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Per- and poly-fluoroalkyl substances (PFASs) include more than 10,000 synthetic chemicals widely used in many different consumer, commercial, and industrial products. Their persistence makes them ubiquitous into the natural environment (water, soil, air). The control of this environmental challenge involves the prohibition of certain uses and the appropriate management of contaminated waste.

Regulatory requirements are very heterogenous according to the media considered (drinking water, wastewater, industrial water & air discharge, products, solid waste) but are still becoming stringent. Managing waste contaminated with PFAS requires the use of analytical methods specifically adapted to each step, to: accurately determine waste contamination levels and therefore identify the appropriate treatment; ensure control of the environmental impact by monitoring the treatment process discharges (aqueous, gaseous, and solid).

In response to the PFAS environmental challenge, SUEZ is leading innovative projects to : develop analytical methods specifically designed to meet the needs of customers and treatment sites; provide an overview of PFAS contamination level in the environment; validate the effectiveness of current hazardous waste process for PFAS destruction or immobilization (incineration or stabilization/solidification); investigate new separation (adsorption, reverse osmosis, foam fractionation) and destruction processes.

PFAS Destruction Efficiency (DE) and Destruction and Removal Efficiency (DRE) of SUEZ hazardous waste incineration plants for highly concentrated waste, as separation and concentration efficiencies of foam fractionation for lower concentrated wastewater are examples of results that will be presented.

Keywords: PFAS, waste treatment, waste analysis, separation process, destruction process

147. Biomedical Waste Incinerated in Concrete Production: A Case Study for Immobilization of Potentially Hazardous Materials in Alagoas, Brazil.

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Advancements in materials science and engineering have provided the health sector with a wide range of tools to enhance practicality, safety, and human well-being. However, rapid urbanization and habitat loss have contributed to the emergence of new viruses and variants, straining healthcare systems from supply logistics to waste disposal, as evidenced by the COVID-19 pandemic. In general, healthcare waste is incinerated to minimize contamination risks. Incinerated Biomedical Waste (IBW) has gained attention due to concerns regarding its final disposal, making it a relevant topic in environmental sciences. Concrete presents significant potential for incorporating by-products from diverse chemical compositions, including combustion ashes. IBW, however, may release dioxins, furans, and unstable halogenated compounds or contain heavy metals, hazardous chemicals, and leachable reactive substances. Immobilizing IBW in a cementitious matrix offers a safe, viable, and cost-effective disposal alternative. This study evaluated the mechanical properties of concrete incorporating IBW as a partial replacement for river sand. Physicochemical characterization of IBW was performed using X-ray Diffraction (XRD), X-ray Fluorescence (XRF), and Thermogravimetric Analysis (TGA) techniques, alongside granulometric analysis. Concrete formulations with IBW replacement levels ranging from 5% to 20% were tested. The results indicate that IBW is predominantly composed of calcium, iron, and silicon, with crystalline phases of calcium carbonate and silicate, demonstrating good thermal stability up to 600°C. The particle size distribution classifies IBW within the medium sand range. Mechanical tests on specimens at 28 days revealed a trend of decreasing compressive strength and increasing water absorption as IBW content increased. However, the composites remained within the limits established by Brazilian standards (NBR 5739) for non-structural concrete.

Keywords: healthcare waste, recycling, ash, cementitious composite.

148. Transforming Humanitarian Solid Waste Management: The HAWAI Guidelines. Tosi Robinson, Dorian

Mertenat, A., Ubbiali, S., Zurbrügg, C.

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Solid waste management (SWM) is a crucial component of public health protection in humanitarian contexts. However, field practitioners often face challenges due to the lack of practical evidence-based guidance. Recognizing this gap, new resources have been developed to address SWM challenges in such settings. Among these, the Compendium of Technologies for SWM in Humanitarian Settings is set for publication in 2025. Alongside the Compendium, we have worked on the development of the Humanitarian Aid Solid Waste Assessment and Improvement (HAWAI) Guidelines. The HAWAI Guidelines provide a practical and structured framework to assess and improve collection, transport, disposal, and organics and recyclables management through three key entry points:

Risk Assessment: A systematic approach to identify critical hotspots, prioritize immediate actions, and pinpoint deficiencies requiring longer-term solutions.

Systematic Analysis: A thorough evaluation of each stage within the SWM system to identify weaknesses, and make tailored recommendations for improvement.

Service Implementation: Step-by-step guidance to establish or expand SWM services, ensuring sustainable and context-appropriate solutions.

Designed to be actionable, the HAWAI Guidelines dives into technical and governance aspects and complement the Compendium which focuses on technologies and approaches for SWM in humanitarian contexts. The HAWAI guidelines should be freely accessible by mid-2025. At ISWA, we will introduce the HAWAI Guidelines, demonstrating their applicability and highlighting how they can be used to understand and improve SWM systems – not only in humanitarian but also in development contexts. We aim to show how this practical guidance document can empower practitioners to implement data-driven, context-sensitive solutions that will enhance SWM conditions, protect public health and the environment.

Keywords: solid waste management, assessment, improvement

149. Combining structured behaviour change approach with primary collection to enhance waste segregation: Pentakatha case.

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Penthakata, an urban slum and fishing community in Puri, India, faces acute waste management challenges. Of its 2000 annual tons of waste generated, 14% is dumped untreated near beaches or neighbourhoods, and 76% is channelled to dumpsites as it is mixed waste. The “Penthakata – Optimization of Waste segregation for Effective Recovery (POWER) Project", implemented with Eawag, Usthi Foundation and SAREK, established a primary waste collection system integrated with a structured RANAS (Risk, Attitude, Norms, Ability, Self-regulation) behaviour change campaign to improve source segregation in the community.

Baseline assessments (2024) revealed that the average waste generation is 307 grams per capita per day, with organic waste making up 70% of the waste stream. Only 12% of waste is recovered, while a significant portion—estimated at 760 kg daily—remains uncollected, ending up on the beach or in a community dumping point.

An MoU was signed with the local body, and a pilot area covering 10% of the total slum population was selected for intervention, with the future scope of expanding the learning across the community. The interventions deployed include -

Targeted Behaviour change techniques: The techniques were tailored for Pentakatha to address barriers like low confidence in segregation and perceived effort. The behaviour change campaign used the RANAS approach, which systematically identified key behavioural drivers and barriers to waste segregation in the Pentakatha community. The campaign implemented targeted techniques such as graded messaging, household-level feedback, social comparison, commitment contracts, and visual prompts. Further, community meetings, field coordinator visits, and recognition of best-performing households and hamlets reinforced positive norms.

Decentralised infrastructure: 530 households received two bins for waste storage at the household level, while trolley-based collection adapted to narrow coastal lanes addressed accessibility gaps.

Community-driven governance: Waste committees and doorstep engagement by the field team strengthened ownership, achieving 86% household participation within 30 days. Further, the user fee model is deployed to cover the cost of daily collection and sustain the model.

Early results (March 2025) show increased source-segregated waste (250 kg/day collected) and reduced beach littering. Challenges included aligning collection schedules with fishing livelihoods and mitigating monsoon-related disruptions. The RANAS framework enabled cost-efficient prioritization of high-impact interventions over generic awareness drives. This model demonstrates how merging technical waste solutions with evidence-based behaviour design can address complex urban-informal settlements, particularly in ecologically sensitive coastal zones.

This abstract is part of three submissions focused on Behaviour Change. It is suggested for a joint session with the abstracts by Ms Laura Velasquez and Ms Dalia Ramos.

Keywords: Behaviour change, RANAS, Urban slum, Coastal waste management, Decentralized collection

III. PART 2 - POSTERS IN SPANISH / POSTERS EN ESPAÑOL

RECICLADO Y MINIMIZACIÓN DE RESIDUOS

150. De residuo a fibra: Análisis de métodos de extracción de fibras libres de formaldehído a partir de residuos de MDF mediante diferentes tipos de hidrólisis.

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Los tableros de fibra de madera de densidad media (MDF) son ampliamente utilizados en la industria actual de la madera. Sin embargo, la gestión de sus residuos sigue siendo un desafío y estos terminan mayoritariamente en los sitios de disposición final. El MDF se fabrica a partir de la unión de fibras lignocelulósicas con resinas sintéticas, siendo la urea formaldehído (UF) el adhesivo más utilizado. De acuerdo con la OMS (2006), la UF se clasifica como cancerígeno para los humanos. Por lo tanto, es fundamental eliminar este compuesto de los residuos de MDF, para facilitar alternativas reales de valorización.

