INCREaSE 2025

INternational CongRess on Engineering and Sustainability in the XXI cEntury

JULY 1-4, 2025
Algarve - Faro, PORTUGAL

BOOK OF ABSTRACTS
POSTER SESSIONS

Editors
Gonçalo Prates
Jorge Semião
Nelson Sousa
Rui Cruz

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4th International Congress on Engineering and Sustainability in the XXI Century
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Preface

This book presents the abstracts of the poster presentations from the 4th International Congress on Engineering and Sustainability in the XXI Century, INCREaSE 2025. This book comprises 44 abstracts from authors from various countries across several interdisciplinary areas, including Climate Change, Food Safety and Quality Engineering, Sustainability in Water Management, Information Technology and Artificial Intelligence Applied to Sustainability, and Sustainable Building Technologies.

INCREaSE 2025 was organized by the Institute of Engineering and hosted by the University of Algarve from July 2 to 4, 2025, in Faro, Portugal.

The members of the organizing committee, reviewers, and authors contributed with their dedicated work and efforts to the success of the congress.

Thank you all!

July 2025

Editors
Gonçalo Prates
Jorge Semião
Nelson Sousa
Rui Cruz

Climate change and mitigation, energy and carbon reduction

Comparison of electrolysis technologies for green hydrogen production and renewable energy integration: Preliminary results

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Abstract. The most widely used method to produce green hydrogen is the electrolysis process. The choice of electrolysis technology, depending on the renewable energy source available, will affect the feasibility of this application. Electrolysis technologies include proton exchange membrane (PEM), anion exchange membrane (AEM), and alkaline electrolyzers. Each technology has key limitations and capabilities that have an impact on its suitability for integration with renewables. Alkaline electrolysis technology has reached a state of technological maturity and stability, as well as affordability, which makes it a viable option for a variety of projects. But their ability to respond effectively to the inherent variability of renewables is limited. On the other hand, PEM electrolyzers are more expensive and have significant durability challenges. However, it performs better as it reacts properly to the fluctuations that are typical of renewable energies. AEM technology is another alternative with great potential. AEM electrolyzers are intermediate in cost between alkaline and PEM, with good efficiency and resistance to demanding operating conditions. However, stability and scalability are still limited. Several tests were carried out to assess the suitability of both technologies. This paper aims to provide a comparative technical study of the three technologies and their potential for applications in the integration of renewable energies.

Keywords: Renewable energies, PEM electrolyzers, AEM electrolyzers, Alkaline electrolyzers.

Degradation observation of PEM electrolyser: voltage and current variations in distant cells

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Abstract. Since November 2024, we have conducted operational measurements on a PEM electrolyser, focusing on voltage and current at both the stack and individual cell levels. Our study reveals a clear pattern: cells located further from the water and gas inlets exhibit higher overvoltages compared to those closer to the supply points. This suggests an uneven distribution of reactants, leading to increased electrical stress on peripheral cells and accelerating local degradation.

To assess long-term performance trends, we compared our recent data with previous measurements from December 2019. Although the earlier dataset lacks individual cell voltages, it still indicates a decline in overall system efficiency over time. The observed voltage disparities reinforce the hypothesis that degradation mechanisms are influenced by flow distribution and stack architecture.

Our findings highlight the importance of detailed monitoring at the cell level to optimise maintenance strategies and extend electrolyser lifespan. Identifying early signs of degradation allows for targeted interventions, such as adjusting flow distribution or improving stack design. In this presentation, we will discuss our measurement approach, key observations, and their implications for enhancing the reliability and efficiency of PEM electrolysers in hydrogen production.

Keywords: Hydrogen, PEM electrolyser, Degradation, Ageing, Cell overvoltage.

Experimental validation of AEM electrolyzers: test procedures and performance characterization under fluctuating renewable energy sources

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Abstract. This study presents an experimental validation and performance characterization of anion exchange membrane (AEM) electrolyzers under fluctuating renewable energy sources. A comprehensive set of test procedures has been implemented, including long-term stationary tests, electrolyzer operation curve characterization, and photovoltaic solar tests representing a sunny summer, a cloudy winter, and a heavily fluctuating winter profile. These tests assess both steady-state and dynamic performance under increasing levels of transient content, providing a broader range of scenarios beyond current operation practices in the energy industry. By evaluating the electrolyzer's response to varying renewable energy inputs, this work is able to identify key performance trends, efficiency variations, and system adaptability under real-world conditions. The results contribute to a deeper understanding of AEM electrolyzer behavior, supporting the development of more robust energy integration strategies for green hydrogen production. As a result, this work provides a preliminary foundation for improved test methodologies that better reflect practical operating conditions.

Keywords: AEM electrolysis, Green hydrogen, Renewable energy, Experimental validation.

Fuels in the air. Sustainable housing and safety

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Abstract. This paper deals with the transport of fuels in the air for the prevention and protection of extraordinary events (fires and explosions) due to the uncontrolled burning of air-fuel in places such as homes. Hydrogen is taken as the fuel and compared with traditional fuels such as butane and natural gas. In this transport study, an explosive atmosphere volume can be estimated for a fast estimation of the consequences in the event of burning the mixture, the equivalent conversion to TNT, providing design criteria to improve safety in homes.

Keywords: Decarbonization, Safety, Fuels, Hydrogen, Butane, Natural gas, Methane, Explosions, Fires, Housing, Design.

Integration of biomass gasification and water electrolysis plants for renewable hydrogen production

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Abstract. Water electrolysis is a well-established route to produce hydrogen from renewable sources, using electricity to split the water molecule into hydrogen and oxygen using different technologies (alkaline, proton exchange membrane, anion exchange membrane, or solid oxide electrolysis).
On the other hand, biomass gasification is a mature technology that produces renewable hydrogen and other products in a controlled process using heat and a gasification medium, typically air, steam, or oxygen. The main product of biomass gasification is a mixture of gases, called synthesis gas or syngas, whose composition and calorific value depend on, among other factors, the feedstock and the gasifying agent. Typical components of such syngas are carbon monoxide, hydrogen, methane, nitrogen (especially when air is used as the gasification agent), carbon dioxide, other lighter hydrocarbons, and traces of heavier hydrocarbons, etc. The syngas can be used directly as fuel, to produce renewable fuels, or hydrogen gas after a purification process.
The present study will assess the technical and economic feasibility of integrating both technologies, biomass gasification and water electrolysis, in a hybrid plant for different applications, including the production of a hydrogen-rich synthesis gas for renewable fuel production and the production of pure hydrogen for use in fuel cells. The analysis will include a simple modelling of the integrated plant, evaluating the appropriate sizing of the gasification and electrolysis systems and purification requirements, as well as the potential use of oxygen and heat from electrolysis in the gasification process.

Keywords: Hydrogen production, Biomass gasification, Water electrolysis, Renewable energy.

Management of hybrid energy storage systems

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Abstract. Driven by the growth in renewable energy (RE) and electric vehicle markets, the global battery sector is experiencing rapid growth. This expansion is facilitated by improvements in battery performance modeling, advanced management systems, and optimized economic and energy algorithms. A key area of innovation is the development of hybrid energy storage systems (HESS), which are increasingly being researched and demonstrated for their effectiveness in grid integration with RE and the implementation of advanced energy management strategies. The integration of complementary storage technologies within HESS aims to significantly improve competitiveness, optimize energy utilization, and enhance grid stability.

The Renewable Energies Chair of the University of Évora is developing a simulation tool to optimize the sizing and energy management of HESS. To validate the effectiveness of optimized HESS solutions, we use our microgrid, which is made up of different technologies for energy storage and production. In this work, we evaluate the technical, energetic, and economic performance of integrating second-life lithium-ion batteries and a vanadium redox flow battery into our PV-powered microgrid.

This comprehensive tool simulates system performance across diverse conditions and integrates user specifications. It enables real-time algorithm implementation for optimized HESS, including solar PV integration, and supports multi-objective optimization. It also facilitates the identification of application-specific ESS solutions by considering load profiles, client needs, spatial constraints, technical limitations, and local factors.

