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Date:

December 3rd-4th, 2024

Venue:

Oujda, Morocco

Editors:

- Prof. Kamal Hirech, Higher School of Education and Training, Mohammed First University, Oujda, Morocco
- Mr. Rachid Hjaji, Hanns Seidel Fondation

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Preface

The Proceedings of the International Conference on Education and Environment 2024 (ICEE24) bring together the abstracts of keynotes and research papers presented at the ICEE24 Conference, organized by the Higher School of Education and Training of Oujda-Morocco in partnership with the Hanns Seidel Foundation and the Green Initiatives Center. The conference was held at the Knowledge Campus, Mohammed First University, Oujda-Morocco, on December 3 and 4, 2024. This event served as a vital forum for discussing the intersection of education, environmental sustainability, and sustainable development, emphasizing how innovative practices and knowledge exchange can foster a greener and more resilient future.

ICEE24 brought together leading experts, educators, researchers, and policymakers to explore and debate pressing global challenges. The themes spanned environmental education, green technologies, renewable energies, ecological conservation, and sustainable industrial practices. The conference aimed to highlight groundbreaking research and practical approaches to addressing environmental emergencies while promoting concrete strategies that contribute to achieving global sustainability goals.

The abstracts in this collection provide an overview of advancements and discussions across several key areas. Topics include strategies for environmental education for future generations, integrating sustainability into academic curricula, advancements in renewable energy technologies, green transition policies, biodiversity conservation methods, and the socio-economic impacts of sustainable practices on communities and industries. These contributions underscore the importance of interdisciplinary and global collaboration in shaping educational frameworks and technological innovations capable of addressing environmental crises.

ICEE24 also played a crucial role in fostering international collaboration and knowledge exchange. The participation of attendees from multiple countries, both in person and virtually, enriched the discussions and highlighted the importance of collective efforts in tackling complex environmental challenges.

We extend our deepest gratitude to all the authors, members of the organizing and scientific committees, and participants from various institutions and countries whose contributions ensured the success of ICEE24. Their dedication, expertise, and collaborative spirit have made this event a success and paved the way for fruitful exchanges and future initiatives in the fields of education and the environment.

Prof. Kamal Hirech

Chair of the ICEE24 Conference

Higher School of Education and Training,

Mohammed First University, Oujda - Morocco

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In-vehicle Network Security: Detecting Anomalies in CAN Bus Frames by Analyzing Data Field Sequences

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Abstract

Modern vehicles are equipped with many driver assistance mechanisms to make life easier for drivers. These features are made possible by the use of a range of technologies, first and foremost the CAN (Controller Area Network) bus, which is a means of communication between electronic control units (ECUs). Scientific research has revealed the weakness of this protocol and the availability of WIFI, Bluetooth, USB, OBD2 connection in the vehicle increases the possibility of attack from the outside. The risk of attack increases according to the vulnerability of the system under attack (engine ECU, anti-lock braking system ABS, gearbox, GPS...), that's why manufacturers and researchers are working to find solutions to this problem. In this paper, we have proposed an approach to deal with any attack on car security. It is presented by an algorithm that uses crypto-graphic bases that protects data, detects attack attempts and takes into account the real operating time of the automotive nodes. This approach is implemented on the Software level as how it can be applied on the Hardware side or both at same time, cheaper and more secure.

Keywords

Anomaly Detection, Intrusion Injection, CAN Bus Frames, OBD2

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Material and Electrical Defects in Photovoltaic Systems-Environmental Impacts and Challenges

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Abstract

Photovoltaic (PV) systems, crucial for sustainable energy generation, often suffer from various material and electrical defects that can significantly hinder their performance and longevity. Material defects such as microcracks, delamination, and degradation of encapsulants affect the mechanical integrity of PV modules, leading to efficiency losses and increased failure rates. Electrical defects, including hotspots, mismatched cells, and connection issues, further exacerbate these problems, reducing the overall power output and system relia-bility. These defects not only compromise the efficiency of energy conversion but also have broader environmental implications. Increased failure rates neces-sitate more frequent replacements and disposal of PV modules, contributing to electronic waste and resource consumption. Furthermore, the energy payback time of PV systems is extended, delaying the environmental benefits of transi-tioning to renewable energy sources. Understanding the nature and impact of these defects is crucial for improving PV system durability and maximizing their environmental contributions.

Keywords

Electrical Defects, Sustainable Energy, Environmental Impacts

Professional Experience, Workload, and Stress Perception among Secondary School Teachers: A Cross-Sectional Study in Tetouan, Morocco

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Abstract

Secondary school teachers often face high levels of stress, which can negatively impact their mental and physical health, as well as their professional performance. This study, conducted in Tetouan, Morocco, aimed to identify the factors associated with perceived stress among secondary school teachers. A cross-sectional survey was carried out in April 2021 with 147 experimental science teachers. The distributed questionnaire included general questions as well as the 10 items of Cohen et al.'s Perceived Stress Scale. Data collection was conducted in accordance with ethical guidelines. Among the teachers who participated in the study, 51.7% were women, with a female-to-male ratio (F/M) of 1.07. Their ages ranged from 24 to 61 years. The majority of the teachers were married (78.2%) and had an average of 2 children. They had a median professional experience of 15 years (Q1-Q3: 10 years – 21 years) and taught an average of 5 classes, with an average of 33 students per class. They provided 20 hours of teaching per week. Only 21.1% of the teachers regularly practiced a sport. Multivariate analysis results showed that perceived stress levels among teachers significantly increased with the number of years of professional experience and the number of classes taught. However, perceived stress significantly decreased with age and regular physical activity. This study highlights the importance of considering these factors in managing occupational stress among teachers. Further studies are needed to propose concrete interventions and healthy habits to reduce the risks of developing work-related stress among teachers.

Keywords

Perceived Stress, Secondary School Teachers, Associated Factors, Sports Activity, Stress Management

Proximate Composition of the Local Hemp Seed (Beldiya Ecotype), Fatty Acid Profile, and Oxidation Stability of Its Oil as a Local Product from Northern Morocco

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Abstract

The United Nations Organization, effectively recognizing its medicinal and nutritional value, recently reclassified Cannabis sativa in international agreements. Hempseeds, considered as a by-product by Cannabis growers, could be a good source of key nutrients such as long-chain fatty acids n-3 and essential amino acids with high bioavailability. The goal of this study was to find out the proximate composition, fatty acid profile, and health lipid indices of hempseed from a local ecotype called "Beldiya" in Morocco's northern region. Lipids were extracted from seeds according to the Bligh-Dyer method (cold method), then methylated and separated by gas chromatography. The results show that the studied hempseeds “Beldiya” has an oil content of 32.81±0.43% with an oil oxidative stability index at 101 ℃ of 10.82±0.47 hours. The average values of dry matter, ash, and protein content are 94.08±0.72%, 4.29±0.03%, and 24.84±0.9% respectively. The fatty acid profile analysis shows that the oil of “Beldiya” hempseeds has a polyunsaturated fatty acid (PUFA)/saturated fatty acids and n-6/n-3 PUFA ratio of 5.13±0.02 and 3.48±0.02, respectively. These findings demonstrate that hempseed's nutritional and balanced value as an edible fruit can contribute to a healthy lifestyle.

Keywords

Cannabis sativa L., Fatty Acids, Hempseed Oil, Oxidation Stability, Proximate Composition

Substituting the PID Controller with a Recurrent Neural Network Model for the Optimization of Solar Photovoltaic Systems

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Abstract

Photovoltaic (PV) systems are of paramount importance to the global energy transition. However, their operational management cannot be considered easy, as it is affected by climate changes as well as sudden weather alterations. Typically, a PID controller is employed to manage energy generation by systematically adjusting the values of the setting parameters. This, however, has a shortcoming regarding how quickly one can adapt to changes in the environment. The aim of this research is to improve the control and performance of photovoltaic systems through the adoption of neural network models to replace the conventional PID controllers. The proposed recurrent model has the potential to forecast energy production levels based on past and present weather conditions, thus allowing for more intelligent management of PV systems. In contrast to PID, which tends to follow fixed methods, this model learns from previous experiences and alters system output parameters according to changes in conditions instantaneously. Such adaptability improves the systems capability to cope with prevailing climatic conditions and enhances performance and energy efficiency. To validate this new approach, simulations were conducted in comparison with those of the conventional PID controller. The findings show that the production and response time of the recurrent neural model in photovoltaic systems are far superior to those of the PID controller. This technique can be utilized more quickly without losing quality when new weather data becomes available, representing a powerful alternative for improving the production of solar energy systems.

Keywords

PID Controller, Recurrent Neural Network, Optimization, Solar Photovoltaic Systems, Forecast Energy Production

A Bibliometric Analysis on the Concept of Sustainable Business Models and Its Relationship with the Creation of Territorial Value

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Abstract

In a context where sustainability has become a central issue for businesses and territories, this study aims to identify the importance of new sustainable business models (NBMS) and their interactions with the creation of territorial value. This study is one of the first to use bibliometric methods to describe and analyse the evolution of literature published on the subject. For this purpose, the bibliometric analysis method was based on a 25-year dataset (1999-2024) collected by analyzing 115 articles via Zotero and randomly by analyzing 1,648 via Web Of Science. Using VOSViewer software, this analysis provides an overview of the research themes to present a complete knowledge map of the structure study field of new sustainable business models and territorial value creation. We will show the results of the interactions between NBMS and the creation of territorial value. In this way, the links found will be analyzed and deciphered to weave a complete field of research addressing all the themes and subjects covered. This manuscript will conclude with a general discussion highlighting the possible interactions between NBMs and the creation of territorial value. The main contributions of this study will provide some perspectives for the future.

Keywords

Sustainable Business Models, Territorial Value, Innovation, Bibliometrics, VOSWiever

Towards Sustainable Performance: Corporate Social Responsibility Commitment and Challenges of Moroccan Ports

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Abstract

The ecological transition of Moroccan ports is now an essential requirement to deal with increasing challenges of climate change and environmental degradation. This transition aims to reduce the ecological footprint of port activities and ensure sustainable performance for their organization. Therefore, rethinking the logistics chain of Moroccan port organizations towards sustainable and green logistics is the key to ecological and green ports. The present study will be dedicated to discovering the initiatives of the Moroccan port sector in terms of social responsibility while aligning with the three aspects of sustainable development. A sustainability assessment is conducted within Moroccan ports using an evaluation framework derived from the literature. Subsequently, semi-structured interviews were conducted with CSR managers across different Moroccan ports to deepen this evaluation and identify the challenges and constraints that hinder the transition to green ports. The results allow for the evaluation of the CSR commitment of Moroccan ports and their level of maturity in this area. They also propose pathways to improve the competitiveness of the Moroccan port sector compared to the global leaders in international trade, and to overcome the economic, social, and environmental challenges of this sector in order to promote sustainable and resilient logistics.

Keywords

Sustainable, Performance, Responsibility, Ecological, Ports, Logistics, Development, Sustainability

Evaluation of the Impact of the Inquiry-Based Approach on Students' Learning Regarding Major Water-Related Issues in Secondary Education

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Abstract

Sustainable water management represents a major global challenge, especially in the face of pollution, drought, and overexploitation. This study, which aims to assess the impact of the inquiry-based approach on awareness and learning among secondary school students regarding these issues, presents findings that are of significant importance. Two groups of students participated in the study: a control group, which received traditional classroom instruction, and an experimental group, which was exposed to an inquiry-based approach. The experimental group engaged in an outdoor activity centered around an exhibit illustrating water-related challenges, promoting an active approach through their questions. The same questionnaire was administered to all students to compare the results between the two groups and evaluate the effect of the inquiry-based approach. The results show differences between the two groups, suggesting that the inquiry-based approach may impact students' understanding of water-related issues and their environmental awareness compared to traditional teaching methods. These findings are crucial for educators, researchers, and policymakers interested in teaching methods and environmental education, as they encourage reflection on the potential effectiveness of active learning methods in teaching environmental topics.