En Montevideo, capital de Uruguay, los multilaminados como el MDF, representan el 0.8% de los residuos domiciliarios (BID, 2018). En Uruguay no hay producción local de tableros aglomerados con resina sintética, dificultando aún más su reintegración al ciclo productivo y valorización, terminando en el relleno sanitario de la ciudad. En este contexto, entre 2023 y 2024 el Dpto. de Ing. Ambiental del Instituto de Mecánica de los Fluidos e Ing. Ambiental de Facultad de Ingeniería de la Universidad de la República desarrolló un proyecto enfocado en el análisis de alternativas de valorización para este tipo de residuos, en conjunto con emprendimientos ubicados en el Parque Tecnológico Industrial de la Intendencia de Montevideo.

A nivel internacional, los tratamientos aplicados para la valorización de residuos de MDF incluyen el reciclaje físico o desintegración, el reciclaje bioquímico y la producción de energía (Zimmer & Bachmann, 2023). Este proyecto se enfocó en el reciclaje físico, con el objetivo de eliminar el formaldehído y obtener un material libre de este compuesto. Dado que el material es susceptible a la hidrólisis y las condiciones alcanzadas con tratamientos de vapor pueden mejorar aún más la hidrólisis de la resina (Savov et al., 2023), se evaluaron dos tipos de hidrólisis. La primera consistió en hidrólisis en un medio ácido, básico y con agua, bajo condiciones de agitación y calor a 80 °C durante 90 minutos. El segundo método se llevó a cabo mediante un autoclave, proporcionando vapor y presión constante, con variaciones en tiempos y niveles de presión para determinar las condiciones óptimas. Posteriormente, se comparó la cantidad de formaldehído removido, mediante el estudio de pérdida de nitrógeno utilizando el método NKT y el análisis elemental. En este contexto, los resultados demostraron una remoción de resina de hasta el 95 % con hidrólisis ácida y 92% con hidrólisis termoquímica analizadas por el método NKT. En cuanto al análisis elemental, se obtuvo una remoción de 94 % para la primera hidrólisis y 82 % para la segunda. Adicionalmente, se evaluó la pérdida de masa en cada ensayo, con el propósito de establecer una relación entre ambos parámetros. Los resultados obtenidos permitieron determinar la eficiencia de estos tratamientos en la eliminación del formaldehído y su potencial aplicación en estrategias de reciclaje.

Palabras clave: Residuos de resinas sintéticas, Valorización de fibras de MDF, Remoción de formaldehído,

151. Análisis de la reducción de residuos plásticos de un solo uso en la Universidad Nacional de Ingeniería (UNI): Implementación de una normativa restrictiva entre 2024 y 2025.

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La generación de residuos plásticos de un solo uso ha experimentado un incremento significativo en los últimos años, impulsada principalmente por su bajo costo, facilidad de acceso y la limitada concientización sobre sus impactos ambientales, especialmente en instituciones educativas. Este fenómeno se observa de manera evidente en la Universidad Nacional de Ingeniería (UNI), donde el uso de bolsas plásticas continúa siendo una práctica común a pesar de las regulaciones vigentes. En este marco, la presente investigación tiene como propósito evaluar la reducción en la generación de bolsas plásticas en la UNI mediante la implementación de una normativa restrictiva durante el periodo 2024-2025.

Tradicionalmente, los estudios sobre la generación y composición de residuos en entornos académicos se han basado en metodologías de caracterización. Sin embargo, esta investigación introduce un enfoque innovador, práctico y cuantitativo, que combina la implementación de una normativa restrictiva y la fiscalización activa por parte del personal competente. La metodología contempla la caracterización de residuos antes y después de la publicación de la norma, complementada con campañas de sensibilización dirigidas a la comunidad universitaria. Estas campañas se desarrollarán tanto en medios virtuales como presenciales, promoviendo el uso de materiales reutilizables y minimizando el consumo de productos desechables.

El enfoque de esta investigación busca no solo generar conciencia ambiental, sino también contribuir al cumplimiento de las regulaciones relacionadas con la minimización del plástico en la UNI. Para ello, se involucra la participación activa de diversas autoridades universitarias, como la Unidad de Servicios Generales, encargada de capacitar a los concesionarios comercializadores; la Dirección General de Administración, responsable de acciones de fiscalización; y el equipo de investigación, que llevará a cabo charlas y talleres de sensibilización dirigidos a estudiantes, docentes y personal administrativo.

En una evaluación inicial realizada en noviembre de 2024, se identificó que la UNI genera semanalmente un promedio de 3,892 bolsas plásticas de un solo uso (equivalente a 23 bolsas por punto ecológico por día) y 315 sorbetes. A partir de las medidas propuestas, que incluyen campañas de sensibilización y acciones de fiscalización aplicadas de manera continua durante tres meses, se espera cuantificar la eficacia de la normativa en la reducción del uso de plástico. Los resultados obtenidos permitirán evaluar el impacto de las estrategias implementadas y contribuirán al desarrollo de políticas sostenibles en el ámbito universitario.

Palabras clave: normativa de restricción, educación ambiental, caracterización de residuos

152. Incorporación de fibras de MDF en materiales acústicos a partir de materiales reciclados.

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El uso de tableros de fibras de densidad media (MDF), ha pasado de ser el menos usado en la industria de la madera en la década de 1990 a convertirse en el segundo más usado a escala mundial en los últimos años (Irie et al., 2023). Estos tableros se fabrican a partir de fibras lignocelulósicas unidas entre sí mediante resinas, siendo la urea-formaldehido la más usada. Esta resina aumenta la resistencia de los tableros y tiene un costo bajo pero debido a su carácter cancerígeno (IARC, 2006), complejiza la valorización de los residuos generados a partir de este material, provocando que, mayoritariamente, terminen en rellenos sanitarios.

En Montevideo, capital de Uruguay, los multilaminados representan en 0,8 del material que ingresa al relleno sanitario (BID, 2018). Con el fin que este material se reincorpore al proceso productivo se debe remover la resina de las fibras, para así poder trabajar con ellas. Existen distintos métodos, basados en la susceptibilidad a la hidrólisis de las resinas, para separarlas de las fibras. Dentro de ellos se encuentran la hidrólisis sumergiendo el material en solventes, la hidrólisis ácida, básica y con agua contando con un sistema de agitación y calor, y la hidrólisis con calor y vapor en autoclave. Las últimas dos fueron las evaluadas en el marco de un proyecto desarrollado entre el 2023 y 2024 por el Departamento de Ingeniería Ambiental del Instituto de Mecánica de los Fluidos e Ingeniería Ambiental de la Facultad de Ingeniería de la Universidad de la República (DIA-IMFIA), que tuvo como objetivo definir una propuesta de valorización de residuos de materiales compuestos por resinas sintéticas, basada en la economía circular. Como resultado de esto se obtuvieron fibras que presentaban bajo contenido de nitrógeno, lo que indicaría una baja presencia de formaldehído.

En Uruguay, no hay empresas dedicadas a la fabricación de paneles de MDF, por lo que no sería posible la incorporación de estas fibras a nuevos paneles. Debido al equipamiento con el que cuenta el Grupo de Investigación de Contaminación Sonora del DIA-IMFIA, en el marco de este proyecto, se plantea la fabricación y ensayo de materiales con fines de acondicionamiento acústico, utilizando como materia prima las fibras de madera obtenidas, papel y cáscara de arroz. Posteriormente, se realizaron ensayos en tubo de impedancia a los materiales fabricados, siguiendo algunas de las pautas establecidas en la Norma ISO 10534-1. El material fabricado con papel y fibras dio Ri mayores que el yeso para las frecuencias hasta 2000 Hz, mientras que el panel de cáscara de arroz y fibras presentó un Ri mayor al yeso en 125 Hz y luego en 1000 y 2000 Hz.

Palabras clave: Residuos MDF, Reciclaje, Reutilización, Materiales acústicos

153. Trazabilidad de materiales reciclables: eficiencia y transparencia en la economía circular.

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Pereira, Carla

(1) CEMPRE Uruguay, Montevideo, Uruguay, (2) Plan Vale, Montevideo, Uruguay

La trazabilidad en la gestión de residuos reciclables es clave para mejorar la transparencia, eficiencia y comercialización de materiales. Sin datos confiables, es difícil garantizar la calidad del material reciclado, fortalecer los modelos de Responsabilidad Extendida del Productor (REP) y conectar el downstream con el upstream en la cadena de valor del reciclaje.

Para abordar este desafío, CEMPRE Uruguay junto al Plan Vale han desarrollado la Plataforma de Trazabilidad de Envases Reciclables, una herramienta digital que permite registrar el flujo de materiales desde su ingreso en plantas de clasificación hasta su valorización o venta. Este sistema no solo digitaliza procesos, sino que también ha impulsado cambios estructurales en la toma de decisiones, integrando tecnología en las plantas de clasificación mediante la instalación de infraestructura para mejorar su operativa.

