ICCETSD

यस्मिन् सर्वाणि भूतानि आत्मैवाभूद् विजानतः।
तत्र को मोहः कः शोक एकत्वमनुपश्यतः ॥

Graphic Era
Deemed to be University

1ST INTERNATIONAL CONFERENCE ON

(ICCETSD)

CURRENT ENVIRONMENTAL TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

2024

www.iccetsd.geu.ac.in

SOUVENIR CUM ABSTRACT BOOK

About the University

Graphic Era (Deemed to be University) is the culmination of the hard work of its visionary founder, Prof. (Dr.) Kamal Ghanshala, who had the dream to change the destiny of thousands of youths through quality and holistic education. In 1993, he embarked on the mission to transform the higher education landscape of the Doon Valley with Twenty-nine thousand rupees in his pocket and loads of determination in his heart.

His vision gained concrete shape in 1996 the form of the Graphic Era Institute of Technology (GEIT). In 2008, it was accorded the status of Deemed University under Section 3 of the UGC Act, 1956 vide Notification F.9-48/2007-U.3 (A) dated 14 August 2008 and approved by the Ministry of Human Resource Development, Government of India.

Today, Graphic Era (Deemed to be University) stands tall as NAAC 'A+' accredited university with 7 NBA accredited programs and is ranked among the Top 55 universities of India in MHRD's National Institutional Ranking Framework (NIRF) with All India Rank 52 in the Engineering Category, All India Rank 59 in Management Category, and All India Rank 52 in the University Category.

The premier university regards industry-academia partnership as an integral part of teaching methodology & curriculum and has taken big initiative in engineering programs by getting into partnerships with Tata Technologies and IBM. Moreover, it hosts Technology Business Incubator that funds, mentors and nurtures ideas, start-ups and technology-based entrepreneurship.

Graphic Era (Deemed to be University) has acquired transnational dimensions through student exchange and knowledge-sharing programs with many foreign universities and has been acclaimed and honoured at international forums for its brilliance in upholding the highest standards of education. The alumni of Graphic Era are making their mark Worldwide in marquee brands like Apple, Google, Microsoft, HSBC, to name a few and in the service of the nation in all wings of the Armed forces.

About the Department

The Department of Environmental Science at Graphic Era (Deemed to be University), Dehradun, offers a transformative education in environmental science, combining theoretical foundations with practical experience. GEU's M.Sc. in Environmental Science program is led by renowned faculty with international expertise, who provide invaluable mentorship to foster environmental leadership. Students benefit from unparalleled research opportunities through partnerships with premier institutions, allowing them to engage in innovative environmental studies. With a diverse research focus, the curriculum covers vital topics like biodiversity, bioenergy, and sustainable development, offering students the flexibility to tailor their learning path towards their unique interests. GEU is deeply committed to sustainability, cultivating future leaders dedicated to making impactful environmental changes. By joining GEU's Environmental Science program, students not only gain a solid academic foundation but also join a vibrant community working toward a sustainable future through pioneering solutions.

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Message

Prof. Kamal Ghanshala
President
Graphic Era Group of Institutions

In an era marked by rapid technological advancement and unprecedented environmental crises, addressing global environmental challenges and fostering sustainable development has become exceedingly important. The present generation's commitment not only towards meaningful utilization of available resources but also preservation and creation of resources for generations to come, has also to be underlined.

I am glad to know that the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, is being organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun. It will provide a platform for interdisciplinary dialogue that addresses contemporary global challenges. The focus on emerging environmental technologies, coupled with innovative initiatives like the Eco-Mela will certainly add to the conference's potential to catalyse transformative changes in this field.

I am sure that the conference will bring together intellectuals, leading scientists, research scholars and students to exchange and share their research ideas in the domain of environmental science and sustainable development and will undoubtedly inspire actionable ideas and forge new pathways toward a greener and more resilient future.

I extend congratulations to the organizing team for their efforts in bringing together a distinguished assembly of experts, scholars, and practitioners. I am confident that the discussions and deliberations during this conference will result in meaningful outcomes that will resonate beyond its duration.

With best wishes

Kamal Ghanshala

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MESSAGE

It gives me immense pleasure to extend my warm greetings on the occasion of the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun.

In an era marked by rapid technological advancements and pressing environmental challenges, the theme of ICCETSD 2024 holds profound significance. Addressing climate change, resource scarcity, and ecological degradation requires not only innovative technologies but also collaborative efforts across disciplines and borders. This conference provides an exceptional platform for academics, researchers, industry experts, and policymakers to converge, share insights, and chart a course toward sustainable development.

As Chancellor of Graphic Era (Deemed to be University) and a member of NITI Aayog, I am deeply committed to fostering initiatives that align with India's national vision of sustainability and environmental stewardship. Conferences like ICCETSD 2024 are crucial in bridging the gap between scientific discovery and practical implementation, ensuring that our advancements in environmental science contribute meaningfully to society.

I am particularly delighted by the inclusion of the Eco-Mela, which exemplifies the innovative spirit and community engagement central to Graphic Era's ethos. Such initiatives inspire creative problem-solving and promote awareness of sustainable practices among all stakeholders.

I congratulate the Department of Environmental Science and the organizing committee for their dedication and vision in organizing this landmark event. I am confident that the discussions, deliberations, and collaborations fostered during ICCETSD 2024 will yield transformative solutions that address pressing global challenges.

I extend my best wishes to all participants and look forward to the impactful outcomes of this conference. Together, let us advance the shared mission of creating a sustainable and resilient future for generations to come.

(Dr. V. K. Saraswat)
Chancellor, Graphic Era (Deemed to be University)

New Delhi
10.12.2024

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Message

It is a matter of great pride to extend my heartfelt greetings to all participants, speakers, and organizers of the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun on 9& 10 December, 2024.

As humanity faces complex environmental challenges such as climate change, biodiversity loss, and resource depletion, the need for innovative and sustainable solutions has never been more urgent. ICCETSD 2024 stands as a testament to our collective commitment to addressing these pressing issues through cutting-edge research, technology, and collaboration.

This conference provides a unique opportunity for academicians, researchers, policymakers, and industry leaders to come together and share their expertise. The interdisciplinary approach of ICCETSD 2024 ensures a holistic understanding of sustainability and fosters the exchange of ideas that can lead to impactful solutions. Initiatives like the **Eco-Mela,** which highlights eco-friendly innovations and sustainable practices, are particularly commendable for inspiring creativity and promoting community engagement.

Graphic Era (Deemed to be University) has always prioritized fostering academic excellence, research innovation, and social responsibility. ICCETSD 2024 embodies these values, serving as a platform to bridge the gap between knowledge creation and its application for the betterment of society and the environment.

I commend the efforts of the Department of Environmental Science and the organizing committee for curating this remarkable event. I am confident that the discussions and deliberations during ICCETSD 2024 will inspire actionable solutions and meaningful collaborations that contribute to a sustainable future.

Wishing ICCETSD 2024 grand success and all participants a rewarding and enriching experience. Let us work together to shape a resilient and sustainable world for generations to come.

Prof. Rakesh Sharma
Pro-Chancellor
Graphic Era (Deemed to be University)

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MESSAGE

It is with great pleasure to know about the 1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024), hosted by the Department of Environmental Science, on 9-10 December, 2024.

I was informed that the conference focus on cutting-edge environmental technologies and sustainable development highlights its timeliness and relevance. By bringing together distinguished researchers, academicians, industry leaders, and policymakers, ICCETSD 2024 fosters an interdisciplinary dialogue that is crucial for driving impactful solutions. The inclusion of initiatives like the Eco-Mela, showcasing sustainable innovations and practices, further enriches the event's scope and outreach.

Graphic Era (Deemed to be University) is deeply committed to fostering excellence in education, research, and community engagement. This conference reflects our dedication to creating platforms that address societal challenges through collaboration and innovation.

I extend my heartfelt congratulations to the Department of Environmental Science and the organizing committee for their efforts in bringing this vision to life. I am confident that the insights and outcomes of this conference will contribute significantly to advancing sustainable technologies and practices globally.

I wish ICCETSD 2024 great success and encourage all participants to make the most of this opportunity for learning, networking, and contributing to a sustainable future.

Prof. Narpinder Singh

FRSC, FAACC, FNA, FNASc, FNAAS, FAFST(I), FPAS

Vice Chancellor

Message from the Vice-Chancellor, Graphic Era Hill University

It is with immense pride and joy that I extend my warm greetings to all the participants, distinguished speakers. and dedicated organizers of the lst International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024), hosted by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun, on December 9-10, 2024.

In today's world, where we face critical challenges such as climate change, loss of biodiversity, and dwindling natural resources, the pursuit of sustainable and innovative solutions has become a global priority. ICCETSD 2024 represents a significant effort to address these pressing issues through advanced research, technological advancements, and collaborative efforts.

This conference serves as a vibrant platform for experts from academia, industry, and governance to converge and exchange their knowledge and perspectives. The interdisciplinary nature of ICCETSD 2024 promotes a comprehensive approach to sustainability, encouraging impactful discussions that can drive tangible change. Initiatives like the Eco-Mela, which showcases eco-friendly innovations and sustainable practices, are especially noteworthy for fostering creativity and engaging the community in meaningful ways.

At Graphic Era Group of Institutions, we have always emphasized the importance of academic rigor, research-driven innovation, and societal responsibility. ICCETSD 2024 embodies these core principles, bridging the gap between theoretical knowledge and practical application to serve society and safeguard our environment.

I commend the exceptional efforts of the Department of Environmental Science and the organizing team for conceptualizing and executing this impactful event. I am confident that ICCETSD 2024 will pave the way for innovative solutions, foster valuable collaborations, and inspire all attendees to contribute actively to a sustainable future.

Wishing ICCETSD 2024 great success and hoping that all participants have an enriching and fulfilling experience. Together, let us work towards creating a greener and more resilient world.

6 Dec 2024

Prof. Prof. Sanjay Jasola
Vice-Chancellor
Graphic Era Hill University

Message from the Dean (Projects), Graphic Era (Deemed to be University)

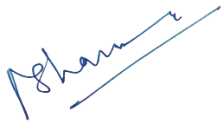
It gives me great pleasure to extend my warm greetings to all participants, speakers, and organizers of the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun scheduled from 9 to 10 December, 2024.

The challenges posed by climate change, environmental degradation, and resource scarcity have underscored the need for innovative and sustainable solutions. ICCETSD 2024 is a timely initiative that brings together researchers, academicians, industry leaders, and policymakers to exchange knowledge and ideas that contribute to addressing these pressing global issues.

This conference not only serves as a platform for the presentation of cutting-edge research but also fosters interdisciplinary collaborations aimed at creating a greener and more sustainable future. A noteworthy feature of this event is the **Eco-Mela**, which showcases eco-friendly innovations and sustainability-focused practices. Such initiatives reflect the commitment of Graphic Era (Deemed to be University) to fostering a culture of environmental stewardship and community engagement.

As the Dean (Projects), I am proud to witness the university's proactive role in facilitating such meaningful discussions and initiatives. I commend the Department of Environmental Science and the organizing committee for their relentless efforts in making ICCETSD 2024 a reality. Their dedication to addressing critical environmental challenges through knowledge-sharing and innovation is truly commendable.

I am confident that the deliberations and outcomes of ICCETSD 2024 will inspire actionable solutions and long-lasting collaborations. I wish the conference grand success and encourage all participants to actively engage in this unique opportunity to contribute to sustainable development. Together, let us pave the way for a brighter, greener, and more sustainable future.



Prof. Pradeep Kumar Sharma
Dean (Projects)
Graphic Era (Deemed to be University)

Message from the Head, Department of Environmental Science

It is with great pride and enthusiasm that on 9 and 10 December, 2024, I welcome you all to the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun.

This conference is a reflection of our collective commitment to address the most pressing environmental challenges of our time. In an era marked by unprecedented ecological crises, there is an urgent need to explore innovative technologies and interdisciplinary solutions that promote sustainability and environmental stewardship. ICCETSD 2024 provides a platform to bring together leading experts, researchers, industry professionals, and policymakers from around the globe to exchange knowledge and foster collaborations.

The conference's focus on emerging technologies and sustainable development reflects the dynamic and transformative role that science and innovation can play in creating a resilient future. The inclusion of the **Eco-Mela** as part of the event is a unique initiative aimed at showcasing eco-friendly innovations and fostering a culture of sustainability within the community.

I would like to take this opportunity to express my heartfelt gratitude to our distinguished guests, keynote speakers, and participants for their valuable contributions to the conference. I also commend the tireless efforts of the organizing committee, faculty members, and students who have worked diligently to make ICCETSD 2024 a reality.

As the Head of the Department of Environmental Science, I am confident that the insights and outcomes of this conference will inspire actionable ideas, promote meaningful partnerships, and contribute to the global pursuit of sustainable development.

I wish ICCETSD 2024 great success and hope that all participants have a rewarding and enriching experience. Together, let us strive to create a greener and more sustainable future.

Prof. Pratibha Naithani
Head of Department
Environmental Science
Graphic Era (Deemed to be University)

Message from the Organizing Secretary, ICCETSD2024

It is with immense joy and a deep sense of responsibility that I welcome you all to the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun.

The idea of ICCETSD 2024 was born from the realization that addressing today's complex environmental challenges demands innovative approaches and collaborative efforts. This conference aims to bring together leading minds from academia, industry, and policymaking to discuss the latest advancements in environmental technologies and their application toward achieving sustainability goals.

Our program is designed to foster meaningful dialogue, exchange cutting-edge research, and encourage interdisciplinary collaboration. A special highlight of ICCETSD 2024 is the **Eco-Mela,** a platform to showcase eco-friendly innovations and ideas that embody the spirit of sustainable development. This initiative reflects our commitment to engaging the community and inspiring change at every level.

Organizing this conference has been a journey of dedication, teamwork, and an unwavering belief in the power of collective action. I extend my heartfelt gratitude to our distinguished keynote speakers, session chairs, and all participants for their contributions. I also sincerely thank the organizing committee, faculty members, and students whose tireless efforts have made ICCETSD 2024 a reality.

As the Organizing Secretary, I am confident that this conference will serve as a catalyst for transformative ideas and actionable solutions. Let us seize this opportunity to build networks, share insights, and contribute meaningfully to the global mission of sustainability.

I wish ICCETSD 2024 grand success and hope it leaves a lasting impact on all who participate. Together, let us take steps toward a brighter, more sustainable future.

Dr. Rachan Karmakar
Organizing Secretary, ICCETSD 2024
Graphic Era (Deemed to be University)

Message from the Convenor, ICCETSD2024

It is with immense pride and enthusiasm that I welcome you all to the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun (9-10 December, 2024).

ICCETSD 2024 has been envisioned as a platform to address the pressing environmental challenges of our time. With the growing impacts of climate change, environmental degradation, and resource depletion, there is an urgent need to bring together diverse perspectives and innovative ideas to develop sustainable solutions. This conference provides a unique opportunity for academicians, researchers, policymakers, and industry leaders to engage in meaningful discussions and foster collaborations that transcend disciplines and borders.

A special feature of ICCETSD 2024 is the **Eco-Mela**, an initiative that highlights eco-friendly innovations and sustainable practices. This event reflects our commitment to encouraging not just academic discussions but also practical solutions and community participation in sustainability efforts.

As Convenor of ICCETSD 2024, I am proud of the meticulous planning and hard work that has gone into organizing this conference. I extend my heartfelt gratitude to our keynote speakers, session chairs, and participants for their invaluable contributions. I also commend the organizing committee, faculty, and students for their dedication and teamwork in making this event a reality.

I am confident that the insights, discussions, and collaborations generated during ICCETSD 2024 will have a lasting impact, inspiring transformative actions toward achieving global sustainability goals.

I wish the conference grand success and encourage all participants to engage actively, share knowledge, and contribute meaningfully to the shared mission of building a sustainable future.

Suman Naithani

Dr. Suman Naithani
Convenor, ICCETSD 2024
Graphic Era (Deemed to be University)

Message from the Co-Conveor, ICCETSD2024

It is my immense pleasure to extend a warm and heartfelt welcome to each of you to the **1st International Conference on Current Environmental Technologies for Sustainable Development**, organized at the prestigious Graphic Era (Deemed to be University). This conference serves as a platform to bring together brilliant minds, researchers, and practitioners from across the globe to deliberate on innovative solutions and strategies for achieving sustainable development through cutting-edge environmental technologies.

As the Co-Convener, I am truly honoured to be a part of this remarkable event, which aims to foster collaboration, spark insightful discussions, and inspire actionable outcomes in addressing some of the most pressing environmental challenges of our time.

I express my sincere gratitude to our distinguished keynote speakers, delegates, and participants for contributing their valuable time and expertise. Your participation ensures that this conference will be a resounding success.

I look forward to the vibrant exchange of ideas, groundbreaking presentations, and meaningful interactions over the course of this conference. Let us all work together to pave the way for a sustainable future.

Once again, welcome to GEU, and I wish you a productive and enriching experience at Conference.

Looking forward to an engaging and fruitful experience for all.

Warm regards,

A.K Arya

Ashish Kumar Arya
Co-Convener,
ICCETSD2024

Message from the Member Secretary, Pollution Control Board

It is my privilege to extend warm greetings and congratulations to the organizers, participants, and distinguished guests of the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, hosted by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun from 9 to 10 December, 2024.

The environmental challenges we face today—climate change, pollution, biodiversity loss, and resource scarcity—demand urgent and innovative solutions. This conference provides an excellent platform for academicians, researchers, policymakers, and industry leaders to come together and share cutting-edge research, ideas, and solutions that address these pressing issues.

As the **Member Secretary of the Pollution Control Board**, I recognize the critical role of such initiatives in promoting sustainable technologies and practices. The deliberations at ICCETSD 2024 hold the potential to drive impactful policies and technologies that align with our mission to ensure cleaner air, water, and land for all. The conference's interdisciplinary approach reflects the interconnectedness of environmental issues and emphasizes the need for collaborative efforts across various sectors. A notable feature of this event is the **Eco-Mela,** which showcases eco-friendly innovations and practices. This initiative is a commendable effort to engage communities and stakeholders in the journey toward sustainability and demonstrates how academic research can be translated into real-world impact.

I applaud the Department of Environmental Science and the organizing committee for their dedication and vision in curating this impactful conference. I am confident that ICCETSD 2024 will inspire actionable insights, foster meaningful collaborations, and contribute significantly to advancing environmental conservation and sustainable development goals.