Preliminary results and integration strategies are presented. The insights gained from this real-world validation process will further refine and enhance the accuracy of the simulation tool.

Keywords: Energy, Batteries, Photovoltaics, Storage.

Relationship of air quality with other influencing parameters in the cities of Algeciras and Faro

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Abstract. More and more health problems related to air quality are becoming known. In this work, we want to analyze the influence of environmental parameters related to the quality of the air that citizens breathe, focusing the study on the cities of Algeciras (Spain) and Faro (Portugal). To this end, air quality indices and their relationship with temperature, intensity, and direction of the wind have been monitored and interpreted for one hundred days.

We find it interesting to analyze and compare pollution between both cities, as they have similar infrastructures yet are located in very different environments. We believe it is important to understand which indicators contribute to poorer air quality and their influence. In the case of O_3, it appears as a secondary pollutant resulting from the reaction between atmospheric O_2, solar radiation, and a catalytic element (which could be unburned hydrocarbons).

It will be necessary to identify mediating sites and, if possible, the most industrialized or traffic-heavy areas that could generate pollution. We must not forget that the proximity of other cities could also contribute to the pollution generated. As conclusion, we will carefully consider monitoring other parameters that are relevant for future conclusions, proposing pollution mitigation measures, and measures that the population should take to avoid the effects of pollution. The latest data for air quality officially compiled in Portugal and Spain are for 2023. According to AQI classification, the air quality in Algeciras has the values: 1% of very poor, 4% of poor and 17% in moderate quality. PM10 and PM2.5 are the pollutants that contribute most to low air quality. In Faro, there is no record of days with very poor air quality. The worst periods for air quality in Faro account for 3% of poor and 7% of average air quality. In Faro, the concentration of particles also contributes to the reduction in air quality.

Keywords: Air quality, Pollution, Temperature, Wind.

Technical-economic feasibility study of hydrogen production via direct gasification of refuse derived fuel

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Abstract. The energy transition towards a sustainable future requires innovative solutions for hydrogen production from alternative sources. This study investigates the technical and economic feasibility of producing H_2 from the thermal gasification of refuse-derived fuel (RDF), comparing two technological configurations.

In the first scenario, the syngas generated through the direct gasification of RDF is used to generate electricity in a gas turbine, which subsequently powers a proton exchange membrane (PEM) electrolyser for hydrogen production. This process also captures carbon dioxide from the exhaust gases. In the second scenario, the syngas undergoes steam reforming to increase hydrogen yield, followed by a gas separation system. The results indicate that both configurations are viable, with overall energy efficiencies of 37.55% and 33.07%, respectively. The economic analysis demonstrates a hydrogen production cost ranging between 4.30 €/kg and 4.59 €/kg, with positive net present value (NPV) values and an internal rate of return (IRR) above 13%, indicating investment attractiveness.

These findings suggest that producing hydrogen from RDF not only reduces the environmental impact of waste but also offers an economically viable alternative for sustainable hydrogen generation, contributing to the decarbonization of the energy sector.

Keywords: Gasification, Hydrogen, RDF (Refuse-Derived Fuel), Sustainability, Economic feasibility.

Unlocking the potential of decentralized solar PV in residential buildings: a data-driven approach to energy certification

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Abstract. The decentralized potential for solar photovoltaic (PV) utilization on rooftops and building covers remains significantly underexploited in Portugal. Currently, the energy generated by PV systems installed in residential buildings accounts for only about 2% of this potential. Investing in a solar PV system can be considered an Energy Efficiency Improvement Measure (EEIM) for a residential building and, as such, is evaluated within the framework of the Energy Performance Certificate (EPC) issuance process. This certificate serves as a crucial decision-support tool for building owners and occupants by presenting key energy and environmental performance indicators, along with estimated investment costs and simple payback periods associated with the proposed EEIM. This study aims to assess the impact of using real electric load profiles in calculating the EPC indicators compared to the results obtained using standardized regulatory profiles. To achieve this, real energy consumption data was directly measured from the electricity meter via a Home Area Network (HAN) communication interface provided by the Distribution System Operator (DSO) for Smart Metering Equipment (SME). The data acquisition and storage system was based on the open-source platform Home Assistant, running as an operating system on a Raspberry Pi minicomputer and integrated with IoT devices. The measurement campaign took place between May 2024 and March 2025. The analysis of daily consumption profiles, with statistical significance, allowed for the assessment of the load shedding potential of regulated energy uses, contributing to the refinement of the proposed calculation methodology.

Keywords: Photovoltaic Systems, Energy performance certificate, Building management Systems, Load profiles, Open source.

Food safety and quality engineering

AI-driven sustainable citrus farming: hyperspectral imaging for nutritional status assessment

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Abstract. This study presents a novel integration of portable hyperspectral imaging and advanced deep learning techniques as a non-invasive technique to assess the nutritional status of citrus plants in real time, predicting a wide range of elements, including macronutrients (N, P, K, Ca, Mg, S) and micronutrients (Fe, Mn, Zn, Cu, B, Mo, Cl, Na). Traditional foliar analysis in laboratories is expensive and time-consuming, requiring expert interpretation. In contrast, hyperspectral imaging captures a wide range of wavelengths, providing insights into leaf pigment composition, water content, and nutrient distribution, offering a faster, non-destructive alternative. By leveraging hyperspectral cameras, particularly the portable Specim IQ, and enhancing them with deep learning models, such as Meta's Segmentation Anything Model, this approach enables instant nutritional status assessment.

The proposed methodology involves the following structured pipeline: field sample collection, hyperspectral imaging of leaves, laboratory foliar analysis for ground truth labeling, image segmentation, data preprocessing, feature extraction, and machine learning model training using AutoML techniques.

Our preliminary approach demonstrates that simple statistical summaries (mean spectral values of segmented leaf regions) are sufficient to achieve strong predictive accuracy, with mean absolute errors of 0.227 for N, 0.019 for P, and 0.227 for K, each corresponding to less than 15% relative error.

This combination of portable hardware and full-range nutrient assessment represents a significant advancement over prior work, which often relied on lab-based systems or limited nutrient estimation. The resulting tool offers a scalable, field-deployable solution for citrus growers, supporting timely and cost-effective decisions in fertilization and irrigation management.

Keywords: Hyperspectral imaging, Precision agriculture, Deep learning, AutoML.

Antimicrobial properties of sodium alginate films loaded with laurel and olive leaves extracts

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Abstract. The application of edible films is a promising approach to food preservation and environmental sustainability. This study aimed to evaluate the antimicrobial properties of sodium alginate films (SA) impregnated with laurel (LLE) and olive (OLE) leaf extracts against foodborne pathogens. SA (1%) and glycerol (0.5%) were mixed in distilled water overnight. Then, freeze-dried extracts obtained by ultrasonic-assisted extraction were dissolved in distilled water and added: LLE 0.5% + OLE 0.5% and LLE 1% + OLE 1%. The films were cast and dried at 35 ºC for 24 h. The antimicrobial activity was determined at 0 and 24 h by the viable cell count assay against *Listeria monocytogenes*, *Staphylococcus aureus*, *Salmonella* Typhimurium, *Enterococcus faecalis*, and *Escherichia coli*. Samples with 0.1 g in 2 mL of brain heart infusion broth (BHI) were inoculated with ~10^6 CFU/mL of each microorganism (standardized by OD600) and incubated at 37 ºC. The counts increased for all samples after 24 h. No antimicrobial activity was observed for SA films without extracts. The best results were observed for SA+LLE1%+OLE1% after 24 h against *S. aureus* and *L. monocytogenes* with lower counts of 1.95 and 1.64 log CFU/g, respectively. The use of LLE1%+OLE1% also resulted in lower counts of 1.33, 1.14, and 0.85 log CFU/g for *S.* Typhimurium, *E. faecalis*, and *E. coli*, respectively.

The extracts incorporation may contribute to foodborne pathogens control, thereby supporting regulatory compliance. The absence of *L. monocytogenes* or *Salmonella* is required for certain products. The films may assist in achieving these standards, particularly with lower contamination levels.