Keywords

Inquiry-Based Approach, Issues, Water, Secondary School, Learning

Assessment of Anthropogenic Impacts and Global Changes on Coastal Ecosystems of Eastern Morocco: Comparative Study of the Mouths of the Moulouya and Kert Rivers

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Abstract

The coastal ecosystems of the Eastern Rif, particularly the river mouths of Moulouya and Kert, are increasingly subjected to anthropogenic pressures, including urbanization, intensive agriculture, and discharges of domestic and industrial waste. These biodiverse coastal ecosystems play a crucial role in biological productivity and the regulation of biogeochemical cycles. However, human activities have resulted in significant habitat degradation, exacerbated by the impacts of global climate change. This comparative study aims to analyze the effects of anthropogenic pressures and global changes on the mouths of the Moulouya and Kert rivers, utilizing multidisciplinary biotic and abiotic data. The analyses include benthic macrofauna, which serve as indicators of ecological quality, and sediments that act as a medium for various contaminants, such as heavy metals and pesticides. A network of sampling stations has been established to cover both river mouths, and multiple analyses of the biotic environment are currently underway. Multivariate statistical methods will be applied to compare the ecosystems based on local and global environmental pressures. The anticipated results will enhance our understanding of the spatiotemporal dynamics of these coastal ecosystems and propose sustainable management measures to preserve their ecological integrity. Additionally, this study will contribute to the development of adaptation strategies in response to the impacts of global changes and increasing local pressures.

Keywords

Coastal Ecosystems, Moulouya and Kert River Mouths, Benthic Macrofauna, Sediment, Anthropogenic Pressures, Global Changes

Investigating the Calco-Carbonic Balance of Drinking Water in Fes Morocco Using Principal Component Analysis and Multiple Linear Regression

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Abstract

The quality of drinking water is crucial for public health and the sustainability of distribution systems. This study investigates the calco-carbonic balance of drinking water in Fes, Morocco, employing two analytical methods: Principal Component Analysis (PCA) and Multiple Linear Regression (MLR). PCA is used to explore the interactions among various physicochemical parameters, while MLR aims to predict the Langelier Index (saturation index) based on these parameters. Through comprehensive data collection, this research highlights the complex interplay of factors influencing the calco-carbonic balance, vital for preventing scaling. Scaling can lead to significant operational challenges, including reduced water flow, decreased energy efficiency, increased maintenance costs, and potential deterioration of water quality. Key parameters identified as influential to the calco-carbonic balance include temperature, total hardness, dissolved oxygen, conductivity, pH, Complete Alkalinity Title (CAT), and the Langelier Index. The analysis produced a robust model with a coefficient of determination of 0.93 and a standard error of 0.03, indicating strong predictive capability. This study provides valuable insights into the chemical processes related to scaling and offers practical recommendations for water management practices, aiming to guide targeted interventions to maintain and enhance drinking water quality in Fes.

Keywords

Calco-carbonic Balance, Drinking Water Quality, Principal Component Analysis, Multiple Linear Regression, Langelier Index, Water Management, Scaling Prevention

Legal Protection of the Environment: A Comparative Law Study

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Abstract

The environment is one of the values that the legislator seeks to protect and preserve, as the latter has given it criminal protection, which is one of the most prominent manifestations of the legal protection of the environment. This is due to the deterrent and injunctive effect of criminal sanctions by extending the rule of law through the criminal judiciary. Each country, within the scope of its territorial sovereignty, has issued legislation and laws to protect the environment and combat pollution, while supporting this legislation with criminal sanctions that force the violators to respect it, because there is no point in issuing legislation intended to protect the environment that does not include a penalty that deters the violator and restores the situation to what it used to be. The purpose of punishment is to achieve general deterrence and thus provide the conditions for the legislative hall to achieve its intended purpose. Criminal or penal law is one of the important and effective means that the international and national community always resort to in combating and controlling damage to the environment, pollution and corruption. Therefore, we will describe the criminal penalties and sanctions prescribed for the protection of the environment by studying the original and supplementary penalties and the reasons for aggravating the penalty.

Keywords

Protection, Penalty, Pollution, Legislation, Punishement

Optimization of Dye-Sensitized Solar Cells: Advanced Materials and Morphologies for Efficient Photoanodes

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Abstract

Dye-sensitized solar cells (DSSC) are once again gaining attention for capturing indoor light and powering wireless devices. They offer several advantages such as low cost, high flexibility, wide angular response, and lightweight design, which have encouraged the use of advanced photonic architectures and specific photosensitizers, while also being compatible with portable devices. However, to fully harness their potential, it is essential to focus on improving their spectral compatibility, low-light collection mechanisms, and developing efficient photoanodes through scalable, high-yield production methods. Our study focuses on the efforts undertaken to enhance the efficiency of dye-sensitized solar cells (DSSC) by integrating a variety of materials into the fabrication of photoanodes, primarily metal oxides such as TiO_2 and ZnO. Although ZnO has better electron mobility, TiO_2 is preferred due to its superior dye adsorption capacity and stability in acidic environments. Among the different crystalline forms of TiO_2 (anatase, rutile, brookite), anatase is the most commonly used in DSSC because of its better energy conversion efficiency. The morphology of the materials, particularly the use of nanoparticles to maximize surface area, also plays a crucial role. Research is focused on optimizing the structural and electronic properties of TiO_2, as well as improving electron mobility and dye adsorption through various nanoarchitectures.

Keywords

DSSC, Photoanodes, Anatase, Adsorption, Surface, TiO_2

Sustainable Management of Environmental Challenges in Viticulture: The Role of Bacillus spp. in Crown Gall Biocontrol and Alleviating Abiotic Stresses

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Abstract

Grapevine cultivation, like other crops, is significantly influenced by environmental factors such as soil conditions and climate, which affect both yield and grape quality. In addition to these challenges, pathogens like Allorhizobium vitis, the causal agent of crown gall, severely reduce plant productivity and quality, resulting in substantial economic losses. While conventional plant protection methods remain the primary means of controlling this disease, their limitations and the scarcity of effective chemical products highlight the need for sustainable alternatives. Biological control offers an environmentally safe and cost-efficient approach to managing plant diseases, with Bacillus species being among the most promising biocontrol agents. Known for their antimicrobial properties and plant growth-promoting effects, Bacillus spp. employ several mechanisms, including the production of antibiotics, extracellular enzymes, siderophores, volatile compounds, nutrient competition, and induced systemic resistance (ISR). Moreover, under environmental stress conditions such as drought, salinity, and heavy metal accumulation, Bacillus spp. enhance plant stress tolerance by producing exopolysaccharides, siderophores, and key phytohormones like indole-3-acetic acid, gibberellic acid, and ACC deaminase. This study explores the biocontrol potential of Bacillus spp. against crown gall disease and its role in promoting physiological adaptations in plants to combat both abiotic and biotic stresses.

Keywords

Grapevine, Biotic Stress, Crown Gall Disease, Abiotic Stress, Biocontrol, *Bacillus* Spp

Toxic Medicinal Plants Used in Moroccan Traditional Medicine

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Abstract

Medicinal plants have been used for therapeutic purposes since ancient times. These plants are generally perceived as safe, but they could also be toxic. In this study, we reveal the toxic and potential toxic species used as medicines by Moroccan people in order to compile and document indigenous knowledge of those herbs. This study offers a thorough review of the toxicological profiles of herbal medicines through a bibliographic analysis of over 1,000 medicinal plants from Morocco. We identified 181 plant species with toxic properties, distributed across 70 families, with the Lamiaceae and Asteraceae families showing the highest diversity. Our results are summarized in two key tables: the first lists 48 plant species cited as toxic without experimental validation, while the second provides details on 133 species with confirmed toxicities and identified toxic compounds. Additionally, we investigated the compounds properties of 35 plants and identified 124 distinct toxic compounds. The study found that toxicity impacts multiple organ systems, with gastrointestinal, neurotoxic, renal, and hepatic effects being the most common. The review indicates the scientific name of the plant, the vernacular name, the part used, the LD50 (lethal dose 50). This research highlights the urgent need for rigorous toxicological studies to ensure the safety of herbal medicines and emphasizes the importance of ongoing vigilance in their use and development.

Keywords

Toxic Plants, Toxic Compounds, Toxicity, Traditional Medicine

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The Role of Communication in Environmental Education: Challenges and Perspectives

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Abstract

This essay examines the critical role of communication in environmental education, highlighting both the obstacles and potential it entails. It begins by analyzing the fundamentals of communication—identifying the sender, the recipient, the content of the message, and the surrounding context. The article illustrates how communication influences our perceptions and discussions on environmental issues, establishing it as an essential instrument for fostering awareness and motivating sustainable decisions. The article emphasizes the efficacy of various communication tactics in engaging individuals on environmental issues. Persuasive communication has the power to shift people's attitudes, encouraging them to embrace eco-friendly habits. On the other hand, educational communication builds understanding, giving people the knowledge, they need to make smart, informed choices about the environment. Together, these approaches strengthen environmental responsibility and inspire real action. This study takes a close look at various communication tools—from traditional media like print and television to digital platforms—examining how each influences awareness and supports sustainable practices. By exploring these strategies, the research highlights how thoughtful communication can connect deeply with people, sparking genuine engagement and motivating lasting, meaningful change.

Keywords

Communication, Education, Environment, Awareness Campaigns, Citizenship

Effect of Gelling Agent and Plant Growth Regulators on in Vitro Shooting and Rooting of *Stevia rebaudiana* Bertoni

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Abstract

Stevia rebaudiana Bertoni is a medicinal plant of economic importance that produces diterpenes glycosides with no calories in its leaves. This herb is a vital crop for the world because it is a new natural sugar replacement. This plant's in vitro growth and development were significantly impacted by its genotype, exogenous plant growth regulators, and gelling agent type. The purpose of this study was to assess how both plant growth regulators (PGRs) and two distinct gelling agents (Agar and Gelrite) affected the growth and multiplication of stevia plants. For shoot proliferation, nodal explants were positioned in Murashig and Skoog (MS) media supplemented with 6-Benzylaminopurine (BAP), Kinetin (Kin), and Indole-3-acetic acid (IAA). The medium was then gelled with either Gelrite or Agar. In vitro shoot segments were cultivated on MS medium without PGRs and gelled with either 3 g/l of gélrite or 7 g/l of agar for rooting after four weeks. On MS medium gelled with agar, direct shoot forms worked quite well. Plants cultivated on MS medium supplemented with 0.5 mg/l of BAP and 0.5 mg/l of IAA produced the greatest number of shoots. A long shoot with the greatest number of internodes was formed using MS medium devoid of PGRs (control). The best media for stevia rooting was agar-gelled.

Keywords

Gelling Agent, Multiplication, Nodal Explant, Rooting, Shoots, *Stevia rebaudiana*

Gum Arabic: A Sustainable Biotechnological Solution to Prolong the Shelf Life and Improve Post-Harvest Quality of Fruits

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Abstract

Gum Arabic, a natural biopolymer extracted from Acacia trees, represents an innovative and environmentally friendly alternative for developing bio-based packaging in the food industry. Used as an edible coating, it extends the shelf life of fruits while preserving their post-harvest quality. With its film-forming properties, gum Arabic creates a natural barrier that limits water loss, reduces the respiratory activity of fruits, and inhibits microbial growth. Compared to traditional plastic packaging, gum Arabic offers a biodegradable solution, contributing to the reduction of plastic waste and environmental preservation. By incorporating this biopolymer into the production chain, this approach supports sustainable development and the transition toward green technologies in the food sector. However, the sensitivity of gum Arabic to humidity requires further research to improve its stability, particularly under real storage and transportation conditions. As a bio-based material, it has considerable potential to address ecological challenges, reduce post-harvest losses, and offer a sustainable alternative to conventional packaging, thereby meeting the needs of a more responsible industry.

Keywords

Gum Arabic, Bio-based Coating, Fruit Preservation, Sustainable Development, Green Technologies, Eco-friendly Food Packaging, Microbial Inhibition

The Role of Educational Institutions in Promoting Awareness of Sustainable Development Issues: A Systematic Review

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Abstract

In light of the environmental, social, and economic challenges currently facing the world, sustainable development emerges as a comprehensive framework aimed at balancing the needs of both present and future generations. In this context, educational institutions play a fundamental role in raising awareness of sustainable development issues, particularly through SDG Goal 4, which calls for "ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all." This goal seeks to empower both educators and learners to build a more sustainable and inclusive society. This study presents a comprehensive systematic review of the literature related to education and sustainable development by analyzing articles published in 2024. The review identifies the objectives of these studies, methodologies used, and draws conclusions and recommendations. The review process included the following stages: article collection, eligibility assessment, quality evaluation, and data coding, aiming to explore the relationship between education and achieving sustainability on a global scale. Through analyzing prior studies, this paper highlights the strengths and limitations of integrating sustainable development concepts into educational curricula, offering recommendations to enhance the role of educational institutions in increasing the awareness of younger generations about the importance of sustainability and its impact on their lives and future.