Wishing ICCETSD 2024 grand success and all participants a rewarding and enriching experience. Let us work together to build a cleaner, greener, and more sustainable future.

Dr. Parag Dhakate
Member Secretary
Pollution Control Board

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प्रो० के० के० पंत
निदेशक

Prof. K.K. Pant
Director

Message

It gives me immense pleasure to extend my heartfelt congratulations to the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun, for organizing the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)** from December, 9-10, 2024.

In the face of escalating environmental challenges such as climate change, pollution, and resource depletion, the need for innovative and sustainable solutions has never been more critical. ICCETSD 2024 provides an invaluable platform for leading academicians, researchers, industry experts, and policymakers to converge and explore cutting-edge advancements in environmental technologies. Such initiatives are crucial in addressing global sustainability goals and fostering interdisciplinary collaboration.

As the Director of IIT Roorkee, I am deeply encouraged by the conference's focus on emerging technologies and their practical applications in achieving sustainable development. The integration of research, innovation, and community engagement is a hallmark of impactful initiatives, and ICCETSD 2024 embodies this ethos. The inclusion of the **Eco-Mela,** showcasing eco-friendly innovations and sustainable practices, is particularly commendable, as it bridges the gap between academic discussions and community-level impact.

At IIT Roorkee, we recognize the transformative power of technology in creating a sustainable future. Conferences like ICCETSD 2024 play a pivotal role in catalyzing research and fostering partnerships that contribute meaningfully to the national and global sustainability agenda.

I congratulate the organizers for their vision and dedication in curating this event and extend my best wishes to all participants for a productive and enriching experience. May ICCETSD 2024 inspire actionable insights and foster collaborations that advance the shared mission of creating a greener and more sustainable world.

(K.K. Pant)

Message from the Director & Head, Bureau of Indian Standards, Dehradun

It is an honor to extend my warm greetings to all participants, speakers, and organizers of the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, organized by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun.

In today's world, the quest for sustainable development has become a defining challenge, requiring innovative solutions and collaborative efforts. ICCETSD 2024 provides an excellent platform for experts from academia, industry, policy making and standardization bodies to come together, exchange ideas, and address pressing environmental challenges through emerging technologies.

As the **Director and Head of the Bureau of Indian Standards (BIS), Dehradun**, I am particularly delighted to see the focus on advancing technologies that align with national and global standards for sustainability. Establishing robust standards and guidelines is essential in ensuring the effective implementation of sustainable practices, and conferences like this play a pivotal role in bridging the gap between research and real-world application.

The inclusion of the **Eco-Mela**, showcasing eco-friendly innovations and practices, is commendable as it promotes awareness and inspires practical solutions among participants and the broader community. It reflects a holistic approach to sustainability, combining academic rigor with community engagement.

I applaud the efforts of the Department of Environmental Science and the organizing committee for curating this impactful event. I am confident that the discussions and collaborations fostered during ICCETSD 2024 will contribute significantly to shaping a sustainable future and aligning with the national mission for environmental conservation.

Wishing ICCETSD 2024 grand success and all participants a rewarding and enriching experience. Together, let us strive toward a greener, cleaner, and more sustainable world.

Saurabh Tiwari
Director & Head
Bureau of Indian Standards, Dehradun

Message from the AIG Regional Office, MoEFCC, Dehradun

It is a privilege to extend my heartfelt congratulations to the Department of Environmental Science, Graphic Era (Deemed to be University), for organizing the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, scheduled for **December 9-10, 2024**. This event represents a significant step toward addressing the critical environmental challenges of our time.

As the world grapples with the interconnected crises of climate change, resource depletion, and biodiversity loss, platforms like ICCETSD 2024 offer a beacon of hope. By fostering dialogue among researchers, policymakers, industry leaders, and academicians, this conference aims to generate transformative ideas and solutions that contribute to sustainability.

The unique blend of academic rigor and community engagement that this conference offers is commendable. The **Eco-Mela**, in particular, stands out as an innovative feature, bridging theoretical knowledge with practical applications by showcasing eco-friendly technologies and sustainable practices. Such initiatives not only highlight advancements in environmental technologies but also inspire collective action toward achieving a greener future.

The Ministry of Environment, Forest and Climate Change (MoEFCC) is deeply committed to fostering research and collaboration to promote sustainable development. ICCETSD 2024 aligns perfectly with this vision by emphasizing cutting-edge research and encouraging partnerships across disciplines and sectors.

I extend my best wishes to all participants for fruitful discussions and meaningful collaborations during this event. May ICCETSD 2024 lead to impactful outcomes that will guide our efforts toward creating a sustainable and resilient world for future generations.

With warm regards and best wishes for the success of ICCETSD 2024,

Ms. Neelima Shah, IFS
AIG
Regional Office, MoEFCC, Dehradun

Message from the Deputy Director, Ministry of Environment, Forest and Climate Change (MOEFCC), Dehradun

It is with great pleasure that I convey my best wishes to the organizers, speakers, and participants of the **1st International Conference on Current Environmental Technologies for Sustainable Development (ICCETSD 2024)**, hosted by the Department of Environmental Science, Graphic Era (Deemed to be University), Dehradun (9,10 December, 2024).

Environmental conservation and sustainable development are critical imperatives for our time. With the accelerating impacts of climate change and resource depletion, it is essential to harness the power of emerging technologies to address these challenges. ICCETSD 2024 provides a much-needed platform for researchers, academicians, industry leaders, and policymakers to come together, exchange insights, and propose innovative solutions for a sustainable future.

As the **Deputy Director of the Ministry of Environment, Forest, and Climate Change (MOEFCC)**, I am particularly encouraged by the focus on interdisciplinary collaboration and the integration of technology with environmental stewardship. Such efforts are crucial to achieving the objectives outlined in national policies and global sustainability frameworks.

I applaud the efforts of the Department of Environmental Science and the organizing committee for their commitment to advancing environmental sustainability through this landmark conference. I am confident that the deliberations and outcomes of ICCETSD 2024 will inspire transformative actions and meaningful collaborations.

Wishing ICCETSD 2024 grand success and all participants a fruitful and enriching experience. Together, let us contribute to building a resilient and sustainable future.

Dr. Vipin Gupta
Deputy Director
Ministry of Environment, Forest and Climate Change (MOEFCC), Dehradun

INDEX

Paper: 001

Sustainable Fuel Alternatives: The Impact of Algae Biodiesel on CI Engine Efficiency.

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ABSTRACT:

Current research into microalgae as a renewable energy source has greatly expanded, relying heavily on both fundamental and applied studies across various disciplines such as biology, physiology, culture methods, and culture systems. These investigations encompass a broad spectrum of algae, from single-celled organisms to complex multi-cellular species. Algae, commonly found in damp areas and water bodies, thrive globally in both terrestrial and aquatic environments. Their growth primarily depends on three natural elements: sunlight, carbon dioxide, and water. Through photosynthesis, algae and certain microbes convert sunlight into chemical energy. This paper explores the experimental process of producing biofuel from microalgae harvested from a campus pond. The transesterification process was employed to extract lipids from the algae, and potassium hydroxide (KOH) was used to purify the resulting algae biofuel. In addition to that pilot project was carried to check the suitability of algae biodiesel on CI engines.

Keyword: Microalgae, biofuel, CI engine, transesterification, hydroxides.

Paper: 002

Safeguarding Sacred Lands: The Van Panchayat Approach to Biodiversity Conservation in the Kailash Sacred Landscape, Uttarakhand India

ABSTRACT:

The Van Panchayat (Community forest) co-management system plays a crucial role in preserving the unique characteristics and biodiversity of the Kailash Sacred Landscape area in the Indian Himalayan Region (IHR). Through community involvement and collaborative management, these areas are effectively protected, benefiting both local ecosystems and global biodiversity. The Van Panchayat model, deeply rooted in the Indian administrative framework, empowers communities to govern and sustainably and manage their forests, contributing to both ecological and human well-being in mountain communities. The research conducted in the Johar valley in Pithoragarh district of Uttarakhand sheds light on the importance of community forest in supporting livelihoods and fostering resilience in the face of environmental, social, and governance changes. Van Panchayats in Uttarakhand own 60-70% of land, with 12,065 registered in the state and 1,621 in the Johar valley, accounting for 15% of forested land under their supervision. Van Panchayat are a community-governed system supporting mountain communities ecological and human well-being and sustainable livelihoods. A Van Panchayat Committee is being formed to enforce laws in the Van Panchayat Forest, aiming to conserve the environment, ecology, and Biodiversity and adapt to changes in Johar Valley communities.

Keywords: Kailash Sacred Landscape, Indian Himalayan Region, Van Panchayats, Uttarakhand Himalayas, Community based Conservation

Paper: 003

An assessment of socioeconomic vulnerability in a few selected villages of Gosaba Block in Sundarban, India by Artificial Neural Network

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&

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ABSTRACT:

The Indian Sundarbans are an endangered ecosystem with a unique biogeographic composition that is sensitive to natural disasters such as storms, floods, and cyclones, putting its socioeconomic systems at risk due to environmental stresses. The purpose of this study was to examine the rural population's current socioeconomic vulnerability to climate change at the local level. Furthermore, the goal is to identify and validate key elements that increase the degree of vulnerability in some selected villages with 160 households in the Gosaba Block on the fringes of the Sundarban, using an Artificial Neural Network (ANN) prediction model. The present study used an integrated vulnerability strategy, which included socioeconomic and biophysical factors to generate vulnerability indices for each family. The exposure, adaptive capacity, and sensitivity indexes were computed by weighting each indicator's starting eigenvalues with a percentage of variance using principal components analysis (PCA). According to these criteria, 156 households (97.5%) received an extremely high vulnerability score, whereas 4 homes (2.5%) got a moderate vulnerability grade. Income creation sources from remittances, proximity to the market, age of the respondent, family size, building social networks, storm surges, subsidiary sources of household income. Dwelling years, increased temperature, embankment breaches, and income level are all strong predictors of socioeconomic vulnerability. As a result, a policy effort should prioritize increasing existing social and financial capital, facilitating access to local government, and boosting community-based activities.

Keywords: Vulnerability Index; exposure; adaptive capacity; sensitivity; Artificial Neural Network (ANN)

Paper: 004

Microbial inoculants in agriculture and its effects on plant microbiome

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ABSTRACT:

The utilization of microbial inoculants is becoming more pivotal in the pursuit of sustainable agricultural production systems. Because of soil erosion, deterioration, salt deposition, unwanted element and metal deposition, water scarcity or surplus, and an unbalanced nutrient supply system, the soil's potential to supply nutrients is steadily declining which is having a drastic impact on our agricultural system .The right formulation and delivery techniques are requisite for a successful microbial inoculation in order to overcome the competition from the native soil-plant microbial population.The emphasis is more on achieving environment friendly and sustainable farming.There is some evidence that the structure and function of a plant's microbiome are altered when bacteria are injected into the soil, plant, or seed. As a result of their requirement, specificity, and ability to be used in a variety of combinations, microbial inoculants have come to be recognized as practical and sustainable solutions for preserving and even improving the health of the soil.

Paper: 005

Biosorption of Chromium by *Aspergillus flavus* Isolated from Ganga River

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ABSTRACT:

Water pollution by heavy metals due to discharge of industrial and anthropogenic waste leads to serious environmental and health problems as most of these heavy metals are carcinogenic in nature. In the present study arsenic biosorption capacity fungal strain HGF8 isolated from Ganga River in Haridwar, which was examined as *Aspergillus flavus*, following 16S rDNA sequence analysis, was examined for different physical parameters such as pH, time of incubation and temperature. Experimental results indicate that the *Aspergillus flavus* isolate has maximum tolerance capacity up to 1000 mgL^{-1} with highest metal uptake at pH 7, 120 hours, and 35^0C. The surface chemical functional groups of *Aspergillus flavus* was identified by FTIR were amino, carboxyl, hydroxyl and carbonyl groups. The morphological changes were examined by SEM analysis.

Keywords: Biosorption, Arsenic, Aspergillus flavus, Ganga River

Paper: 008

Biomedical waste management and their impact on the Environment

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ABSTRACT:

Biomedical waste poses significant environmental and public health risks, necessitating effective management and disposal practices, particularly in hospitals and healthcare facilities. This waste encompasses a wide range of materials generated during patient care, medical research, and clinical interventions. Improper handling can lead to severe consequences, including environmental contamination and the spread of infectious diseases. Traditional disposal methods, such as incineration, often release toxic emissions, contributing to air pollution and long-term ecological harm. Infectious waste, which constitutes approximately 10% of hospital waste according to the World Health Organization (WHO), presents heightened risks of disease transmission, particularly via sharp instruments and the dissemination of hazardous compounds. Hazardous biomedical waste is categorized into infectious, toxic, and radioactive types, each requiring specific handling and treatment protocols. Globally, a variety of waste management strategies are employed, including incineration, autoclaving, microwaving, shredding, chemical treatments, and landfilling. Each method offers distinct advantages and limitations based on efficiency, environmental impact, and cost-effectiveness. This review examines the classification, health and environmental impacts, and available technologies for the treatment and disposal of biomedical waste. To mitigate the adverse effects on ecosystems and communities, it is crucial to implement sustainable waste management practices. These include adherence to regulatory frameworks, the promotion of waste segregation and recycling, and the adoption of innovative technologies to minimize hazardous byproducts. By prioritizing environmental stewardship and public health, healthcare facilities can reduce the detrimental impact of biomedical waste.

Keywords: Biomedical waste sources; Environmental pollution; Public health hazards; Waste disposal

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Paper: 009

The Importance of Recycling in Waste Management for Environmental Sustainability

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ABSTRACT:

Waste management has become a critical aspect of environmental sustainability, and recycling plays a pivotal role in addressing the global waste crisis. Recycling refers to the process of converting waste materials into new, reusable products, thereby reducing the consumption of fresh raw materials, minimizing energy use, and lowering greenhouse gas emissions. This practice contributes to conserving natural resources, preventing pollution, and reducing the strain on landfills. Moreover, recycling helps in reducing the demand for new materials, promoting a circular economy where products are reused and recycled rather than discarded.

One of the most significant environmental benefits of recycling is the reduction of landfill waste, which otherwise leads to methane emissions and groundwater contamination. Effective recycling programs can also lower the energy needed for the production of goods, as manufacturing with recycled materials requires significantly less energy than creating products from virgin resources. For instance, recycling aluminum can save up to 95% of the energy required for producing new aluminum from bauxite ore. Additionally, recycling reduces deforestation, mining, and water pollution, all of which are direct consequences of excessive consumption of natural resources.

The importance of recycling extends beyond environmental benefits. It fosters economic growth by creating job opportunities in the recycling and manufacturing industries. Communities that invest in robust recycling systems benefit from reduced waste disposal costs and improved public health due to lower pollution levels. However, the success of recycling efforts depends on public awareness, participation, and the development of efficient recycling infrastructures that can handle a variety of materials.

Keywords: Recycling, waste management, environmental sustainability, circular economy, pollution reduction, energy conservation, landfill reduction, natural resource conservation, economic benefits, public awareness.

Paper: 011

Enhancing Mental Health Support through Chatbot

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ABSTRACT

In recent times due to high potential, ease of use, and excellent value, chatbots have garnered a lot of attention lately as a crucial component of mental health support services.. It begins by exploring different chatbot architectures and their underlying technologies, explaining what each chatbot can provide in terms of personal interaction. Secondly includes research evidence evaluating the mental health benefits of chatbot interventions (e.g., depression, anxiety and stress). Our aim in this study is to help users by answering their questions appropriately and compassionately. We investigated and used three different technologies to create chatbots. Bag of Words (BoW), also known as Term Frequency-Inverse Document Frequency (TF-IDF), and RoBERTa (Transformer-based model). While TF-IDF and BoW methods are used to identify and extract text patterns from pre-recorded data, RoBERTa uses deep learning to improve the chatbot's response quality and generate relevant responses. By combining these techniques, chatbots can provide authentic and context-sensitive interactions that enhance user experience and provide motivation. There are few limitations in chatbot which we will adhere to such as ethical considerations, providing more psychology friendly responses, etc.

Keywords: Chatbots, Jupyter Notebook, Natural Language Processing, BoW, RoBERTa, TF-IDF.

Paper: 012

Smart Intrusion Detection Systems: A Novel Intrusion Detection Framework by Leveraging SMOTE-ENN with RF and XGBoost

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ABSTRACT:

The increasing sophistication of cyber-attacks demands the development of more advanced intrusion detection systems (IDS) capable of identifying both current and evolving threats with high accuracy. This research introduces an innovative IDS framework based on machine learning techniques, which incorporates SMOTE-ENN (Synthetic Minority Over-sampling Technique combined with Edited Nearest Neighbors) to address class imbalance, alongside Random Forest (RF) and XGBoost classifiers to boost detection performance. Utilizing the NSL-KDD dataset, this approach tackles the challenges posed by imbalanced datasets that often hinder the detection of minority attack types. The experimental results show a significant improvement in accuracy, precision, recall, and F1-score compared to traditional models. These findings indicate that the proposed approach can greatly enhance cyber threat detection and prevention, leading to stronger network security.

Paper: 013

Sustainable Tourism Development Through Homestay: A conceptual study on Hilly District of Uttarakhand

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ABSTRACT:

Tourism in Uttarakhand has emerged as a key industry due to its multiplier effect, fostering not only the development of the tourism sector but also generating income and employment. Additionally, tourism plays a vital role in conserving the state's cultural heritage. Homestay tourism helps in promoting sustainable tourism and achieving sustainable tourism goals which critically help in conservation of nature and preservation of cultural heritage of state.

Homestay refers to staying in an individual home and paying for the same, these homes are either managed by an individual or group, hence it is a classic example of CBT Community-Based Tourism which helps in promoting sustainable tourism. Homestay preserves nature & culture, reduces out-migration and at the generates self-employment.