Uno de los avances más significativos del proyecto es la normalización de la taxonomía de materiales reciclables, permitiendo por primera vez que todas las plantas hablen el mismo idioma y registren datos bajo criterios unificados. Este estándar tiene el potencial de facilitar la interoperabilidad entre plantas, municipios e industrias recicladoras, asegurando información de mayor calidad para el desarrollo de estrategias de economía circular.

Este trabajo presentará los avances y aprendizajes de la plataforma, destacando su impacto en:

Trazabilidad en tiempo real, proporcionando datos verificables para la toma de decisiones.

Mejora en la gestión operativa de plantas de clasificación, integrando tecnología y equipamiento.

Unificación de criterios en la clasificación de materiales, permitiendo consolidar datos a nivel nacional.

Estrategia de escalabilidad, asegurando que las plantas con diferentes niveles de desarrollo puedan adoptar la herramienta con el soporte necesario.

Además, se discutirán los desafíos para la expansión del modelo a nivel nacional y su potencial replicabilidad en otros países de América Latina. La trazabilidad no solo optimiza procesos internos, sino que también permite evaluar la reciclabilidad real de los materiales en la práctica, generando datos estratégicos para políticas públicas y esquemas de REP más eficientes.

Esta iniciativa demuestra que la digitalización del sector de reciclaje no es solo una herramienta de control, sino un motor de cambio estructural que mejora la integración de los actores y profesionaliza la economía circular en la región.

Palabras clave: trazabilidad, reciclaje, digitalización, economía circular, responsabilidad extendida del productor, taxonomía de materiales, gestión de residuos, interoperabilidad, plantas de clasificación, escalabilidad

154. Digital WasteBank Argentina. Herramientas Financieras disruptivas para la Economía Circular.

Welsh, Sebastián

Este método innovador fue desarrollado por la Fundación Banco de Residuos del Litoral Argentino.

Este documento presenta una estrategia innovadora de financiamiento para la economía circular basada en dos herramientas financieras disruptivas: el Crédito Circular y Digital Circular Cash (DCC). Ambas herramientas están respaldadas por una unidad básica contable denominada Patrón Recurso Natural, que convierte el potencial energético de los residuos en valor económico tangible.

La metodología propuesta incorpora la medición, registro y verificación (MRV) de residuos sólidos urbanos, alineada con estándares internacionales como el Greenhouse Gas Protocol e ISO 14064. Este método inicia con la segregación y clasificación específica de residuos en origen, diferenciándolos en orgánicos, inorgánicos combustibles y no combustibles, así como residuos tóxicos. Seguido por un proceso riguroso de pesaje digital, registro manual y digitalizado, se garantiza una trazabilidad completa y transparente de los residuos gestionados.

Posteriormente, mediante un análisis simplificado del ciclo de vida (ACV), se contabiliza la energía consumida y las emisiones generadas en las etapas de recolección, transporte y tratamiento. Este balance energético y ambiental permite asignar un valor económico preciso a los materiales recuperados, estableciendo así la base para emitir el Crédito Circular o Digital Circular Cash (DCC).

Finalmente, la estrategia facilita el financiamiento sostenible, convirtiendo los residuos recuperados en activos financieros circulares que empoderan a las comunidades locales. Además, fomenta prácticas sostenibles mediante incentivos monetarios claros y promueve la implementación de tecnologías disruptivas como Blockchain, acelerando la transición hacia una economía circular inclusiva y participativa.

Palabras clave: Palabras clave: Financiamiento circular, WasteBank, Digital Circular Cash (DCC), Blockchain, MRV digital, economía circular disruptiva, Patrón Recurso Natural.

155. Uso de residuos de construcción y demolición para la rehabilitación de parques urbanos en la Ciudad de México.

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El desarrollo urbano de la Ciudad de México (CDMX) ha generado problemáticas ambientales y sociales significativas, como el manejo inadecuado de residuos de construcción y demolición (RCD) y el deterioro del espacio público.

La CDMX genera entre 14 000 y 17 000 toneladas diarias de RCD, de las cuales solo una fracción mínima es reciclada. Los RCD son frecuentemente dispuestos en rellenos sanitarios o tiraderos a cielo abierto; asimismo, también se disponen de manera ilegal en terrenos baldíos, áreas de conservación ecológica o cauces de ríos, provocando daños ambientales. Además, el manejo inadecuado por parte de pequeños y grandes generadores evidencia la falta de una visión integral y de políticas públicas efectivas por parte de las autoridades.

Por otra parte, la gestión de parques urbanos de la CDMX enfrenta varios desafíos, como la falta de planificación integral, la escasa coordinación institucional y la poca participación ciudadana. Aunque ha habido un aumento en la cantidad de áreas verdes urbanas, varias son de acceso limitado o están mal distribuidas, lo que genera inequidad espacial.

A pesar de este panorama, los RCD tienen un alto potencial de aprovechamiento. En la CDMX se han desarrollado proyectos que han demostrado su viabilidad técnica como agregado reciclado en la fabricación de mobiliario urbano, banquetas y caminos en parques, como en la 2ª Sección de Chapultepec, el Parque Cuitláhuac y el Parque Bicentenario.

El uso de los RCD como agregados reciclados para la rehabilitación de parques urbanos representa una alternativa viable y sostenible para la CDMX. Esta estrategia no solo contribuye a la reducción del impacto ambiental, sino que también mejora las condiciones sociales y económicas de la ciudad. Casos como los de Chapultepec, el Parque Bicentenario y el Parque Cuitláhuac demuestran que, con una visión integral y una adecuada gestión, es posible transformar los desafíos urbanos en oportunidades para construir una ciudad más equitativa y comprometida con el desarrollo sostenible.

Palabras clave: residuos de construcción y demolición, parques urbanos, sostenibilidad, reciclaje, medio ambiente

156. Análisis de la reducción de residuos plásticos de un solo uso en la Universidad Nacional de Ingeniería (UNI): Implementación de una normativa restrictiva entre 2024 y 2025.

Curi, Timoty

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Palabras clave: normativa de restricción, educación ambiental, caracterización de residuos

157. Transformando Residuos en Oportunidades: Innovación Sostenible en el Reciclado de Plásticos RAEE.

Vazquez, Yamila Victoria

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La acumulación de plásticos provenientes de Residuos de Artículos de Eléctrica y Electrónica (RAEE) es un problema ambiental en crecimiento. Cada año, se generan más de 18 millones de toneladas de estos residuos los cuales, en su mayoría, terminan en vertederos desperdiciando un recurso clave para la Economía Circular (EC). Actualmente, las estrategias de valorización de plásticos RAEE representan un nicho prometedor en el contexto global, que demanda cada vez más productos sostenibles y responsables. En este sentido, se propone desarrollar productos sostenibles de alto valor agregado utilizando los plásticos RAEE mayoritarios, Acrilonitrilo-Butadieno-Estireno (ABS) y Poliestireno de Alto Impacto (HIPS). En este sentido, se plantea el desarrollo de productos masivos (alta rotación y bajo margen) y de objetos de diseño (alto margen y baja rotación). Esta oportunidad de mercado proyecta, para los próximos 10 años, un crecimiento del mercado de objetos de diseño y productos masivos elaborados a partir de plásticos reciclados; impulsado por las tendencias de sostenibilidad y las preferencias de los consumidores. Para el caso de los objetos de diseño, al momento se obtuvieron prototipos de portaobjetos a partir de placas y probetas, con diferentes texturas y colores semejantes al mármol y al granito, según el tipo de proceso utilizado. Se proyecta contar con un portfolio de al menos 5 objetos de diseño y el escalado de los procesos de fabricación de los mismos. Por otra parte, estudios de envejecimiento acelerado demostraron que los materiales conservan propiedades mecánicas aceptables lo que permitiría la elaboración de productos para ser expuestos a la intemperie. Adicionalmente, mediante ensayos de combustión se demostró que los materiales conservaron propiedades antillama sin el agregado de nuevos aditivos. En base a estos resultados, se identifica como una alternativa prometedora de productos masivos el desarrollo de carcasas para luminarias exteriores. Para la fabricación de ambos tipos de productos se proponen métodos sencillos y típicos del procesamiento de plásticos: termocompresión y moldeo por inyección. Esto hace que puedan adaptarse a líneas tradicionales de reciclado, reduciendo costos. Además, los materiales a utilizar no necesitan del agregado de aditivos ni plásticos vírgenes. En este sentido, el plástico que da origen al residuo puede reinsertarse en el mercado mediante nuevos productos, a través de metodologías sostenibles que fomentan la circularidad de plásticos RAEE. Por último, es importante mencionar que la empresa MUTA de la ciudad de Bahía Blanca Argentina, un emprendimiento gastronómico en construcción que busca que toda su cadena productiva sea ambientalmente responsable, se presenta como aliado estratégico de la propuesta para la prueba piloto de los productos a desarrollar.