Keywords

Educational Institutions, Sustainable Development, Awareness, Systematic Review

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Study, Design, Construction and Remote Supervision of a Domestic Photovoltaic Desalination System

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Abstract

Climate change and global warming are causing sea levels to rise, which is degrading groundwater quality through salt infiltration. In this context, the aim of this study is to set up a domestic multi-stage solar desalination system (purely photovoltaic) equipped with a remote acquisition and supervision kit, designed to supply drinking water to people living in regions suffering from high groundwater salinity. The system developed in the course of this work will make it possible to produce a daily quantity of around 20 litres per day, and to monitor the operation of the plant in real time, thereby guaranteeing the quantity and quality of the fresh water produced. It will also offer the possibility of intervening remotely in the event of a breakdown or malfunction. After describing the operation of the photovoltaic distiller, this work presents the structure of its control and supervision system. This includes managing the start-up and shut-down of the distiller, monitoring its operation, collecting data, and controlling the connection to the photovoltaic generators.

Keywords

PV, Climate Change, Water, Desalination, Photovoltaic

Study, Design, Construction and Supervision of a Hydrogen Production System Using Photovoltaic Renewable Energies

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Abstract

In this work, we show the feasibility of using renewable energies, in particular photovoltaic systems, to produce hydrogen in order to meet energy needs while reducing greenhouse gas emissions. In this context, and in order to harness the saline water from Douar el Hamri (located 80 km north-west of Oujda), characterised by a conductivity of 4,000 µS/cm and a salinity level of over 2g/l, we have designed a system consisting of a 345 W PV panel and a boost-type DC/DC converter that feeds stainless steel electrolysers to break down the saline water into hydrogen and oxygen using electrolysis. This process produces ‘green’ hydrogen, a clean energy source that can be used by the Douar's inhabitants to run their generators and generate electricity. When the system is switched on and under lighting conditions of 1000 W/m^2, the first results show the appearance of a significant quantity of hydrogen and oxygen. Compared with traditional methods of producing hydrogen, this approach offers advantages in terms of sustainability, reducing the carbon footprint and contributing to the energy transition to renewable sources.

Keywords

PV, Climate Change, Water, Desalination, Photovoltaic

Opportunities and Challenges in Integrating Augmented and Virtual Reality in Environmental Education

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Abstract

The integration of Augmented Reality (AR) and Virtual Reality (VR) into environmental education offers substantial opportunities for enhancing engagement and comprehension of complex environmental issues. However, several challenges hinder their widespread adoption, including technological barriers, insufficient teacher training, and variability in access to resources. This article explores the opportunities and challenges associated with AR and VR in environmental education. We examine the potential benefits of AR and VR, such as immersive learning experiences that foster deeper connections to environmental issues and promote sustainability awareness among students. Through a qualitative analysis of existing literature and case studies, we identify key obstacles educators face, including resistance to change, lack of technical support, and the need for pedagogical training. Actionable strategies for overcoming these challenges are proposed, such as developing professional development programs for teachers, forming partnerships with technology providers, and implementing AR and VR projects that engage students in hands-on learning. The findings suggest that by addressing these challenges and leveraging the opportunities presented by AR and VR, educators can significantly improve the effectiveness of environmental education. Ultimately, the article concludes that integrating AR and VR into educational frameworks can empower students to become informed stewards of the environment, preparing them for future ecological challenges.

Keywords

Augmented Reality, Virtual Reality, Environmental Education, Sustainable Development, Educational Innovations

Effect of Doping Rare-earth Elements on the Structural and Dielectric Properties of $Sr_2RETi_2Nb_3O_{15}$ Compounds (RE = Gd, Sm, Nd)

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Abstract

Tungsten bronze tetragonal (TTBs) materials have showed a particular attractive properties, especially in the electronic field (electrical, magnetic, etc) and for their catalytic behavior. The TTBs are widely studied in various application areas as ferroelectric materials, semiconductors, energy storage and photo-degradation catalytic applications. In this work, the impact of rare-earth substitution on the structural and dielectric properties of $Sr_2RETi_2Nb_3O_{15}$ (RE = Gd, Sm, Nd) materials was investigated. The synthesis was carried out by solid-state reaction methods, and the proposed structure of the samples and their electrical properties were confirmed and investigated using the X-ray diffraction (XRD) and complex impedance spectroscopy (CIS) techniques, respectively. The results showed that the rare-earth substitution affects the crystal structure, where the transition from space group *P4bm* (for Sm and Nd) to *P4/mbm* (for Gd) was recorded, which attributed to the effect of the gap between ionic radius. Furthermore, the CIS results showed a drastic effect of the substitution reaction on the dielectric constants and losses. On the other hand, the electrical results showed a ferroelectric behavior for the Sm and Nd, however the Gd exhibited a paraelectric behavior. The findings, in this paper, suggest a potential enhancement in dielectric performance, making these materials promising candidates for applications in electronic devices and high-performance capacitors.

Keywords

Materials, Ferroelectric, Rare-earth, X-Ray Diffraction (XRD), Complex Impedance Spectroscopy (CIS)

Contribution to the Study of the Effect of a Biofertilizer Derived from Co-digestion on Quinoa Cultivation (*Chenopodium quinoa*)

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Abstract

Due to drought and low soil fertility, Moroccan farmers have a limited choice of crops. In this context, quinoa (Chenopodium quinoa) shows promise for these conditions. Organic fertilizers show significant potential for improving agricultural production. bThe present work investigates the effect of biofertilizing quinoa using a biofertilizer derived from the anaerobic co-digestion of olive mill wastewater (OMW), fish waste (FW) and fruit and vegetable residues (FVW). For this purpose, an experiment was conducted in a greenhouse at the experimental station of the Faculty of Science at Mohammed first University. The experimental treatments included four (4) digestates with a mixture of equal proportions (33% each) of olive wastewater, waste, and cattle dung as inoculum. These mixtures were digested through methanization using two inoculum/substrate (I/S) ratios of 2:1 and 3:1. The results obtained show that the application of digestate has a positive effect on the growth and development of quinoa. However, the combined treatments, namely T5, T6, and T8, which include both digestate and organic fertilizers, have shown a more significant effect on most morphological and physiological parameters, as well as agronomic parameters, specifically yield.

Keywords

Quinoa, Digestate, Fertilizer, OMW, FW, FVW, Growth, Yield

The Effect of Climate Change and Drought on Aleppo Pine (*Pinus halepensis*) Forests in the Geopark Mgoun, High Atlas of Morocco

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Abstract

Climate change in Morocco has led to drought, rising temperatures, and decreased precipitation, profoundly impacting vegetation. Unprecedented dieback has been observed in Aleppo pine (*Pinus halepensis Mill*) forests in the High Atlas, prompting an assessment of climate perturbations' role in this degradation. Climate indicators such as TX90 and TN90 (days with extreme temperatures), P10mm (days with precipitation under 10 mm), Tmin, Tmax (minimum and maximum average temperatures), average temperatures, and the bioclimate index (Q2) were used to evaluate fluctuations. Supervised classification with Sentinel-2 data (10m resolution) on Google Earth Engine calculated the Aleppo pine vegetation area. Results show significant increases in TX90, TN90, Tmin, Tmax, and average temperatures (by 1 ℃) from 1960-2020, with P10mm and overall precipitation rates falling by 77.14 mm. Q2 indicates increasing aridification, shifting sub-humid areas to arid and semi-arid climates. Aleppo pine forests lost 22 km^2 (40% of their area) between 2015 and 2022. Statistical analysis reveals a strong correlation between pine dieback and temperatures, while precipitation shows no correlation with vegetation cover behavior in August. Evapotranspiration also shows a severe decrease during the study period, confirming plant stress. As a result, monitoring and conservation policies are highly recommended.

Keywords

Climate Change, Aleppo Pine, Temperatures, Precipitation, Morocco

Optimization of the Grafting Technique in Argan (*Argania spinosa L. Skeels*) and Carob (*Ceratonia siliqua L.*) in the Eastern Region of Morocco

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Abstract

The main objective of this study was to optimize the grafting technique in Argan (*Argania spinosa L. Skeels*) and Carob (*Ceratonia siliqua L.*) in the eastern region of Morocco. The grafting technique proved to be the most suitable for the production of argan seedlings, and the use of young rootstocks (4 weeks) and intercalary grafts improved the success rate (60% success rate) and shortened the time needed to establish the weld. The success of Argan grafting depends significantly on the choice of genotype and type of graft. The "X" genotype stands out with a success rate of 26.66% on two-year-old rootstocks. "CHOUIHYA" also offers good prospects, with a success rate of 16.66%. The "BENI-SNASSEN" and "SOUHAYL" genotypes are less successful, with "SOUHAYL" being particularly recalcitrant. For hypocotyl grafting of Argan trees on 4-week-old rootstocks, the "BENI-SNASSEN" genotype is promising in terms of success rate, but suffers from rot problems. "SOUHAYL" has a moderate success rate but a very high wilting rate, compromising its viability. "CHOUIHYA" is the least successful, with high wilt and rot rates. Grafting without leaves has an overall advantage in terms of success rate, while grafting with leaves is more vulnerable to fungal attack. To optimize grafting, it is preferable to choose leafless grafts while ensuring grafting conditions that minimize the risk of wilting, such as rigorous humidity control. Optimizing grafting in Carob has revealed that the type of rootstock and scion influences the success of apical cleft grafting. Rootstocks from young mother plants (PMJ) showed a better success rate (26.66%) than those from mature mother plants (PMA) with 13.33%. Another study showed that the use of leafy rootstocks and crown grafts improved grafting success.

Keywords

Optimization, Grafting, *Argania spinosa*, *Ceratonia siliqua*, Genotype, Cloning, Rahma Variety, Eastern Morocco

Advanced Printed Sensors for Environmental Applications: A Path Towards Sustainable Monitoring Solutions

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Abstract

Printed sensors represent a transformative advancement in sensor technology, utilizing innovative printing techniques to create flexible, cost-effective, and highly customizable sensing devices. Their versatility allows integration into numerous applications across diverse fields such as monitoring a wide range of environmental factors e.g. air and water quality, soil conditions, and atmospheric changes among others. These sensors demonstrate high sensitivity and accuracy in detecting pollutants, temperature variations, humidity levels, and other critical parameters essential for environmental assessment and protection. The adaptability of printed sensors to operate under various environmental conditions expands their applicability, making real-time monitoring feasible in both urban and remote settings. This is particularly valuable in areas where traditional monitoring systems are impractical or too costly to implement, thus broadening the scope of environmental monitoring. Their lightweight and flexible design further enhances their suitability for deployment in challenging environments, including remote and hard-to-reach locations. The integration of printed sensors with wireless communication technologies enables the formation of comprehensive monitoring networks, facilitating continuous data collection and real-time data transmission. These networks aggregate information from multiple sensors, improving situational awareness and supporting data-driven decision-making in environmental management, policy development, and disaster response. Research efforts continue to focus on enhancing the performance of printed sensors, improving their sensitivity, and ensuring long-term reliability. Advances in materials science and printing techniques are driving improvements in sensor capabilities, leading to greater accuracy and durability. This paper provides a comprehensive review of recent developments and challenges in printed sensor technology, discussing their applications in environmental monitoring and highlighting their potential to address pressing environmental issues. By exploring advancements in sensor materials, fabrication methods, and integration with digital technologies, the paper aims to underscore the transformative potential of printed sensors in revolutionizing environmental monitoring practices. Ultimately, these insights contribute to the sustainable management and protection of natural resources, aligning with global efforts to promote a more sustainable future.

Keywords

Printed Sensors, Environmental Monitoring, Sustainable Technologies, Flexible Electronics Environmental Protection, Materials Science for Sensors

Environmental Education Through Clubs and Climate Resilience in Morocco: A Statistical Analysis of Activation Factors

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Abstract

Environmental education is now a fundamental pillar of sustainable development. In this context, Morocco, like other countries around the world, has been working for several decades to address environmental challenges by engaging in a process of valorizing and protecting its resources, with the aim of ensuring sustainable development. The integration of environmental education into educational systems is therefore seen as an essential means to achieve the Sustainable Development Goals. This education, which is considered a holistic and long-term process, addresses all dimensions of the individual, including the physical, biological, emotional, intellectual, spiritual, motor, active, and creative aspects. It should not only raise awareness about the disruption of natural balances, but also provide training in responsibility and action. In this sense, the National Charter for Education and Training has established the legislative and regulatory framework for school activities, while various guides and notes related to school life have provided concepts and directions to activate these activities, including the creation of educational clubs as a key mechanism to achieve this goal. Among these clubs, environmental clubs are crucial components of environmental education and can play a vital role in combating the impacts of climate change through school-based activities. However, the implementation of these clubs has not been as effective as expected and remains influenced by several factors that require thorough analysis. In this contribution, we aim to analyze the various factors that contribute to the success or failure of environmental clubs as a critical pillar in the fight against climate change impacts. For this purpose, we have chosen the Sidi el Aidi High School, under the Provincial Directorate of Settat, as the focus of our study. Forty-two individuals were selected to respond to a questionnaire designed to analyze the factors that hinder or facilitate the activation of these clubs, which are fundamental structures for fostering an environmental culture aimed at addressing climate change. The results of the study revealed several factors that hinder the activation of these clubs, including a lack of resources, funding, motivation, training, and time. Therefore, it is essential to strengthen the training programs and resources allocated to environmental clubs in order to enhance their impact on environmental education and improve efforts to combat the effects of climate change.