Keywords: *Sustainable Tourism, Community-Based Tourism, Employment*

Paper: 014

Green Synthesis of Gold Nanoparticles Using Ficus Auriculata Bark extract, Characterization and Their Antineoplastic Activity

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ABSTRACT:

The synthesis of gold nanoparticles ($HAuCl_4 \cdot 3H2O$) from *Ficus auriculata* bark extract was presented in this paper using a green method. Currently, the most promising route for metallic nanoparticle synthesis is the green synthesis route, which utilizes various plant parts. Nanomedicine makes use of biocompatible nanomaterials for diagnostic and therapeutic purposes. The synthesis of gold nanoparticles was initially detected through a visual color change from light purple to dark pinkish purple and further confirmed by surface plasmonic resonance using UV-Vis spectroscopy. TEM and XRD analysis revealed that the absorption maximum band observed at 534 nm indicates the formation of Au nanoparticles, with a predicted energy band gap of 2.32 eV, crystalline nature, and cubic closed packed phase with an average size of less than 14 nm for the synthesized HAuCl4 · 3H2O NPs. The stability of HAuCl4 · 3H2O NPs was attributed to the capping of oxidized polyphenols, as established by FTIR study. It can be concluded that *Ficus auriculata* can be efficiently used in the production of potential anticancer HAuCl4 · 3H2O NPs for commercial applications. The anticancer activity of gold nanoparticles was assessed using the MTT assay, and the results indicated that the synthesized gold nanoparticles from *Ficus auriculata* bark extract effectively demonstrated anticancer activity.

Keywords: Gold nanoparticles; *Ficus auriculata*; cubic closed packed phase; anticancer activity; MTT assay

Paper: 015

UTILIZATION OF PINE LITTER WASTE FROM FOREST FLOOR INTO SOME VALUE ADDED BY-PRODUCTS' FOR PREVENTING REPEATED FOREST FIRES AND SOCIO-ECONOMIC DEVELOPMENT OF RURAL POPULATION IN UTTARAKHAND STATE HILLY AREAS

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ABSTRACT

The commercial use of pine leaf litter waste from Chir Pine (*Pinus* sps.) trees dominant forest floors, has potential to significantly solve two important issues: (i) reducing the frequency of forest fires and (ii) promoting the socioeconomic advancement of the rural population. Pine leaf litter poses a serious fire risk, especially during the summer months. It is mostly composed of dried pine needles. Nonetheless, this waste material can be transformed into goods with additional value, which has positive effects on the environment and the state rural economy. Pine litter can be used to make a variety of potential value-added by-products, some of which include: bio-briquettes (white coal), biochar and compost, handicrafts and cottage industries, paper and packaging material, essential oils and extracts, and more.

The environmentally friendly use of discarded pine litter from Uttarakhand monoculture plantations forest areas, with a high concentration of pine trees will offer a win-win option. The hazards of forest fires can be reduced and surrounding rural communities are given new chances for their economic growth and extra income production by turning this trash into value-added sailable products. This strategy not only supports sustainable lives for the rural inhabitants in the hilly terrain, but it will also improves efforts to save the forests by wild fires.

This forest department and community-based joint approach can help to resolve environmental issues like reducing forest fires, wildlife & biodiversity conservation and global warming, while also offering a chance to improve the socio-economic standards of stakeholders / rural communities. This strategy can result in sustainable forest conservation, benefiting the environment and the local people who depend on forests, by converting a fire hazard material into a financial asset.

Keywords: Pine litter waste, forest floor, wild fires, stakeholders, socio-economic development.

Paper: 016

Systematic review on AI-Enhanced Smart Filtration Systems for Nutrient Recovery and Pollutant Minimization in Municipal Wastewater

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ABSTRACT:

The municipal wastewater is facing widespread issues specially in nutrient recovery and pollution reduction. With further urbanization, sustainable treatment systems will be critical for efficiency requirements. This review discusses the potential of AI to advance filtration technologies in meeting these requirements. The review also highlights the framework for an AI-enhanced filtration system designed for India's complex wastewater treatment systems. Traditional treatment systems work well, but they are not well adapted to changing pollutant loads and varying nutrient concentrations. In contrast, AI provides real-time adaptive optimization in simultaneous nutrient recovery processes in terms of removal of nitrogen, phosphorus and other contaminants. This review, summarizes international research incorporating recent developments from AI and machine learning domains where limitations relevant to the scenario of wastewater in India are focused for smart filtration systems. The amalgamation of real-time IoT sensor data with AI algorithms in such systems enables dynamical adjustment of the operational parameters which reduce the downtime and operational costs besides predicting system faults beforehand. In addition, it also comes with a filtration design that combines AI-driven predictive algorithms with mechanical filtration processes. Design considerations include fluid dynamics and material efficiency; it has been developed in cooperation with mechanical engineering experts and is designed to scale and be climate-resilient. AI-enhanced wastewater treatment holds much promise toward finding sustainable, cost-effective solutions to urban needs in India as well as environmental cleanup. It sets the stage for future research and implementation that would lead to the scaling of such systems into real applications.

Keywords: Wastewater Treatment, Nutrient Recovery, Artificial Intelligence (AI), Smart Filtration Systems, Sustainable Wastewater Management.

Paper: 017

Recent advancements in Microbial Fuel Cell Technology: A Global Review

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ABSTRACT:

With rising global issues of energy demand and water pollution, Microbial fuel cells (MFCs) have emerged as a promising technology for sustainable energy production and wastewater treatment. Microbial fuel cells can treat wastewater, generate clean and green electrical energy by using bacteria as a biocatalyst to oxidize the biodegradable substrates i.e. organic matter, which makes this technology stand out. This review examines the recent advancements in MFC technology, focusing on new innovations such as alteration and improvement in electrode materials, microbial communities, and system configurations. To add further, the utilization of nanomaterials and multi chambers has significantly improved the performance and efficiency of MFCs. In the enhancement of MFCs, the discovery of novel electroactive microorganisms and the optimization of microbial consortia have improved electron transfer processes. Modernization of the system design, including the advanced technology of hybrid and stacked MFCs, has further amplified power output and scalability. This review also discusses the benefits of MFCs on the environment, such as carbon footprint reduction, renewable energy generation, and wastewater treatment. Stressing the need for interdisciplinary research, this review highlights the challenges and prospects of MFC technology, aiming to overcome the current issues, limitations and achieve commercial viability. Microbial fuel cells portray a promising approach to wastewater treatment, merging environmental benefits with the potential for renewable energy production.

Keywords: Microbial Fuel Cells (MFCs), sustainable energy, wastewater treatment, electroactive, nanomaterials.

Paper: 018

Water conservation and effective management of freshwater resources

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ABSTRACT

Water conservation and effective management of freshwater resources are crucial for sustaining water availability amid increasing demand, population growth, and climate change. While water covers over 70% of the Earth's surface, the majority is found in oceans, which contain high concentrations of salt, making it unsuitable for human and plant use. Only about 3% of Earth's water is freshwater, and much of this is locked in glaciers or inaccessible, leaving a small fraction available for consumption. Furthermore, freshwater resources are not evenly distributed across the globe, resulting in water abundance in some regions and severe scarcity in others, particularly in areas with rapidly increasing demand. Moreover, freshwater is not equitably distributed globally, a condition that makes water available in excess in some parts while in others there are increasing scarcity of water. The research examines the significance of efficient water use, sustainable resource management, and innovative practices that reduces wastage and optimize availability. Water conservation involves strategies such as reducing waste, employing efficient irrigation, and promoting public awareness to encourage responsible consumption. Water management concentrates mainly on preserving and equitably distributing water resources through integrated approaches, such as watershed management, infrastructure development, and water recycling. The involvement of national governments through the creation and implementation of policies and regulations are crucial to achieving standard of water quality, distribution rights, and compensations for sustainable practices. Technological advancements, such as smart water meters, desalination, and remote sensing, provide valuable tools Effective monitoring and improving water management systems requires technological advancements, such as smart water meters, desalination, and remote sensing, the research recommends a joint approach which brings together individual, industry, and government in addressing the protection of water resources and ensure their availability for the generations after us.

Keywords: Conservation, Management, sustainability, Climate Change and water

Paper: 019

Enhancing Urban Resilience: The Role Of Urban Forestry And Green Spaces In Sustainable City Development

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ABSTRACT:

Urban forestry and green spaces play a pivotal role in enhancing urban environments through varied ecological, social, and economic bene1ts. Urban forests, comprising trees and vegetation in city areas, signi1cantly contribute to mitigating local heat islands, improving air quality by absorbing pollutants, and sequestering carbon. For instance, urban forests in the United States remove approximately 45 million tons of climate-warming carbon dioxide annually.

Additionally, these green spaces over substantial mental health benefits, including reduced stress levels, improved mood, and enhanced cognitive functions, as evidenced in studies showing that accessible greenery have implemented successful urban forestry initiatives aimed at increasing tree canopy and fostering environmental resilience. Furthermore, urban green spaces support local biodiversity; spaces can decrease anxiety and depression. Cities worldwide, such as

Melbourne, Australia, and Curitiba, Brazil, improve storm water management, and provide recreational opportunities, thus promoting community well-being. However, to optimize these benefits, careful planning and management are required, taking into account species selection, site conditions, and long-term sustainability. The integration of urban forestry into city planning is essential for creating sustainable, healthy, and livable urban environments.

Keywords: Urban Forest, Carbon Sequestration, Mental Well-Being, Sustainability.

Paper: 020

Preserving the Paradise: Sustainable Tourism in Uttarakhand

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ABSTRACT:

A wealth of natural beauty, spanning mountains and forests, has been bestowed upon the state of Uttarakhand located in the foothills of the Himalayas. It is home to a diverse range of rare plants and animals, a comfortable climate, and a tranquil setting. Uttarakhand offers, pilgrimage tourism, hill stations, also adventure and nature tourism to the visitors. The numerous glaciers in this region are the source of India's principal rivers, such as the Ganga and the Yamuna. Tourism is a core component in Uttarakhand's economy. Economic growth, infrastructure development and cultural exchange are some of the merits of tourism. However, adverse outcomes such as environmental degradation, strain on natural resources, overcrowding, traffic, culture erosion, etc should not be overlooked. Sustainable travel that emphasizes taking in the area's biodiversity, natural beauty, and cultural legacy as well as reducing adverse environmental effects and helping out the local population. Uttarakhand's concerns are about safeguarding its delicate natural environment and mountain heritage. In order to continue making profit from tourism besides reducing the detrimental effects on the environment, infrastructure, and local residents, sustainable tourism practices are crucial. This paper investigates about the impact of tourism on the state and the need for sustainable practices.

Keywords: Sustainable, Tourism, Environment, Infrastructure, Culture erosion

Paper: 021

Understanding application effect of arbuscular mycorrhizal fungi in Vigna radiata (mung bean) under agricultural field conditions

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ABSTRACT:

Arbuscular Mycorrhizal Fungi (AMF) play a crucial role in regulating key physiological processes and promoting plant growth, serving as essential components of terrestrial ecosystems. Their interaction with plant roots enhances phosphorus nutrient uptake and fosters symbiotic relationships between plants and microbes. The application of AMF has emerged as a promising strategy for enhancing plant growth and development, including shoot branching, root architecture, and stress response. Our study investigated the diverse effects of AMF (25-100ml per kg seeds) on the growth of *Vigna radiata* (mung bean) under agricultural field conditions in Dehradun, Uttarakhand, India. The aim was to assess the impact of AMF on key growth parameters and plant biomass. Our findings showed that the application of AMF significantly enhanced root and shoot development, leading to improved of nutrient uptake, which contributed to the enhanced growth rates of mung bean. This research highlights the potential of AMF to promote plant growth and boost the agricultural productivity of mung bean. By exploring applications level of AMF, the study paves the way for developing innovative strategies to enhance plant performance under challenging conditions, thereby contributing to food security and supporting sustainable agricultural practices.

Keywords: AMF, mung bean, plant growth promotion, nutrient uptake, sustainable agriculture.

Paper: 022

Navigating Uncertainty in Solar PV Waste: Towards Effective Environmental Management Solutions

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ABSTRACT:

The global expansion of solar photovoltaic (SPV) technology has been instrumental in driving the transition toward sustainable energy. However, the impending surge of end-of-life (EoL) PV panels poses a significant challenge for environmental management, as millions of metric tons of solar waste are projected by mid-century. This paper examines the complexities and uncertainties associated with solar PV waste management, emphasizing the environmental risks of improper disposal and the urgent need for effective solutions. The study highlights the limitations of current strategies, including fragmented regulations, insufficient recycling infrastructure, and economic hurdles that hinder widespread adoption of recycling practices. In reviewing emerging technologies and global efforts, this paper identifies promising advancements in PV recycling, such as chemical and thermal recovery methods, eco-design innovations, and automated dismantling systems. Additionally, it discusses the potential of policy frameworks like extended producer responsibility (EPR) to incentivize sustainable waste management. Despite these developments, significant research gaps remain, particularly in understanding the environmental impact of informal recycling and improving the economic viability of advanced recycling techniques. The paper concludes by outlining future research directions, advocating for interdisciplinary efforts that integrate technological, economic, and policy innovations. By addressing these challenges proactively, the solar industry can ensure that the environmental benefits of solar energy are not undermined by waste management issues, ultimately contributing to a more sustainable and circular economy.

Keywords: SPV, EoL management, waste management, uncertainty in PV waste, environmental impact

Paper: 023

A Systematic Comparative Study on the Detection of Phishing Website Emails Using Machine Learning Techniques

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ABSTRACT:

Phishing continues to be a common online security risk where hackers trick people into revealing sensitive information through fake emails. This systematic review of literature explores recent progress in detecting phishing emails, with a specific emphasis on using machine learning methods. I evaluated 80 academic publications published within the past five years, which included journals, conferences, workshops, theses, and influential websites. The study investigates various detection methods like heuristic techniques, SVM, RF, and CNN to assess and compare their effectiveness. Recent findings indicate that machine learning techniques, particularly deep learning, have a lot of promise in enhancing precision in detection. Commonly utilized datasets such as Phish Tank are examined alongside methods that merge hybrid approaches. The criticism points out concerns like data access and computational requirements, suggesting possible research directions to improve the efficiency of phishing detection.

Keywords: Phishing, Phishing Detection, Machine Learning, Deep Learning, Cyber security, Systematic Literature Review, Email Security

Paper: 024

Bioefficacy of the predatory reduviids Rhynocoris kumarii on the hemipteran pests of cotton, Dysdercus cingulatus and Phenacoccus solenopis.

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ABSTRACT:

Mealy bugs and Red cotton bugs cause severe damage to cotton. Biological control may provide an affordable and sustainable option for the reduction of these losses. Functional response and stage preference are the tools employed to evaluate the efficiency of a predator. We studied the bioefficacy of 48 hours starved *Rhynocoris kumarii* third, fourth and fifth stadium and adult in petri dishes (9.5 cm X 1.3 cm) with cotton leaves. The stage preference was evaluated from the third instar to adult of *R. kumarii* on all the nymphal stages of *Dysdercus cingulatus* and *Phenacoccus solenopis*. Invariably, the third instar of *D. cingulatus* and *P. solenopis* were preferred by all the tested life stages of *R. kumarii*. The functional response of *R. kumarii* exhibited Holling's type II curvilinear decelerating response where a positive correlation was obtained between the prey density and the number of prey consumed by the predator. The number of *D. cingulatus* killed by *R. kumarii* were 37.4, 40.6, 39, 31.4 preys / predator / day, attack rate wasn0.63, 0.68, 0.65, 0.52 preys / predator, searching time was -2.675, -4.196, -1.535, -1.535 for the third, fourth, fifth and adult predators respectively. With reference to the consumption of *P. solenopis*, the third instar of *R. kumarii* consumed the maximum number of prey (5.0 prey / predator / day) than fourth instar (3.55 preys / predator / day) and fifth instar (3.50 preys / predator / day). The rate of attack of adult female predator was quite low (1.50 preys / predator / day) but fairly consistent. From laboratory observation, it can be concluded that the third to fifth nymphal instars of *R. kumarii* can be used for the management of both *P. solenopis* and *D. cingulatus* in cotton fields.

Keywords: Bioefficacy, *Dysdercus cingulatus*, Functional response, *Phenacoccus solenopis*, *Rhynocoris kumarii*, Stage preference.

Paper: 025

Restoring Coastal Habitats: The Promise of Blue Carbon in Climate Mitigation

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ABSTRACT

Rising atmospheric carbon dioxide (CO_2) levels pose significant threats to marine and coastal ecosystems, leading to ocean acidification and disrupting the delicate balance of these habitats. Coastal ecosystems, such as mangroves, salt marshes, and seagrasses, are critical for carbon storage, yet they are increasingly vulnerable to degradation from human activities and climate change. The loss of these ecosystems not only releases stored carbon back into the atmosphere but also diminishes their capacity to sequester future emissions. In response to these challenges, blue carbon technologies using remote sensing, carbon accounting Framework, Deep blue carbon Research which are emerging as a vital solution. These technologies focus on the conservation and restoration of coastal habitats that effectively capture and store carbon. Innovative projects are being developed to enhance the management of these ecosystems through various methodologies such as Nuclear, Isotopic Techniques, Innovative monitoring rules, carbon accounting Etc, that include remote sensing, hydrology interventions, and community engagement in sustainable practices. Such initiatives not only contribute to climate mitigation by increasing carbon stocks but also provide co-benefits like improved biodiversity, enhanced resilience against climate impacts, and economic opportunities for local communities. By integrating blue carbon technologies into national policies, we can harness the potential of these ecosystems to combat climate change while supporting sustainable development goal.

Keywords: Coastal Ecosystems, Vulnerable, Remote sensing , Climate Impacts, Carbon Stocks

Paper: 026

Exploring Silver-Based Nanocomposites for Efficient Toxic Dye Removal

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ABSTRACT

Modern science is making great strides in the field of green nanoparticle production. An aqueous leaf extract of Azadirachta indica was chosen in this study to create silver nanoparticles (AgNPs) in a sustainable manner. The reducing and capping agents were used to reduce a 0.1M AgNO3 solution. AgNP synthesis was effective, as evidenced by the reaction mixture's hue changing from originally colorless to brown. The particle size range of 20–25 nm was validated using transmission electron microscopy (TEM). Following their green synthesis, these silver nanoparticles were used to create nanocomposites with gum rosin and poly(acrylamide) via free radical polymerization. The thermal initiator and crosslinking agents used in the process were potassium persulphate (KPS) and N,N′-methylenebisacrylamide (MBA). In this Fourier-transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX), and thermal analysis through thermo gravimetric analysis/differential thermal evaluation (TGA/DTA), a thorough characterization of the AgNPs and nanocomposites was carried out. UV-Vis spectroscopy indicated that the nanocomposites effectively removed the hazardous malachite green dye, demonstrating their strong dye removal capacity. The results highlight the green synthesis protocol's ease of use, speed, and environmental friendliness. They also highlight the efficient use of plant resources and show how versatile the protocol may be in the domains of nanotechnology and biomedicine.