Keywords: Edible films, Plant extracts, Antimicrobial activity, Foodborne pathogens.

Development of chemometrics techniques for the analysis of temporal spectral data

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Abstract. The traditional application of Vis-NIR spectroscopy in post-harvest fruit analysis focuses on predicting internal quality attributes (IQA) based on reflectance spectra. While this method is effective for parameters such as Soluble Solids Content (SSC) and Dry Matter (DM), its reliability decreases for other attributes, such as titratable acidity, pH, firmness, and starch, which show inconsistent results. We classify these parameters as Predictable IQA (PIQA) and Not Predictable IQA (NPIQA). A key limitation of Vis-NIR spectroscopy arises from the broad and overlapping nature of absorption bands, where spectral features are primarily dominated by water absorption and structural tissue effects. Despite this lack of specificity, PIQA can still be reliably estimated due to their significant presence in fruit composition. However, the inversion of spectral data into PIQA values is complex due to contamination from various chemical and structural interferences. While PIQA provides a glimpse of fruit quality at a given time, tracking its temporal evolution is crucial for orchard management and determining the Optimal Harvest Date (OHD). Traditionally, this is achieved by sampling fruits over time and observing IQA progression. This work explores an alternative approach by analyzing the temporal evolution of spectral data rather than relying solely on IQA predictions. By maintaining the integrity of spectral information, new insights into physiological changes can be inferred. Spectral history can be analyzed either by tracking individual fruits or by averaging spectra from multiple samples over time. The latter approach, which reduces noise and instrumental drift, is more practical for orchard management. A critical challenge in temporal spectral analysis is distinguishing true chemical changes from baseline shifts caused by structural modifications. Statistical methods such as t-tests and Wilcoxon Rank Sum Tests (WRST) must be applied with caution, as they may produce misleading conclusions if spectral variations due to light scattering are not accounted for. To address these challenges, this study explores chemometric preprocessing techniques to minimize unwanted variations and enhance spectral comparisons. In this preliminary work we present the first results of the method based on spectral simulations and the application of basic chemometric preprocessing techniques, such as normalizations, standard normal variate (SNV) and multiplicative scatter correction (MSC).

Keywords: Vis-NIR Spectroscopy; Post-harvest; Chemometrics; Internal quality attributes.

Enhancing fresh-cut pomegranate arils with fortified edible coatings derived from fruit by-products

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Abstract. Pomegranate arils are rich in antioxidants, vitamins, and fiber, making them an attractive choice for health-conscious consumers. Despite their benefits, their widespread consumption faces challenges due to the difficulty of the fruit peeling process and the highly perishable nature of the arils. Their short shelf life often leads to spoilage, prompting the exploration of preservation methods, including the development of edible coatings made from natural by-products, which is the objective of this study. To this end, by-products of avocado, pomegranate, and lemon were used to reformulate edible coatings aimed at extending shelf life. The antioxidant capacity of the coatings and the coated arils was evaluated using FRAP and ABTS assays. A microbial analysis (total viable count) was also conducted over one week of storage at 5 °C. FRAP results showed that pomegranate-based coatings contained approximately 12 mg Trolox equivalents/kg, compared to ~4 mg for avocado and ~0.5 mg for lemon. Furthermore, when applied to pomegranate arils, pomegranate-based coatings led to a slight increase in antioxidant capacity, followed by coatings from avocado and lemon, while lemon-based coatings achieved the greatest reduction in aerobic bacteria after one week, decreasing counts by ~0.5 log CFU/g compared to the uncoated control. In conclusion, while further optimization is needed, fruit by-products such as pomegranate, lemon, and avocado show promise as ingredients for fortified edible coatings that can extend shelf life and enhance the nutritional quality of fresh-cut products.

Keywords: *Punica granatum*, Food losses, Revalorization, Phenolic compounds, Antioxidants.

Evaluating thermal shock efficacy for *Salmonella* inactivation in carbonara: A HACCP validation approach

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Abstract. To address the dual challenge of preserving culinary tradition and ensuring food safety, this study explores the safe use of fresh eggs in carbonara—a dish traditionally prepared by incorporating raw eggs after cooking. Drawing from a comprehensive literature review, the study examines both the epidemiology of egg-related foodborne illnesses and the intrinsic antimicrobial properties of eggs-namely the cuticle, ovotransferrin, and lysozyme—highlighting their limitations under typical culinary conditions. In the experimental phase, eggs were inoculated with *Salmonella* Enteritidis and incorporated into carbonara dishes prepared under controlled conditions. Three starting pasta temperatures (70 °C, 80 °C, and 90 °C) were evaluated, with temperature profiles monitored and statistical analyses conducted to assess how initial thermal shock impacts bacterial reduction. Detailed temperature decay profiles and their correlation with microbial inactivation emphasize the critical role of precise heat control. Findings indicate that rapid exposure to high temperatures is essential for effective *Salmonella* inactivation (reduced by more than 2 log), whereas extended exposure beyond the initial thermal shock offers minimal additional benefit. Additionally, the study applies HACCP principles to identify critical control points in the cooking process and proposes enhancements—such as incorporating encapsulated antimicrobial compounds - to reduce microbial risk at lower temperatures. This integrative approach not only validates a safe operational window for raw egg use in carbonara but also lays a foundation for developing improved, science-based safety strategies for culinary practices that balance tradition and modern food safety requirements.

Keywords: Carbonara, Raw egg, *Salmonella* Enteritidis, Critical control points, Heat treatment.

Evaluation of commercial fish-based “purée baby foods” for further development of technological strategies to reduce the metal(oids) levels

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Abstract. Fish is rich in essential nutrients, such as polyunsaturated fatty acids, necessary for neurodevelopment in toddlers and young children. In Spain, strategies are being implemented to increase fish servings per week, at home, and in school canteens. However, the presence of heavy metals and metalloids in fish must be considered when formulating infant foods. It is also important to account for the type of fish, production method (wild-caught vs. farmed), fishing/farming area, and industrial processing. This study aims to assess the presence of metal(oids) in fish-based purée baby food products (PBFF) available on the Spanish market as a basis for the development of metal(oids) reduction strategies. The first step was to identify the range of available products and analyse their labelling, focusing on fish content, type, and production method. A mineral profile analysis was then performed by ICP-MS, detecting metal(oids). The study found that PBFF represents 12.04-13.13% of the total purée baby foods, with fish content usually around 8%. Hake was found in over 50% of the PBFF. Few products (28%) specified the production method, but wild-caught hake was commonly identified. Given the vulnerability of the target population, the study could recommend using farmed fish for infant foods, as aquaculture offers better control over metal(oids) levels. Additionally, Spain is the largest aquaculture producer in the EU, making this approach a safer and more sustainable alternative to other production methods. On the other hand, processing methods, such as fish baking, would need to be optimised to lower these compound levels.

Keywords: Purée baby food, Fish, Heavy metals, Metalloids, Reduction strategies.

Evaluation of hand hygiene practices and associated risks in a food production environment

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Abstract. This study aimed to analyze hand hygiene processes in a food production environment and assess the risks associated with these practices. A case study was conducted in a food production unit of a public higher education institution. The research involved on-site observation, totaling 1,076 records. A data collection tool was developed to identify and evaluate risk factors in the hand hygiene process, including the type of washing, drying methods, washing duration, use of hygiene products (soap or antibacterial agent), and washing location. The results indicated that in 86% of observations, the required hand hygiene was not performed. Among these cases, 53% were related to leaving the production area without proper hand hygiene before returning. In 14% of cases where hand hygiene was performed, 27% were unnecessary. Additionally, task change was the primary reason for hand hygiene, representing 27% of cases. Further findings revealed that 65% of hand hygiene occurrences took place in inappropriate locations, 90% lacked proper washing methods, only 34% involved adequate drying, and the average washing time was 6.15 s.
The findings highlight significant gaps in hand hygiene practices in the studied environment, emphasizing the need to reinforce proper hygiene protocols to minimize food safety risks.