Palabras clave: RESIDUOS, RECICLADO DE PLÁSTICOS, RAEE, SOSTENIBILIDAD

CAMBIO CLIMÁTICO Y GESTIÓN DE RESIDUOS

158. Educación en sostenibilidad en territorios costeros, para contrarrestar los impactos del cambio climático.

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Es evidente que el cambio climático ha golpeado severamente a las comunidades más vulnerables, es así como el presente resumen pretende abordar la realidad de los habitantes y negocios pertenecientes a los territorios costeros en una extensión aproximada de 165 kilómetros de playa pertenecientes a los departamentos de La Unión, San Miguel, Usulután y La Paz, departamentos que aún no experimentan depredación de empresas de hostelería y turismo de playa. A partir de lo anterior se planteó la siguiente interrogante: ¿Pueden las prácticas sostenibles contribuir a salir de las condiciones de pobreza en las comunidades de territorios costeros? El estudio buscó evaluar la existencia de prácticas sostenibles en las comunidades de los territorios costeros de El Salvador con gran dependencia del turismo. El cambio climático ha contribuido a acrecentar la vulnerabilidad de las poblaciones de zonas costeras y contrariamente a ello se está apostando por un turismo sostenible como país, pero con atención a grandes inversionistas extranjeros en las zonas turísticas de playa; el estudio fue realizado con un enfoque empírico con método mixto (encuesta, entrevistas a actores claves y observación). Los resultados reflejan poco conocimiento de las prácticas sostenibles tanto en habitantes como en los responsables de negocios de atención a turistas, provocando con ello más deterioro social, económico, ambiental en los territorios. Se identificó como vacíos de conocimiento: educación para la sostenibilidad de los territorios, aplicación de prácticas sostenibles en las comunidades y negocios, así como aprovechamiento de la recolección de desechos orgánicos para generación de combustibles entre otras áreas de oportunidad.

Palabras clave: Sostenibilidad, Territorios turísticos, Pobreza, Cambio climático.

159. Caracterización y composición de residuos sólidos en eventos masivos. Caso Encuentro UNI: Ciencia y Tecnología UNICTEC 2024.
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La gestión adecuada de los residuos sólidos es un desafío crítico debido al crecimiento exponencial de la población mundial, lo que resulta en la generación de grandes volúmenes de desechos. En Lima Metropolitana, se producen anualmente más de 3 millones de toneladas de RS municipales, de los cuales el 94% son gestionados adecuadamente (Ministerio del Ambiente, 2022). En la Universidad Nacional de Ingeniería (UNI), se generan aproximadamente 2.5 toneladas de residuos por día; sin embargo, este cálculo no incluye los residuos generados durante eventos masivos como ferias y exposiciones. La generación de residuos se incrementa significativamente debido a la alta afluencia de personas y las actividades propias de estos eventos.

El evento insignia de la UNI es el Encuentro UNI: Ciencia y Tecnología – UNICTEC, organizado por el Vicerrectorado de Investigación de la UNI y para el año 2024 se realizó del 20 al 22 de noviembre. En este evento destacan la Expoferia Tecnológica y la Sesión de Posters, ubicadas en el Coliseo UNI y la Explanada Puerta Coliseo, respectivamente. Contaron con 41 stands y la presentación de 29 posters que mostraron los principales inventos y prototipos de investigación desarrollados por grupos de investigación, institutos especializados y unidades de investigación de diversas facultades. Estas actividades estuvieron dirigidas a la comunidad universitaria, estudiantes de nivel escolar y público general interesado en tecnología e innovación.

Durante el evento UNICTEC 2024, se llevó a cabo un estudio de caracterización de residuos generados específicamente en la Expoferia Tecnológica y la Sesión de Posters. Este estudio permitió analizar la composición y cantidad de residuos generados mediante una metodología estructurada en cuatro fases: planificación interna, aseguramiento logístico, caracterización de residuos adaptada a la Guía para la Caracterización de Residuos Sólidos Municipales (Ministerio del Ambiente, 2019) y análisis de datos. Los resultados mostraron una generación per cápita de 0.22 kg/stand/día, con un 81.4% de residuos aprovechables entre residuos inorgánicos (73.7%) y orgánicos (7.7%). Los residuos no aprovechables representaron el 18.6%, predominando las envolturas de snacks (9.7%), el polipapel (3.9%) y el papel higiénico (1.9%). Cabe resaltar que, dentro de los residuos inorgánicos, se observó un alto porcentaje de residuos líquidos (30.0%), generados principalmente por la acumulación de líquido en botellas de gaseosa y restos de agua embotellada, además del líquido proveniente del servicio de coffee break ofrecido a los ponentes de los stands durante el mediodía. Por último, se contabilizó como residuo un total de 29 posters de material foan, con un peso total de 12 kg.

Estos hallazgos subrayan la necesidad de implementar estrategias de reducción, reutilización y reciclaje en futuras ediciones del evento, fomentando la concienciación ambiental y un modelo de gestión de RS eficiente y sostenible.

Palabras clave: gestión de residuos, caracterización de residuos, expoferia, sostenibilidad

160. Sello Buen Gestor: Una herramienta de transformación en la gestión sostenible de residuos alineada a la economía circular.

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El Sello Buen Gestor (SBG) es un distintivo privado y voluntario, desarrollado específicamente para Gestores Ambientales. Fue creado por la Unión de Gestores del Ecuador, de la mano de CERES como desarrollador técnico. Este sello reconoce la excelencia en la gestión de residuos y desechos de empresas gestoras que operan en cualquier etapa de su cadena de valor. Su diseño versátil permite adaptarse a diversos modelos de negocio, fomentando una gestión ambiental responsable y orientada a la mejora continua.

El SBG surge como respuesta a la necesidad de abordar los impactos ambientales, sociales y económicos derivados de una gestión inadecuada de residuos. Alineado con los desafíos del cambio climático y la economía circular, el SBG impulsa prácticas sostenibles, la economía circular y la responsabilidad ambiental, posicionándose como una herramienta técnica de alto valor estratégico para las empresas generadoras y gestoras. Su objetivo es establecer un marco de referencia para evaluar y reconocer la gestión integral de residuos, visibilizando el compromiso de las organizaciones con la sostenibilidad, economía circular promoviendo la eficiencia operativa y la reducción de impactos negativos en los aspectos ambiental y social.

El esquema se basa en cinco ámbitos con criterios específicos, evaluados mediante un proceso de segunda parte:

- Desempeño Ambiental: uso eficiente de recursos, reducción de emisiones y prevención de la contaminación.
- Alineación con ODS: integración de los Objetivos de Desarrollo Sostenible en la estrategia y operaciones.
- Sociedad: derechos humanos, prácticas laborales éticas, salud ocupacional y vinculación comunitaria.
- Economía Circular: estrategias de reutilización, reciclaje, innovación y encadenamientos sostenibles.
- Transparencia y Gobernanza: ética corporativa, cumplimiento normativo y buenas prácticas empresariales.

Cada indicador se califica de 0 a 3 según el nivel de evidencia y cumplimiento, con una ponderación total. La evaluación es realizada por una organización designada que verifica la documentación y resultados.

El SBG permite generar valor reputacional y estratégico para las organizaciones certificadas, promoviendo la gestión de los riesgos ASG de las empresas gestoras. Fortalece la economía circular, la innovación, la equidad social y la trazabilidad en la cadena de valor, posicionando a las organizaciones como referentes confiables ante clientes y autoridades. Toma en cuenta el cumplimiento normativo local así como marcos internacionales de reporte y evaluación de impactos ASG, garantizando validez técnica y alineación regulatoria.

El SBG es una herramienta que impulsa a las organizaciones hacia modelos sostenibles, resilientes e innovadores.

Palabras clave: residuos, sostenibilidad, distintivo, certificación, circular, gestor ambiental, medio ambiente, ecuador

161. La Factorización como estrategia para una GIRSU sustentable.

Sagasti, Lisandro

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Las formas tradicionales de gestión de los RSU han resultado insuficientes para reducir su impacto ambiental, sobre todo en lo que respecta al material orgánico, y esta tarea continúa representando un grave problema especialmente en Argentina y Latinoamérica.

A pesar de los esfuerzos los resultados siguen siendo muy desalentadores. En nuestro país es común encontrarnos con rellenos sanitarios deficientes y carentes de planificación, semejantes a basurales a cielo abierto y con altas emisiones de GEI.