Keywords: Gum rosin, Nanocomposite, Dye, Green synthesis, Biological Activity

Paper: 027

Advancements in Landcover Analysis: A Review of Spatial Data-Based Change Detection and Prediction Techniques

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ABSTRACT:

Changes in land use and land cover (LU/LC) are significant natural problems that impact our world. Techniques for change identification and forecasting are essential for analysing LU and LC with geographic datasets. The different change detection and forecast methods, such as feature extraction, multispectral analysis, machine and deep learning approaches, and the use of GIS and remote sensing tools, are the main topics of this overview article. One of the most crucial approaches to studying LU/LC is through multispectral remote sensing data. To take various characteristics from the data, such as form, color, and plant index, these data are used for feature extraction. These characteristics can be used to spot ground vegetation shifts. Analysing LU/LC shifts has also involved the use of deep learning and machine learning methods. These methods have proven to be very successful at spotting and forecasting shifts in land vegetation. Convolutional neural networks (CNNs), for instance, have been used to accurately identify LU and LC using satellite imagery. Google Earth Engine (GEE) has become a potent tool for analysing LU/LC shifts in recent years. A lot of satellite data can be accessed and analysed using GEE's user-friendly UI, which can be used to spot and foretell changes. Overall, this overview article provides a comprehensive examination of the various methods by which LU/LC analysis can identify and foretell changes. The study demonstrates the significance of utilizing geographic information and cutting-edge software such as GIS, remote sensing, multispectral analysis, machine learning, and deep learning.

Keywords: Change detection, change prediction, LU/LC, GIS, and remote sensing. Multispectral, machine learning, and deep learning approaches on LULC, Google Earth Engine

Paper: 028

Development of Water-Immersed Latent Fingerprints on Non-Porous Surfaces using a Novel Eco-Friendly Calcium Carbonate-Based Small Particle Reagent

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ABSTRACT:

This study explores the challenges of visualizing latent fingerprints deposited on non-porous surfaces submerged in water and introduces a Novel Eco-Friendly calcium carbonate based Small Particle Reagent (SPR). The research focuses on the synthesis and effectiveness of the calcium carbonate-based SPR on various crime scene-relevant surfaces, including polymer, wood, metal, and glass. To enhance contrast and visibility, the reagent was stained using Methyl Red, Rhodamine B, and Methylene Blue. The study highlights the SPR's working principle and demonstrates its advantages over traditional heavy metal-based formulations.

The results reveal that the methylene blue-conjugated calcium carbonate SPR delivered the best performance across all tested surfaces, with latent fingerprints developed even after an immersion period of up to 8 weeks. Glass surfaces emerged as the most compatible for fingerprint visualization using this novel SPR. Additionally, the reagent exhibits fluorescence under UV light at 365 nm, and XRD analysis determined the crystallite size of calcium carbonate to be approximately 420 nm.

This novel SPR is effective across a range of surfaces encountered at crime scenes. Its raw materials are cost-effective, widely available, and environmentally friendly, making it a practical and sustainable alternative for forensic applications.

Keywords: Small Particle Reagent; Water-Soaked Latent Fingerprint; Water Immersed Latent fingerprint; Novel SPR Reagent; Calcium carbonate-based SPR; SPR; Non-porous surface; Fingerprint.

Paper: 029

Analyzing Historical Rainfall Data for Trend Detection and Agricultural Decision-Making

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ABSTRACT

Rainfall patterns are critical in determining agricultural productivity, water resource management, and climate resilience. This study focuses on analyzing historical rainfall data to identify trends, patterns, and anomalies that influence agricultural planning and management. By employing statistical methods and data visualization techniques, the study examines temporal and spatial variations in rainfall across selected regions. Machine learning models are utilized to predict future rainfall trends, providing actionable insights for optimizing crop selection, planting schedules, and water resource allocation. The results aim to support evidence-based decision-making, enhance agricultural sustainability, and mitigate risks associated with climate variability. This research emphasizes the importance of integrating historical data analysis with predictive tools for effective agricultural planning.

Keywords: Rainfall, Agricultural Productivity, Data Analysis, Agricultural Planning

Paper: 030

Effective Management of Solid Waste: A Case Study of Tumakuru City, Karnataka, India

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ABSTRACT

Effective planning on waste management can be achieved by the collection of proper data on waste generation and composition in Tumakuru city is required. so to help obtain this wards are selected based on socio-economic status, randomly selected households in each ward were surveyed to obtain data on the rate of waste generation, physical composition, sorting, segregation efficiency, and per capita of the waste. the result shows that the waste generation in Tumakuru city was about 0.32kg/person/Day which accounts for about 145 tons of waste per day for the estimated current population of about 4.5lacs. Nationally biodegradable waste generated was about 50-60% and non-biodegradable waste generated was about 40-50%. The average household generation rate among other cities except bangaluru city was high, so high-income wards was less generated than lower-income wards. So proper segregation of waste at the household level as well as during sorting and transportation is also very much important till it reaches the disposal facility. effective segregation is 80% at the household level, while labeling of bins is also important in the segregation of waste properly to dispose of it without any damage to the environment.

Keywords: Segregation, Solid waste, Household waste, Physical Composition, Income Groups, Efficiency

Paper: 031

Sustainable management of agro industrial waste as potential adsorbent for wastewater treatment: kinetic, thermodynamic and equilibrium study

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ABSTRACT

In the current work, the malachite green (MG) dye was removed from synthetic wastewater by employing a sustainable adsorbent Cajanus cajan (Tur Dal Husk) as an adsorbent. The activated carbon based on Tur Dal Husk (TDH) was prepared and analyzed by analytical techniques methods like the analyzes surface area involving Brunauer-Emmett-Teller (BET) analysis, scanning electron microscopy (SEM), and Fourier transform infrared spectroscopy (FTIR). The impacts of multiple causes, specifically pH, adsorbent quantity, contact duration, and the concentration of dye was investigated about the elimination of MG dye. The equilibrium isotherms underwent analysis through the Freundlich and Langmuir models. The highest ability to absorb was obtained as 24.81 mg/g, 30.95 mg/g, and 36.49 mg/g at 303K, 313K, and 323K respectively. The separation factor value confirmed that the adsorption was beneficial at the adsorption conditions. The kinetics exhibited behavior consistent with pseudo-second-order kinetics. The thermal variables, involving entropy (ΔS), Gibbs free energy (ΔG), and enthalpy (ΔH), revealed that adsorption is a process that occurs naturally and absorbs heat during the process.

Keywords: Tur Dal Husk (TDH); Malachite Green; Cajanus cajan; Sustainable; Kinetics; Energy

Paper: 032

Fe_2O_3-Coated Waste Cenosphere: Advancements in Material Properties for Industrial Applications

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ABSTRACT:

In this era of fast industrial development, along with rapid progress comes the imperative need for sustainability. Future generations will reap the consequences, both positive and negative, of our actions toward nature. Therefore, as we strive to discover more efficient means of production and optimize processes, pollution control emerges as a significant challenge in the face of swift development. Every industry generates numerous by-products. Disposing of these by-products is not always feasible, whether due to economic factors, labor intensity, or environmental concerns. Many of these by-products can become potential pollutants if released unchecked into the environment. Hence, effective by-product management is crucial for ensuring the sustainability of development. This research focuses on waste material, fly ash cenosphere a major component of fly ash notorious for causing issues in coal combustion, especially in thermal power plants, and overburden from mining activities. The raw material was characterization using Field emission scanning electron microscopy, X-ray fluorescence, Fourier- transform infrared spectroscopy, and X-ray diffraction. While dealing with cenospheres, known for various applications, we discovered that when layered and incorporated with metals or metal oxides, they can be used in innovative applications requiring both the properties of cenospheres and metals/metal oxides. Our specific focus was on layering cenospheres with iron (III) oxide, commonly known as hematite ore of iron. We proposed a comprehensive procedure, detailing the chemistry and potential applications of this product.

Keywords: Industrial development; Sustainability; Cenospheres; Iron Oxide; Environmental

Paper: 033

Management of Air quality Through Advance Pollutant Removal Technologies

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ABSTRACT:

Air pollution refers to the presence of harmful substances in air that can have detrimental effects on human health, environment and climate. The pollutants can be either natural or man-made. Addressing air pollution requires combination of regulatory measures, technological advancement to reduce emissions and protect air quality. Effective air quality management involves implementations of policies, strategies and technologies aims to monitor, regulate and reduce the airborne contaminants. Key components of air quality management includes setting of the air quality standards based on scientific research to limit emission of harmful pollutants such as particulate matter (PM), nitrogen oxides (NOx), sulfur dioxide (SO_2) and volatile organic compounds (VOCs). It also involves the promotion of clean technologies such as renewable energy and emission control devices which can reduce pollution at source level. The public awareness campaigns encourage individuals and communities to adopt behavioural changes such as reducing energy consumption and adopting sustainable practices helps in reducing air pollution. Ongoing challenges includes urbanization, industrialization and climate change requires continuous innovation and international cooperation. Effective air quality management helps in reducing air pollution and safeguarding both human well-being and the environment.

Keywords: Air Pollution, Air Quality Management, Sustainable Practices, Urbanization

Paper: 034

Solid Waste Management: A sustainable approach towards Environmental Protection

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ABSTRACT:

Solid waste management is the process of collecting and treating the solid wastes. It offers solutions for recycling items that do not belong to garbage or trash. Waste management is the conversion of solid waste into valuable resources. Every day, tonnes of solid waste are disposed of at various landfill sites. This waste comes from homes, offices, industries and various other agricultural related activities. These landfill sites produce foul smell responsible to pollute the surrounding air and affect the health of humans, wildlife and our environment. Solid waste management practices aims to minimize the quantity of waste produced through strategies such as waste prevention, recycling, composting, and resource recovery. Seeing the adverse impacts of solid waste and increasing pressure on environment it is essential to adopt the sustainable waste management pratices that will help in protection of environment and mitigation of green houses gases. Key for reducing waste is the adoption of the "reduce, reuse, recycle" (3Rs) framework, which encourages sustainable consumption patterns, extends the lifecycle of materials and reduces dependency on landfills. Policymakers and local governments are increasingly integrating circular economy principles into waste management plans to ensure resources are continuously cycled through the economy rather than discarded.

Keywords: Solid waste management, Reduce, Reuse, Recycle**.**

Paper: 035

Green Innovations: Eco-Friendly Technologies Transforming Key Industries

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ABSTRACT:

Eco-friendliness is becoming an essential part of development because it helps in minimizing environmental harm by reducing negative environmental impacts, conserve resource and promotes sustainability. Growing awareness, economic benefits, and social expectations shift us towards eco-friendly technologies. The advantages are conservation of biodiversity, improved public health, economic growth and employment, sustainable resource use, reduction in environmental impacts and enhanced corporate reputation. Ecofriendly technologies such as renewable energy, carbon capture, low- carbon buildings, energy- efficient devices, waste reduction and recycling, sustainable agriculture, green transportation, water conservation, bio-based materials and circular economy initiatives. This review discusses the various eco-friendly technologies, their impacts, advantages, disadvantages and ways to achieve them.

Keywords: Eco-friendly Technology, Sustainability, Conserve Resources, Development and Economy.

Paper: 037

Eco-Friendly Synthesis of Zinc-Copper Mixed Metal Oxide Nanoparticles Using Lac Biowaste: Antifungal Efficacy Against *Alternaria alternata* and *Fusarium oxysporum*

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ABSTRACT:

Fungal-induced plant diseases pose a significant challenge to global agriculture, compromising crop quality, reducing yield, and threatening food security, ultimately leading to substantial economic losses. Addressing this issue necessitates sustainable and environmentally benign solutions. In this study, zinc-copper mixed metal oxide nanoparticles (ZnCuO-NPs) were synthesised via a simple, one-pot, eco-friendly method utilising Button lac (BL) and Seed lac (SL) extracts as natural reducing and stabilising agents. These extracts, derived from lac biowaste produced by *Kerria lacca* insects on diverse forest trees and shrubs in the Himalayan Terai and other Indian regions, offer an innovative and sustainable approach to nanoparticle synthesis. The crystalline structure of the ZnCuO-NPs was confirmed through PXRD analysis, while FTIR spectra revealed characteristic metal-oxygen (M-O) bonds with peaks at 559 cm^{-1} and 555 cm^{-1}. Morphological assessment via FESEM-EDX demonstrated irregular particle shapes with slight aggregation. The antifungal activity of the synthesised NPs was evaluated against two phytopathogenic fungi, *Fusarium oxysporum* and *Alternaria alternata*. Among the tested formulations, ZnCuSL-(O) NPs exhibited superior antifungal efficacy, outperforming both ZnCuBL-(O) NPs and ZnCu-(O) NPs, making them a promising eco-friendly alternative to conventional fungicides. This work highlights the novel utilisation of lac biowaste in the sustainable production of functional nanoparticles and underscores their potential in strengthening plant defence mechanisms against fungal pathogens. The findings present a green and cost-effective solution for enhancing agricultural sustainability and provide a viable pathway for eco-friendly crop protection strategies.

Keywords:

Paper: 038

Development and Evaluation of Oral Disintegrating Films from Okra Mucilage Enriched with Hyaluronic Acid for Functional Food Applications

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ABSTRACT:

Oral disintegrating films (ODFs) offer a patient-friendly solution with improved convenience and a rapid onset of action, making them ideal for delivering various health benefits. These films are specifically designed for geriatric and pediatric populations and individuals who experience difficulty swallowing. This study focuses on the development and characterization of ODFs formulated primarily from okra mucilage (OM), hyaluronic acid (HA), vitamin C-loaded bioactive glass nanoparticles (VBG NPs), and clove essential oil. A bio-inspired method using a fructose template was employed to synthesize the VBG NPs. Nutrient analysis of OM indicated its richness in protein, carbohydrates, magnesium, and flavonoids (quercetin), which contribute to its antioxidant properties. The physicochemical properties of the ODFs, assessed through contact angle measurement, surface pH, opacity, and in vitro disintegration time, revealed rapid disintegration in simulated saliva. The neutral surface pH of these films suggests they are non-irritating to the oral mucosa. Incorporating VBG NPs and essential oil (EO) enhanced the thermal and mechanical properties of the films. Moreover, the infusion of EO into the film matrix resulted in a porous structure and conferred antibacterial activity, as demonstrated by FE-SEM micrographs and antibacterial disk diffusion assays. The resulting novel, nutrient-rich ODFs exhibit hemocompatibility, with a hemolysis rate (HR%) of less than 5%, making them well-suited for functional food applications.

Keywords:

Paper: 039

Fabrication and Assessment of eicosane/poly(styrene-co-butylacrylate) microencapsulated phase change materials using an ultrasonicated mini-emulsion approach

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ABSTRACT:

This study presents the synthesis and characterization of microencapsulated phase change materials (MPCMs) tailored for latent heat storage applications. Eicosane/Poly(styrene-co-butylacrylate) [ESE/Poly(Sty-co-BA)] microcapsules were fabricated using a novel ultrasonic-assisted mini-emulsion polymerization technique, where n-Eicosane (n-ESE) was encapsulated within a Poly(Styrene-co-Butylacrylate) shell. The synthesized microcapsules were meticulously analyzed using Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), Transmission Electron Microscopy (TEM), X-ray Diffraction (XRD), and Fourier Transform Infrared (FTIR) spectroscopy. DSC results revealed the ESE/Poly(Sty-co-BA) microcapsules exhibited melting and crystallization temperatures of 35.72 °C and 32.27 °C, with impressive latent heat values of 220.53 J/g and 218.57 J/g, respectively. These microcapsules demonstrated exceptional performance with an encapsulation ratio of 91.93%, encapsulation efficiency of 91.59%, and a remarkable thermal storage capacity of 99.63%. TGA analysis confirmed a three-step degradation process, indicating robust thermal stability. This work introduces a versatile and efficient approach for producing advanced phase change materials with potential applications in smart textiles, thermo-sensitive coatings, and passive cooling or heating systems for energy storage. These findings highlight the innovative potential of ultrasonic-assisted mini-emulsion polymerization in advancing thermal energy storage technologies.

Keywords: Microencapsulation, Phase change materials, Poly(Sty-co-BA), n-ESE, ESE/poly(Sty-co-BA)

Paper: 040

Self-Healing Materials Progress in Elastomers and Thermoplastic Polyurethanes

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ABSTRACT:

Self-healing polymers represent a groundbreaking class of materials capable of autonomously repairing mechanical damage, such as cracks and scratches, thus extending material life and reducing the need for external repairs. These materials are especially promising in industries requiring durability and sustainability, including automotive, electronics, and medical devices. Among self-healing polymers, elastomers are particularly noteworthy due to their ability to recover from damage while maintaining their original properties. The self-healing behavior of elastomers is driven by dynamic chemical bonds, such as Diels-Alder reactions, metal coordination, hydrogen bonds, ionic interactions, and disulfide bonds. These bonds allow for reversible healing under mild conditions, enabling materials to repair autonomously. This review focuses on recent advancements in self-healing elastomers, with particular emphasis on thermoplastic polyurethane (TPU), a polymer known for its high elasticity, tensile strength, and wear resistance. Incorporating self-healing mechanisms into TPU enhances its performance by improving its repairability without compromising its mechanical properties. However, achieving a balance between high repair efficiency and maintaining mechanical strength remains a challenge. The paper also highlights the critical issues surrounding the scalability, stability, and long-term performance of self-healing materials, particularly in harsh environmental conditions. Furthermore, it discusses the future directions of self-healing polymers, pointing toward the need for innovations that enhance healing efficiency while maintaining or improving overall material properties. By reviewing the preparation methods, healing mechanisms, and applications of self-healing elastomers, this work provides valuable insights into the future of advanced polymer technologies with self-healing capabilities.

Keywords: Self-healing Polymer; Elastomer; Hydrogen bond; Disulfide bond.