Keywords: Hand hygiene, Food production, Risk assessment, Food safety, Hygiene compliance.

Food safety in bacalhau à Brás: Thermal analysis and risk mitigation

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Abstract. Bacalhau à Brás poses a food safety risk due to the addition of raw eggs after cooking. Safety depends on residual temperature, which varies with time and heat dissipation. Understanding this thermal behavior is crucial to ensuring safety while maintaining quality. *Salmonella* spp. causes around 150 million illnesses and 60,000 deaths annually. The HACCP system recommends proper heat processing for foods with raw eggs, as inadequate temperatures may not eliminate biological hazards. This study evaluated the dish's thermal behavior and conducted experimental inoculation tests to assess risk reduction. After cooking, the product's temperature drop was monitored in a controlled environment (24 °C), from 80 °C to 50 °C. The minimum safe temperature (60 °C) was reached in 15.6 minutes, with 50 °C in 27.6 minutes (1.13 °C/min). For inoculation tests, Bacalhau à Brás batches were prepared and subjected to temperatures of 50, 55, 60, 65, 70, and 75 ºC before adding eggs inoculated with *Salmonella*. At 55 °C, bacterial destruction ranged from 99.27% to 99.84%, while at 75 ºC, it reached 99.99%, the only temperature ensuring complete elimination. These findings help determine the safest time to add eggs, reducing health risks. Future research will explore encapsulated antimicrobial compounds to eliminate bacteria at lower temperatures.

Keywords: Risk management, Eggs, Temperature, Gastronomy.

Oxidative stability of chicken meat coated with sodium alginate blended with plant extracts

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Abstract. This study explored the potential of polylactic acid (PLA) packaging combined with sodium alginate-based coatings enriched with laurel (LLE) and olive (OLE) leaves extracts for chicken meat preservation.
Sodium alginate SA (1%) and glycerol (0.5%) were mixed in distilled water overnight. Then, freeze-dried extracts were dissolved in distilled water and added: LLE 2% and OLE 1% + LLE 1%. Chicken breast pieces were coated by spraying, packed in PLA trays and film, and tested for pH, TBARS, and TVB-N for 13 days at 4 ºC. The pH determinations were performed using a pH electrode for penetration measurements. TBARS (mg malondialdehyde (MDA)/kg) was performed colourimetrically using a UV–vis spectrophotometer at 532 nm. The interference generated by TBA-sugar complexes (440 nm) and nonspecific turbidity (600 nm) was removed. The TVB-N (mg/100 g) was determined using an Automatic Distillation and Titration System following the apparatus procedures. LLE+OLE coatings promoted higher pH stability (5.7-5.8) during storage with no significant differences observed, contrary to control samples (5.7-6.0). LLE and LLE+OLE coatings successfully retarded lipid oxidation with no significant changes in TBARS observed during storage. LLE coatings were able to maintain TVB-N values within acceptable limits (25-28 mg/100 g) throughout storage, while control samples exceeded 50 mg/100 g.
The antioxidant properties of phenolic compounds present in plant-based extracts, the protective effects of the coatings against oxygen, and the ability of the extracts to control the growth of proteolytic bacteria may explain the results obtained and show an effective biodegradable and eco-friendly alternative to conventional packaging materials.

Keywords: Edible films, Plant extracts, Oxidative stability, TBARS, TVB-N.

Potential health benefits and ultrasound bioactive compounds extraction of lettuce by-products

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Abstract. Lettuce (*Lactuca sativa*) is a good source of various health-beneficial bioactive compounds, although the losses of this vegetable during its production can reach the 45-60% of the worldwide production. The objective of the present work is to optimize the bioactive compound extraction using ultrasounds (US) as green technology, applied by probe and bath, during 10, 20, 30, and 60 min at 50 ºC in two different solvents (water and methanol). The phenolic content and the antioxidant capacity were spectrophotometrically assessed by Folin-Ciocalteu and FRAP methods, respectively, and the phenolic profile was studied by LC-MS- QqQ. The concentration of phenolic compounds in lettuce extracts was 1.5-6.5 g gallic acid equivalents per kg of sample, while the total antioxidant capacity was of 20-30 g Trolox equivalents per kg of sample. The obtained results showed as the US extraction by probe improved the amount of bioactive compounds extracted by 20% compared to the US bath. Also, methanol solvent was more effective in extracting phenolic compounds (2-fold increase), while water as a solvent extracted higher amounts of organic acids (+35%). By the other hand, the concentration of compounds extracted increased until kept constant after 20 min. In conclusion, although further research is needed to optimize the US extraction, lettuce by-products have been demonstrated to be a good source of antioxidant compounds to be revalorized and reintroduced in a circular economy scenario.

Keywords: *Lactuca sativa*, Food losses, Revalorization, Phenolic compounds, Antioxidants.

Rethinking aquaculture feeds: Technological innovations in sustainable protein alternatives and their influence in the amino acid profile of gilthead seabream

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Abstract. The growth of aquaculture has driven the search for alternative protein sources that reduce dependence on fishmeal and fish oil without compromising product quality while enhancing sustainability. This study evaluates the total amino acid profile in gilthead seabream (*Sparus aurata*) fed with alternative and more sustainable feeds. Animals were farmed at Instituto de Acuicultura Torre de la Sal (IATS), sampling at 300 g and 800 g. Three diets were tested: a control diet (fishmeal and fish oil), and two experimental diets: one based on meat by-products (poultry and pig) and another on single-cell proteins and insects. Kruskal-Wallis and Dunn's tests revealed significant differences in 4-hydroxyproline, serine, and threonine among feeds of different formulations and granulometries, while most amino acids showed no significant variation. These results suggest that alternative protein sources provide a similar amino acid profile to traditional ingredients, ensuring adequate nutritional intake. However, it remains to be confirmed if these differences could affect the fish's amino acid composition, sensory attributes and nutritional value. To analyze the fish total amino acid profile, samples will undergo LC/MS-MS after three hydrolysis methods: acid hydrolysis, for quantifying: Arg, Asp, Cys, Glu, Gly, His, Ile, Leu, Lys, Phe, Pro, Ser, Thr, Tyr and Val; acid hydrolysis with pre-oxidation, for Cys; and alkaline hydrolysis, for Trp and Ala. These alternative diets promote sustainability by utilizing underexploited resources, but further research is needed to evaluate their impact on fish quality and food safety before large-scale implementation.

Keywords: Sustainable aquaculture, Alternative protein sources, Total amino acid profile, By-product feed, *Sparus aurata*.

Information technology and artificial intelligence applied to sustainability

AMURA – ZIDAY: a smart solution for early spill detection.

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Abstract. The occurrence of large oil spills from tankers has been clearly decreasing since the 1970s, but the majority of spills are small (84% according to ITOPF, 2006) and many of them go undetected. For instance, according to COPERNICUS, in 2020, only a third of the 7.672 potential oil spills detected had a response, and only 208 were finally confirmed as oil spills. This low percentage of confirmed cases is because existing technologies are not capable to accurately identifying spills on sea. This is particularly relevant in ports, where a high density of marine traffic and bunkering operations occurs. To address this, the Algeciras Bay Port Authority (APBA) has validated the use of a digital decision-making support tool for monitoring the marine environment through satellite images. The tool has been developed by two Spanish start-ups (Hiades and Orbital EOS), and it uses 10 m resolution satellite images from Copernicus´s Sentinel 1 and 2 constellations. It analyses 25 images per month, from ESA and NASA. The primary function of the tool is oil-spill detection, with capabilities to characterize the type of product involved. Additionally, the integration of AIS (Automatic Identification System) data makes it possible to identify the source of spills and helps identify the possible causes of marine pollution incidents by analyzing the trajectories and maneuvers of vessels in the vicinity. The platform also includes automatic reporting features to quickly respond to these incidents. Future stages will integrate in-situ measurement devices and operational forecasting to enhance accuracy and effectiveness.

Keywords: Oil-spill detection, AI, Satellite images, AIS data, Marine pollution.