Keywords

Climate Change, Sustainable Development, Environmental Education, Climate Resilience

Identification of Pedagogical Innovation in Environmental Education in Science Programmes in Morocco

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Abstract

With the aim of characterizing pedagogical practices related to environmental education and climate change in school curricula in Morocco, this article has classified educational activities according to three areas: the Surface Learning Area (SLA), the Deep Learning Area (DLA) of knowledge and the Creative Learning Area (CLA). These areas help to identify the different levels of capacities to be developed: Attitudes, Skills, and Knowledge. The categorization made it possible to highlight the predominance of pedagogical activities centered on superficial and non-permanent knowledge (SLA), limiting learning to the memorization and understanding of basic concepts. In contrast, pedagogical activities that emphasize practical activities engaging students in applied tasks requiring well-mastered and permanent knowledge (DLA), as well as those that focus more on the development of attitudes, favoring interaction, collaboration, and critical thinking (CLA), are in the minority. The results obtained serve as a useful guide for adapting programs to encourage more innovative and balanced teaching practices. This, in turn, helps designers structure teaching approaches that strengthen student engagement and improve the quality of learning in the fields of environment and sustainable development. This approach will make it possible, on the one hand, to fully integrate the three levels of capacities, and on the other, to ensure a greening of Moroccan curricula, aligning them with the principles of 'GREEN education,' which serves as a true lever for achieving sustainable development goals.

Keywords

Environmental Education, Climate Change, Educational Practices, Educational Innovations, Student Engagement, Green Education

Removal of Bisphenol A (BPA) from Aqueous Solutions Using Cellulose-Based Materials as Adsorbents

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Abstract

Bisphenol A (BPA) is a widely recognized endocrine disruptor detected extensively in the natural environment, including surface waters. This compound is commonly used to manufacture various consumer products, such as bar soaps, lotions for the face and body, shampoos, sunscreens, nail polishes, and household detergents, as well as numerous other industrial applications. Research indicates that BPA is linked to a rise in various health issues globally, including infertility in both men and women, disruptions in normal child growth and development, and heightened risks of hormone-related cancers like breast, prostate, and ovarian cancer. Several effective technological methods exist for removing BPA from aqueous environments. However, adsorption has proven to be more efficient and faster than alternative removal techniques, offering advantages such as low cost, simplicity, and reduced harmful by-products. Owing to its abundance, biocompatibility, renewability, non-toxicity, and biodegradability, Cellulose is considered a promising material for the development of bio-based adsorbents for BPA removal. This review seeks to summarize recent research focused on the removal of BPA from water using cellulose-based adsorbents. The literature demonstrates that cellulose composite materials have shown encouraging results for the elimination of BPA from water.

Keywords

Cellulose-based Materials, Endocrine Disrupting Chemicals, Adsorption, Bisphenol A, Aqueous Solution, Adsorbents

Online Learning and Communication Skills: Case of Faculty of Letters and Human Sciences, Dhar El Mahraz Students.

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Abstract

To what extent does the integration of artificial intelligence in educational environments influence students' organizational learning? How do interactions with AI-based systems shape their abilities to acquire, share, and apply knowledge in an organizational context? We will attempt to adopt a qualitative method and collect data through semi-structured interviews to be conducted with students who are using artificial intelligence in education and learning. The empirical study highlights several key findings regarding online learning's impact on communication skills. It shows that 39.5% of students benefit from digital communication tools, while 50% face challenges like social isolation. To enhance communication skills, strategies such as using online platforms, fostering active participation, and providing constructive feedback are emphasized. The results suggest that a flexible and diverse approach is essential to meet the different needs and preferences of students in an online learning environment. This research emphasizes the importance of adapting online teaching strategies to enhance communication skills. It highlights the need to integrate interactive tools to overcome social isolation and non-verbal communication barriers while personalizing approaches to meet individual student needs. Additionally, increased training for both teachers and students in digital skills is essential for fostering a more effective and inclusive online learning environment.

Keywords

Online Learning, Communication Skills, Digital Tools, Collaboration Platforms, Interactive Activities, Student Engagement

A Multilevel PV Inverter Control with Minimal Total Harmonic Distortion (THD)

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Abstract

In this article, we improved the control of the multilevel inverter for a photovoltaic system connected to the grid, in order to minimize the total harmonic distortion of curren. This topology being considered as a new converter topology applied to photovoltaic systems and has the advantage of very high-energy efficiency, but has the disadvantage linked to harmonics injected into the grid, which causes switching of states if the number of levels increases, which increases the rate of harmonic distortion. In this paper, an improved control based on sinusoidal control (SPWM) and space vector control (SVPWM) was proposed to improve the control of multilevel inverters. The simulation is based on MATLAB SIMULINK platform is presented for different multilevel inverter topologies with fewer switches and with different control methods and sinusoidal pulse. A detailed comparison of various Sinusoidal Pulse Width Modulation (SPWM) and vector control schemes (SVPWM) is presented in this article with reference to Total Harmonic Distortion (THD) in the output voltage and current of the grid. This control strategy eliminates current harmonics and improves the quality of energy supplied to the grid by the photovoltaic system, and it can be seen that among all the control methods, the THD is minimum at the output of different multilevel inverter topologies.

Keywords

Multilevel Inverter, Photovoltaic System, Three-phase Inverter, Sinusoidal Control, Harmonics Distortion, Grid

Wireless Diagnostics: Study of Real-time Monitoring and Analysis of Vehicle States

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Abstract

Aggressive and unreasonable driving is one of the most common causes of traffic accidents, endangering both lives and property. In order to decrease traffic accidents and enhance road safety, we critically need dependable and efficient methods for tracking and identifying drivers' driving patterns. The main aim of this paper is to understand and monitor driving in real time. We use a data-logging device that can be installed in any car equipped with CAN Bus (Control Area Network) and OBD-II (On-Board Diagnosis) standards to monitor and analyze the vehicle's current actions. The vehicle's steering wheel angle, speed, throttle position, engine speed, engine fuel consumption, coolant temperature and vehicle location data are all measured by the in-vehicle monitoring system. Analysis of the information gathered enables us to define the driving style generated by the driver. A thorough analysis of these factors shows the limits defining the state of how someone drives. Furthermore, the experimental results show that the approach proposed can successfully recognize driving states and driver behavior, with the aim of ensuring a suitable and acceptable level of safety. This analysis can be used to improve policies and design more robust driver training and driver education programs.

Keywords

Driver Behavior, Aggressive Driving, Traffic Accidents, CAN Bus

Checklist of Known Moth Flies (Diptera: Psychodidae: Psychodinae) from Morocco with Distributions

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Abstract

Moth flies (Diptera: Psychodidae: Psychodinae) are a diverse and widespread group of small insects. Primarily associated with humid environments, they also display a significant, yet largely unexplored, ecological diversity. Adult Psychodinae are mostly found in wet, shaded habitats. Many known species are considered aquatic, semi-aquatic, or terrestrial. The world fauna of Psychodinae consists at present of approximately 3000 recognized and described species belonging to more or less than 100 genera. Till now the contributions to Psychodinae of Morocco are very fragmented and remain patchy. Here we present a comprehensive checklist of all species known till now in the country, with their distribution across the Moroccan regions, such as the Rif Mountains, the Beni Snassen Mountains, the Atlantic plain and the Atlas Mountains. The habitats, ranging from terrestrial, lotic and lenitic aquatic ecosystems, were surveyed using various methods from 2004 to 2015.

Keywords

Moth-flies, Psychodinae, Morocco

Integrating Digital Twins and Ai For Enhanced Water Resource Management and Environmental Sustainability

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Abstract

This paper presents a critical review of the transformative potential of integrating digital twins and artificial intelligence (AI) in modern water resource management, addressing escalating challenges of water scarcity, pollution, and climate-driven disruptions. Traditional water management systems often fall short of providing the timely insights needed to handle increasingly complex water quality and distribution issues. Digital twins, enhanced by AI, offer an innovative solution by creating real-time, dynamic simulations of water systems that enable continuous monitoring, predictive maintenance, and proactive risk management. Through in-depth analysis of global case studies including AI-driven water quality prediction in Malaysia, urban water distribution and energy consumption optimization in Singapore, wastewater management advancements in Europe, improvements in wastewater treatment plants, and efforts to address inefficiencies in the outdated water system in China, this study highlights substantial improvements in predictive accuracy, resource efficiency, and environmental resilience achieved by these technologies. AI integration within digital twins empowers operators to anticipate and respond to water quality fluctuations, infrastructure stress points, and pollution events, ensuring regulatory compliance and sustainable water use. Despite their proven benefits, the paper also discusses significant implementation barriers, including data integration challenges, high infrastructure costs, and cybersecurity concerns. This research underscores digital twins and AI as pivotal tools for advancing sustainable water management globally, advocating for further innovation to scale these technologies to underserved regions. Together, digital twins and AI hold immense promise in building resilient, adaptive water systems capable of meeting future environmental and urban demands.

Keywords

Digital Twins, Artificial Intelligence (AI), Water Resource Management, Predictive Analytics, Real-Time Monitoring, Environmental Sustainability

Investigating the Effectiveness of the National Flood Protection Plan (NFPP) in Mitigating the Inundation Events in Morocco

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Abstract

Despite its semi-arid to arid climate, Moroccan territory, like all Mediterranean countries, is susceptible to significant flooding. Such events have repeatedly occurred, often causing major damage to both public and private infrastructure as well as agriculture and resulting in numerous casualties. In response to the severity of these damages, the Moroccan government initiated a comprehensive study in 1999. This study culminated in the creation of the National Flood Protection Plan (NFPP), which aims to establish a comprehensive and detailed understanding of the actual and potential flooding risks throughout the entire country. This initiative seeks to identify and plan the various measures necessary to address these menaces. In the present study, we discuss the key stages and procedures followed to develop the NFPP, explore the reliability of the approaches used to create flood hazards maps, and examine the efficacy of the protection measures and the flood prevention options. The study further emphasizes the legal frameworks and regulations that bolster flood protection, alongside the institutional structures tasked with implementing action plans. Our examination indicates that while the National Flood Protection Plan (NFPP) has played a crucial role in alleviating flood impacts, current land use regulations are unclear and still insufficient. There is a pressing need for more comprehensive and explicit legislation to effectively govern urban development in flood-prone regions. Additionally, enhanced collaboration and information sharing among the responsible administrative bodies are necessary for improving flood management strategies.

Keywords

Moroccan Territory, National Flood Protection Plan (NFPP), Flood Hazards Maps, Legal Framework, Institutional Structures

Coping Strategies Adopted by Nursing Students to Effectively Manage Academic Burnout

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Abstract

The sustained tension and pressure that characterize nursing training are risk factors for academic burnout, especially in the absence of sufficient opportunities for recuperation and effective coping mechanisms among nursing students. Therefore, our study explores the coping strategies adopted by these students to address this issue. In total, 91 students enrolled in the sixth semester of training at the Higher Institute of Nursing Professions and Health Techniques (HINPHT) of Taza, participated in our cross-sectional exploratory research. Measurement instruments included a questionnaire of general student characteristics, the Copenhagen Burnout Inventory (CBI), and Ways of Coping Checklist (WCC) consisting of 27 items. The results reveal that a majority proportion of 60.4% of students reported a high level of personal burnout. In terms of coping strategies, 43.30% of respondents turned to seeking social support, 31.90% adopted emotion-focused coping, and 24.80% used a problem-focused coping strategy. These results underline the importance of seeking social support within our sample to cope with academic burnout. Although this is an active adjustment strategy rather than a readily available resource for students, the predominance of this dimension highlights the multiple benefits of social ties in managing burnout and emotional regulation among nursing students.