Paper: 041

Layered Double Hydroxides: Multifunctional Materials for Catalysis and Biomedical Innovations

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ABSTRACT:

Layered double hydroxides (LDHs), a class of anionic clays characterized by positively charged host layers and interlayer anions, have emerged as versatile materials with immense potential in catalysis and biomedical applications. The structural tunability of LDHs, including their exfoliation properties, topological transformations, and confinement effects, makes them highly adaptable for diverse uses. In catalysis, LDHs serve as catalysts, supports, or precursors, with properties that can be optimized through defect engineering, modulation of surface acidity/basicity, and geometric/electronic tuning. These features also enable the synthesis of advanced supported metal catalysts with controllable particle size, morphology, and electronic properties, fostering innovations in heterogeneous catalysis. In the biomedical realm, LDHs exhibit remarkable biocompatibility, pH-sensitive biodegradability, high loading capacity, and interlayer ion exchangeability. These properties, coupled with their ease of surface modification, make LDHs ideal for applications such as drug and gene delivery, bioimaging, cancer therapy, biosensing, tissue engineering, and antimicrobial activity. Recent advances in LDH-based nanocomposites and functional coatings highlight their potential in addressing critical challenges in healthcare. Despite their promise, the clinical translation of LDHs remains limited, necessitating further research into scalable synthesis methods, tailored functionalities, and comprehensive safety assessments. This unified exploration underscores the transformative potential of LDHs in catalysis and biomedicine, while emphasizing the need for continued innovation to overcome current limitations and unlock their full potential in real-world applications.

Keywords:

Paper: 042

Magnesium Oxide-Enhanced Biochar Derived from Municipal Solid Waste for Lead Removal from Landfill Leachate

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ABSTRACT:

Municipal solid waste (MSW) poses an increasing challenge in many developing countries. If not managed properly, the organic fraction of MSW can degrade and contribute to environmental pollution by releasing methane and carbon dioxide through landfill gas emissions. Organic MSW can be converted into biochar, offering opportunities for environmental remediation, including landfill leachate treatment. This study explores the potential of biochar derived from MSW for treating lead, a toxic heavy metal commonly found in landfill leachate. Pristine (P-BC) and magnesium oxide-modified (MgO-BC) biochars were produced through pyrolysis at 450°C in a muffle furnace. The modification with magnesium oxide (MgO) was implemented to enhance the adsorptive properties of the biochar, improving its effectiveness in removing lead from landfill leachate. Adsorptive performance was assessed through batch experiments under varying conditions, including pH, contact time, biochar dosage, and initial lead concentration. Scanning electron microscopy (SEM) and Fourier transform infrared spectroscopy (FTIR) analyses demonstrated significant improvements in the modified biochar's surface morphology and functional groups. Adsorption experiments demonstrated that MgO-BC exhibited superior adsorptive capabilities compared to P-BC across all batch conditions. MgO-BC achieved a high yield of 43.79% and a pH of 8.54, whereas P-BC had a lower yield of 34.43% and a pH of 9.67. This study highlights the potential of MSW-derived biochar for lead removal from landfill leachate. Biochar production can also reduce landfill waste volumes and mitigate the environmental impacts of landfilling, offering a sustainable approach to waste management and pollution control.

Keywords: Lead, Municipal solid waste, Biochar, Leachate, Sustainable Development Goal, Pyrolysis

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Paper: 043

Taguchi's Design Approach to Optimize Reaction Parameters for Biodiesel Production from Sal (Shorea Robusta) Oil

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ABSTRACT:

The optimization of sal oil, a non-renewable resource, for the synthesis of biodiesel is the main focus of this study, which also looks at the important factors affecting yield. Every year, sal seeds yield about 180,000 tons of fruit per acre. By examining the signal-to-noise (SN) ratio, the Taguchi technique was used to determine the variables affecting the yield of biodiesel. While mechanical agitation and reaction temperature remained constant, the molar ratio of methanol to oil, reaction time, and catalyst concentration were selected as variables for adjustment. The experiments were planned using a L9 3x3 orthogonal array (DOE). The findings showed that the most important factor influencing the yield of sal biodiesel was catalyst concentration, which was followed by the reaction duration and the molar ratio of methanol to oil.Each parameter's contribution was evaluated using the analysis of variance (ANOVA); the model validation was 95.12%, with an R-squared value of 0.959. An 8:1 methanol to oil ratio, 1 g of KOH catalyst, and a 75-minute reaction time with continuous stirring at 60°C were determined to be the ideal parameters. The yield of biodiesel under these ideal circumstances was 96.39%. The final biodiesel's physicochemical characteristics were investigated and found to satisfy ASTM D7652 requirements. Consequently, it was demonstrated that sal oil methyl ester (SOME) was a potential feedstock for the manufacture of biodiesel.

Keywords: Sal oil, Taguchi method, Sal Oil Methyl Ester, Fuel properties.

Paper: 044

An Overview of the Future Prospects and Challenges of TiC-Reinforced Magnesium Matrix Composites

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ABSTRACT:

Magnesium matrix composites (MMCs) reinforced with Titanium Carbide (TiC) has garnered significant attention in the field of advanced materials due to their enhanced mechanical properties and lightweight characteristics. This review paper provides a comprehensive analysis of recent advancements in the development, characterization, and applications of Mg-TiC composites. It also included synthesis methods, liquid metallurgy and powder metallurgy techniques, and the impact of TiC reinforcement on the microstructure and properties of the magnesium matrix. This review paper discusses the improvements in hardness, strength, and wears resistance achieved through TiC reinforcement, as well as the influence of reinforcement volume fraction and particle size on composite performance. Additionally, it highlights the challenges associated with the processing and fabrication of Mg-TiC composites, such as issues related to interfacial reactions and the dispersion of TiC particles. The current applications in aerospace, automotive, and structural engineering are examined, underscoring the potential benefits of Mg-TiC composites in high-performance environments. Future directions for research are proposed, emphasizing the need for optimized processing techniques and further exploration of the mechanical behavior and long-term performance of these composites. This reviews aims to provide a detailed understanding of the state-of-the-art in Mg-TiC composites and guide future innovations in this promising material system.

Keywords: NMCs, Titanium Carbide, Mg-TiC Composites,

Paper: 045

The Intelligent City: Where Technology Meets Sustainability

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ABSTRACT:

Over 4 billion people live in cities, and by 2050, the number of people living there is predicted to be double. To keep up with this rapid population growth, cities need to embrace innovation. A smart city makes use of technology to enhance its resident's quality of life, sustainability, and services. Through engagement and participatory action, the smart city model is said to offer solutions that will support sustainable development and a high standard of living while managing natural resources wisely. This aims to critically examine the theoretical underpinnings and practices of smart cities, as well as the ways in which the concept is applied and offers a critical analysis of this model and attempts to implement smart urban technologies in modern cities, focusing on the new practices of ubiquitous eco-cities as model smart city projects. Today's smart cities are known to use digital technologies to make urban operations more efficient and their services more accessible, as well as to enhance the quality of life for their residents. In order to balance technological advancements with social, economic, and environmental sustainability, future research should concentrate on scalable models, creative financing, and context-specific solutions using data-driven decision-making, citizen participation, and efficient governance. This review paper emphasizes how integrating technology into smart cities can lead to sustainable urban development.

Keywords: Technology, Sustainable development, Urban planning, innovation, digital technologies

Paper: 046

Valorisation of pine needle waste into biochar beads and exploring the efficacy in wastewater treatment.

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ABSTRACT:

Uttarakhand fosters a rich biodiversity with about 70 % of its area covered by forests. Of this, about 16 % of the total land is occupied by chir pine forests (scientific name: *pinus roxburghii)*. Annually, over 1.5 million tonnes of pine needle are shed as forest litter. Due to their highly inflammable properties, these pine needles are the major cause of forest fires in Uttarakhand. Forest fires release CO_2, SO_X, and NO_X, causing not only a great deal of air pollution and respiratory ailments but also eye irritation or even loss of visibility. Soil microbiota, nutritive properties of soil and soil seed bank are damaged, disrupting the growth of native vegetation. Hence, it is critically important to find a sustainable way of its utilization. Since pine needle serves as an easily available and abundant source of lignocellulosic biomass, it serves as a suitable raw material to be converted into a sustainable and green bio-adsorbent. This review explores the potential of pine needle biochar for wastewater treatment. It also dives into the possibility of biological degradation of pine needle waste using a microbial consortium.

Keywords: Biochar, Biodegradation, Microbial consortium, Pine needle, Wastewater treatment.

Paper: 047

Assessing the Environmental Lifecycle of Polylactic Acid: Harmonizing Renewable resources, biodegradability and Waste management to support a Circular Economy

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ABSTRACT:

Polylactic Acid (PLA), is a bio-based, thermoplastic and biodegradable polymer derived primarily from renewable resources like corn, sugarcane, or other starch-rich crops has gained prominence attention over the last two decades as an alternative to traditional petroleum-based plastics within a sustainable framework. This study assesses the environmental lifecycle of polylactic acid, focusing on optimizing the use of renewable resources, evaluating its biodegradability, and identifying effective waste management strategies and control to support a circular economy. It examines the agricultural resources needed for feedstock cultivation, the energy requirements during production, and the challenges of end-of-life options, including the limitations of industrial composting and recycling. The study also explores how improving polylactic acid's compostability, biodegradability, and recycling rates and capabilities can enhance its role in reducing plastic waste, addressing current waste infrastructure constraints and supporting sustainable material flows; as well as, comparing its environmental impact with other emerging bioplastics like polyhydroxyalkanoates (PHAs). Findings suggest that, with targeted innovations in waste management and enhanced recycling methods, polylactic acids can better align with circular economy goals, helping to reduce reliance on fossil fuels, minimize plastic pollution and promote sustainable resource use. This assessment offers recommendations for policy and industry practices to maximize polylactic acid's sustainability potential in the transition to a more circular and sustainable economy.

Keywords: Polylactic acids, Biodegradability, Circular economy, Waste management, Compost

Paper: 048

A study on Spatial and Temporal Analysis along with the habitat ecology and abundance of Odonates along the Gaula River, Haldwani Nainital.

Author:

ABSTRACT

Odonates, encompassing dragonflies and damselflies, are predominant insects inhabiting diverse habitats such as forest edges, cultivated fields, meadows, ponds, and rivers. Their distribution, however, is limited by a life cycle requiring an aquatic larval stage, positioning them as valuable indicators of ecosystem health. From 2022 March to 2024 April, a study was conducted along a 10 km stretch of Gaula River, Haldwani (Nainital), examining the spatial and temporal distribution of odonates across seven sub-sites categorized by vegetation cover, lentic water characteristics, and microhabitat conditions. Collections were made following Sutherland in which sweep nets were used to capture the specimens, followed by field photography and further identification in the laboratory.

A total of 46 species were documented, in which Anisoptera were dominant over Zygoptera represented by 25 species in contrast to 21 species of damselflies. Among dragonflies, Libellulidae showed the highest diversity, followed by Gomphidae and least by Aeshnidae; whereas in damselflies, diversity was highest in the family Coenagrionoidae, followed by Platycnemididae, Chlorocyphidae, Euphaeidae, Calopterygidae, Lestidae, Platystictidae. Seasonal as well as spatial fluctuations were analyzed, with abundance 1182 in pre monsoon, 593 in monsoon and maximum in post monsoon with 1506.

Generalized species observed included *Trithemis festiva, Crocothemis servilia,* and *Neurobasis chinensis,* while *Anax immaculifrons, Anax nigrofasciatus, Ceriagrion fallax, Coeliccia renifera, and Copera marginipes* were specialized species, influenced by microhabitat conditions and minimal disturbance. Given the lack of baseline data on odonates distribution and vegetation relationships, this study provides essential preliminary insights into their ecological roles.

Paper: 051

Phytoremediation of Cypermethrin-Contaminated Agricultural Soil Using *Tagetes erecta*

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ABSTRACT:

The extensive use of cypermethrin in agriculture has raised serious concerns about its impact on soil health, the environment, and human health. Phytoremediation, an eco-friendly and sustainable approach, offers a promising way to address this issue. In this study, we explored the potential of *Tagetes erecta* (African marigold) to remediate agricultural soils contaminated with cypermethrin. The experiment was conducted in a controlled environment and assessed the *Tagetes erecta's* ability to degrade, absorb, and stabilize cypermethrin residues. Our finding showed that *Tagetes erecta* significantly reduced (15.43-19.73-fold) the levels of cypermethrin in the soil. Furthermore, our findings showed that growing *Tagetes erecta* improved soil health by boosting microbial diversity and reducing overall toxicity. These findings highlight *Tagetes erecta* as a cost-effective and environmentally friendly solution for restoring contaminated soils. Beyond remediation, cultivating Marigold can support sustainable farming practices, making it a valuable tool for addressing pesticide pollution in agriculture.

Keywords: Phytoremediation, African Marigold, Cypermethrin, Soil health

Paper: 052

Plant Growth Data Classification

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ABSTRACT:

Plant growth is shaped by various environmental and management factors, making the prediction of growth milestones essential for enhancing agricultural efficiency. This research analysis a dataset featuring soil type, sunlight duration, irrigation frequency, fertilizer type, temperature, and humidity to classify plant development stages. The data undergoes preprocessing steps such as managing missing values, eliminating duplicates, scaling numerical features, and encoding categorical variables using one-hot encoding. Further a comparative analysis of machine learning algorithms, including Random Forest, Support Vector Machines (SVM), Decision Trees, K-Nearest Neighbours (KNN), and Logistic Regression, is performed to evaluate the overall model performance in classifying plant growth milestones. The Random Forest model demonstrates the highest accuracy, achieving a cross-validation score of 94.83% after hyperparameter tuning using Grid Search.

Paper: 054

IMPACT OF BIODIESEL PRODUCTION ON GLOBAL FOOD SUPPLY CHAINS AND ITS CONSEQUENCES FOR BIODIVERSITY

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ABSTRACT:

Biodiesel has recently emerged as competitive choice to meet global renewable energy demand with rise in energy demand and depleting fossil fuels, dependence on biodiesel is more likely to increase at rapid pace. India as per its Policy on Biofuels 2018 aims to achieve target of blending 5% biodiesel in diesel by 2030.This paper aims to highlight both positive and negative effects of biodiesel production on Food supply chain and its effect on flora and fauna.

First and second generation biodiesel production has already sparked debate of Food vs Fuel as it will have direct impact on Food supply chain. In race to rise biodiesel production global food prices are likely to increase by 10% to 15% and even more if food supply chain is not regulated efficiently. This will lead to higher food insecurity in low income countries as food become expensive and less accessible. Although if more intelligent choices are made by shifting focus on agricultural waste, such as crop residue like corn stalks, wheat straw, rice husks and other non-food biomass which is not intended for human consumption, debate of Food vs Fuel can be fully eradicated. Research suggests that greenhouse gases (GHG) emissions can significantly decreased by the use of biodiesel as it is believed to be carbon neutral while it has been observed that race to increase production can lead to deforestation and habitat destruction. Deforestation leads to habitat loss for countless species of flora and fauna. Focus on monoculture farming for biodiesel production can reduce genetic diversity which can make ecosystem more vulnerable. Use of chemicals for higher yields can pollute water of nearby sources. Intensive monoculture farming can also lead to soils erosion, nutrient depletion and overall soil degradation. While studies suggest third generation biodiesel production for example from algae can arrest these environmental concerns. This paper focuses on the impact of biodiesel production from different sources, on the biodiversity and suggests techniques to avoid them.

Keywords: Biodiesel, Food vs Fuel, GHG, Carbon neutral, Deforestation, Monoculture farming

Paper: 055

Impact of Diethyl Ether Additives to Improve Emission Characteristics Of GSOME and its respective Blends with Diesel in VCR Engine

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ABSTRACT:

The impact of diethyl ether (DEE), an oxygenated additive in a diesel-GSOME blend, on the emission parameters of a diesel engine with a variable compression ratio (VCR) is examined in this study. Pure diesel and diesel blends including GSOME and DEE at volumetric percentages of 5%, 10%, and 15% were among the four fuel combinations that were investigated. A single-cylinder VCR diesel engine was employed for the experiments, and the emission performance of each fuel blend was compared with baseline values obtained from diesel fuel alone. According to the findings, the diesel-GSOME blend's oxides of nitrogen (NO_x) emissions lowered by 8.72%, 7.74%, and 12.98% for the three compression ratios (CR 14, CR 16, and CR 18) when 10% DEE was added. At the same compression ratios, the DEE 10 mix also resulted in a 10.34%, 15.07%, and 20.36% decrease in carbon monoxide (CO) emissions. However, it was found that the DEE 10 blend enhanced hydrocarbon (HC) emissions by 35.58%, 20.57%, and 44.72% for all compression ratios. Overall, the results indicate that the best combination for lowering emissions over the engine's operating range is the diesel-GSOME-10% DEE blend (D80GSOME10DEE10). This study indicates how GSOME can be blended with different amounts of DEE additives to lower exhaust emissions in VCR diesel engines.

Keywords: GSOME, Diethyl Ether, Blending, VCR Engine, Exhaust Emission

Paper: 056

Production of Biofuel from algae: Current scenario and future scope

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ABSTRACT:

The production of biofuel from algae represents a promising avenue for sustainable energy solutions, leveraging the unique characteristics of algae as a biofuel feedstock. Current advancements have demonstrated the potential of algae to produce high yields of lipids & carbohydrates which can be converted into biodiesel, bioethanol and other valuable biofuels. Research has focused on optimizing growth conditions, enhancing lipid accumulation, and deve loping efficient extraction and conversion technologies. Despite significant progress, challenges such as high production costs, scalability issues, and technological limitations remain. Future prospects include innovations in improved cultivation techniques, and integrated biorefinery processes to address these challenges and enhance the economic viability of algal biofuels. The integration of algae-based biofuels into existing energy systems could contribute to reducing dependence on fossil fuels and mitigating climate change impacts.

KEYWORDS: Microalgae, Biodiesel, Algae cultivation, Harvesting, Macroalgae, Bioethanol

Paper: 057

Integration of AI and TOPSIS approaches to Improve Anaerobic Digestion and Waste-to-Energy Systems

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ABSTRACT:

Anaerobic Digestion is a process through which microorganism breakdown biodegradable materials in the absent of oxygen converting them into biogas, serving as a renewable energy source while reducing environmental challenges from waste accumulation and greenhouse gas emission. Inefficiencies in AD systems are common due to the complex interactions among feedstock composition, operating conditions, and microbial activity, despite their potential. Optimization requires a robust structure to manage the ever-changing and interrelated factors that affect the process. Artificial Intelligence (AI) and Multi-Criteria Decision Making (MCDM) tools, such as Technique for Order Prioritization by Similarity to Ideal Solution (TOPSIS) technologies, offer innovative approaches and new solutions to these challenges. AI improves process control by providing predictive capabilities and adaptability for real-time adjustments, ultimately increasing methane yields, reducing costs, and improving system stability. TOPSIS enhances this process by evaluating choices using various factors like biogas quality, energy efficiency, and environmental footprint to pinpoint the most optimal solutions for intricate situations. The combination of artificial intelligence (AI) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) present a novel approach to enhancing anaerobic digestion (AD) systems by tackling issues in co-digestion strategies, substrate selection, and reactor designs. This review emphasizes effective strategies for enhancing waste-to-energy processes by using AI to predict microbial responses in changing environments and applying TOPSIS to assess the sustainability of different setups. It also highlights important areas where research is lacking, such as limited understanding of microbial relationships and the need for more reliable data to enhance these systems. This innovative approach shows that integrating AI and MCDM can lead to significant enhancements in waste-to-energy systems, helping to reduce environmental impacts and support global sustainable development objectives.