Integrating data assimilation and machine learning for enhancing wave forecast accuracy

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Abstract. Accurate predictions of wave height are crucial for human well-being and safety along our coastlines. To date, there are several wave forecast systems based on physics-based numerical models, AI, and data assimilation. Since these systems can lack accuracy, it is crucial to create methodologies to develop more reliable predictions. In this regard, data assimilation utilizing the so-called 'Error-Prediction' method can be a suitable approach to improve model predictions. Following this method, the errors between wave height observed and predicted wave height values will be computed, and then tools able to predict these errors will be developed. Finally, the forecast predictions will be adjusted. Machine learning (ML) algorithms are very suitable tools for predicting the error due to their excellent ability to simulate non-linear mechanisms governing physical processes. Thus, the main goal of this project is to explore the suitability of data assimilation and ML to improve the accuracy of the Iberia–Biscay-Ireland (IBI) system run by the Spanish agency Puertos del Estado to forecast wave conditions up to 24 hours. Among the numerous ML techniques, we will focus on exploring artificial neural networks and deep learning algorithms to predict the errors based on wave and meteorological conditions. The Portuguese coast was selected as a case study with up to nine buoys and forecast information since 2018. This data will be used for ML model development, training, and verification. Once implemented, we envision these techniques will improve wave prediction to better support sustainable ocean-related activities and risk reduction planning.

Keywords: Wave height prediction, Error-prediction, Iberia-Biscay-Ireland system, Deep learning, Sustainable blue economy.

Optimized energy management and control strategies applied to small and medium prosumers smart grids

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Abstract. Prosumers have emerged as an alternative for energy management in smart grids. In these systems, prosumers both generate and consume energy, but also establish a higher level of control over the energy balance. This context allows for the establishment of strategies that optimize the availability of the prosumer's energy resources, individually and in conjunction with the rest of the system where it is integrated. To establish and validate specific management strategies between energy prosumers, this work analyzes the optimization of the control of these remotely interconnected systems. Each prosumer system is made up of an energy laboratory, based on microgrid technology and electrochemical storage. Firstly, this will be tested in the INTA's microgrid, which is based on photovoltaic fields, batteries, and supercapacitors storage systems, along with hydrogen technologies. This microgrid will be both managed locally and will also consider external parameters from the rest of AGERAR Plus energy facilities. The control strategy between prosumers evaluates the key variables of these elements, their operating ranges and the establishment of operating modes that respond to a balance between all the prosumers that establish the network. The main parameters considered are power levels, state of charge, availability of supply resources, as well as the demand of each prosumer. Energy management between prosumers proves to be a more effective alternative, giving greater scope of operation to the global system and optimizing the elements of each microgrid.

Keywords: Prosumers, Renewables, Sustainability, Energy management.

Smart rooms to smart hotels: HVAC optimization and indoor temperature prediction. A machine learning approach

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Abstract: This study focuses on building a machine learning model to enhance energy efficiency and optimization in 4-star and 5-star hotels with a centralized climatization system. The machine learning (ML) model will predict the future temperatures of hotel rooms over the next twenty-four hours. The goal is to maintain room temperatures within a comfort range (20 ºC – 25 ºC) while optimizing the usage of the chiller, as it is the main source of electricity consumption and can significantly reduce operational cost while cooling or heating rooms. To train our ML models, we collected data from temperature and humidity sensors installed in hotel rooms and used XGBoost, Random Forest, and Linear Regression as our main algorithms. All three algorithms generated good results for our model, with R^2 values ranging between 79% and 83%, while XGBoost led at 83.24%. These results demonstrate the importance of maintaining room temperatures within the comfort range to improve guest experience, satisfaction, and identify the optimal setpoint for the chiller, reducing energy waste.

Keywords: HVAC Optimization, Chiller setpoint, Machine learning, XGBoost, Energy optimization.

Sustainability in water management

Comparison of different potential evapotranspiration datasets for mainland Portugal

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Abstract. The study presents a comprehensive comparative analysis of the spatial patterns and magnitudes of potential evapotranspiration (PET) in mainland Portugal. To this end, PET data from the GLEAM and ERA5-Land reanalysis databases were analyzed alongside PET estimates derived from the Hargreaves - Samani, Thornthwaite, and Penman-Monteith empirical models. The input variables for these models were obtained from ERA5-Land database. The study covers the period from January 1, 1980, to December 31, 2023. Since the reanalysis data and PET estimates have different time scales – daily for the reanalysis data and the Hargreaves-Samani and Penman-Monteith models, and monthly for the Thornthwaite model – not all comparisons are feasible. At this stage, only maps of long-term annual averages are presented. The results obtained so far regarding spatial patterns suggest that the PET GLEAM database is unsuitable for mainland Portugal. In fact, its spatial variability does not align with the established theoretical knowledge, as, for example, it suggests that the hotter, inland southern regions of the country exhibit significantly lower PET than the cooler coastal areas, which contradicts the current state of the art. Except for the Penman-Monteith model, whose computations are still in progress, all the other PET maps display similar and theoretically consistent spatial patterns, although much smoother in the case of Thornthwaite estimates. Regarding the magnitudes, a validation was previously conducted based on 20 ground meteorological stations. The results showed that PET ERA5-Land significantly overestimates the reference values, whereas the PET GLEAM and the estimates from the applied models align closely with them.

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Keywords: Potential evapotranspiration, Reanalysis databases, Empirical models, Mainland Portugal.

Drone-based methodologies for monitoring deformation in coastal breakwaters

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Abstract. The action of waves on coastal defense infrastructures can cause gradual deterioration of these civil works, compromising their integrity and functionality, which can lead to serious economic and environmental losses. Periodic and systematic monitoring during the service life of these elements is essential to identify incipient deformations, changes in the shape of the infrastructure, ensure their stability, and implement targeted maintenance works as needed. Traditionally, deformation control has been carried out by classical survey procedures, which often require laborious monitoring work with a relatively high cost/benefit ratio. This communication presents a novel low-cost methodology based on the use of SfM photogrammetry from drones, which offers numerous operational advantages, such as the possibility of fast and efficient implementation before and after storm events and the obtention of adequate altimetric and planimetric accuracies, ideal for monitoring purposes. Likewise, the methodology allows obtaining information with very high spatial density even when applied to elements of complex geometry, which enables the elaboration of deformation models that aid in the identification of the processes causing the deterioration of the infrastructures and in the design of prevention and mitigation measures. This methodology has been applied to the breakwater of the Guadalete River estuary (Bay of Cadiz, Spain), a 1700 m-long rubble mound breakwater whose distal end is experiencing differential subsidence due to the erosive action of waves and dynamic loads produced during storms. This study presents the instrumentation, methodology and workflow, preliminary results and potential procedural improvements.

Keywords: Structure from motion; UAV, Breakwater, Coastal defense, Structure deformation.

Ecotoxicity of sulfamethoxazole: Impact on freshwater ecosystems and oxidative stress in fish

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Abstract. The study investigates the ecotoxicological effects of sulfamethoxazole (SMX) on various aquatic organisms, including fish (*Cyprinus carpio*), crustaceans (*Daphnia magna*, *Heterocypris incongruens*), microalgae (*Selenastrum capricornutum*) and bacteria (*Escherichia coli*). Acute toxicity tests revealed that the EC50 for microalgae growth was impacted by SMX exposure (EC50-72h 24.77±6.43 mg/L), indicating a harmful inhibitory effect. However, crustaceans and fish did not exhibit observable acute toxic effects at the concentrations tested (10 to 100 mg/L), with their respective LC50 values >100 mg/L.

In a 14-day exposure test, fish were exposed to concentrations of 10 and 100 µg/L SMX. The results showed significant oxidative stress and hepatotoxic effects, demonstrated by substantial changes in enzymatic activities (SOD, CAT, GPX, GRED, GST, G6PDH), particularly in the gills and liver. These effects occurred at concentrations lower than 100 mg/L, where no mortality was registered, suggesting that sublethal doses of SMX may induce significant biochemical changes. The findings highlight the potential ecological risks of SMX, particularly its sublethal effects on fish. While the LC50 values indicate no immediate lethal effects on crustaceans and fish at the tested concentrations, alterations in enzymatic activities and the presence of oxidative stress suggest longer-term ecological impacts.