En este contexto, desde STP Ingeniería Ambiental nos abocamos al estudio y el diseño de propuestas superadoras que posibiliten que los espacios para el tratamiento de residuos dejen de ser focos insalubres o de contaminación, y se conviertan en complejos sustentables, amigables con el ambiente y la comunidad. Nuestra obsesión está focalizada en el tratamiento de los residuos orgánicos, un eje que consideramos poco explorado y que constituye una de las principales fuentes de gas metano (CH4) y uno de los mayores responsables del cambio climático.

Producto de esta búsqueda, desarrollamos lo que denominamos “factorización de la GIRSU”, es decir, la automatización del proceso, apoyada en la ingeniería y la tecnología adecuada para el tratamiento de todos los residuos; una propuesta que pretende modificar el paradigma en la gestión de los RSU.

Esta visión nos impulsó a diseñar plantas de tratamiento estratégicas que promuevan la circularidad de los residuos a través de la valoración de las dos variables principales: secos y orgánicos.

En ese marco, fue fundamental el acercamiento a Zewan, una tecnología disruptiva e innovadora que propone el tratamiento sustentable de los residuos orgánicos, a partir de un proceso físico/mecánico de pasteurización de la fracción orgánica del residuo que ataca directamente la formación de gas metano producida por la descomposición; y evita la formación de lixiviados y malos olores.

Esta metodología, además de eliminar las principales variables contaminantes, convierte ese residuo orgánico en un material bacteriológicamente estable con múltiples posibilidades de reutilización.

Para que la estrategia de factorización y tratamiento a través de Zewan sea más eficiente, contemplamos asimismo el diseño de una estrategia global que integre el compromiso de la comunidad en la separación en origen de los residuos y el mejoramiento del servicio de recolección a través de la incorporación de camiones eléctricos, lo cual nos permitirá incluso avanzar en la trazabilidad de los RSU para determinar el destino de la totalidad del material reciclado.

La tarea no es sencilla, requiere tanto de voluntad política como de un fuerte compromiso del sector privado y de las comunidades locales. Sin embargo, estamos confiados en que más temprano que tarde concretaremos el sueño de la factorización de la gestión de los RSU, de la reutilización de los residuos orgánicos y de la promoción de espacios de tratamiento 100% sustentables.

Palabras clave: Residuos, fracción orgánica RSU, metano, reciclaje, economía circular, gei, factorización, gestión sustentable rsu, +di+i.

GOBERNANZA Y ASUNTOS LEGALES

162. Evaluación de la gestión de residuos sólidos urbanos desde la perspectiva de la economía circular en municipios pequeños de Brasil.

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La implementación de la economía circular en la gestión de residuos sólidos urbanos (RSU) en municipios pequeños enfrenta desafíos significativos en países en desarrollo, donde las limitaciones financieras y estructurales dificultan la adopción de soluciones sostenibles. En Brasil, el 70,6% de los municipios tienen menos de 20.000 habitantes, lo que evidencia la urgencia de mejorar la gobernanza ambiental para fortalecer la gestión de RSU. Este estudio evalúa la alineación de las políticas públicas locales con los principios de la economía circular, identificando brechas y oportunidades para mejorar la eficiencia del sistema. Se aplicó un modelo de evaluación basado en indicadores de desempeño, desarrollado mediante el método Delphi, con la participación de expertos, gestores públicos y representantes del sector del reciclaje. El estudio se realizó en cinco municipios de la región sudoeste del estado de Paraná, Brasil, seleccionados según criterios poblacionales, económicos y estructurales. Se analizaron diez dimensiones clave, incluyendo prevención y reducción de residuos, eficiencia en la recolección y separación, infraestructura para el procesamiento, impacto social y empleo, sostenibilidad financiera, participación comunitaria y gobernanza intermunicipal. La recolección de datos incluyó análisis documental de los Planes de Gestión Integral de Residuos Sólidos (PGIRS) municipales, entrevistas con gestores y evaluación comparativa de desempeño entre los municipios. Los resultados muestran que, a pesar de la existencia del Plan Nacional de Residuos Sólidos (PNRS, Ley Federal nº 12.305/2010), la implementación de la economía circular sigue siendo limitada. Se identificaron barreras como baja adhesión a la recolección selectiva, falta de infraestructura para compostaje, escasos incentivos económicos para recicladores, resistencia cultural a la segregación en origen y debilidades en la fiscalización ambiental. Además, la dependencia de vertederos sanitarios intermunicipales con capacidad restringida compromete la sostenibilidad del sistema de disposición final de residuos. Sin embargo, se han identificado buenas prácticas, como programas de educación ambiental, asociaciones entre municipios y cooperativas de reciclaje y la implementación de incentivos fiscales para empresas que adoptan prácticas circulares. El estudio concluye que, para facilitar la transición hacia la economía circular en municipios pequeños, es fundamental fortalecer la gobernanza ambiental, promoviendo la cooperación intermunicipal, incentivos financieros, modernización de la legislación local y capacitación técnica de los gestores públicos. Este estudio propone un modelo de evaluación replicable en otros municipios con características similares en Brasil y América Latina, permitiendo monitorear el avance de las políticas públicas de RSU desde la perspectiva de la economía circular.

Palabras clave: economía circular, gestión de residuos, gobernanza ambiental

163. Vacío normativo y desigualdad en la gestión de residuos domiciliarios rurales: un análisis jurídico y ambiental desde la experiencia brasileña.

Starck, K. (1)
Winckler, S. T. (2), Rigailo, I. O. (3)

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La gestión de residuos rurales representa un desafío ambiental en países en desarrollo. En Brasil, la Política Nacional de Residuos Sólidos (PNRS – Ley Federal n.º 12.305/2010) establece directrices para los residuos sólidos urbanos (RSU), pero omite la regulación específica para los residuos generados en áreas rurales, donde reside más del 12% de la población brasileña. Esta omisión compromete la recolección universal, fomenta prácticas inadecuadas y expone a riesgos múltiples.

Este estudio analiza las implicaciones legales y socioambientales de dicha laguna normativa, mediante una revisión de leyes nacionales (PNRS, Ley de Crímenes Ambientales, Ley de Improbidad Administrativa) y normas como la Norma de Referencia n.º 01/2021 de la Agencia Nacional de Aguas y Saneamiento Básico (ANA). Se destacan las limitaciones del marco jurídico actual, que vincula los mecanismos de financiamiento de la recolección al impuesto predial urbano brasileño (IPTU) y a la factura de agua, instrumentos inaplicables en la mayoría de las propiedades rurales. Como resultado, solo el 13% de los domicilios rurales son atendidos por servicios formales, mientras más del 50% de los residuos son quemados o enterrados, según datos del Instituto Brasileño de Geografía y Estadística (IBGE).

A nivel internacional, países como China, India y Ghana enfrentan problemáticas similares. En China, la descentralización ha generado dificultades operativas para los gobiernos locales, promoviendo la quema de residuos y la contaminación del aire y del agua. En Ghana, la falta de infraestructura generó soluciones comunitarias como compostaje y reciclaje, integrando principios de economía circular adaptados al medio rural. Estas experiencias refuerzan la urgencia de que Brasil revise su marco e adopte instrumentos financieros adecuados, incluyendo mecanismos de compensación ambiental.

El estudio propone la reformulación de la PNRS, con inclusión de metas específicas para la recolección rural (en consonancia con los Objetivos de Desarrollo Sostenible (ODS) 11 y 12), creación de consorcios intermunicipales, incentivos fiscales para tecnologías de valorización in situ y mecanismos tarifarios alternativos. Se enfatiza la necesidad de incorporar los principios de prevención, precaución y equidad territorial, reconocidos en tratados internacionales ambientales. La inacción normativa no solo perpetúa la exclusión de millones de ciudadanos rurales del derecho al saneamiento, sino que también contraviene compromisos multilaterales en materia de desarrollo sostenible, en particular las metas de la Agenda 2030 (ODS 11.6 y 12.5 sobre gestión y reducción de residuos) y los compromisos del Pacto para el Futuro, que abogan por la inclusión de las zonas rurales en la agenda sostenible. Asimismo, limita el avance hacia la universalización de los servicios públicos en contextos de alta vulnerabilidad.

Palabras clave: Residuos rurales, marco legal, universalización, Brasil, derecho ambiental, economía circular

164. Gestión asociativa para la implementación de la Ley de responsabilidad extendida del productor en la provincia de Llanquihue: Avances, desafíos y lecciones para la transición a la economía circular.