Keywords: Anaerobic digestion (AD), Artificial intelligence (AI), TOPSIS, Waste-to-energy systems, Multi-criteria decision-making (MCDM)

Paper: 058

Machine Learning and Geospatial Technology in Flash Flooding Investigation at Nainital Region

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ABSTRACT:

The natural and anthropogenic stimuli at Himalayan region induced susceptibility to flash floods and landslides considered by its considerable topographical scale and elevation. The study focuses on the Nainital region of Himalaya where several topographical, thermal and atmospheric parameters have been taken into consideration for flash flood occurrences. Specifically, the study examines the intricate interactions between land and atmosphere and their interplay with local terrain. The pre-flood and post flood parameters have been considered carefully. Beside that the aerosol optical depth, cloud cover thickness, and total precipitable water vapor, have also been examined and exhibit a remarkable correlation with flash flooding event on October 17th to 19th, 2021 and 2023 flooding. These events have been devastating and resulted in enormous loss of life and property in the study area. The historical flooding pattern indicates flash flooding predominantly during June to September, but the inconsistent signals of October flash flooding advocates a possible shift in isohyets (a line having same precipitation value) pattern in the area. This could be probably predisposed by variable climate in this mountainous region. Several statistical analyses mostly non-parametric; including the Autocorrelation function (ACF), Mann–Kendall (MK) test, Modified Mann–Kendall, and Sen's slope (q) estimator, have been used to determine extreme precipitation characteristics from 2000 to 2023. The findings may communicate a general non-significant increasing trend, except for July, that showed a non-significant decreasing trend. Furthermore, machine learning and geospatial data from Meteosat-8 have been integrated to reduce uncertainty in the prediction and examination of the result. The study advocates the results received from this hybrid approach in revealing the truth from measuring and monitoring flash flooding from the real time remote sensing data. It may play a pivotal role in providing adaptation and mitigation strategy for viksit Bharat Goals.

Keywords: Machine learning, remote sensing, sentinel data, flash flooding, isohyet shift, Vikshit Bharat, sustainability, future earth.

Paper: 060

Sustainable Agriculture- Integrated Farming for Future Generation

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ABSTRACT:

Sustainable agricultural production depends on the quality and availability of natural resources like soil and water. Agricultural expansion may be supported by the protection and sustainable use of these finite natural resources through appropriate location-specific regulations. Indian agriculture is still largely dependent on the rainfed system which occupies about 60% of the gross sown area and contributes to 40% of the total food production. Therefore, the conservation of natural resources and raising of rain-fed agriculture are the only ways to feed the growing population of the country. The National Mission for Sustainable Agriculture (NMSA) has been formulated to enhance production in rainfed areas by adopting the integrated farming system, efficient use of water, soil health management, and optimal utilization of resources. Integrated farming is therefore a form of agriculture that combines several farming techniques to get the maximum yields and good profits and at the same time protect the environment. Crop rotation, the use of animal manure and crop residue to enhance soil, the use of cover crops and organic compost, the combination of livestock, crops, fish, and poultry, the use of an environmentally friendly management system, and so on are examples of integrated agricultural methods. Integrated farming provides several benefits, including enhanced productivity, diversified incomes, lower production risk, better environmental stewardship, sustainable growth, a pollution-free environment, more employment, etc. This paper suggests that integrated farming can be helpful for future generations in many ways, including food security, reduced greenhouse gas emissions, better resource utilization, reduced chemical fertilizer, rural development, knowledge sharing, and so many others.

Paper: 061

Environmentally sustainable zirconium-ferrite nanoparticles for removal of methylene blue dye

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ABSTRACT:

Environmental contamination from synthetic dyes, such methylene blue (MB), is a serious threat to human health and ecosystems. In order to effectively remove MB from aqueous solutions, this work explores the production, characterization, and use of zirconium-ferrite nanoparticles (ZF-NPs) as environmentally acceptable adsorbents. ZF-NPs, which had a particle size range of 16–20 nm, high surface area of 392 m^2/g, and a pore volume of 0.1723 cm^3/g, were made using a straightforward co-precipitation process. Batch adsorption tests were conducted to evaluate the effects of several operational parameters, including adsorbent dosage, pH, concentration of dye, and contact time. For optimum adsorption, a ZF-NP dosage of 0.2 g/L, a solution pH of 4.0, an initial MB concentration of 10 mg/L, and a contact time of 60 minutes were required. The best description of the adsorption process was given by the Langmuir isotherm model, which had a maximum adsorption capacity of 238.09 mg/g and Kinetic studies revealed that a pseudo-second-order model (R2 = 0.999) governed the adsorption. These findings show that ZF-NPs are extremely effective and ecologically friendly adsorbents, providing a viable way to reduce dye contamination in wastewater treatment. Additional research on these nanoparticles' reusability may improve their usefulness.

Keywords: Dyes, Metal oxide nanoparticles, Adsorption, Isotherm, Kinetics.

Paper: 062

Development of Iron-Based Porous Metallopolymeric Material and Evaluation of Its Efficiency in Arsenic Removal from Water

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ABSTRACT:

Extreme arsenic contamination in aquatic environments poses significant health risks to millions of people, with prolonged exposure through arsenic-laden drinking water potentially leading to fatal outcomes. In this study, a novel porous polymeric network incorporating an iron moiety—poly(ferric trimethacrylate) (pFeTMA)—was synthesized via suspension polymerization. By varying the monomer, crosslinker, and porogen, an optimized pFeTMA adsorbent with high arsenic removal efficiency was developed. The fabricated pFeTMA demonstrated remarkable affinity for arsenic due to the cohesive integration of the iron moiety within the polymeric chain. Comprehensive characterization of the material was performed using SEM, XRD, FTIR, BET, and XPS analyses. The adsorbent exhibited maximum adsorption capacities (qe exp) of 41.39 mg g-1 for As(V) and 37.35 mg g-1 for As(III), attributed to its unique porous structure (surface area: 197 m2 g-1; pore size: 0.93–2.36 μm). Adsorption isotherm studies revealed maximum capacities of 45.10 mg g-1 for As(V) and 40.88 mg g-1 for As(III) based on the Langmuir model. The adsorption kinetics followed a pseudo-second-order model with high correlation coefficients (R2= 0.9918 for As(V) and 0.9789 for As(III)). Furthermore, an artificial neural network (ANN) model, trained and validated using a three-layer backpropagation network (structure: 4-10-1), achieved high accuracy with correlation coefficients (R>0.99). This highlights the potential of the ANN model for predicting adsorption behavior with precision.

Paper: 063

Microalgae Bioactive Compounds: A Sustainable way to Biofertilization and Soil Health Improvement

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ABSTRACT:

The excessive use of chemical fertilizers for enhancing agriculture crop yields results in serious issues, including soil structure instability, accumulation of toxic chemicals, and disturbances in the life balance between soil and microflora. Microalgae have been identified as sustainable and reliable substitutes for chemical fertilizers in agriculture, with benefits including enhanced soil fertility, promoted nutrient management, and reduced dependency on chemical fertilizers. Microalgae, a wide range of photosynthetic microorganisms, have drawn significant attention for their potential to serve as sustainable biofertilizers. Their substantial profile of bioactive compounds, including polysaccharides, phytohormones cytokinin, auxin, abscisic acid, brassinosteroid, proteins, carotenoids, phycobilin, and terpenoids, phenolic compounds, fatty acids, and terpenoids, contributes to soil fertility and plant growth development. Such compounds enhance nutrient availability, promote beneficial microbial activity, and improve soil integrity, giving microalgae an environment-friendly alternative to chemical fertilizers. Extracts from microalgae are utilized extensively in crop production because they provide growth-promoting qualities that enhance a crop's ability to tolerate abiotic stresses involving extreme temperatures, drought, salinity, and mineral deficiency. Research findings indicate that different microalgae (*Chlorella vulgaris, Nannochloropsis salina, Arthrospira platensis, Dunaliella salina)* extracts are applied to crops such as tomato, bean, and cucumber, lettuce and others significantly promoting plant height, number of leaves, and flowers, root length and shoot length. This implies how microalgae-derived metabolites improve soil health, and their ability to stimulate nitrogen fixation, phosphorus solubilization, and organic matter enrichment. Microalgae bioactive compounds present a sustainable and multifunctional solution for modern agriculture, addressing the need for enhanced crop productivity and environmental conservation.

Keywords: Microalgae, Bio-active compounds, Biofertilizer, Metabolites, Soil health

Paper: 064

PGPR as an eco-friendly approach for soil salinity mitigation and sustainable agriculture

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ABSTRACT:

Plant Growth-Promoting Rhizobacteria (PGPR) offer a promising eco-friendly strategy to mitigate soil salinity and enhance sustainable agriculture. Soil salinity is a significant abiotic stress limiting crop productivity worldwide, adversely affecting plant growth, nutrient uptake, and soil microbial diversity. PGPR, a group of beneficial microorganisms residing in the rhizosphere, can alleviate salinity stress through the production of phytohormones (indole-3-acetic acid, gibberellins, and cytokinin - promote root elongation and stress tolerance), exopolysaccharides (improve soil aggregation and reduce salt ion toxicity), osmoprotectants (proline and glycine betaine to maintain osmotic balance), nitrogen fixation and mineral (phosphorus, potassium, iron, and zinc) solubilisation. PGPRs enhance plant tolerance to salinity by improving nutrient availability, maintaining ionic balance, and reducing oxidative damage through enzymatic antioxidants such as catalase, superoxide dismutase, and peroxidase, and non-enzymatic antioxidants like glutathione and ascorbate.

Despite their potential, the practical application of PGPR in salinity-affected soils requires further research. Future studies should focus on identifying and developing salt-tolerant PGPR strains suited to diverse agro-climatic zones and crop systems. Integrating PGPR with advanced biotechnological tools such as metagenomics and transcriptomics can unravel the molecular basis of their stress-mitigation mechanisms, such as the expression of genes like acdS (ACC deaminase), and enzymatic antioxidants such as cat (catalase), sod (superoxide dismutase), and pox (peroxidase) that reduce ROS damage in plants. Field trials are crucial to assess PGPR efficacy in real-world conditions, considering interactions with native microbiota and long-term soil health. Combining PGPR with eco-friendly practices like biochar, vermicompost, and precision agriculture can enhance agricultural sustainability in saline soils. Additionally, biofortification using PGPR can improve crop nutrition by increasing iron and zinc uptake in cereals and addressing both salinity stress and micronutrient deficiencies. These integrated strategies offer the potential for sustainable and nutritionally secure agriculture under saline conditions.

Keywords: Biofortification; Mineral solubilization; Phytohormone; Salt stress; Salinity tolerance

Paper: 065

Exploring Biodiesel As A Sustainable Alternative To Conventional Fuels: Emission Analysis From Waste Cooking Oil Blends

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ABSTRACT:

Air quality in northern India, particularly in regions like New Delhi, has reached alarming levels, with the Air Quality Index (AQI) soaring to hazardous levels (e.g., 449). The rising pollution levels have triggered health warnings and disrupted industrial operations. Vehicular emissions, primarily from diesel and petrol-powered engines, are among the most significant contributors to this environmental crisis. As these fossil fuels are both finite and environmentally detrimental, there is an urgent need to identify alternative energy sources that are sustainable, eco-friendly, and capable of meeting energy demands. Biodiesel emerges as a promising solution in this context. Produced through transesterification of natural oils and fats, including waste cooking oil, biodiesel is a renewable, biodegradable fuel with a significantly lower environmental footprint. Its advantages include reduced emissions of carbon monoxide (CO), hydrocarbons (HC), carbon dioxide (CO_2), and particulate smoke, along with improved engine lubricity. Moreover, its compatibility with existing diesel engines makes it a practical substitute for conventional fuels, promoting waste reduction and resource circularity. This research focuses on the production of biodiesel from waste cooking oil and evaluates the emissions of NO_x, CO, HC, CO_2, and smoke from vehicles operating at varying speeds using biodiesel blends. By analyzing these emissions, the study aims to demonstrate biodiesel's potential to mitigate air pollution while offering a sustainable energy alternative. The results are expected to provide critical insights into biodiesel's environmental benefits and its viability as a replacement for fossil fuels, addressing both the energy and pollution crises. This study underscores the need for adopting biodiesel as a cleaner fuel alternative, highlighting its role in reducing vehicular emissions and fostering environmental sustainability in urban regions grappling with severe air pollution.

Keywords: Biofuel, Sustainability, IC engine, Emission, Alternate Fuel

Paper: 066

Upper Limb Exoskeleton For Daily Activity Helping In Muscle Activity Reduction

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ABSTRACT:

Carrying heavy weights and packages is commonplace in various industries, homes, and offices. The simple act of lifting and carrying these loads is often required, yet in the long run it causes body aches and even musculoskeletal problems. Generally, the strain is on people's backs and shoulders, and sometimes arms. Chronic back pain, tendonitis, and carpal tunnel syndrome are merely examples of what repetitive strain on the joints and muscles may produce. This is where exoskeletons play a crucial role in alleviating these issues. An exoskeleton is one of the wearable devices that tends to enhance the physical capabilities of a human. It mainly takes up a framework of mechanical components that can be used for the performance of physical tasks either by supporting or enhancing the movements. Mainly, exoskeletons are applied in rehabilitation in order to help people with disabilities. Exoskeletons have some excellent benefits regarding the carrying of heavy packets or lifting of heavy loads. It aids in redistributing the weight of the load, which decreases the direct pull on the wearer's muscles and joints. An exoskeleton supports the body in proper alignment and provides aid to the arms, shoulders, and back, thus reducing possible overexertion and injury. An upper limb exoskeleton is basically an orthotic device designed to assist with functions of the arm and shoulder movements. A load is balanced to be able to offer better weight distribution and lessened fatigue in the upper limbs. By distributing the weight across a broader area, the exoskeleton helps to maintain balance, preventing injuries in the upper limbs. Exoskeletons, especially upper limb exoskeletons, have a number of advantages in terms of exposure to the physical stress developed at handling heavy weights and packages. Devices improve and smoothen out muscle fatigue plus maintain a neutral posture to prevent permanent musculoskeletal damage. These devices, when incorporated into the workplace, make people work with physically demanding tasks more effectively and safely, thus reducing injury rates and increasing productivity.

Keywords: Muscle activity, Back Pain, Work Place Safety, Upper Limb Exoskeleton, Injury

Paper: 067

A Comprehensive Analysis Of Sustainable Tourism: An In-Depth Analysis Of Practices And Impacts In Uttarakhand

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ABSTRACT:

The research focuses on a study of sustainable tourism and its practices concerning Uttarakhand. Tourism is a continuously developing sector that is developing organically by improving its brands and quality to attract diverse travelers globally. Uttarakhand is an emerging destination that is attracting discerning tourists while promoting sustainability. Uttarakhand employs a long-term plan for regulated tourism, emphasizing its status as a unique destination while maintaining the industry's sustainability and economic contribution. The privatisation of the tourism sector has been a key component of Uttarakhand's successful tourism strategy. The state of Uttarakhand has made great strides in promoting ecotourism and other forms of nature-based tourism. As a result of the abundant natural resources in the country, ecotourism has become the most rapidly expanding subset of the tourism market. The article addresses themes such as sustainable tourism, practices, tactics, and local community participation. A comprehensive analysis will be provided, accompanied by relevant data and statistics. This study will be beneficial for tourism organizations, academics, decision-makers, and all other stakeholders involved in tourism.

Keywords: Sustainable, Tourism, Tourist, Development

Paper: 068

Impact of Slope on Forest Canopy Height Estimation Using Space-Borne LiDAR

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ABSTRACT:

Canopy height is an important indicator of biomass and the associated, global aboveground carbon stock. It has been ranked as a high-priority biodiversity variable to be observed from space. The spaceborne lidar is widely used to retrieve forest canopy height at various scales. However, the reduced accuracy of spaceborne lidar in complex forest terrains is one of its major limitations, where steep slopes distort the canopy height model and systematically alter tree crown representations, compromising the extraction of biophysical parameters. To address this limitation, we conducted a study to estimate the canopy height of a tropical seasonal forest in the northwest Himalayan foothills of India using Global Ecosystem Dynamics Investigation (GEDI) data (RH95) and the machine learning (ML) algorithm. We minimized the impact of slope on canopy height estimation by filtering high-quality lidar datasets based on slope gradient and validating predictions against ground-measured maximum canopy height. The field-measured maximum stand canopy height was used to validate the predicted canopy height maps generated by all models. We observed an improvement in the correlation between field-measured and predicted maximum canopy height, with R^2 increasing from 0.64 to 0.71 after excluding lidar samples from steep terrain. Additionally, removing GEDI footprints on steep slopes reduced overestimation, enhancing the accuracy of the canopy height model. This study highlights the importance of tailored preprocessing, like excluding steep terrain data and utilizing high-quality LiDAR datasets, to enhance canopy height models and emphasizes assessing ground-based measurements for validating spaceborne lidar in diverse forest conditions.