Keywords: Antibiotics, Sulfamethoxazole, Toxicity, Aquatic effects, Fish, Oxidative stress.

eDNA metabarcoding as an alternative tool for biodiversity monitoring in Romanian freshwater ecosystems

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Abstract. Research addressing alternative genomic tools for environmental bi-monitoring has significantly increased over the last ten years; however, knowledge gaps were reported. Among the most targeted gaps are the need for quality control in reference databases, improved taxonomic coverage for species monitoring in single countries, and the enhancement of barcode libraries to ensure effective use of metabarcoding for biodiversity monitoring. In Romania, the studies approaching environmental DNA (eDNA) metabarcoding are still in their infancy. In this study, we utilize eDNA metabarcoding to obtain comprehensive, DNA-based taxonomic information for the lotic freshwater ecosystem, comparing it with conventional morphological methods. The results from eDNA metabarcoding of water and sediment confirmed the effectiveness of this alternative method for phytoplankton, meio- and macrofaunal communities' taxonomic resolution compared to morphologically-based identification.

Keywords: eDNA metabarcoding, Freshwater ecosystems, Alternative method, Biodiversity.

Estimation of evaporation in Andalusian reservoirs: proposal of an index for the assessment and classification of reservoirs

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Abstract. Evaporation is a key element of the water budget that must be considered during planning and management. In arid and semi-arid climates, evaporation losses from reservoirs account for a significant portion of the annual regulated volume and compromise the efficiency of these infrastructures. This work analyses the evaporative losses from reservoirs of Andalusia (Spain), a Mediterranean region of 87,000 km^2 that is subject to significant water stress. The objective is: (i) to estimate the annual volume evaporated from large reservoirs (> 5 hm^3) and (ii) to propose an index to classify them according to the evaporative losses. Descriptive characteristics, morphometrical, and hydrological information of a total of 76 large reservoirs were retrieved from institutional sources. Subsequently, the monthly average flooded area was calculated from the Area Volume Elevation curve (AVE). The monthly average evaporation rate of each reservoir was calculated through the FAO Penman-Monteith equation using data from the regional network of meteorological stations. The combination of both variables has allowed to estimate the mean monthly volume of water evaporated in each reservoir. The results were contrasted with the isotopic content (^{18}O and ^{2}H) of a selection of the reservoirs studied. The isotopic analysis, particularly the d-excess parameter, supports the observed differences of these reservoirs in terms of evaporation. The annual average volume evaporated from Andalusian reservoirs was estimated at 547 hm^3/year (8.0 % of the inflows). The proposed index can serve as a key instrument for prioritizing investments, redesigning underperforming infrastructures, and integrating evaporation efficiency into sustainable water planning and management.

Keywords: Reservoir Evaporation; Classification index; Andalusian reservoirs; Reservoir efficiency; Isotopic content.

Evaluation of gridded precipitation datasets in the metropolitan region of Belo Horizonte, Brazil

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Abstract. High spatial variability in rainfall needs dense monitoring networks to capture extreme events. However, in many regions – including the Metropolitan Region of Belo Horizonte (MRBH) in Brazil – rain gauge networks are sparse and unevenly distributed, leading to gaps in observational data. As a result, interpolation methods are widely used to generate gridded rainfall products for hydrological modelling. This study evaluates the performance of two such products: the monthly CRU-TS (v4.08) dataset at 0.5° resolution, available during 1901 to 2023 with coverage of all land areas (except Antarctica); and the daily BR-DWGD dataset at 0.1° resolution, available during 1961 to 2024, covering Brazil area. Precipitation from 15 stations (Brazilian National Water Agency) was analyzed, during 2001 to 2023 (data without fails), at both annual and monthly scales. Performance was assessed using Pearson correlation (r), Nash-Sutcliffe efficiency (NSE), and root mean squared error (RMSE). The results demonstrate that the BR-DWGD dataset consistently outperforms CRU-TS – yielding lower RMSE and higher NSE (>0.77) and r (>0.90) at both scales – with its best performance observed at the monthly scale (r > 0.96, NSE > 0.97). These findings support the use of both datasets for representing precipitation in the MRBH, particularly highlighting the robustness of the BR-DWGD dataset. The datasets can be used in regions with scarce observed precipitation. In addition, it can be a practical tool for filling gaps in damaged rain gauges. The datasets will also be important for hydrological modeling that provides tools for water resource management, basin development, and natural disaster prevention.

Keywords: CRU-TS, BR-DWGD, Gridded precipitation, Rainfall interpolation, Hydrological modelling.

Micropollutants in blue-green infrastructures

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Abstract. Project Springiness is a Water4All network-based European consortium of five partners composed of water sector practitioners, blue-green infrastructures (BGI) designers and researchers, water quality analysts, and risk assessment experts with considerable experience in the field. Within the Faculty of Engineering of the University of Porto (FEUP), the research groups involved will carry out the analysis of the proxy compounds in water and other relevant matrices (soil, vegetation) using expedited protocols that observe the principles of Green Analytical Chemistry, and the subsequent estimation of human exposure and risk parameters. The initial action was to conduct a thorough review of the already existing literature on the subject, linked to BGIs. A considerable gap in knowledge was found on the assessment of micropollutants and their potential hazardous effects related to this field, which should be decreased to support the environmental friendliness of these constructions, under the smart cities framework. Nevertheless, it was possible to obtain a list of the most common organic (PAHs) and inorganic (heavy metals) chemicals studied so far (mostly in water matrices), with the respective concentration ranges whenever possible. This review is the first step to address the analysis of water, soil and vegetation matrices from the BGI installations of the project, with the ultimate goal of obtaining proxy compounds for the most relevant families of contaminants to perform the pertinent risk assessment.

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Keywords: Blue-green infrastructures, Microcontaminants, Water, Soil, Vegetation.

Modelling drought classes time series for groundwater monthly assessment and prediction in Algarve region

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Abstract. Log-linear quasi-association models have been successfully applied to analyse and predict drought class transitions derived from standardized precipitation evapotranspiration index (SPEI) time series in Portugal. These kinds of models proved to be suitable for fitting the SPEI drought transitions and are considered a reliable tool for capturing the dynamics of drought severity changes since they estimate the probabilities associated with transitions between the different drought severities. In the context of groundwater drought monitoring, the standardized groundwater index (SGI) is used and is computed from groundwater levels available from the SNIRH piezometric network. The aim is to employ similar models to the transitions between SGI drought classes and compare them with the SPEIs of different accumulation periods for the Algarve region. The purpose is also to evaluate the effectiveness of these tools in predicting short-term transitions in groundwater drought. The findings contribute to improving water management practices and enhancing early warning systems to mitigate the impacts of drought in the Algarve, with potential applications in other parts of the world.

Keywords: Generalized linear models, Loglinear models, Analysis of variance.

Sustainability challenges in urban landscaping: Assessing irrigation demands in Coquimbo, Chile

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Abstract. Urban green areas are essential for environmental quality and social well-being, but maintaining them under water scarcity presents sustainability challenges. This study evaluates current and projected irrigation demands in the city of Coquimbo, located in Chile's arid north, where annual rainfall averages only 130 mm. Using municipal data from 958 water meters and evapotranspiration estimates for two major parks (Tierras Blancas and O'Higgins), the study identifies inefficiencies in water use: Tierras Blancas consumes 98% more water than required, while O'Higgins is under-irrigated by 17%. Projections indicate a 4.56% annual increase in green space and a 2.25% population growth, potentially reaching the World Health Organization's recommended 9 m² of green space per capita by 2036. By 2040, irrigation demand is expected to triple to 2.74 million m³/year. However, Coquimbo's reclaimed wastewater capacity (108,000 m³/day) could sustainably meet this demand if properly managed. These findings highlight the urgent need for optimized irrigation systems and alternative water sources to ensure sustainable urban development in water-stressed regions.