Tapia, F. (1)
Rumie, M.W (1)

Asociación de Municipalidades de la provincia de Llanquihue para el manejo sustentable de residuos y gestión ambiental, Asociación de empresas y profesionales para el medio ambiente

La Asociación de Municipalidades de la Provincia de Llanquihue, que agrupa a nueve comunas del sur de Chile, ha consolidado un modelo de gestión colaborativo para enfrentar los desafíos en la gestión de residuos y la implementación de la Ley REP. Desde su formación, la Asociación ha demostrado que el trabajo conjunto entre municipios permite avanzar en soluciones eficientes y sostenibles, optimizando recursos y fortaleciendo la gobernanza territorial.

Uno de los principales logros ha sido la expansión de la infraestructura para la valorización de residuos. A través de la combinación de financiamiento propio, aportes públicos y colaboración con el sector privado, se han puesto en funcionamiento siete Instalaciones de Recepción y Almacenamiento de Residuos (IRAR o puntos limpios) y se han proyectado nuevas inversiones estratégicas, incluyendo una planta de clasificación y pretratamiento, así como la tercera etapa del relleno sanitario provincial La Laja.

Sumado a esto, se han instalado más de 120 puntos verdes en escuelas de toda la provincia, acompañados de retiros periódicos y capacitaciones a la comunidad escolar. Este enfoque integral ha permitido mejorar la cobertura y eficiencia del reciclaje en la región, fomentando una cultura ambiental desde la base educativa.

La implementación de la Ley REP en un territorio diverso como la Provincia de Llanquihue ha requerido un esfuerzo sostenido de articulación entre los municipios y los Sistemas de Gestión Colectivos (GRANSICs), garantizando que las decisiones beneficien equitativamente a todas las comunas, sin favorecer solo a las más grandes. A través de mesas técnicas, procesos de planificación estratégica y herramientas propias de seguimiento, se han alcanzado acuerdos que permiten una implementación gradual y equitativa de los sistemas de recolección y tratamiento de residuos, alineando las necesidades locales con los objetivos nacionales de economía circular. Estas y otras acciones han permitido recuperar y valorizar, entre 2023 y lo que va de 2025, más de 1.264 toneladas de materiales reciclables.

A pesar de los avances, el trabajo asociativo presenta desafíos constantes. La sostenibilidad financiera del sistema, la consolidación de modelos de gestión eficientes y la incorporación de nuevas tecnologías siguen siendo aspectos clave a fortalecer. Sin embargo, la experiencia de la Asociación demuestra que la cooperación intermunicipal es una estrategia efectiva para superar barreras y construir un sistema de gestión de residuos más resiliente y sostenible.

La experiencia de Llanquihue es un testimonio del impacto positivo de la asociatividad en la implementación de políticas públicas ambientales. Entre los aprendizajes destacan la importancia de contar con herramientas propias de seguimiento, planificación estratégica compartida y una gobernanza territorial articulada. Este modelo es replicable en otros territorios para una transición efectiva hacia una economía circular.

Palabras clave: Llanquihue, REP, reciclaje, asociatividad, cooperación,

TRATAMIENTO BIOLÓGICO DE RESIDUOS

165. Uso de tecnología innovadora para el tratamiento de residuos orgánicos de comedores en una planta de procesamiento de gas natural en Perú: Experiencia de implementación de un compostador automático.

Pinto, Estrella

Manuel Espinoza Bleuse ; José Luis Burga Zapata

Hunt LNG Operating Company

Los residuos orgánicos provenientes de comedores pueden constituir hasta un 20% del total de los residuos generados en una planta de procesamiento de gas natural (Planta de GNL). Estos residuos pueden fácilmente convertirse en un problema ambiental si no se gestionan adecuadamente. Su rápida degradación ocasiona la generación de malos olores y atrae plagas, representando así un problema de salubridad. Su disposición final en rellenos sanitarios viene siendo la alternativa tradicional en Perú y, si bien el compostaje manual es una alternativa ambientalmente viable que permite obtener una materia prima ideal para el mejoramiento de suelos; presenta algunas complicaciones operativas, como la demanda de recursos de mano de obra, uso de insumos y largos periodos de procesamiento.

Ante dicha problemática, en 2024 como parte de la evaluación constante de iniciativas de economía circular en la Planta de GNL ubicada en Perú, se implementó y evaluó durante 5 meses un equipo automático mecánico de compostaje con capacidad para tratar 300 kg de residuos orgánicos en 24 horas mediante un proceso controlado, eficiente, limpio y libre de malos olores. Los resultados obtenidos fueron satisfactorios: se compostaron 17,178 kg de residuos orgánicos, equivalentes a aproximadamente el 30% del total de los residuos orgánicos generados en los comedores de la Planta de GNL. Se obtuvo así un beneficio ambiental, evitando el envío de residuos a un relleno sanitario y generando a su vez 3,408 kg de compost. El equipo de compostaje alcanzó una tasa de conversión en peso del 80.16%, operando ciclos promedio de 26.7 horas. Para la puesta en marcha se requirió solventar los costos asociados al alquiler del equipo, operación y supervisión, adecuaciones eléctricas requeridas, costos de movilización y desmovilización y consumo eléctrico (23.38MWh por los 5 meses que duró el piloto). Considerando todo ello, se obtuvo que el costo por tratar 1 ton de residuos orgánicos mediante el equipo de compostaje fue 23.3 veces más que el costo de disponer dicha tonelada de residuos en un relleno sanitario, donde los únicos costos asociados son los de transporte y tarifa de disposición.

Durante el periodo de evaluación se pudo determinar que el rendimiento del equipo se vio afectado por la presencia de residuos con alto contenido de humedad y grasas, como las mermas de sopas y frituras; llegando a tener ciclos operativos de hasta 47 horas.

Finalmente, si bien es un desafío hacer económicamente rentable el empleo de tecnologías innovadoras de este tipo, por los costos de energía e infraestructura asociados; podemos concluir que su uso presenta innegables beneficios en términos de practicidad, reduciendo considerablemente el esfuerzo y tiempo requeridos para la producción de compost frente a un proceso manual, y constituye una alternativa con enfoque circular viable para la valorización de residuos orgánicos en contraparte a la alternativa tradicional de disposición final en un relleno sanitario.

Palabras clave: compostaje, compostador automático, economía circular, residuo orgánico

166. Valorización integral de residuos del circuito gastronómico de la ciudad de Bahía Blanca.

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En Argentina, se generan 1,02 kg diarios de RSU por habitante, siendo la mitad los denominados "residuos orgánicos". El objetivo de este trabajo fue diseñar un sistema de valorización integral de residuos provenientes del circuito gastronómico de la ciudad de Bahía Blanca, que sea técnicamente factible, económicamente viable y socialmente aceptado. Se realizó una etapa de diagnóstico, y a partir del entendimiento de la problemática alcanzado, se diseñó el trabajo de campo, con especial énfasis en lograr un diseño sostenible, acorde a la realidad del sector, que permitió hacer un análisis de las diferentes alternativas para valorar los residuos generados y lograr una propuesta basada en cuatro pilares fundamentales: 1) Correcta separación en origen de los residuos: donde es fundamental el compromiso y la capacitación permanente del personal de las casas de gastronomía; 2) Recolección diferenciada: será imprescindible el compromiso del municipio, en cuanto al cumplimiento del circuito de recolección diferenciada y al manejo de los residuos para asegurar su trazabilidad hasta la planta de tratamiento propuesta; 3) Disponibilidad de una planta para el tratamiento y valorización de las corrientes: es fundamental disponer de la planta de tratamiento propuesta gestionada de tal manera que permita garantizar la trazabilidad de los residuos para asegurar la valorización diseñada para cada corriente: 4) Existencia de un marco jurídico y de gestión que garantice la sostenibilidad económica e institucional. A partir de las proyecciones realizadas se estimó que el circuito gastronómico genera en promedio 140 tn mensuales de RSU, de los cuales más del 75% podrían valorizarse. A partir de la fracción mayoritaria de los residuos orgánicos, es posible obtener un producto de alto valor agronómico, como es el compost, posible de ser certificado y otorgarle así estatus comercial. La corriente constituida por la fracción restante de residuos orgánicos y el residuo generado como resto de los platos, es tratada anaeróbicamente por la tecnología de biodigestión. Por otra parte, la corriente que incluye vidrio, plásticos, cartón y metales será incorporada al circuito de reciclado existente en Bahía Blanca. A su vez, todo restaurante que se adhiera al programa tendrá un "Sello Verde", que le permita realizar campañas de marketing propias en relación a su compromiso ambiental. Este diseño, que redunda en una importante disminución de la cantidad de materia que se envía al relleno sanitario para su disposición final, requiere sin embargo de una gran articulación institucional público-privada. La aplicación del programa propuesto, acotado a un sector específico de la ciudad permitirá visualizar un caso de éxito en la gestión integral de residuos. Así, se podrán mostrar resultados concretos, que permitan ser fuente de motivación y punto de partida para nuevas líneas de gestión, con el fin último de lograr una ciudad consciente y responsable en el manejo de sus residuos.