Keywords: Canopy height, GEDI, Biodiversity, Tropical Forest, Northwest Himalaya

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Paper: 069

Mechanical Analysis of Copper and Stainless Steel 304 by TIG Welding

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ABSTRACT:

Dissimilar welding has emerged as a key process in modern engineering to join two or more materials of different properties together to give components of improved performance and functionality. The requirements of dissimilar welding are due to several needs to optimize material usage, reduce costs, and achieve certain design requirements as such in aerospace, automobiles, construction, and medical applications. Dissimilar welding applies various materials such as stainless steel, aluminum alloys, copper, titanium, and duplex stainless steel. The option of these materials is picked with considerations of their mechanical properties, corrosion resistance, and specific applications. Dissimilar metal joints are used in various engineering applications such as nuclear power plant, coal fired boilers, automobile manufacturing industry. The major techniques utilized included Tungsten Inert Gas (TIG) as this technique is noticed for its precision, adaptability, and high-quality joints. TIG welding applies a non-consumable tungsten electrode and an inert shielding gas, typically argon, to prevent oxidation within the weld area. This technique is highly effective in thin sections and dissimilar materials where the control of heat input and the prevention of defects are paramount. Within this work, TIG welding is used to join the various materials like 316L stainless steel and aluminum alloys widely used in industries such as aerospace and medical device manufacturing. Results of this study show that the welding parameters optimized for such a process and combining current, travel speed, and shielding gas composition facilitate producing defect-free joints through TIG welding. Thus, this work demonstrates the flexibility and consistency of TIG welding in joining dissimilar materials, pointing to its key role in the advancement of manufacturing technologies and the production of high-performance components in various industries.

Keywords: Dissimilar Welding, TIG, Copper, Stainless Steel, Tensile strength

Paper: 070

THE IMPACT OF INWARD FDI AND USAGE OF NATURAL RESOURCES ON GREENHOUSE GAS EMISSIONS IN INDIA: AN ARDL APPROACH

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ABSTRACT:

This study assesses the long-term and short-term relationship between Greenhouse Gas (GHG) emissions, Foreign Direct Investment (FDI) inflow, Natural Resources (NR), Renewable Energy (RE), and Technological Development (TD) in India using times series data for the period 1990-2023. The study used an Autoregressive Distributed Lag (ARDL) bound test with an Error Correction Model (ECM) to estimate the relationship between the variables. The result confirms a long-run relationship between the variables. Specifically, FDI and RE negatively impact GHG emissions in the short- and long-term. For the other determinants of GHG emissions, usage of natural resources and TD have had a positive effect in the long term. This reveals that an increase in FDI does not cause environmental degradation, while more use of natural resources contributes positively to the environment in the Indian context. However, all the effects are significant in the short term but appear insignificant in the long term.

Keywords: FDI, Natural Resources, Greenhouse gas, ARDL, Environmental degradation.

Paper: 071

Enhanced Oil Recovery through CO_2 Utilization as a Circular Economy Model for India's Oil and Gas Sector: Unlocking Efficiency and Reducing Emissions

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ABSTRACT:

India's oil and gas sector is at a critical juncture, grappling with declining domestic oil production and the urgent need to reduce greenhouse gas emissions. CO_2-enhanced oil recovery (CO_2-EOR) offers a transformative pathway to address these challenges by combining increased oil recovery from mature fields with permanent CO_2 sequestration. Globally, CO_2-EOR has demonstrated its potential as a circular economy model, contributing to energy security and carbon reduction simultaneously. This paper evaluates the feasibility of adopting CO_2-EOR in India's oil and gas sector, focusing on its techno-economic viability, environmental benefits, and implementation challenges.

This paper explores the techno-economic viability of CO_2-EOR in India, assessing factors like oil recovery potential, carbon sequestration capacity, and associated costs. A comprehensive review of India's major sedimentary basins, including the Mumbai Offshore, Krishna-Godavari, and Cambay basins, reveals a theoretical CO_2 storage capacity of approximately 3.4 Gt, with significant potential for oil recovery through EOR. Key case studies and global benchmarks, such as the Weyburn-Midale and Petra Nova projects, underscore the dual benefits of CO_2-EOR in enhancing production and achieving climate targets. Indian pilot projects, like those in the Gandhar field, provide valuable insights into adapting this technology to local geological and economic conditions. The analysis concludes that with the right regulatory frameworks, public-private partnerships, and carbon pricing mechanisms, India can accelerate its transition to a low-carbon economy while revitalizing aging hydrocarbon fields, contributing significantly to its net-zero emissions goal by 2070.

Keywords: CO_2-Enhanced Oil Recovery, Decarbonization, Carbon capture utilization storage, Climate change, Circular Economy

Paper: 072

Utilisation of nature-based wastewater treatment system in rural areas of India

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ABSTRACT:

Out of total population in india more than 65% of staying in rural areas. As per report of 2021 report total 39604 MLD wastewater generated by villages. This wastewater will become important source of irrigation especially during summer season if it treated properly. It is also a good source for gardening flushing and even for groundwater recharge provided treated water standards. By the year 2030, there will be an increase of 44% of wastewater generated as compared to now. Out of the total usage major portion is for irrigation, domestic household supply, energy usage and industry usage. For this wastewater many treatment processes are available among them decentralized wastewater treatment is very effective and it is further more effective if this accompanied with nature-based waste water treatment systems. With comparison centralized West water treatment systems need equipment's for collection pipelines systems for pumping connections equipment's for treatment. These nature-based waste water treatment plants are very effective as they require less skilled personal so this more suitable for developing countries like India. These nature-based systems use soil bacteria plants and all other natural processes to treat wastewater. These there are very effective tools as they use less chemicals, less energy consuming, low impact on environment, simple and cost effective.

Keywords:

Paper: 073

Nature Based Solutions for wastewater treatment in rural areas of India

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ABSTRACT:

Out of total population in India more than 65% of staying in rural areas. As per report of 2021 report total 39604 MLD wastewater generated by villages. This wastewater will become important source of irrigation especially during summer season if it is treated properly. It is also a good source for gardening, toilet flushing and even for groundwater recharge provided treated water meets standards. By the year 2030, there will be an increase of 44% of wastewater generated as of now. Out of the total usage major portion is for irrigation, domestic household supply, energy usage and industry usage. For this wastewater many treatment processes are available among them, Decentralized Waste Water Treatment(DWWT) is very effective and it is further effective if accompanied with nature based wastewater treatment systems. With comparison centralised wastewater treatment systems needs equipments for collection, pipelines systems for pumping, connections equipment for treatment. However nature based wastewater treatment plants are very effective as they require less skilled personal and so this is more suitable for developing countries like India. These Nature Based Solutions (NBS) use soil, bacteria, plants and other natural processes to treat wastewater. These are very effective tools as they use less chemicals, less energy consuming, have lesser impact on environment, simple and cost effective. Examples are Constructed Wetlands, Floating Treatment Wetlands, green roofs, leaving walls, waste stabilization ponds, high rate algal ponds and vermifiltration etc. After these types of treatment processes water will be suitable useful for irrigation, gardening and groundwater recharge etc.

Keywords: Nature Based Solutions (NBS), Decentralized Waste Water Treatment (DWWT), Constructed Wetlands, green roofs, vermifiltration

Paper: 074

Analyzing the influence of operational parameters on proton exchange membrane fuel cell performance: A comprehensive review

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ABSTRACT:

Proton Exchange Membrane Fuel Cells (PEMFCs) present a promising and eco-friendly method for producing clean energy, providing a sustainable technological solution for energy generation. This study systematically evaluates the impact of various operational factors on PEMFC efficiency, offering an in-depth analysis of their performance. Parameters examined include flow field design, hydrogen supply properties, operating temperature, humidification levels, and pressure conditions. The flow field is essential for the distribution of reactants and products within PEMFCs, while humidification affects membrane conductivity and water management within the cell. Additionally, the influence of pressure on mass transport and electrochemical reactions in PEMFCs is analyzed, investigating how pressure affects reactant distribution and cell performance to refine operational conditions. By thoroughly analyzing these operational parameters, this study aims to provide valuable insights for the design and improvement of PEMFCs, supporting advancements in efficient and clean energy technology. These findings are intended to guide future developments in PEMFCs, promoting their integration into various applications for a sustainable energy future.

Keywords: Proton Exchange Membrane Fuel Cell, Catalyst Layer, Carbon Nanotubes, Proton Exchange Membrane.

Paper: 075

A survey on energy and green audit of an educational institute in Delhi NCT

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ABSTRACT:

The levels of air pollution in Delhi NCR and NCT region which is the capital city of the world's most populous country and across various other states in India has risen to extremely dangerous levels causing havoc and life-threatening situation due to which people are facing serious health issues. According to a study, the average greenhouse gas emissions in Delhi from year 2017 to 2021 was 51,081 $ktCO_2e$. There are more than 30 universities and thousands of their affiliated colleges and institutions along with around 6000 schools in Delhi NCT and NCR region which highly contribute to the emissions of GHG's. Also, there is no proper research on the contribution of GHG's and carbon emission from these educational institutions, and how these educational institutions can reduce their carbon emission and be sustainable paving a way towards achieving the UN sustainable development goals of achieving the net zero by 2050. An energy audit is a systematic evaluation of energy usage to find areas where efficiency can be improved, energy consumption can be lowered, and renewable energy sources integrated. A green audit entails assessing the institution's environmental effect to discover opportunities to improve sustainability practices and promote eco-friendly operations. It focusses on resource management, waste reduction, and environmental awareness to attain net zero and sustainability goals.

This paper presents a unique survey of energy and green audit of an educational institution in Delhi NCT region, understanding the energy consumption patterns, finding out ways to reduce carbon emissions by integration of renewable energy sources such as solar energy and biodiesel fuels with the conventional sources, green audit and achieving net zero. After the audit results the list of recommendations has been given on how these targets can be achieved, the breakeven of investing money for sustainable future as investing into renewable sources is a challenge for these educational institutions keeping in mind the higher costs and financial constraints of the educational institutions.

Keywords: Energy audit, Green Audit, Renewable Energy, Sustainability, Net Zero, Educational institutions.

Paper: 076

Corporate Social Responsibility, Green Organization Culture and Organizational Citizenship Behavior towards Environment in Banking Sector

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ABSTRACT:

The growing emphasis on environmental sustainability has compelled organizations across sectors to adopt practices that address environmental challenges while aligning with economic and social objectives. This study critically reviews the interconnections among Corporate Social Responsibility (CSR), Green Organizational Culture (GOC), and Organizational Citizenship Behavior towards the Environment (OCBE) in achieving organizational sustainability. CSR initiatives play a dual role, directly shaping eco-conscious organizational strategies and indirectly influencing employee behaviors through ethical and social commitments. The study emphasizes OCBE as a voluntary, non-mandated behavior by employees that supports environmental objectives, linking individual actions to organizational sustainability outcomes. It further explores the mediating role of GOC and OCBE, which enhance the impact of CSR initiatives by fostering an environmentally supportive organizational identity and promoting employee engagement in green practices.

Using insights from diverse sectors, including healthcare and manufacturing, the review highlights the synergistic effects of these components. Empirical studies employing methodologies such as Structural Equation Modeling (SEM) and Partial Least Squares (PLS) underscore the positive correlations between CSR, and organizational performance, mediated by GOC and OCBE in Banking Sector. The findings demonstrate that integrating green values into human resource practices and CSR strategies significantly improves environmental and social performance, enhancing organizational sustainability. This research contributes to the growing body of knowledge by offering a comprehensive understanding of how organizations can strategically align their human resource policies, cultural practices, and CSR efforts to achieve sustainability. It provides actionable insights for practitioners and policymakers aiming to develop green workforces and achieve long-term ecological and economic balance.

Paper: 077

Harvesting Water from Air – Innovative Technologies for a Sustainable Future

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ABSTRACT:

Water scarcity is a growing World-Wide issue, especially in areas with limited access to freshwater Supplies. By retaining water vapor from the atmosphere, atmospheric water Generators (AWG) offers a feasible substitute for conventional methods of obtaining clean water. This research examines the several technologies used in Atmospheric Water Harvesting (AWH), such as VCR-AWG system, adsorption, desorption, Fog harvesting, Dew Water harvesting, Thermoelectric cooling and condensation, each of which has a unique way of absorbing or retaining atmospheric moisture. The effectiveness and capacity of AWG systems have been greatly increased by recent developments in materials science, including hydrogels. The sustainability and affordability of these systems have been further improved by the incorporation of renewable energy sources, especially solar power. However, there are still issues to be resolved, such as maximizing energy usage, scalability, and performance under different atmospheric circumstances. In addition to discussing the current state of research on AWG, this paper examines the economic and environmental aspects influencing the viability of large-scale application and highlights key advancements and their possible uses. By tackling these issues, AWG has the capability to serve significantly in supplying a sustainable and reliable water source in water stressed areas across the world.

Keywords: harvesting, sustainability, water, air, technology, scarcity.

Paper: 078

Green synthesis of nanoparticles from Himalayan propolis and its antioxidant and antidiabetic potential on streptozotocin-induced rats

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ABSTRACT:

Diabetes mellitus is a metabolic condition characterized by elevated blood glucose levels. As the prevalence of diabetes continues to rise, it has become necessary to seek alternate therapies. Propolis is a honeybee product that combines salivary enzymes and beeswax with exudate from plant resins. The main goal of this study is the green synthesis and characterization of propolis-mediated nanoparticles and check their therapeutic potential. The characterization of nanoparticles was done with FTIR analysis, FESEM, EDS, HRTEM and XRD. *In-vivo* antidiabetic potential was examined on the streptozotocin-induced Wistar rats. Treatment with propolis-mediated nanoparticles exhibited a hypoglycemic effect and significant improvement in pancreatic islets of Langerhans. The results revealed that the greener synthesis of propolis-mediated nanoparticles can also potentially be used in the treatment of other oxidative stress-related diseases.

Keywords:

Paper: 079

Phyto-mediated synthesis of ZnO nanoparticles using *Melia azedarach* seed extract: Larvicidal and antioxidant activities

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ABSTRACT:

Insects cause about 10–20% of crop yield decline each year; protecting crops from pest infestation is still a major global concern. Although synthetic pesticides have long been used as the mainstay of pest management, overuse of these agents has disrupted ecosystems, increased pest resistance, and created several health risks. In the present work ethanolic extract of *Melia azedarach* seeds were used for synthesis of ZnO nanoparticles. Nanoparticle characterisation was done using FESEM, EDS, HRTEM and XRD analysis. The larvicidal potential of the nanoparticles was observed against second instar larvae of *Spodoptera frugiperda* and the results showed dose dependent effect on mortality of the larvae after 24 and 48h. Antioxidant potential of nanoparticle was studied using DPPH assay. According to the observations *M. azedarach* seed-mediated ZnO NPs have the potential to be used as very effective larvicidal and antioxidant agents in the creation of new nanoparticle-based biomedical therapies for future investigations.

Paper: 080

Ecological Diversity and Taxonomic Analysis of Moth Species (Lepidoptera: Heterocera) from Solan and Shimla District of Himachal Pradesh.

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ABSTRACT:

This study evaluated moths' (Lepidoptera) diversity, distribution and conservation status in the Solan and Shimla districts of Himachal Pradesh, India. Moth samples were collected at night using the Light trap method from April 2022 to September 2023 across 10 sites (5 from each district): Nalagarh, Baddi, Kandaghat, Bajhol, Darlaghata, Rohru, Kotkhai, Chaupal, Jubbal and Shimla. These sites were located at an altitude of 350-1250 meters above sea level. A standard protocol was followed for collection, preservation and Identification.

A total of 612 moth specimens (323 from Solan & 289 from Shimla) were collected, representing 120 species, 102 genera, 29 subfamilies, and 15 families. Solan (107 species) and Shimla (105 species) represented similar species richness. Genitalia Dissection was conducted for 73 species to ensure accurate identification. The family Erebidae was dominant with 299, (49%) individuals. The most abundant species observed was *Trabala vishnou* (Lefebver, 1827). The species richness peaked in July and declined significantly from September onward.

The study highlights the ecological importance of moths as pollinators and indicators of environmental health. With increasing habitat degradation and climate change, moth diversity in these regions may face significant threats. Among the recorded species, 3 are currently listed under Schedule II of the Indian Wildlife Protection Act, 1972, emphasizing the need for targeted conservation measures. Regular monitoring and updated documentation will aid in assessing population trends and potential vulnerabilities of these species.

Paper: 081

Investigation of Nutritional Profile, Polyphenolic and Antioxidant Potential of Multiflora Bee pollen from India

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ABSTRACT:

Bee pollen is renowned for its apitherapeutic properties, offering a unique combination of nutritional and therapeutic benefits. It is a rich source of proteins, carbohydrates, polyphenolic compounds, vitamins and minerals, which contribute to its diverse biological activities including antioxidant, hepatoprotective, anti-cancer and anti-inflammatory properties. In this study, the nutritional profile of multiflora bee pollen was evaluated, revealing the significant amounts of proteins, carbohydrates, vitamins and minerals. The antioxidant and polyphenolic potential of the pollen were estimated using different solvent systems. Among these, the ethanolic extract of multiflora bee pollen showed the higher antioxidant activity demonstrated with DPPH ((2,2'-diphenyl-1-picry-hydrazyl) and ABTS (2, 2-azino-bis-3-ethylbenzothiazoline-6-sulphonic acid) radical scavenging assays, with an IC50 value of 30.69±1.41 µg/mL and 33.76±1.53 µg/m, respectively. Further analysis through GC-MS identified the presence of major bioactive compounds in the ethanolic extract. These results suggests that ethanol is the most effective solvent for extracting the bioactive components of bee pollen, maximizing its potential for therapeutic applications.

Paper: 082

Role of Remote Sensing and AI in Monitoring Carbon Sequestration and Pest Dynamics in Teak and Diverse Forest Ecosystems

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ABSTRACT:

Forests are essential to global carbon sequestration, serving as critical buffers against climate change by absorbing significant amounts of atmospheric carbon dioxide. However, their capacity to perform this vital function is increasingly compromised by the combined pressures of pest infestations and environmental changes, including deforestation, habitat fragmentation, and climate variability. These challenges threaten not only forest health but also their ecological services, such as biodiversity conservation and soil stabilization. Teak forests, highly valued for their timber and economic contributions, are particularly vulnerable. Their susceptibility to pest infestations, compounded by environmental stressors, reduces their carbon sequestration potential, posing risks to both local economies and climate mitigation efforts. Similarly, diverse forest ecosystems, characterized by their rich biodiversity, face threats that compromise their resilience and productivity. Recent advancements in remote sensing and artificial intelligence (AI) present promising solutions for addressing these challenges. Remote sensing technologies, such as satellite imagery, LiDAR, and hyperspectral imaging, enable large-scale, high-resolution monitoring of forest biomass and canopy health. AI enhances these capabilities by analysing complex datasets, identifying patterns, and predicting trends, such as pest outbreaks and changes in carbon dynamics. Together, these technologies provide critical tools for real-time monitoring, early warning systems, and data-driven forest management strategies. This review examines the current state of research on these technologies, their integration for effective forest management, and identifies gaps in knowledge. It underscores the need for interdisciplinary approaches and collaborative efforts to ensure the sustainability of forest ecosystems and their vital contributions to climate change mitigation.