Keywords

Nursing Students, Coping Strategies, Academic Burnout

Green Guidance: Reconciling Individual Career Pathways and Sustainability Challenges, Exploratory Study with Guidance Counselors in Morocco

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Abstract

In the current socio-economic context marked by increased pressure on the environment, resulting in hazardous natural phenomena (pollution, drought, etc.), it is essential, for the common well-being of humanity, to collectively work towards environmental protection and the achievement of the Sustainable Development Goals (SDGs). While the role of the educational system is crucial in this endeavor, School and Career Guidance (SCG), as a component of this system, is also called upon to engage. The concept of "Green Guidance," developed by Peter Plant in 2014, offers a practical response to ecological concerns. It focuses on raising awareness among individuals about the environmental impact of their career choices while encouraging career counselors to integrate ecological considerations into training paths. This approach emphasizes the need to view individual success not only from an economic and psychological perspective but also by considering global social and environmental issues within a sustainability framework. This study serves as an exploratory effort to examine the potential for establishing "Green Guidance" within the SCG system in Morocco. It investigates how career counselors consider the effects of the ecological transition in supporting students' personal projects, emphasizing the importance of broadening reflection spaces to enable young people to develop responsible and community-oriented agency. Using a questionnaire administered to 300 career counselors across the national territory, the research will shed light on their awareness of this new approach in the field of SCG, its potential contribution to environmental protection efforts, and will identify promising practices among both students and professionals related to Green Guidance. Additionally, it will identify obstacles that need to be overcome for better integration of this approach into career counseling practices. Based on its findings, the study will propose strategic recommendations for policymakers, educators, and counselors aimed at promoting career paths focused on sustainability and contributing, through SCG, to the ecological transition to build a greener and a more resilient economy.

Keywords

School and Career Guidance, Green Guidance, Pathways, Ecological Transition, Sustainability, Support

Public Transport and Sustainable Development: Building a Greener Future for Agadir

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Abstract

In light of Agadir's fast urban growth, this report examines the vital role public transportation plays in the city's sustainable development. Given Agadir's growing problems—such as air pollution, traffic jams, and restricted access to some areas—it is necessary to evaluate how public transportation might help. The existing transportation system, which is mostly made up of buses, suffers from inefficiencies, poor coverage, and a dependency on fossil fuels, which exacerbates social inequality and environmental degradation in terms of access to mobility. Around the world, cities are realizing that they must embrace more sustainable methods that strike a balance between social justice, environmental preservation, and economic growth. Agadir is not an anomaly. The Aamalway Bus Rapid Transit (BRT) is one of the most promising projects in this area. The goal of this project is to update public transportation across the city, emphasizing increased dependability, speed, and environmental sustainability. The 15.5-kilometer BRT project is intended to limit the use of private vehicles, ease traffic, and cut CO_2 emissions. In order to foster social inclusion, it also seeks to expand transportation options in underprivileged communities. The project's true impact is still unknown because its efficacy in accomplishing these objectives has not yet been thoroughly investigated. However, a thorough evaluation of the Aamalway BRT's performance in accomplishing these objectives is still pending. The project offers an excellent example of how Agadir's public transit infrastructure can support sustainable urban growth. The study presents the BRT as a crucial initiative to be assessed in further research rather than attempting to draw firm judgments regarding the project's success or failure. In order to provide insights that will direct future decisions toward the creation of a more sustainable, equitable, and environmentally friendly urban mobility system, the report will analyze this example in order to highlight the opportunities and problems related to extensive transport reforms in Agadir.

Keywords

Sustainable Development, Agadir, Mobility, Bus Rapid Transit, Public Transport

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Climatic Variability in the Upper Section of the Larbaâ River, Taza Province: Droughts Periods and Exceptional Precipitations

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Abstract

The Mediterranean region has been experiencing sudden and inexplicable spatial and temporal variations in its climatic characteristics over the past two decades. Precipitation is one of the most significantly impacted parameters, as it serves as the primary source of water on the Earth's surface. The Larba â catchment, located at the forefront of the Eastern Rif Mountains and covering an area of approximately 247 square kilometers, provides an ideal environment for studying such climatic variations. To conduct the study, we utilized observational series of monthly and annual rainfall over a span of 65 years (from 1958 to 2023). Then, by utilizing the moving average method, we investigated the interannual variability of precipitation within the Larba â Basin. Geographic Information Systems (GIS) were employed to track the spatial variability of rainfall throughout the observed period, ultimately assessing the correlation between precipitation and both the North Atlantic Oscillation (NAO) and the Mediterranean Oscillation (MO). Subsequently, we identified drought periods and their severity using indicators such as EM, SPI, and API. Furthermore, we analyzed a daily precipitation series over a 39-year observation period (from 1981 to 2020) primarily to detect exceptional rainfall events that possibly caused violent floods, particularly in the Sebt Boukellal rural center. By comparing the laws of random phenomena, such as the GEV Law, Log Normal, Gumbel, and Pearson Type III Law, we were able to identify the most suitable law for determining the return periods of exceptional precipitation, ranging from 5 to 100 years.

Keywords

Larba âCatchment, Climatic Variability, Drought Periods, Exceptional Precipitation

The Impact of Augmentative and Alternative Communication (AAC) Strategies on the Integration of Autistic People into Society Within the Framework of Sustainable Development (SD)

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Abstract

The integration of people with autism into society is a key objective of (SD), which seeks to create an inclusive and equitable society. (AAC) offers solutions to overcome communication barriers for people with autism, enabling them to participate actively in society and in (SD) initiatives. The aim of this project is to assess the impact of (AAC) strategies on the social and professional inclusion of people with autism, particularly in SD-related initiatives. To this end, a literature review was conducted to identify empirical studies and theoretical frameworks related to the use of (AAC) among people with autism. Data were collected from scientific articles, institutional reports and case studies on the integration of people with autism in (SD) sectors. The results show that (AAC) promotes the social and professional integration of people with autism, enabling them to communicate and participate in community initiatives such as urban agriculture or recycling. AAC enhances the skills of autistic people while contributing to the Sustainable Development Goals (SDGs), in particular social inclusion and decent employment. The (AAC) has great potential for improving the inclusion of people with autism, particularly in (SD) projects. However, further efforts are needed to overcome the challenges of accessibility, training and social acceptance. For sustainable inclusion, cooperation between decision-makers, communities and professionals is essential.

Keywords

Inclusion of Autistic Individuals, AAC, Sustainable Development, Social and Professional Integration, Communication Barriers

The Effect of an Eco-friendly Additive on the Electrodeposition of Zn-Ni Alloy Coating for Application in the Automotive Industry

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Abstract

Corrosion has been causing a big deal of damage over the years, both materially and economically. Not only does it waste raw materials and energy, it can also cause serious accidents and, in some cases, contribute to the pollution of the natural environment. Corrosion resistance is an important requirement for materials commonly used in many manufacturing industries and particularly in the automotive industry. Corrosion resistance is one of the basic standards of the automotive industry, particularly in harsh climates, as it can cause serious damage to vehicles. Among metal protection methods against corrosion, electroplating provides a smooth surface and a better bond between the particles and the metal substrate. Zn-Ni alloys have attracted considerable interest due to their ability to resist corrosion. Zn-Ni electroplating can be improved for a specific nickel composition in the Zn-Ni alloy compared with that of Zinc deposited alone, it can also be improved by adding various additives. The main objective of our research was to analyze how our eco-friendly additive influences the characteristics of the deposits obtained, in particular their morphology after electrodeposition, and their resistance against corrosion, using different concentrations of this additive (0g/l, 0.25g/l, 0.5 g/l, 1g/l). To this aim, several deposits were produced and their properties rigorously examined. The surface morphology of the deposits was analyzed by microscopy scanning electron microscopy (SEM), while energy dispersive spectroscopy (EDS) was carried out to assess the chemical composition of the deposits. Electrochemical impedance spectroscopy (EIS) was used to investigate the corrosion resistance of every deposition. The results show that the addition of the eco-friendly additive has a remarkable impact on the Morphology as well as the resistance against corrosion of Zn-Ni coatings, offering interesting prospects for improving protection processes in industrial applications, and paves the way for future studies on the use of food additives in electrochemical processes and on the mechanisms by which our additive influences metal deposits.

Keywords

Zn-Ni Electrodeposition, Eco-friendly Additive, SEM/EDS, Corrosion Resistance, Metal Surface Protection, Automotive

Exploring Fungus Gnats (Diptera: Bolitophilidae, Keroplatidae and Mycetophilidae) in the Bouhachem Natural Park Project: Literature Data and New Records

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Abstract

Fungus gnats are a group of nematocerans flies of Diptera comprising six families placed in the superfamily of Sciaroidea. They are considered one of the largest groups of Diptera with more than 5400 species known in the world. Adult fungus gnats are associated with humid areas, especially moist woodlands. They are usually found in shady and moist habitats such as cavities and root systems of fallen trees, overhanging stream banks, and among undergrowth of woods. Larvae of mycetophilids develop mostly in fungal fruiting bodies, or in fungal mycelia in dead wood and soil litter. Few species may develop in myxomycetes, in rotten wood, bryophytes, bird's nests, or caves. Keroplatids are generally found on fungi in damp forests or in caves. Larvae feed on fungi. Moroccan fungus gnats are represented with four families: Bolitophilidae, Keroplatidae, Mycetophilidae and Sciaridae. The Bouhachem Natural Park Project used to shelter only the Mycetophilidae family with its 31 species present in the park. In this work, we aim to re-evaluate the current biodiversity of the fungus gnats in the Bouhachem Natural Park Project, one of the most important protected areas in terms of faunal and floral diversity, mentioning new records of species, genera and even families from the park. The novelties include new records of species (3) and genera (1) for Morocco and North Africa alongside with species (3) new to science.

Keywords

Biodiversity, Bolitophilidae, Diptera, Keroplatidae, Morocco, Mycetophilidae, New Records, New Species

The Mediating Role of the Ambidexterity of Green Innovation on the Relationship Between Green Intellectual Capital and the Environmental Performance of Moroccan Exporting Firms

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Abstract

Global economies struggle to balance economic growth and CO_2 emission reductions, jeopardizing Sustainable Development Goals despite COP26 commitments. Industrial relocation from developed countries to emerging markets, driven by lower costs and lax environmental regulations, exacerbates this issue. The European Union, through the "Green Deal" and the "Fit for 55" plan, aims for carbon neutrality by 2050 and enforces the Carbon Border Adjustment Mechanism (CBAM). While this initiative supports environmental standards, it could disadvantage developing countries like Morocco by increasing export costs. Despite these challenges, Morocco is strengthening its cooperation with the EU to modernize trade relations, while facing the dilemma of reducing emissions without hindering sustainable economic growth. It is in this context that this research analyzes the influence of green intellectual capital (GIC) of export firms on their environmental performance (EP), examining the mediating role of green innovation ambidexterity (GIA). The central questions of the study are: How does GIC influence EP? What role does GIA play in this relationship? What actions can export firms take to improve their EP? Three main reasons justify this research: 1) The lack of empirical evidence on the proposed relationships. 2) The absence of research on this topic in the context of Moroccan export firms. 3) GIC, as an emerging field, requires further development in the intellectual capital literature. To address these questions, a quantitative approach is adopted, using Structural Equation Modeling (PLS-SEM). The results indicate that two components of green intellectual capital, namely green human capital and green relational capital, are positively associated with environmental performance. However, green structural capital only affects environmental performance in the presence of green exploration innovation as a mediating variable.

Keywords

Green Intellectual Capital, Green Human Capital, Green Structural Capital, Green Relational Capital, Green Exploitation Innovation, Green Exploration Innovation, Environmental Performance, Export Firm

Modelling Impacts of Climate Change on Habitat Suitability of *Lavandula stoechas* in the Tanger-Tetouan-Al Hoceima Region (North of Morocco)

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Abstract

Species distribution modeling serves as a vital tool in ecological conservation, particularly for forecasting changes in species' habitats under varying climate scenarios. Understanding such changes is essential for the preservation of biodiversity, especially for species that are vulnerable and underexploited. This study aimed to simulate the current distribution of suitable habitats for *Lavandula stoechas* in the Tanger-Tetouan-Al Hoceima region (North of Morocco) and to evaluate the potential impacts of climate change on its habitat suitability by the 2050s and 2070s. Using two shared socioeconomic pathways (SSP 126 and SSP 254), we projected future habitat suitability under different climate scenarios. The modeling process employed MaxEnt, a widely recognized method, using presence-only data combined with ten critical environmental variables. These variables, mainly climate and soil related, included factors like precipitation, temperature, pH, cation exchange capacity and soil texture (sand, silt, and clay). Validation of the models was conducted using AUC and Jackknife methods, demonstrating robust performance with AUC scores exceeding 0.85, indicating strong predictive power. The study found that pH, soil texture, isothermality (bio3) and the precipitation of driest month (bio14) have a significant influence on the current habitat distribution of the species. Projections suggest that suitable habitats for *Lavandula stoechas* may decrease by 2050 and the 2070s two shared socioeconomic pathways (SSP 126 and SSP 254). Significant loss of native habitats is likely, highlighting the need for strategic conservation planning. Based on these projections, we recommend designating areas that are vulnerable to climate change as conservation protection zones to safeguard this species.