Palabras clave: RESIDUOS SÓLIDOS URBANOS, GASTRONOMÍA, COMPOSTAGE, BIODISGESTIÓN, VALORIZACIÓN

CIERRE Y MEJORA DE BASURALES A CIELO ABIERTO

167. Cierre de basurales a cielo abierto en la región transfronteriza.

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La gestión de residuos requiere en la actualidad nuevas miradas, nuevas soluciones, principalmente a escala regional y de ciudades intermedias que representan en nuestro caso, en la región trasfronteriza de Argentina y una amplia mayoría de las ciudades de los países americanos. El actual contexto internacional y los nuevos paradigmas ambientales permiten el desarrollo de nuevas agendas de colaboración que permiten deslumbrar espacios de trabajo en las regiones transfronterizas americana

Como antecedente, en el marco de la XXI Reunión del Foro de Ministros de Medio Ambiente de América Latina y el Caribe (Buenos Aires, Argentina, 2018), se estableció la Coalición voluntaria de gobiernos y organismos pertinentes para el cierre progresivo de los basurales en América Latina y el Caribe. La Coalición que desarrollo una Hoja de Ruta para el cierre progresivo de los basurales y la transición efectiva hacia la gestión integral de residuos en la región, así como promover el desarrollo de orientaciones técnicas, facilitar el fortalecimiento de capacidades e intercambio de información, y sensibilizar sobre la importancia de la correcta gestión de los residuos. Este marco requiere de la intervención y la acción en nuestro espacio territorial, donde en primer lugar consideraremos la situación y perspectiva regional

Entre los grandes problemas ambientales que presentan las provincias del Nordeste Argentino (NEA), en el marco de la Región Transfronteriza, principalmente con Paraguay y Brasil y en particular las ciudades intermedias, se encuentra la gestión y disposición final inadecuadas de sus residuos sólidos urbanos (RSU), con el consiguiente alto impacto ambiental negativo. Esta situación se ha mantenido en las últimas décadas.

En la mayoría de las ciudades pequeñas y medianas de la región, no se cuenta con datos precisos sobre las características, la composición ni la cantidad de residuos que gestionan a diario. En todas ellas, se toman decisiones que afectan la ejecución presupuestaria de los gobiernos locales sin datos ni estudios de referencia, lo que genera dos situaciones muy comunes: por un lado, se evita la inversión; por otro, se realizan gastos e inversiones con base en una decisión política, pero acompañada de errores técnicos instrumentales.

El estudio y las acciones en desarrollo pretenden definir la situación heredada y actual de la región en relación a la gestión de RSU, al ambiente y su entorno, identificando y valorando la naturaleza e importancia tanto en las deficiencias como de las fortalezas encontradas y las necesidades para poder desarrollar una transformación de la gestión de residuos hacia la economía circular.

Este trabajo forma parte del proyecto de investigación "PROYECTO URBANO Y ARQUITECTÓNICO para CIUDADES SOSTENIBLES" PI-22-U002, acreditado por el Consejo Superior de la Universidad Nacional del Nordeste. Se enmarca en los Temas Estratégicos Prioritarios del Área Temática: Medio Ambiente y Sostenibilidad, en el marco de la Docencia y la Investigación Universitarias.

Palabras clave: Nueva Agenda Urbana, ODS2030, GIRSU, Economía Circular, Tecnología de Gestión

RELLENOS SANITARIOS

168. Uso de revestimientos de arcilla geosintética en rellenos sanitarios con taludes importantes.

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Los revestimientos geosintéticos de arcilla GCL son materiales compuestos fabricados industrialmente que combinan arcilla de bentonita y geosintéticos para aplicaciones de sellado: Generalmente, el material está hecho con arcilla y geotextiles no tejidos y tejidos, o alguna combinación de geotextiles y geomembranas. El ángulo de fricción del plano medio mal hidratado de la bentonita aislada se supera mediante punzonado con aguja de todos los componentes, creando un esfuerzo cortante uniforme que se imparte al GCL. Los GCL se utilizan en todo el mundo desde hace casi cuatro décadas, incluida latinoamerica. La norma especifica los requisitos mínimos para la ubicación, diseño, implementación y operación de rellenos sanitarios de diferentes tamaños, para la disposición final de los residuos sólidos urbanos. Los GCL se utilizan generalmente para reemplazar o aumentar los mantos de arcilla compactados. La permeabilidad al GCL suele estar en el rango de ≤ 5 x 10-11 m/s. Una de las principales ventajas de los GCL perforados con aguja es que se pueden instalar en aplicaciones de pendientes pronunciadas (por ejemplo, en una pendiente de 45 m de largo en una aplicación de vertedero en una pendiente de 1:2 (26,6°)). Para tales aplicaciones, es importante evaluar el esfuerzo cortante de la interfaz del GCL y demostrar que el esfuerzo cortante interno del GCL es suficiente para cumplir con los criterios de diseño.

Palabras clave: Residuos, rellenos sanitarios, geosinteticos, medio ambiente, Taludes

COMUNICACIÓN Y ASPECTOS SOCIALES

169. Modelo de organización y gestión centrado en la participación ciudadana para un abordaje más sostenible de la problemática de los residuos en las Sierras Chicas, Córdoba, Argentina.

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Frente a la degradación ambiental que implica el actual modelo de producción y consumo, y el crecimiento poblacional y la concentración urbanística, uno de los desafíos más preocupantes que los municipios enfrentan consiste en la gestión de los residuos sólidos urbanos (RSU). Entre los retos de esta gestión, el económico supone, en un contexto de restricción económica, la formulación de políticas públicas que asignen eficientemente recursos a los procesos claves; el ambiental implica la necesidad de afrontar, desde enfoques más integrales, la gestión de RSU desde los procesos upstream (la comunicación, la educación ambiental y la participación de todos los stakeholders) hasta los procesos downstream (recolección y disposición final), para promover un mejor cuidado del ecosistema; por último, que aquí abordamos, el social comprende, fundamentalmente, generar empleo verde, integrando a los "trabajadores informales" con pleno reconocimiento de sus aportes y garantizando condiciones de trabajo dignas. Así, esos retos mencionados delinean la propuesta contenida en este trabajo, que integra aportes que permitan a los municipios de la región de las Sierras Chicas mejorar la sostenibilidad económica, social y ambiental con la que gestionan sus RSU a través de un tablero de mando integral (TMI) concebido como modelo de organización y gestión del cambio y adaptado al entorno y tipo de organización destinataria. Mediante el desarrollo del TMI, resulta posible mejorar dicha sostenibilidad, de manera tal que, si se modifican las prioridades en la asignación de recursos y se estimula el contacto con la ciudadanía, es esperable que los cambios de hábitos influyan satisfactoriamente en la tasa de generación de residuos y, por tanto, se reduzcan los recursos requeridos y el impacto en el ambiente, a la vez que se promueve la generación de empleo verde. Tras una breve revisión de la problemática de los RSU, se expone el modelo de organización y gestión del cambio basado en el TMI con perspectivas adaptadas para una estrategia que, en vez de buscar rentabilidad, se focaliza en la sostenibilidad como resultado del cambio de los procesos de participación ciudadana, atendiendo a objetivos resultantes de la integración de la ENGIRSU (SAyDS, 2005), los ODS 2030 (ONU, 2015) y los lineamientos de la EC (AEMA, 2017). Luego, se repasa el relevamiento y la evaluación del grado de desarrollo e implementación de la GIRSU en los municipios de la región, en los que se incluyen propuestas tomadas como referencia sobre el posible desempeño del modelo propuesto. Finalmente, se desarrollan las iniciativas estratégicas para cada proceso clave de la GIRSU y una estimación del impacto progresivo en la sostenibilidad específicamente social, sin desatender a la económica y la ambiental, en un período de diez años. Ello permite concluir que sería posible mejorar la triple sostenibilidad, siempre y cuando se garantice el compromiso político y su continuidad como política de Estado.

Palabras clave: Gestión del cambio, GIRSU, Participación ciudadana, Economía Circular, Sostenibilidad

170. Análisis de la implementación de buenas prácticas para mejorar la recolección selectiva y valorización de residuos sólidos domiciliarios. Caso Comas, en Lima Metropolitana.