Keywords: Urban green spaces, Irrigation demand, Water scarcity, Sustainability, Coquimbo (Chile).

Sustainable neutralization of acidic wastewater in the petrochemical industry using alkaline industrial residues and real-time monitoring technologies

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Abstract. The petrochemical industry generates highly acidic wastewater due to maintenance activities, whose conventional treatment involves high costs and significant environmental impact due to transportation to specialized treatment plants. This research proposes an in situ neutralization method using alkaline waste from nearby industries, aiming to reduce costs and minimize environmental impact.

The study develops an optimized chemical purification process, continuously monitored in real time through low-cost sensors based on Arduino technology. The efficiency of various alkaline residues in pH neutralization and the quality of the treated water will be evaluated to ensure its feasibility for industrial reuse.

The methodology includes the characterization of acidic wastewater, selection and assessment of alkaline residues, experimental design of the treatment process, and the development of a continuous monitoring system. Expected outcomes include a significant reduction in operational costs, decreased CO_2 emissions, and the promotion of a circular economy model by repurposing industrial waste as a treatment agent.

This innovative approach provides a sustainable and efficient solution for managing acidic wastewater in the petrochemical industry, optimizing treatment processes while aligning with environmental sustainability strategies.

Keywords: Acidic wastewater, Neutralization, Petrochemical industry, Circular economy, Real-time monitoring.

Sustainable rehabilitation: Water and energy management in a house in northern Portugal

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Abstract. Located in the mountains of northern Portugal, in the Arouca region, this project consists of rehabilitating a schist house built 30 years ago, to transform it into a self-sufficient dwelling. Built conventionally and almost empirically, the original structure had spatial, thermal, and structural problems.

Climate change exacerbates water scarcity and wildfire risks in Portugal, particularly affecting agricultural and forested areas. Wildfires are expected to become more frequent, leading to accelerated soil erosion and increased sediment yield in affected catchments. These changes are compounded by socio-ecological vulnerabilities in mountain regions, where population decline and land abandonment have created fire-prone landscapes. The recurrence of fires is altering forest composition, favouring the spread of invasive species, which thrive in post-fire conditions.

Through the integration of high and low technologies and sustainable materials, the aim was to enhance the existing, creating a building in harmony with its inhabitants and the natural context. Thus, dependence on public water and electricity supply networks was reduced by installing an integrated water collection, storage, and treatment system, as well as bio-based and non-toxic materials in the interior, promoting a higher quality of living without long-term carbon impact.

To this end, a rainwater harvesting system has been installed, as well as a compact water purification plant with a low contaminant load and a set of photovoltaic panels with high-efficiency thermal devices, guaranteeing the building's self-sufficiency.

This holistic approach, adapted to the specificity of the place and the client's way of life, connects the project to the needs of the inhabitants, promoting a significant improvement in their quality of life and reducing the environmental impact of construction.

Keywords: Sustainable rehabilitation, Water conservation, Energy efficiency, Bioclimatic architecture, Self-sufficient housing.

The frequency of extreme discharge and rainfall: The case study of Muriaé River (southeast Brazil)

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Abstract. The study aimed to address the non-stationary behavior of extreme hydrological events in the Muriaé River watershed, located in southeast Brazil (approximately 8,126 km²) and particularly prone to flooding. To achieve the study's objectives, a methodology combining the Peaks Over Threshold (POT) sampling technique with a Kernel Occurrence Rate Estimator (KORE) was adopted. Additionally, an exploratory analysis was conducted to examine how large-scale climate variability patterns or teleconnections can provide insights into the behavior of extreme hydrological events. Compared to the traditional Annual Maximum Series (AMS) technique, POT offers the advantage of selecting multiple extreme events per year, provided that specific theoretical assumptions are met. The approach results in larger and more representative samples of extreme events, also enabling an understanding of their temporal frequency. For climate teleconnections, the study focused on the influence of the El Niño–Southern Oscillation (ENSO) on extreme hydrological events. Based on the daily records from 4 stream gauging stations approximately under natural conditions and 8 rain gauges with influence on the watershed of the stations, according to the Thiessen method, the study showed a positive trend in the frequency of most of the extreme events (i.e., exceptional river discharges and rainfall), meaning an increase in the occurrence rate of such events over time. Most floods occurred during the negative phase of the El Niño-Southern Oscillation phenomenon. However, further studies based on other case studies are required to better understand the hydrological behavior of the watersheds in the region and their potential links to climate teleconnections.

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Keywords: Extreme hydrological events, Peak over threshold, Kernel occurrence rate estimator, Climate teleconnections, Southeast Brazil.

Tracing microplastics from agricultural soils to water systems: Toward sustainability and circularity

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Abstract. Microplastics (MPs) are becoming a big problem for the environment because of their persistence, bioavailability, and potential to transport pollutants. In agricultural systems, MPs mainly come from plastic mulching, irrigation, fertilizers, and greenhouse covers. These particles not only degrade soil health and crop productivity, but they are also transported into aquatic systems via leaching, surface runoff, and wind dispersal, where they are introduced to rivers, streams, and oceans. The circular economy (CE) concept applied to the agricultural environment can be used for the ultimate benefit of the soil environment since agricultural soils receive multiple pollutants that pose risks for the soil and water, and for the products grown and human health. The CE concept is based on eliminating waste and pollution, circulating products and materials, and regenerating nature, so understanding the pollution to introduce measures for MPs elimination is a significant contribution to CE and sustainability. Therefore, the abundance and type of MPs pose a challenge in terms of investigating the physicochemical reactions and interactions that can develop between plastics and inorganic or organic compounds present in soils. This study focuses on the pollution of microplastics in agricultural soils and their potential pathways to water systems, highlighting the broader environmental implications and the need for sustainable management. Preliminary results from FTIR spectroscopy show that polyethylene, polypropylene, and polystyrene are the main types of MP found in farmland soils. These findings give ground-level knowledge of MP pollution in the tested soils. Future research will extend to investigate the MP in nearby streams.

Keywords: Microplastics, Agricultural soil, Circular economy, Sustainable development, Microplastic transport.

Sustainable building materials and technologies

Application of advanced coatings for more sustainable automotive industry production tools

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Abstract. This project focuses on the implementation of two approaches to enhance the sustainability of production processes for the automotive sector: advanced coatings applied to manufacturing tools, and the reconditioning of tools and components through powder-based additive manufacturing.
By employing self-adaptive, multifunctional, and sensor-based coatings, it is possible to improve friction, wear, oxidation, and corrosion resistance without the need for harmful lubricants. These coatings, applied via sputtering technologies, will have the ability to monitor production parameters such as pressure and temperature. Key objectives include creating low-friction, anti-adhesive coatings and integrating sensor technologies to enable smart, eco-efficient production, specifically for injection molds, stamping parts, and machining tools, ensuring enhanced performance with reduced environmental impact. Reconditioning involves enhancing the performance of worn tools and components through powder-based additive manufacturing. Techniques such as binder jetting, laser cladding, and HVOF will be used to add materials like WC-Co to worn surfaces, improving hardness and tribological properties. This will not only restore tools but also increase their lifespan, reducing material consumption and CO_2 emissions. The project focuses on the industrial-scale application of these technologies, with particular emphasis on the development of WC-Co powders for use in reconditioning.
The use of the coatings is expected to lead to a reduction of approximately 330 tons of CO_2 equivalent per year through enhanced tool lifespans and reduced material waste. The reconditioning approach should lead to a reduction of about 106 tons of CO_2 equivalent annually through tool recovery and the extended life of reconditioned components. Together, these approaches aim to significantly reduce the environmental impact of the associated industrial processes while enhancing manufacturing efficiency.

Keywords: Sustainable manufacturing, Smart coatings, Additive manufacturing, Tool reconditioning, Environmental efficiency.