Keywords

Lavandula stoechas, Habitat Suitability, MaxEnt, Species Distribution Modelling

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Study of the Effect of Graphene on the Mechanical Behaviour of Cementitious Materials

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Abstract

Improving the mechanical properties of cementitious materials is crucial for the construction sector, not least to meet the growing demands for infrastructure durability and strength while minimizing environmental impact. The cement industry is indeed responsible for a significant share of CO_2 emissions, motivating the search for more sustainable solutions. In this context, the incorporation of nanomaterials such as graphene and its derivatives is attracting considerable interest due to their exceptional properties, including enhanced mechanical strength and microstructural improvement of cementitious composites. This study aims to compare the mechanical behavior of raw concrete with that of concrete reinforced with different forms of graphene, including graphene nanoplatelets, focusing on compressive and flexural strength. Concrete samples with various graphene contents were experimentally tested to assess their mechanical performance. In parallel, numerical simulations were carried out using finite element analysis (FEA) with ANSYS to analyze the flexural behavior of the samples. The results show that incorporating graphene significantly enhances compressive strength, ductility, and flexural performance compared with conventional concrete. Simulations confirm these findings, revealing a more uniform stress distribution and reduced cracking in the reinforced specimens. This study underscores the potential of graphene to optimize the mechanical properties of cementitious materials, opening up new avenues for the development of stronger and more durable structures. These discoveries pave the way for a new generation of cementitious materials, capable of extending the lifespan of structures while reducing maintenance costs and the carbon footprint of construction, thereby promoting a more sustainable built environment.

Keywords

Cementitious Materials, Nanomaterials, Graphene Reinforcement, ANSYS Numerical Simulation,
Finite Element Analysis, Mechanical Properties, Performance in Construction, Sustainable Construction

Green Technologies and Biophilic Design in Therapeutic Spaces for Children

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Abstract

In the context of heightened awareness of sustainability and well-being, this research explores the integration of green technologies, artificial intelligence (AI), and biophilic design in therapeutic spaces for children, with a particular focus on middle childhood (children aged 6 to 12 years). The aim is to understand how these elements are capable of optimizing pediatric environments while promoting sustainable practices. This paper uses a qualitative approach based on an exhaustive literature review and analysis of practical cases such as the Children's Hospital of Philadelphia (specializing in pediatric care) and Maggie's Centre in London, the study focuses on the application of natural ventilation systems, indoor gardens, ecological materials, and AI to improve energy efficiency and environmental conditions. The results show that integrating these technologies creates soothing environments that foster healing. For instance, Robin, an AI-based robot used at Wigmore Clinic in Armenia, helps reduce loneliness and stress in hospitalized children. These innovations also raise awareness of the importance of sustainability and energy efficiency. This research highlights the need to rethink pediatric care spaces by integrating biophilic design elements, green technologies, and AI to offer a holistic solution that addresses children's well-being and environmental protection.

Keywords

Sustainability, Well-being, Green Technologies, Artificial Intelligence, Biophilic Design

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The Right to Environmental Education in Moroccan Higher Education

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Abstract

The abstract should be a concise single paragraph, ranging from 200 to 400 words, and should not include any reference citations or footnotes. For research articles, it should provide a brief overview of the background, objective, method, result and conclusion of your article before the main body. In case report, abstract should include background, case presentation and conclusion. It is important to ensure that the abstract presents an objective representation of the article, avoiding the inclusion of results that are not substantiated in the main text and refraining from exaggerating the main conclusions. Students' right to environmental education is crucial to enable them to understand and respond to current ecological challenges. However, in Moroccan higher education, this right is almost non-existent. University programs give little space to environmental issues and sustainable development, thus depriving students of the opportunity to develop a deep environmental awareness. This absence not only compromises the students' understanding of issues such as climate change, natural resource management and biodiversity conservation, but it also hinders their active participation in the ecological transition. Students have the right to an education that prepares them to contribute to a sustainable future, and environmental education should be a central element of this training. Unfortunately, there is a complete absence of taking environmental education into account in the current educational specifications. These documents, which define the objectives and contents of the teaching, do not make environmental education a priority. In addition, there is no clear legal framework governing environmental education in public education, especially at university level. It is essential to revise these specifications taking into account the international commitments made by Morocco, in particular those relating to the Sustainable Development Goals (SDGs) and, in particular, the protection of the environment. Updating the teaching programs in accordance with these international declarations and conventions would make it possible to better respond to global challenges and to form a generation of students aware of environmental issues. This article highlights the need to fully recognize and integrate the right of students to environmental education in Moroccan higher education. By reforming curricula to include these issues, Morocco could train a generation of committed students, ready to face environmental challenges and play a key role in building a more sustainable society.

Keywords

Students' Rights, Environmental Education, Higher Education, Sustainable Development Goals (SDGs), Sustainable Future, Environmental Awareness

Environmental Quality of Oued Taza, Morocco: A Multivariate Approach Using Physicochemical Parameters, Indicator Bacteria and Taxonomic Diversity of Populations

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Abstract

The present work is the result of a study carried out over the period March 2023-April 2024, the aim of which was to determine the environmental quality of Oued Taza using a multivariate approach based on physicochemical parameters, indicator bacteria and taxonomic diversity of populations. To do this, we delimited the study area to 7 stations and carried out spatio-temporal monitoring of benthic macroinvertebrates, bacteriological and physicochemical parameters. Based on the Standardized Global Biotic Index. For each station, we analyzed the aquatic populations and established a biotypology test, bearing in mind that the determination of the macro-invertebrate groups studied requires the collaboration and confirmation of several systematists. Some animals are only known at genus or family level. With the exception of Diptera and Ephemeroptera, macroinvertebrates in the Oued watershed are much less diverse, and their presence depends on the diversity of ecological conditions at each station. The more heterogeneous the biotope, the higher the numbers. The results also enabled us to highlight various types of contamination, mainly expressed by two types of pollution: significant microbial pollution in 100% of the waters, originating from percolating runoff and domestic and industrial wastewater, and low to significant chemical pollution in all the waters studied. The results obtained show that the various parameters: dissolved oxygen, nitrate and nitrite concentrations are too high in relation to national standards in several of the samples analyzed. These results will enrich the database on water quality in the basin, and help decision-makers to make better decisions on water resource management with a view to improving the region's sustainable development.

Keywords

Environmental Quality, Macro-invertebrates IBGN, Diptera, Ephemeroptera

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Fecal Contamination and Environmental Influence in Bivalve Molluscs: A Case Study of Ras El Ma, Morocco

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Abstract

This study evaluates the sanitary condition of commercially significant bivalve mollusk species from the Marchica Lagoon and examines the impact of physicochemical factors on fecal contamination. A total of 72 samples were analyzed for *Escherichia coli* (*E. coli*) enumeration and Salmonella detection. The microbiological assessment revealed higher fecal pollution indicators during autumn and winter, with lower levels in summer. No Salmonella was detected throughout the study. Statistical analysis indicated that temperature and salinity significantly influence fecal indicator loads in the bivalve mollusks of the Marchica Lagoon. According to Moroccan circular number 1508/12, which sets the sanitary standards for the production and marketing of live bivalve mollusks, 90.5% of the samples were deemed safe, while 9.5% required relaying or purification treatment.

Keywords

Bivalve Mollusks, Indicator Bacteria, Moroccan Circular Number 1508/12, Salmonella, Marchica Lagoon

Environmental Impacts of Artificial Intelligence

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Abstract

Nowadays, Artificial Intelligence (AI) tools have revolutionized various sectors, leading to significant advancements in efficiency, productivity, and innovation. However, the environmental implications of these technologies are increasingly concerning. This paper examines the negative impacts of AI tools on our environment, focusing on energy consumption, resource depletion, and electronic waste. The energy-intensive nature of AI model training and deployment contributes significantly to greenhouse gas emissions. High-performance computing centers required for AI operations consume vast amounts of electricity, often sourced from non-renewable energy. For instance, the training process for a single AI model can consume thousands of megawatt hours of electricity and emit hundreds of tons of carbon. Additionally, the production and disposal of AI hardware — such as servers, GPUs, and data centers — result in the depletion of natural resources and generation of electronic waste, exacerbating pollution and environmental degradation. Furthermore, the rapid pace of AI development promotes a cycle of continuous hardware upgrades, leading to shorter device lifespans and increased electronic waste. AI-generated text requires significantly less energy than AI-generated images. Using the most efficient text generation model studied, creating text 1,000 times can use as much energy as 9% of a full smartphone charge. Generating images is by far the most energy- and carbon-intensive AI-based task. Training the bigger, more popular AI models like GPT-3 produced 626,000 pounds of carbon dioxide, equivalent to approximately 300 round-trip flights between New York and San Francisco. This paper emphasizes the need for sustainable practices in the development and deployment of AI tools, including the adoption of energy-efficient algorithms, renewable energy sources, and effective recycling programs. Policymakers, researchers, and industry leaders must collaborate to create sustainable AI solutions that balance technological advancement with environmental preservation.

Keywords

Artificial Intelligence, Environment, Energy Consumption, Resource Depletion, Electronic Waste

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Modeling and Control of an Aerogenerator Utilizing DFIG and Multi-Level Converter Technology

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Abstract

This paper explores the modeling and control of an aerogenerator system integrating a Doubly Fed Induction Generator (DFIG) paired with advanced multi-level converter technology. Multi-level converters are particularly suited to meet the high-performance demands of wind energy systems, providing improved power quality, reduced harmonic distortion, and increased energy efficiency. Utilizing vector control and maximum power point tracking (MPPT) techniques, this study aims to optimize wind energy extraction while ensuring system stability and responsiveness under varying wind speeds. Simulations conducted in MATLAB/Simulink validate the proposed approach, demonstrating significant improvements in dynamic performance and power quality fed into the grid. This work emphasizes the importance of multi-level converters in renewable energy applications, highlighting their potential to enhance the efficiency and reliability of wind power generation systems.

Keywords

Aerogenerator, Doubly Fed Induction Generator, Multi-Level Converter, Wind Energy, Power Quality, Harmonic Distortion, Energy Efficiency, Maximum Power Point Tracking

Optimizing Stability and Performance with a New MPPT Algorithm for Photovoltaic Applications

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Abstract

Photovoltaic (PV) systems play a critical role in renewable energy generation, with the maximum power point tracking (MPPT) algorithm being essential for optimizing their efficiency. This paper presents a novel MPPT algorithm designed to enhance stability and performance under varying environmental conditions. The proposed method leverages advanced adaptive control strategies to dynamically adjust to fluctuations in irradiance and temperature, ensuring rapid convergence to the maximum power point while minimizing oscillations. Simulations and experimental results demonstrate the algorithm's superior tracking efficiency, improved response time, and robustness compared to conventional techniques such as Perturb and Observe (P&O) and Incremental Conductance (IncCond). The findings highlight the potential of the new MPPT approach to improve the overall energy yield and reliability of photovoltaic applications, paving the way for more sustainable energy solutions.

Keywords

Power Electronics, MPPT, Photovoltaics, Energy

Education and Environmental Challenges: Balancing Risks and Opportunities

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Abstract

Education plays a pivotal role in addressing environmental challenges, serving as both a source of resilience and a platform for transformative change. This chapter examines the intricate relationship between education and environmental issues, focusing on how educational systems can navigate the risks and opportunities inherent in this dynamic. Key challenges such as climate change, biodiversity loss, pollution, and resource depletion demand innovative educational approaches that promote environmental literacy, critical thinking, and problem-solving skills. The chapter explores interdisciplinary and experiential learning methods that empower individuals and communities to understand, mitigate, and adapt to these environmental threats. It emphasizes the integration of sustainability principles into curricula to foster awareness, inspire action, and encourage green innovation. The discussion also highlights the role of education in developing green skills and competencies essential for a transition toward a circular economy and sustainable development. By balancing the risks posed by ecological degradation with the opportunities for innovation, collaboration, and societal transformation, this chapter underscores the importance of education as a catalyst for positive change. Ultimately, it advocates for a reimagined educational framework that aligns with global environmental goals, enabling current and future generations to thrive in the face of ecological challenges.