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Se analiza la gestión de residuos sólidos domiciliarios en el distrito de Comas, Lima Metropolitana, un área con una población de 520 450 habitantes en 2017 y una generación per cápita de 0.81 kg/día, de los cuales el 76% corresponde a residuos orgánicos, el 16.35% a inorgánicos y el 7.65% a peligrosos. Este contexto plantea importantes desafíos para la gestión de residuos en un distrito que busca alinearse con los ODS, como salud y bienestar, ciudades sostenibles, consumo responsable y acción climática. La investigación se centró en identificar prácticas que mejoren la sensibilización y valorización de residuos sólidos, utilizando un enfoque mixto que combinó encuestas a residentes y recicladores, así como la caracterización de residuos en un condominio de edificios de 640 hogares. Las encuestas a los vecinos revelaron que la mayoría desconoce cómo separar correctamente los residuos, lo que evidencia la necesidad de capacitaciones. Aunque califican el servicio de limpieza como "regular", sugieren fomentar la educación ambiental y promover la participación comunitaria. Además, el 60% de los residentes prefieren que la recolección de residuos se realice en horarios nocturnos. En cuanto a los recicladores, quienes enfrentan condiciones laborales precarias y bajos ingresos (en promedio 1100 soles/mes), destacaron problemas como la escasa colaboración vecinal, la entrega inadecuada de residuos y la falta de apoyo municipal para acceder a mercados de reciclaje, aunque valoran las capacitaciones recibidas.

La caracterización de residuos sólidos validó los resultados del Estudio de Caracterización de Residuos Municipales del Distrito de Comas (2023), destacando que los residuos reciclables más comunes son plásticos (35.85%), cartón (23.26%) y papel (5.75%), lo que representa una oportunidad para aumentar la segregación de materiales reciclables. Sin embargo, se identificó que la falta de conocimiento sobre separación y reciclaje en los vecinos limita el aprovechamiento de estos materiales.

Se destaca que la gestión de residuos en Comas enfrenta importantes desafíos, como la baja participación vecinal, la falta de incentivos, la informalidad del sector reciclador y escasos recursos de la municipalidad. Los recicladores, en su mayoría hombres con edades promedio de 49 años, trabajan en condiciones precarias y con bajos ingresos, aunque mantienen una buena relación con la municipalidad y valoran las capacitaciones recibidas. Por otro lado, los vecinos, principalmente propietarios, priorizan el gasto en alimentación y tienen bajos niveles de conocimiento sobre separación de residuos, lo que limita su participación en el reciclaje. A pesar de estas dificultades, el estudio identifica oportunidades para mejorar la gestión de residuos mediante campañas educativas continuas, promoción del compostaje de residuos orgánicos, incentivos municipales para mejorar la participación de los condominios y la formalización del sector reciclador.

Palabras clave: Sensibilización, recicladores, condominio

RECUPERACIÓN DE ENERGÍA

171. Uso potencial de Combustibles Sólidos Recuperados en plantas de coincineración y hornos de cemento: Un caso de Minería de Rellenos en Perú.

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La Minería de Rellenos (LFM) consiste en extraer y recuperar recursos de residuos sólidos dispuestos en rellenos sanitarios, usando tecnologías innovadoras y respetando criterios socioambientales, con el fin de reinsertarlos en los ciclos de materia prima. En Perú, existen rellenos sanitarios desde 1990, muchos ya clausurados, cuyo potencial de valorización aún no ha sido evaluado.

La presente investigación evalúa el potencial de aprovechamiento energético de los residuos sólidos enterrados en un relleno sanitario clausurado en la costa peruana. Para tal fin, se excavaron y analizaron residuos con 9 a 10 años de antigüedad, recolectando 7 muestras de 1 m^3 a una profundidad de 3-4 m en una plataforma clausurada de disposición de residuos sólidos no peligrosos de 0.74 ha y 5 m de altura de relleno. Tras el secado y la separación de las fracciones combustibles (plásticos, madera, papel, entre otros), se analizaron sus propiedades fisicoquímicas para determinar su aceptación y clasificación como combustibles sólidos recuperados (CSR), comparándolos con estándares internacionales generales y específicos para su uso plantas de coincineración y hornos de cemento.

Los resultados demostraron que el 31.09 % en masa de los residuos enterrados corresponde a fracciones combustibles, las cuales presentan una humedad promedio de 4.41 %, un Poder Calorífico Inferior (PCI) entre 13.71 y 15.69 MJ/kg, un contenido de cloro (Cl) de 0.3601 a 0.4141 %, y un contenido de mercurio (Hg) en relación al PCI de 0.021 a 0.027 mg/MJ. Estas características permitieron clasificar a estas fracciones como CSR de código de clase PCI 4 - Cl 2 - Hg 2 según el estándar europeo EN 15359. Además, las concentraciones de As, Cd, Sb, Cr, Pb, Tl, Cu, entre otros metal(oid)es, se encontraron por debajo de límites establecidos en estándares internacionales para el uso de CSR en plantas de coincineración y hornos de cemento, tales como la RAL-GZ 724 (Alemania), el Decreto Ministerial 22 (Italia), la Ordenanza de Incineración de Residuos (Austria), y los Criterios de EURITS para la Coincineración de Residuos en Hornos de Cemento.

La alta proporción de residuos combustibles y los bajos niveles de contaminantes hallados respaldan la Minería de Rellenos (LFM) y la producción de CSR para su uso en plantas de coincineración y hornos de cemento como una alternativa para el post-cierre de rellenos sanitarios en Perú, extendiendo su vida útil y valorizando residuos no biodegradables. No obstante, los bajos valores de PCI representan un reto económico a ser abordado. Se recomienda realizar estudios adicionales que comprendan la mezcla de CSR obtenidos de rellenos sanitarios con residuos frescos de carácter doméstico o industriales para mejorar su calidad.

Palabras clave: Minería de rellenos, combustibles sólidos recuperados, relleno sanitario, plantas de coincineración, hornos de cemento

172. Tecnología al Servicio del Territorio: Recolección Inteligente en Uruguay.

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En un mundo atravesado por la triple crisis planetaria —cambio climático, contaminación y pérdida de biodiversidad—, los residuos sólidos urbanos se posicionan como un componente estratégico en la acción climática. Representan la tercera fuente antropogénica de emisiones de metano, un gas cuyo potencial de calentamiento es unas 80 veces mayor que el del CO_2 en un horizonte de 20 años. Su reducción no solo es prioritaria: es una de las vías más eficientes y rápidas para desacelerar el calentamiento global. En ese escenario, la recolección —frecuentemente invisibilizada — emerge como la bisagra crítica del sistema.

En América Latina y el Caribe, la recolección de residuos enfrenta una doble paradoja: es el componente más costoso, pero también el más rezagado en términos de eficiencia y trazabilidad. Según el BID, el 15% de los residuos no se recolecta y solo el 4% se valoriza en la región, mientras una parte significativa termina en sitios no autorizados o con destino desconocido. En ese contexto, las rutas ineficientes, la falta de trazabilidad y los datos dispersos dificultan la planificación, erosionan la confianza ciudadana y frenan la transición hacia una economía circular.

Ante este desafío, la sinergia entre un gobierno departamental de Uruguay y Ecotecno, replantearon la lógica del sistema. En un territorio donde la población puede triplicarse en temporada alta y la operación de recolección debe adaptarse a condiciones cambiantes, se puso en marcha una transformación: digitalizar un servicio rudimentario para convertirlo en un sistema inteligente. Con GROPP —una plataforma tecnológica de gestión integral—, la recolección dejó de ser un proceso invisible para volverse medible, trazable y optimizable.

Ecotecno convirtió a GROPP en el corazón operativo de su gestión. Con etiquetas RFID en los contenedores, cámaras y tabletas en los camiones y una app conectada en tiempo real, GROPP transforma cada servicio en datos. Los conductores pasaron de operar sin visibilidad a ser protagonistas del sis reportan incidencias, validan servicios y alimentan decisiones con información.

La plataforma ofrece trazabilidad, análisis predictivo, gestión de flotas, planificación dinámica y tableros con indicadores clave. La información fluye del territorio al tablero de decisiones: cada kilómetro recorrido, incidencia reportada e imagen capturada, alimenta un sistema vivo que aprende, se adapta y optimiza.

Los resultados son medibles: menos costos, menos tiempo muerto, menos combustible y más transparencia. Pero el mayor impacto está en lo intangible: más confianza institucional, más equidad territorial y una nueva narrativa sobre el valor del servicio público.

La integración de Ecotecno con GROPP propone una solución flexible, que escala por capas y se adapta a contextos diversos. Y lo hace desde el corazón mismo de la operación: la recolección. Allí, donde cada decisión cuenta, la tecnología deja de ser promesa para convertirse en realidad.

Palabras clave: recolección inteligente de residuos, tecnología de recolección, residuos sólidos urbanos, acción climática, trazabilidad operativa, transformación digital, gestión de flotas, plataformas tecnológicas, América Latina, Uruguay