Circular economy approach in the sustainable production of ceramic bricks incorporating water treatment sludge from Algarve

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Abstract. The production of sludge in the water treatment process represents a significant environmental challenge, since its predominant destination is landfills, resulting in waste accumulation. This research aims to assess the technical feasibility of incorporating three Algarve water treatment sludges into the production of ceramic bricks, promoting a sustainable approach based on circular economy principles.

To achieve it, a physical and chemical characterization of the sludge was conducted, where mixtures of clay soil with different proportions of these "residues" were formulated. The resulting samples underwent sintering processes and were tested in order to determine the mechanical strength, water absorption, and ap- apparent density. Subsequently, the results were analyzed, aiming for the optimal sludge content that can be incorporated without compromising the structural properties of this sustainable and innovative ceramic material.

According to the outcomes, it's possible to incorporate 10% of sludges with the clay soil, without significantly affecting the mechanical properties of the bricks, ensuring compliance with regulatory quality standards. This approach enables the reduction of clay raw consumption, minimizes sludge disposal in landfills, and mitigates the environmental impact of the ceramic sector.

In conclusion, the reuse of water treatment sludge in ceramic production represents a viable strategy from both technical and environmental perspectives, supporting the sustainable management of resources and contributing to the transition towards an engineering circular economy.

Keywords: Materials innovation, Water treatment sludges, Águas do Algarve, S.A., Sustainable ceramics, Circular engineering.

Development of geopolymers from industrial waste: Mechanical properties analysis and sustainable applications

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Abstract. The construction sector is one of the most resource-intensive industries and a major contributor to greenhouse gas emissions, particularly in the production of cement and ceramics. In response, sustainable materials such as geopolymers have emerged. These inorganic binders, formed through the alkaline activation of silica- and alumina-rich materials, offer a low-carbon alternative, as their synthesis requires lower temperatures and facilitates waste valorization.

This study investigates the development of geopolymers using industrial by-products and mining residues to replace traditional ceramics. The selected waste materials underwent physicochemical characterization to assess their suitability as precursors. Various test specimens were then prepared with different alkaline activator proportions and subjected to mechanical and physical testing to evaluate their properties.

The results identified an optimal combination of waste materials and activators, yielding a geopolymer with mechanical and physical properties comparable to conventional materials. This highlights its potential for construction applications, reducing reliance on virgin raw materials and mitigating the sector's environmental impact.

The primary environmental benefits of this research include reduced CO_2 emissions, lower energy consumption, and enhanced waste valorization. By promoting a circular economy, this study advances innovative and sustainable alternatives that address contemporary challenges in construction.

Keywords: Geopolymers, Sustainability, Circular economy, Industrial waste, Mechanical properties.

Environmental analysis on the use of thin films in automotive interior components

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Abstract. This project explores the implementation of an innovation in the automotive industry by applying thin-film sensors to functionalize plastic component surfaces. Specifically, it examines the use of Physical Vapor Deposition (PVD) sensorial thin film coatings for car interior components.
The study presents an environmental assessment of two central consoles (automatic gear) to evaluate the replacement of the traditional commercial console with a novel design incorporating PVD-based sensorial coatings. The environmental impact of these consoles was assessed using life cycle assessment (LCA) methodology. A detailed cradle-to-grave process model was developed to analyze the environmental burdens associated with each system. The functional unit was one central console (traditional and novel), with system boundaries extending from raw material extraction through production to end-of-life (EoL) disposal.
Key environmental impact drivers were identified to support development and commercialization efforts. A scenario study and sensitivity analysis were conducted to examine the system's response to variations in model assumptions, scenarios, and parameters. Through this study, it is possible to have a better understanding of the environmental advantages and disadvantages of this recent technology for the automotive industry compared to an existing industry-standard product, and can thus help decision-making for new products in this sector.

Keywords: Sustainable manufacturing, Life cycle assessment, Smart coatings, Automotive industry, Physical vapor deposition.

Geotechnical stabilization of marls using ashes from coal-fired thermal power plants: Analysis of mechanical properties and soil behaviour optimization

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Abstract. In road construction, the presence of marls with high plasticity, expansiveness, and low bearing capacity poses a significant challenge to ground stability. Traditionally, stabilization is achieved through the addition of lime and cement. However, this study investigates the use of ashes derived from coal-fired thermal power plants as a more sustainable and efficient alternative.

To assess their effectiveness, both the physical and chemical properties of the marls and the ashes were analysed. A series of tests was conducted to determine the variations in Atterberg Limits, optimal compaction levels, and California Bearing Ratio (CBR) strength over time for different percentages of ash incorporation.

The results indicate that the addition of ashes from coal-fired thermal power plants significantly enhances the mechanical properties of the soil. With a 10% ash content, the CBR strength quadruples, while the soil's expansiveness is drastically reduced with only 5% ash incorporation. Furthermore, no significant variations were observed in the optimal moisture content or maximum dry density, thereby facilitating application without requiring additional compaction energy. This approach not only optimises soil performance but also aligns with the principles of the circular economy by repurposing an industrial by-product. The stabilization of soils with ashes from coal-fired thermal power plants reduces reliance on conventional materials and mitigates environmental impact, offering an efficient, cost-effective, and sustainable solution for enhancing the durability and safety of road infrastructure.

Keywords: Soil stabilization, Coal-fired power plant ashes, Mechanical properties, Circular economy, California bearing ratio (CBR).

Sustainable polymer materials: The impact of the ageing process on polyurethane composites with waste biomass filler

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Abstract. Polyurethane (PU) elastomers are versatile polymeric materials widely used in numerous industries due to their exceptional mechanical properties and chemical resistance. They are commonly used in applications such as automotive suspension bushings, industrial rollers, seals, gaskets, and medical device components. The growing demand for durable and sustainable polyurethane materials has driven research into the development of novel formulations.

The depletion of non-renewable resources, along with the need to reduce production costs, implement circular economy principles, and lower the carbon footprint of plastics, makes it necessary to create sustainable materials based on renewable feedstocks. The research explores the long-term stability of PU composites filled with waste biomass from wild black cherry wood (*Prunus serotina*), an invasive plant species. A comparison was drawn between the biocomposite and a reference PU elastomer that did not contain the biomass filler. The main goal was to assess the influence of the accelerated ageing process on the mechanical properties of the composites created. The materials were exposed to controlled ageing in a climatic chamber Q-LAB QUV/SPRAY according to the standard ISO 4892-3. Subsequently, the mechanical properties (tensile strength, elongation at break, abrasion resistance, and hardness) were tested.

The findings offer valuable insights into the development of sustainable PU materials and their durability in the long term. The use of waste biomass as a biofiller aligns with ongoing efforts to promote eco-friendly polymer composites.

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Keywords: Polyurethane elastomer, composite, natural filler, circular economy, accelerated ageing.

The process of accelerated ageing of wood-polymer composites and its effect on materials' performance properties

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Abstract. According to the circular economy, existing materials and products should be reused, repaired, renovated, and recycled for as long as possible. The wood-polymer composites (WPCs) obtained in the results were obtained from recycled polypropylene and the wood of the black cherry, an invasive species in Europe. Regulating the growth of this species results in the generation of a very large amount of waste biomass, which, through fragmentation and chemical modification, is suitable for use as a filler in WPCs, allowing the management of waste of renewable origin. The main objective of this work was to find a relation between WPCs accelerated aging and material properties. The wood used for the composites tested was functionalized with citric acid and sorbitol, well known for biocidal effects, to check the durability of the composites in external conditions. Samples with a filler content of 10% were subjected to accelerated aging in an ageing chamber (with UV exposure, temperature reaching 60 °C, and high humidity) for 250 and 500 h, and their properties were determined by mechanical, thermal, and structural tests. It was shown that the bending Young modulus decreased by 30% for PP and by 24% for WPCs. Hardness, bending strength, and crystallinity degree were comparable for PP and WPCs after aging. The results obtained confirm the potential of the obtained materials for outdoor applications, such as decking boards or furniture, and prove the beneficial effect of wood on WPC properties after ageing.

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Keywords: Polymer composites, Renewable filler, Circular economy, Weathering, Ageing.

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