Keywords

Environmental Education, Sustainability, Environmental Literacy, Green Skills, Sustainable Development, Educational Transformation, Environmental Challenges

Sustainable Journey of Cotton: From Farm to Fabric

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Abstract

Cotton production has two major sustainability challenges. They require huge usage of pesticide and water. The cotton plants have great susceptibility to pests and diseases. Moreover, excessive use of pesticides and fertilizers can harm the environment and promote soil degradation. Remote monitoring systems can be used to detect and monitor pests in cotton production. These systems typically involve sensors placed throughout the field that can detect the presence of pests or signs of pest damage. By detecting pests early, farmers can take proactive measures to control them, such as applying targeted pesticides or introducing beneficial insects. This can help to reduce the overall use of pesticides and minimize damage to the cotton crop. Biological control is a method of pest management that uses natural enemies like insects, mites, or bacteria to control pest populations. These natural enemies, known as bio control agents, prey on or parasitize the pests, reducing their numbers without the need for chemical pesticides. Another issue is the high water consumption required for cotton cultivation. This is because they are growing quickly and need a lot of energy to produce cotton. This excessive water requirement can be managed by using smart irrigation systems that can accurately measure and control water application. Machine learning algorithms can analyze real-time data on soil moisture to optimize water usage in cotton production. By monitoring soil moisture levels continuously, these algorithms can predict when plants need to be irrigated. This helps prevent over-irrigation and soil degradation.

Keywords

Bio-control Agent, Cotton Production, Chemicals, Over-irrigation, Pesticide, Soil Degradation, Sustainable, Smart Irrigation

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ESD in Teacher Education at ESEFO: Ecological Content and Practices

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Abstract

In the context of Education for Sustainable Development (ESD), future teachers play a key role in instilling ecological values in new generations. The initial training they receive, particularly at the École Supérieure de l'Éducation et de la Formation d'Oujda (ESEFO), must therefore incorporate pedagogical content and practices aligned with sustainable development goals. However, what ESD-related content is present in the initial teacher training programs at ESEFO? Are the pedagogical practices implemented truly effective for acquiring, transmitting, and applying the ecological competencies needed to establish a genuine "green pedagogy" in the Moroccan educational system? What challenges and opportunities exist for strengthening the integration of ESD into initial training to prepare teachers to promote environmentally conscious education? To address these questions, a mixed-methods approach was adopted, including content analysis and interviews with instructors. This study will focus on analyzing the content from various years and streams of the undergraduate cycle. Additionally, interviews will be conducted with instructors to gauge their involvement in the ecological project, in relation to the current content, and to understand the pedagogical approaches they implement to achieve this goal. The anticipated results will contribute to improving teacher training in sustainable development, aiming to build a more committed and responsible education towards our environment.

Keywords

ESD, Education, The Initial Training, Ecological Values, Green Pedagogy

Education for Sustainable Development: From Awareness to Ecological Values

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Abstract

Ecological awareness is often limited to cognitive learning about environmental issues. However, developing ecological values involves a deeper understanding of these issues, leading to concrete choices and behaviors that support sustainability. Moreover, Education for Sustainable Development (ESD) plays a central role in contemporary educational policies. Yet, simple awareness is insufficient to drive a profound transformation in attitudes and practices. The shift from awareness to a true integration of ecological values requires a psychological change that translates into more tangible commitment. What ecological values should individuals develop? What are the characteristics of each value? How does the transition from awareness to ecological values manifest? To what extent do current initiatives contribute to a lasting transformation of behaviors and mindsets? This paper explores the necessary conditions for a successful transition, drawing on recent research in environmental education. The findings aim to identify the levers and obstacles to an effective shift toward an education infused with ecological values. Ultimately, this research seeks to provide practical recommendations to enhance ESD integration within educational systems, promoting a more sustainable and engaged society. These results will aid in designing more effective educational programs and equipping educators to fully embrace their roles as catalysts for environmental change.

Keywords

Education, Sustainable Development, Awareness, Ecological Values, Psychology, Transition

Teaching Against the Anthropocene: Environmental Humanities and Education for a Sustainable Future

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Abstract

In 1887 Nietzsche wrote "Our attitude towards Nature today, our violation of Nature, with the help of machines and the unimaginable inventiveness of our technicians and our engineers, is Hubris." (Genealogy of Morals) In fact, the whole idea of “humanity” has gradually been built on the basis of a distance from nature. Consequently human civilization has constantly worked to mark its difference from the world of nature and strived to master it. Questioning the dichotomy of “Culture vs Nature” -- a binary opposition signifying an unnatural distancing, an exiting of man from his natural habitat -- is the first step towards building a sustainable future. This enterprise is contingent on an education for environment. If to educate is to care, then education must be thought of differently in order to reach the goal of an eco-friendly learning. The contention of this contribution is that children are caught up in the marketing ideology that postulates that everything is consumable and disposable, and that has an impact on their behavior. This paper seeks to highlight the importance of adopting an environmental humanities approach to education. The main argument is that environmental humanities which is an interdisciplinary field integrating both classical humanities and natural sciences, combined with digital literacy will positively impact education for a sustainable future. Furthermore, it offers the opportunity for research and of opening up new forms of interdisciplinarity both within the humanities and in collaboration with the social and natural sciences, and for shaping public debate and policies on environmental issues.

Keywords

Environmental Humanities, Education, Anthropocene, Digital Literacy, Sustainability

Fibers, Ciment, and Lime in Earth Construction Materials: A Review

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Abstract

This review examines the integration of fibers, cement, and lime in earth construction materials, highlighting their roles in enhancing the mechanical, thermal and durability properties of these sustainable building materials. The use of natural fibers has been a traditional practice in earth construction, providing reinforcement to raw earth and lime-based mortars. The review discusses various types of fibers and their effects on the physical, thermal, mechanical, and hygrothermal properties of earth-based composites. Additionally, it explores the benefits of incorporating cement and lime as stabilizers, which improve the compressive strength and durability of earth materials. By analyzing existing literature, the review identifies optimal compositions and treatment methods that enhance the performance of compressed earth blocks and other earth construction techniques, ultimately promoting more sustainable building practices.

Keywords

Natural Fibers, Mechanical Properties, Thermal Performance, Durability, CEB, Adobe

Adaptive Climate Education: Harnessing Neural Architecture Search for Tailored Regional Learning Paths

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Abstract

As climate change intensifies, there is a growing need for educational solutions that are personalized to the unique environmental and socio-economic challenges faced by different regions. Current climate education models tend to apply a standardized approach, which fails to address the diverse needs and vulnerabilities of specific communities. Our project addresses this issue by leveraging Neural Architecture Search (NAS) to develop an adaptive model that delivers regionally tailored climate education content. NAS is a machine learning technique that automates the design and optimization of neural network architectures by exploring different configurations, such as the number of layers, neurons, and types of connections. The NAS framework evaluates architectures like Convolutional Neural Networks (CNNs) for multimedia content and Transformers for text-based learning, ensuring the most efficient architecture is selected for each region. This approach enables the model to balance performance and computational efficiency. Our methodology begins with the collection and analysis of local and regional educational and environmental data, which is then scaled for broader application. First, we gather educational data from multiple sources, including literacy rates, technology access, and student performance metrics from UNESCO, the World Bank, OECD, and PISA. This data is preprocessed and used to define the NAS search space. Neural Architecture Search (NAS) is employed to explore various neural network architectures, such as CNNs for multimedia content and Transformers for sequential learning. The NAS framework evaluates and optimizes these architectures based on performance metrics like computational efficiency and learning outcomes, ensuring they meet the specific needs of different regions. Finally, the selected architecture is trained on the collected data, and the resulting model personalizes climate education content based on each region's unique challenges and resources. This iterative, data-driven approach ensures that the educational system remains adaptive, effective, and efficient across diverse socio-economic and environmental contexts. Through NAS, we can move beyond the standardized educational models that have been insufficient in addressing the diverse needs of global climate literacy. This platform transforms climate education into a flexible, regionally aware system, equipping learners with the tools necessary to address specific climate impacts, ultimately contributing to a more climate-resilient global society.

Keywords

Neural Architecture Search (NAS), Personalized Climate Education, Machine Learning, Regional Adaptation, Convolutional Neural Networks (CNNs), Educational Data Optimization

Analysis of Natural and Artificial Lighting Performances for a Multi-functional Laboratory Using Smart Spectrometer and DIALux Evo Simulation

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Abstract

Both natural and artificial illumination play a significant part in daily human activity. Natural lighting conditions influence energy consumption in buildings, as insufficient natural light can lead to increased electricity usage for artificial lighting. The multi-functional laboratory at the Department of Engineering Sciences, Faculty of Sciences and Techniques of Errachidia, needs adequate illumination levels that comply with the European lighting standard (EN 12464-1). This research study examines a novel approach for efficient lighting design that is specifically customized for laboratory settings. The study investigates the impact of illumination on various aspects of laboratory work, including productivity, safety, and laboratory staff's general welfare. The goal is to improve visual comfort, task performance, and energy efficiency. The process employs a blend of literature analysis, case studies, experiments, and simulations to assess the efficacy of the suggested lighting design approach. Firstly, we will start with a diagnostic examination of the current natural and artificial lighting system using a smart spectrometer to confirm, on the one hand, the level of illumination during daylight hours. Furthermore, to ascertain the lighting conditions by considering the current fluorescent tubes. On the other side, DAILux evo has been used to design smart lighting systems. A comparative research study was carried out, taking into consideration illuminance levels, homogeneity, glare, and energy usage. Finally, proposals were presented for employing artificial intelligence to boost the quality and efficiency of the proposed lighting design approach. The results provide valuable insights for architects, lighting designers, and laboratory managers looking to optimize lighting systems.

Keywords

DIALux Evo Software, Visual Comfort, Smart Spectrometer

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Evaluation of Environmental Education at a Moroccan Higher Education Institution: A Case Study of the Higher School of Education and Training in Oujda, Morocco

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Abstract

This study investigates the state of environmental education at a Moroccan higher education institution, specifically the Higher School of Education and Training in Oujda. An online survey was conducted with 200 students to evaluate their knowledge, attitudes, and practices concerning environmental issues. The findings reveal a widespread dissatisfaction among students regarding the quality and effectiveness of the current environmental education programs. Although students demonstrate a keen awareness of environmental challenges and express a strong desire for more comprehensive educational initiatives, they perceive existing efforts as inadequate. This disconnect highlights a significant gap between students' understanding of environmental problems and their confidence in the effectiveness of the educational framework designed to address these issues. Furthermore, students indicate a willingness to engage in sustainable behaviors, yet they feel unsupported by the current curriculum and resources available. The study emphasizes the urgent need for a more robust and integrated approach to environmental education at the university level, advocating for reforms that align educational practices with students' expectations and the pressing environmental challenges of the modern world. Additionally, the research calls for enhanced collaboration among educational institutions, governmental bodies, and non-governmental organizations to foster a more effective and impactful environmental education framework. By addressing these deficiencies and promoting a culture of sustainability, the study aims to contribute to the development of a more informed and proactive student body equipped to tackle environmental issues in their communities and beyond.

Keywords

Environmental Education, Higher Education, Environmental Problems, Sustainability

Impact of Al_2O_3 on Biochar Quality in Biomass Pyrolysis Using a Fixed-Bed Reactor

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Abstract

Pyrolysis is one of the most efficient methods for transforming biomass into valuable products such as bio-oil, biochar, and syngas. These products have applications across various sectors, including transportation, agriculture, and cosmetics. Biochar is particularly valued for its numerous advantages: low cost, environmental friendliness, and high stability. Biochar is formed during pyrolysis by decomposing raw materials in an inert environment. This process involves polymerization and carbonization, resulting in stable aromatic structures. Due to its porosity and high carbon content, biochar can also be used as a soil amendment, helping to reduce acidity and increase fertility. Additionally, it has applications in wastewater treatment and as a catalyst in various processes. This work aims to determine the effect of temperature and particle size and the impact of adding catalysts like Al_2O_3 on the yield and quality of the biochar produced. Aspects studied include morphology, calorific value, and pH. These analyses will be performed using different methods such as IR, SEM-EDX, XRD, and elemental analysis.

Keywords

Pyrolysis, Catalyst, Biochar, Temperature, Particle Size, Al_2O_3

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Design, Synthesis, in Vitro and in Silico Characterization of 2-Quinolone-L-alaninate-1,2,3-triazoles as Antimicrobial Agents

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Abstract

Due to the growing issue of antimicrobial resistance, there is an urgent need for the development of new antimicrobial agents. Motivated by the broad antibacterial effects of various heterocyclic compounds, such as 2-quinolone derivatives, we designed and synthesized novel methyl-(2-oxo-1,2-dihydroquinolin-4-yl)-L-alaninate-1,2,3-triazole derivatives. These compounds were created through a 1,3-dipolar cycloaddition reaction between 1-propargyl-2-quinolone-L-alaninate and suitable azide groups, yielding products in good amounts (75-80%). The chemical structures of the compounds were confirmed through spectroscopic techniques, and their antimicrobial activity was tested against both bacterial and fungal strains, showing significant antibacterial effects and weak to moderate antifungal activity. Although the quinolone moiety of our compounds resembles fluoroquinolones, they do not act by inhibiting DNA gyrase. Computational studies suggest that the compounds have favorable physicochemical and pharmacokinetic properties, indicating their potential as candidates for further development as antimicrobial agents for clinical applications.

Keywords

Cycloaddition, Quinolone, Antibacterial Activity, Docking Study

Preparation of a Bentonite Matrix Composite for Heavy Metal Removal

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Abstract

This study examines the adsorption process of Ni^{2+} on bentonite, a clay material, as well as the effect of the composite prepared based on bentonite and natural polymer. The modified bentonite was thoroughly characterized using various analytical techniques such as X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM). The results revealed significant improvements in mineralogical and surface structures compared with untreated bentonite. To study adsorption, variable nickel concentrations ranging from 200 to 4000 mg/L were tested. Experimental isotherm data were analyzed using Langmuir, Freundlich and Temkin models. The fits showed that the Freundlich model best described nickel adsorption on bentonite-biopolymers, with an adsorption capacity of 475 mg/g.

Keywords

Composite, Bentonite, Biopolymers, Adsorption, Heavy Metal and Nickel Removal

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The Influence of Environmental Education on Awareness and Sustainable Behaviors: Bridging Gaps Between Schools and Social Circles

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Abstract

This article examines the influence of environmental education on individuals' awareness and their adoption of sustainable behaviors, emphasizing their interactions with family, friends, and teachers. Although awareness of environmental challenges is steadily increasing, many students express dissatisfaction with the effectiveness of existing educational programs. The study underscores the critical role of family discussions and access to tailored information in fostering environmental awareness and encouraging proactive behaviors. To align with the expectations of younger generations, the study advocates for a stronger incorporation of environmental education into university curricula. This should be complemented by diversifying communication channels to effectively reach a broader audience and inspire collective awareness. Regular conversations about environmental issues within families are also highlighted as a key factor in promoting sustainable practices. These discussions not only reinforce values but also help individuals develop a deeper understanding of ecological challenges. Additionally, the article calls for a reevaluation of current educational strategies to better equip future generations for the pressing ecological issues of our time. Active engagement at both individual and collective levels is essential for building a society that is informed, responsible, and resilient in the face of environmental concerns. By fostering sustainable practices and encouraging regular dialogue about ecological topics, the study aims to contribute to the creation of a community that is both environmentally conscious and prepared to address the challenges of a rapidly changing world.

Keywords

Environmental Education, Social Interactions, Educational Programs, School Curricula, Ecological Challenges

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Advancing Green Transition Through a Micro-grid with an Optimized Energy Management System

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Abstract

The global drive towards sustainable energy and reducing carbon footprints has accelerated the adoption of green technologies. Among these, micro-grids represent a promising solution for decentralizing energy production while integrating renewable energy sources. Since Morocco is characterized by high solar radiation and high wind speed in a lot of area, this paper will conduct a study of a Micro-grid combining PV, Wind turbine installation and MPPT controllers, Energy Storage system and Energy Management System. This study covers in detail the implemented algorithm within MPPT controllers to extract maximum power from PV and Wind turbine and the approach applied to Energy management system to ensure optimal use of the energy produced from the hybrid system based on the load demand, the state of charge of the battery while guaranteeing the sustainability of energy for the load. Simulation results demonstrate significant improvements in energy efficiency, reduction in CO_2 emissions, and cost-effectiveness, thus making a substantial contribution to the green energy transition. This study highlights the potential of optimized Micro-grid systems as a key enabler of future sustainable energy frameworks.

Keywords

Hybrid System, Micro-grid, Solar PV, Wind Farm, Battery, Renewable Energy, Energy Management System, MPPT Controller

AI-Driven Predictive Maintenance for Sustainable Photovoltaic Systems and Environmental Protection

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Abstract

Maximizing the efficiency of photovoltaic (PV) systems is essential for en-suring clean energy production and reducing the environmental impact of energy generation. However, PV systems are prone to a range of faults due to environmental factors such as temperature variations, solar irradiance fluctuations, dust accumulation, and humidity. These faults can lead to re-duced energy output, equipment degradation, and overall inefficiency. This paper explores the use of predictive maintenance driven by Artificial Intelli-gence (AI) to enhance the fault detection process in PV systems. The AI sys-tem integrates both environmental data (solar irradiance, temperature, hu-midity, and wind speed) and operational parameters (voltage, current, power output) to create a comprehensive predictive model. Using machine learning algorithms, the system can identify patterns in data that precede common PV faults such as module degradation, inverter failures, and cable issues. The AI-based approach predicts faults before they lead to significant perfor-mance degradation, allowing for timely interventions such as cleaning, re-pairs, or equipment replacement.

Keywords

Predictive Maintenance, AI, Sustainable Energy

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Composting of Olive Mill Pomace: Process Monitoring and Evaluation of Final Product

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Abstract

The potential use of olive mill pomace through composting provides an environmentally sustainable method for managing by-products of olive oil production, particularly in olive-growing regions. By converting this waste into a nutrient-rich soil amendment, composting enhances soil fertility, promotes sustainable agriculture, and contributes significantly to waste reduction. Therefore, the key objective of this study is to minimize waste generated by the olive oil industry by transforming olive pomace into a valuable resource, thus reducing the need for landfilling or improper disposal of organic by-products For this process, compost production was achieved using aerobic bioreactors with forced aeration, where fresh olive mill pomace was mixed with barley straw (bioreactor-1), barley straw + urea (bioreactor-2), and barley straw + sheep manure (bioreactor-3) in mass ratios to adjust the C/N ratio. The entire composting process took five months. Throughout the process, several parameters were monitored, including moisture content, pH, electrical conductivity (EC), organic matter, carbon-to-nitrogen (C/N) ratio, and phenol levels. Promising results were observed as pH, EC, organic matter, C/N ratio, and phenols were reduced over time, indicating an improvement in the quality of the final compost product. The compost produced acts as a natural soil conditioner, reducing the reliance on chemical fertilizers and supporting eco-friendly and sustainable farming practices. This approach not only enhances soil health but also contributes to the circular economy in olive-growing regions by turning waste into a valuable agricultural input.

Keywords

Olive Pomace, Bioreactors, Composting Process, pH and Moisture Contents, Chemical Profile

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Enhancing Sustainable Development Through Photovoltaic System Optimization

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Abstract

The global transition towards renewable energy is pivotal for achieving sustainable development, with photovoltaic (PV) systems playing a central role in this transformation. This paper investigates the optimization of PV systems as a catalyst for enhancing sustainable development. By improving energy efficiency, minimizing costs, and reducing carbon emissions, optimized PV systems can significantly contribute to meeting sustainability goals. The research focuses on advanced optimization techniques, including smart grid integration, machine learning algorithms, and energy storage solutions, to maximize power output, ensure system reliability, and adapt to varying environmental conditions. Additionally, the paper evaluates the socioeconomic and environmental benefits of deploying optimized PV systems in diverse regions. The study underscores how optimized PV systems can promote clean energy access, reduce dependency on fossil fuels, and support sustainable industrialization. Through a combination of simulations and real-world case studies, this research demonstrates the critical role of photovoltaic optimization in driving sustainable development and fostering a cleaner, more resilient energy future.

Keywords

PV Systems, Renewable Energy, Energy Efficiency, Optimization Techniques, Smart Grid Integration, Machine Learning Algorithms, Energy Storage Solutions

Moroccan Wearable Artificial Kidney: An Ecological Revolution in Hemodialysis

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Abstract

Faced with the challenges posed by the current environmental context, the search for sustainable solutions is attracting growing interest from researchers in various fields, including medicine and more specifically hemodialysis, because it's an energy- and water-intensive therapy and generates large quantities of waste due to its concept. It is therefore imperative to seek sustainable solutions to reduce the ecological impact of hemodialysis, in given its high carbon footprint, particularly that associated with electricity consumption. Hemodialysis is the most widely used treatment of choice for most patients with end-stage renal disease (ESRD) worldwide. However, it requires large quantities of water and energy, contributing to a significant ecological footprint. During a 4-hour hemodialysis session, a patient consumes around 500 liters of water (78 m^3 per year), generates more than a kilogram of potentially hazardous waste, many of which are not recyclable, and in the same session, the hemodialysis machine consumes around 7 kWh of energy, while the water treatment unit consumes around 150 kW/d to ensure its operation. On the other hand, the prevalence of ESRD continues to rise, reaching 9.1% in 2017, an increase of 29.3% since 1990. This situation poses a threat to the natural resource of countries, particularly arid and semi-arid countries, and has a negative effect on the ecology by increasing the carbon footprint associated with hemodialysis unit activity. Nowadays, the green dialysis and ecodialysis approach is at the heart of research. It aims to optimize the water and electricity resources associated with hemodialysis and minimize waste production, through the Recycle, Reuse and Reduce triangle. The ultimate goal of this approach is to combine patient care with responsible management of natural resources. This is one of the purposes of the Moroccan Wearable Artificial Kidney (MorWAK) project. This paper is intended to present a sustainable alternative solution (MorWAK), for treating patients with ESRD. This is a portable hemodialysis device. It is designed to purify patients' blood without the requirement for water, consumes very few energy and generates very few waste products. This device's eco-friendly solution holds the potential to contribute to a sustainable future for public health and change how dialysis is performed.

Keywords

MorWAK, Hemodialysis, End-stage Renal Disease, Ecological Impact of Hemodialysis, Climate Change

Cannabis Sativa: A Multifunctional Resource for Environmental Sustainability

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Abstract

Hemp (*Cannabis sativa* L.), a versatile plant widely recognized for its medicinal and recreational uses, also offers considerable ecological potential. This review explores the environmental applications of cannabis including phytoremediation, sustainable agriculture, biofuel production, and the development of renewable eco-friendly materials. Hemp is highly effective in phytoremediation, capable of absorbing heavy metals and contaminants, thereby improving soil quality. Its fast growth, low water and pesticides requirements, and adaptability to various climates make it an ideal crop for sustainable agriculture, enhancing soil health and reducing chemical dependence. Hemp seed oil can be processed into biodiesel, offering a renewable energy source that reduces greenhouse gas emissions. Additionally, hemp fibers and biomass are being developed into paper, textiles, and bioplastics, providing renewable and biodegradable alternatives to petroleum-based products. Other hemp-based materials like hempcrete are gaining popularity in sustainable construction for their carbon-negative properties. Through these diverse ecological applications, hemp emerges as a valuable resource for addressing environmental challenges, promoting sustainability, and reducing the carbon footprint. This research emphasizes the untapped potential of cannabis as a multi-functional plant for environmental conservation.

Keywords

Cannabis sativa L., Ecological Applications, Sustainability, Phytoremediation, Renewable Materials

Genetic Variability and Morphological Characterization of the Local Cannabis "Beldia" from Northern Morocco

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Abstract

Our study explores the biodiversity of the local Moroccan cannabis population, Beldia. A detailed morphological characterization of Beldia was conducted, providing insights into plant height, general growth habits, and the description of the stem, root system, leaves, male and female flowers, fruits, seeds, as well as the presence and distribution of trichomes. Furthermore, a genetic analysis of Beldia was carried out using simple sequence repeat (SSR) markers on samples collected from four regions in northern Morocco. The genetic diversity and population structure were investigated using GenAlEx 6.5 software and STRUCTURE v2.3.4 software, respectively. The results revealed that Beldia ecotype had a great genetic diversity as indicated by several genetic diversity indices, highlighting its value as a reservoir of alleles for breeding new cultivars with desirable traits. Moreover, the population structure and Mantel test results demonstrated the absence of isolation-by-distance. The geographical distance between regions did not influence the observed genetic differences, suggesting that Beldia seeds were frequently exchanged among farmers across these areas. This conclusion is of great interest in germplasm management and conservation, as all Beldia individuals from the four regions could be grouped into one genetic group, which can be protected as a single evolutionary unit, reducing conservation costs. Our findings contribute to a deeper understanding of the ecological and genetic landscape of Moroccan cannabis, aiding in the efficient management of its genetic variability and the preservation of Beldia's unique genetic identity and purity.

Keywords

Cannabis sativa L., Moroccan Ecotype, Morphological Characterization, Genetic Diversity, SSR Markers