Paper: 083

Green House Gas Methane : Extraction and Benedictions of methane as a resource to fuel the Future Smart Cities

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ABSTRACT:

From the past few years there has been a hike in the global warming due to spike in green house gases emitted due to human expansion and urbanization . Moreover there has been a rapid decline in the natural resources like crude oil and coal that play an essential role in energy generation .The search for alternative energy for environmental protection has been exceptionally pivotal and momentous in emphasizing on sustainable means of extracting energy instead of depending on the conventional energy resources. Here Methane, acts as a break through among all greenhouse gases, which is discharged from abundant sources such as land fill, agriculture, vehicle's exhaust, open sewage, old mines, domestic waste, livestock, factories, etc. and possesses a numerous applications around the globe ruling a global market of USD 95.4 Billion in 2023.This manuscript studied the abundant sources of methane extraction and suggested its applications in numerous fields . As smart cities are coming up as a need of today as well as for sustainable future it becomes important to introduce a finer environment friendly source of energy generation i.e. methane . When methane is used as a resource not only the methane composition from the atmosphere decreases causing decrease in global warming but it also act as an alternative to natural resources that will help to reduce stress from existing non- renewable resources . Therefore introduction of methane as a fuel leads to a revolution to the history of smart city, making cities advance not only on the basis of infrastructure but by refining the atmospheric and climatic conditions as well .

Keywords: Methane, natural gas, sustainability, smart city, global warming.

Paper: 084

Comprehensive Taxonomic Assessment of Odonata in Mandi district: Integrated Approaches to Collection and Identification.

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ABSTRACT:

The order Odonata represents an ancient group of predatory insects characterized by their exceptional aerial capabilities and distinctive morphological features. Comprising dragonflies and damselflies, these insects have existed for over 300 million years, showcasing remarkable evolutionary adaptability. This comprehensive research integrates systematic collection methodologies, advanced morphological analysis, and dichotomous key strategies to investigate Odonata diversity across both broad taxonomic frameworks and region-specific ecological contexts. The Mandi district, with its diverse topographical features ranging from 350 to 4,000 meters above mean sea level, provides an ideal ecological landscape for examining Odonata species composition, distribution patterns, and habitat adaptations. Taxonomic analysis emphasizes the importance of wing structure, body proportions, size variations, and colour polymorphisms that are distinctive to specific subfamilies and genera. These factors collectively provide a comprehensive framework for understanding Odonata diversity at both regional and global scales.

Paper: 085

Assessing the Conservation Status of Nanda Devi Biosphere Reserve: An Approach for Management Planning

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ABSTRACT:

The Man and the Biosphere program of UNESCO aims to improve the relationship between people and their environments by promoting biodiversity conservation and sustainable development. Land degradation, global warming, natural resource depletion, and severe additional threats to biodiversity negatively impact human well-being, reduce Earth's richness, and interfere with vital ecological functions. Integrated management planning is deemed crucial in this context since it is a comprehensive approach that fosters collaboration among diverse stakeholders and seeks to link conservation efforts with sustainable development, considering society's and the environment's demands. One such region that is severely impacted by the current environmental deterioration in the form of habitat destruction, diminished ecosystem services, and climate change is the transition zone of the Nanda Devi Biosphere Reserve. A study has been initiated to prepare village-specific micro-plans in the transition zone and ultimately link them with the entire biosphere reserve through an integrated management plan. To achieve this, pertinent objectives were devised, such as assessing the major floral and faunal groups, identifying areas of critical conservation importance, evaluating the ecosystem services obtained by local communities, evaluating the traditional knowledge base of medicinal and aromatic plants, and identifying threats to the livelihood opportunities to maintain the essential ecological and economic fabric of the region. Major faunal species were identified, traditionally thirty-five medicinal plant species have been documented, major threats to subsistence were understood, rising disaster incidences were seen, and major resource utilization by local people was recognized from our preliminary assessment through discussions with native residents and forest visits. The development of site-specific effective micro-plans will be crucial for ensuring conservation efforts blend with unique local needs, safeguarding ecological integrity, and enhancing the resilience and welfare of the people of the reserve.

Paper: 086

An Arthrospira maxima based biorefinery

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ABSTRACT:

With growing global concern over resource depletion, climate change, and waste management, the development of sustainable biorefineries has become crucial. *Arthrospira maxima*, a cyanobacterium commonly denominated *Spirulina* and known for its high nutritional content and rapid growth, presents a promising bioresource for such systems. This study explores a biorefinery model for *Spirulina* that maximizes resource utilization through innovative extractions and waste valorization approaches. By cultivating *Spirulina* using industrial waste media and recirculating growth resources, the model demonstrates significant reductions in water and nutrient use, aligning with circular economy principles. High-value compounds like phycocyanin and lipids were extracted using green methodologies, which reduce environmental impact compared to conventional methods. Additionally, residual extracted microalgal biomass was redirected to applications such as bioenergy and soil amendment, creating a zero-waste approach. The proposed model supports a transition towards sustainable bioeconomy practices, addressing both environmental and economic challenges. Future research may focus on genetic engineering and technological advancements to further enhance *Spirulina*'s biorefinery potential.

Keywords: Circular Economy; Fertilizer; Phycocyanin; Resource Efficiency; *SpirulinaI*

Paper: 087

SUSTAINABLE TOURISM DEVELOPMENT THROUGH ECO FRIENDLY HOTELS IN DEHRADUN

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ABSTRACT:

Sustainable tourism development is a critical strategy for balancing economic growth with environmental conservation, particularly in ecologically sensitive regions. This study explores the role of eco-friendly hotels in promoting sustainable tourism in Dehradun, a city nestled in the foothills of the Himalayas. The research assesses the perceptions, preferences, and behavioral patterns of 380 respondents, including tourists, hoteliers, and local stakeholders, to evaluate the impact of eco-friendly practices on the tourism experience and regional sustainability. Data was collected through structured questionnaires and semi-structured interviews, ensuring diverse insights. Key findings indicate that eco-friendly hotels significantly contribute to reducing the environmental footprint of tourism by adopting practices such as renewable energy usage, waste management, water conservation, and sourcing local materials. Respondents emphasized that tourists are increasingly inclined to prioritize accommodations that align with environmental sustainability, even if it incurs additional costs. Furthermore, hoteliers acknowledged the dual benefits of eco-friendly practices: environmental preservation and enhanced market competitiveness. The study concludes that eco-friendly hotels are a viable pathway to achieving sustainable tourism in Dehradun. However, it emphasizes the need for greater awareness, incentives for hoteliers, and collaborative efforts among stakeholders to expand the adoption of sustainable practices. This research contributes to the growing body of literature on sustainable tourism by highlighting the practical implementation and benefits of eco-friendly accommodations in a developing urban context.

Keywords: Sustainable Tourism, Eco-Friendly Hotels, Environmental Conservation, Dehradun, Tourist Behavior

Paper: 088

Advancing the non-invasive genetic sampling of rhesus macaque (Macaca mulatta)

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ABSTRACT:

Among all non-human primates, the rhesus macaque (Macaca mulatta) has been extensively studied by researchers across various biological disciplines. The rhesus macaque is an ideal species for studying the connections between social behavior, well-being, and reproductive success due to its ability to thrive in the Anthropocene era. It also serves as an excellent subject for investigating genetic implications of social biology and other topics in evolutionary ecology. Despite being one of the most intensively studied non-human primates, some fundamental questions about this species remain unanswered, in its natural range, due to the difficulty of invasive sampling. In this study, we designed two specific primers targeting the mitochondrial region of the rhesus macaque genome. These primers will enable a plethora of research, involving non-invasive genetic sampling, and help understand this species better.

Keywords: Rhesus macaque, specific primers, Non-invasive genetic sampling.

Paper: 089

Impact of Microplastics on Human Health

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ABSTRACT:

Plastics waste is growing day by day due to its various applications in industries, health care sectors and aesthetics. Microplastics (MPs) are plastic's small particles (less than 5 mm), have become pervasive environmental contaminants due to prominent contamination of plastics solid waste. MPs poses the ability to have severe impact on human health and environment. These particles can originate from the breakdown of larger plastics and related debris, or leach out plastics microbeads from various products. Microplastics have infiltrated various ecosystems, including oceans, freshwater systems, and terrestrial environments, eventually entering the human food chain through the consumption of contaminated water, seafood, and even through aerosols. The potential health risks of microplastics to humans are a growing concern, as their small size allows them to be inhaled, ingested, or absorbed through the skin. Studies suggest that microplastics may contribute to a range of health problems, including inflammation, oxidative stress, and disruption of hormonal systems, potentially leading to long-term issues such as cardiovascular diseases, neurological disorders, and reproductive harm. Despite limited research on direct human health effects, the accumulation of microplastics in human tissues is alarming, necessitating further investigation into their biological interactions, toxicity, and long-term impacts on public health. The study highlights the sources of microplastics, their entry into human systems, and the emerging concerns regarding their potential health implications.

Paper: 090

Environmental Policies and Governance

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ABSTRACT:

Environmental policies include all the values to which an individual or a group of persons or institutions, social, legal and government consider as important in their relationship with one another. Environmental policies and governance are crucial for addressing the global challenges posed by climate change, biodiversity loss and pollution. These policies serve as the foundation for sustainable development and ensure the protection of natural resources for future operations. Effective environmental governance involves a multilevel approach, integrating local, national and international efforts to manage and regulate environmental issues, encompasses both governmental and non-governmental actions, fostering collaboration among stakeholders such as policymakers, businesses, civil societies and international organizations. There is a need for strong regulations that balance economic growth with environmental sustainability. The governance structure must be transparent, inclusive and accountable, ensuring that policies are implemented equitably and focuses on social justice. International agreements such as Paris agreement and the convention on biological diversity explains the importance of cooperative efforts across borders. However, challenges remain in terms of policy enforcement that will ensure the environmental governance adapts to rapidly changing conditions. This research explores the significance of innovative governance models that incorporate adaptive management, stakeholder engagement, and scientific research to address emerging environmental threats.

Keywords: Policies, Governance, Sustainability, Management

Paper: 091

Exploring the Efficiency of Xylanase Enzyme from Trametes hirsuta for Eco-friendly Bleaching of Paper and Pulp

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ABSTRACT:

Ecofriendly bleaching of paper and pulp is essential for managing industry effluent. In this study, four fungal strains were isolated from the sludge of Century Pulp and Paper Mill, Lalkuan, Uttarakhand, India. These fungal isolates were characterized morphologically by colony appearance on PDA and stained with lactophenol cotton blue which revealed that they belong to the genus Trametes. All the fungal strains were screened for xylanase assay. Initial screening on minimal media amended with xylan and 0.2% w/v congo red solution at pH 6 showed that CLSF-6 was able to decolorize up to 7.2 mm in diameter in 7 days which confirms xylanase activity. The quantitative analysis of xylanolytic enzyme production demonstrated that fungal strains CLSF-6 exhibited the highest xylanase activity at 7.1 U/ml on the 20th day of incubation. In the molecular characterization, the isolate was identified as *Trametes hirsuta MH091710*. The effect of different carbon and nitrogen sources was also investigated concluding that xylan at a 1% concentration was the most potent carbon source, achieving a remarkable xylanase activity of 13.26 U/ml on the 20th day. Simultaneously, peptone proved to be the most effective nitrogen source, reaching a peak xylanase activity of 11.19 U/ml by day 20. The research findings showcase the ability of fungal isolates *Trametes hirsuta* to produce xylanase enzyme effectively which is efficient in bleaching of pulp and paper leading to reduced chemical use and pollution.

Keywords: Xylanase, *Trametes hirsuta*, bio-bleaching, pollution, eco-friendy

Paper: 092

Bioremediation of Pulp and Paper Mill Effluents Using Fungi Isolated from Effluent Sludge

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ABSTRACT:

The use of microorganisms to detoxify toxic compounds in pulp and paper effluents offers an ecofriendly and cost-effective alternative to physicochemical methods for effluent treatment. In this research, nineteen fungal strains were isolated from sludge samples collected from kaccha Nala site centaury pulp and paper mill in Lalkaun, Nainital, India. These strains were characterized morphologically by colony appearance on PDA and Lacto phenol cotton blue straining techniques. These fungal strains were screened for ligninolytic enzymes, including laccase (Lcc), lignin peroxidase (LiP), and manganese peroxidase (MnP), using chromogenic substrates ABTS, Azure-B, and Phenol red respectively. Out of nineteen fungal strains only one white-rot fungal strain CLSF-6 was selected for their high potential of enzyme production. The fungal strain such as CLSF-6 showed the highest activity levels: 18.75 U/mL for Lcc, 10.69 U/mL for MnP, and 47.85 U/mL for LiP. Optimized growth conditions revealed that CLSF-6 was efficient in ligninolytic enzyme production with lactose-peptone and lactose-beef extract as effective carbon and nitrogen sources. The crude enzyme extract effectively degraded dyes, with Orange G, Congo red, and Malachite green by CLSF-6 achieving 99.43%, 18.70%, and 4.96% reduction respectively as well as lignin degradation by this strain reached up to 75%. CLSF-6 identified as basidiomycetes, demonstrated strong potential for lignin degradation in paper mill effluents, highlighting their applicability in industrial wastewater bioremediation.

Keywords: Effluents, White-rot fungi, Ligninolytic enzymes, Bioremediation .

Paper: 093

Unveiling the Relationships Between Tree Characteristics, Site Conditions, and Ecological Diversity: A Comprehensive Review

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ABSTRACT:

This study encompasses evaluation of the intricate relationships between tree attributes and environmental factors, leveraging exploratory data analysis and machine learning techniques to predict tree health. By analysing a comprehensive dataset of 1,000 trees, classifying 16 as very healthy, 89 as healthy, 314 as sub-healthy, and 581 as unhealthy. Encompassing measurements such as tree dimensions, soil composition, temperature, and humidity, we identified key drivers of tree health. The Random Forest model, with an accuracy of over 95%, revealed that tree height, Gleason index, and distribution level are pivotal factors influencing tree health, while other variables have a negligible impact. This study presents a data-driven approach to predicting tree health, providing valuable insights for future research and practical applications in forest ecosystem management. The findings contribute to a deeper understanding of the intricate relationships between ecological and environmental factors, enabling more effective tree health assessments and data-informed decision-making. By shedding light on the complex interplay between tree attributes and environmental factors, this study paves the way for improved forest management strategies, ensuring the health and resilience of our precious tree populations. As we continue to face the challenges of climate change and environmental degradation, this research serves as a crucial stepping stone towards a more sustainable future for our planet's ecosystems.

Keywords: Machine learning; Forest ecosystem; Ecological relationships; Random Forest; Environment

Paper: 094

Mammal Richness in Odisha's Mining Landscape, Keonjhar, Odisha, India

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ABSTRACT:

Mining is a resource-intensive human activity that severely degrades the environment, impacting forests and wildlife on multiple scales. It destroys critical habitats, forcing mammals to migrate to less suitable areas, resulting in increased competition for resources and predator vulnerability (Sonter et al., 2022). The Daitari iron ore mine, located in the corridor connecting Similipal and Satkosia Tiger Reserve in Odisha, planned to extend its activities over 746.3325 ha. From July to December 2022, we assessed mammal richness using the line transect method (Buckland et al., 1993) and camera traps (Nichols et al., 2011) around the mine. The study recorded presence of 14 mammal species from 11 families, with an encounter rate of 13.47 signs km^{-1} (±2.3 SE). Four Schedule-I species *viz.,* Asian elephant, Leopard, Leopard cat, and Sloth bear were found in the core zone. The most frequently sighted species were Asian elephant (1.2 ± 0.29 km^{-1}), Sloth bear (1.23 ± 0.42 km^{-1}), and Rhesus macaque (0.2 ± 0.11 km^{-1}). From 22 camera trap locations, 306 photographs were classified, with 57.19% (n=175) representing wildlife. Of these, 33.99% (n=104) were herbivores, 5.23% (n=16) carnivores, 14.4% (n=44) omnivores, 3.59% (n=11) birds, 4.25% (n=13) cattle, 33.66% (n=103) humans, and 4.9% (n=15) stray dogs. The Indian grey mongoose was the most frequently photographed carnivore (RAI=2.56), while the Jungle cat was the least (RAI=0.32). Among herbivores, the Barking deer was most abundant (RAI=13.76), and the Four-horned antelope was the least (RAI=0.64).

Keywords: Mining, Environmental impact, Daitari, Similipal–Satkosia Corridor, Mammal richness, Line transect method, Camera traps encounter rate.

Paper: 095

Impact Assessment and Mitigation Strategies of Wild Boar-Induced Crop Damage in Hill Farming of Garhwal Himalaya, Uttarakhand

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ABSTRACT:

The Garhwal Himalaya region in Western Himalayan region has long been home to a thriving hill farming community, whose livelihoods have been increasingly threatened by the growing prevalence of wild boar crop raids. This research paper aims to investigate the extent and impact of these raids, as well as explore potential mitigation strategies to address this pressing issue. Through a comprehensive review of relevant literature, field observations, and stakeholder interviews, this study provides a multifaceted analysis of the problem, focusing on the ecological, socioeconomic, and policy-related dimensions. The findings reveal the substantial financial and emotional toll these raids have taken on local farmers, as well as the complex interplay between environmental degradation, human-wildlife conflict, and the unique challenges facing hill farming communities in the region. Building on the insights gathered, the paper proposes a holistic, community-based approach to mitigate the adverse effects of wild boar crop raids, encompassing improved agricultural practices, strengthened wildlife management strategies, and enhanced livelihood diversification opportunities.

Keywords: Wild boar, Crop raids, Garhwal Himalaya, Hill farming, Human-wildlife conflict, Mitigation strategies

Paper: 096

Effective Waste Management: A Key Strategy to Mitigate Monkey Menace

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ABSTRACT:

The growing monkey menace in urban and semi-urban areas has become a significant challenge, posing threats to public safety, agriculture, and biodiversity. A critical driver of this issue is the improper disposal and management of waste, particularly food waste, which attracts monkeys to human settlements. This paper explores waste management as a key strategy to mitigate the monkey menace, emphasizing the need for systemic changes in waste handling practices.

Four troops of Rhesus macaques in a 16 Sq.Km area around the Wildlife Institute of India, Chandrabani, Dehradun were followed for behavioural observations. Along with that garbage dump locations within the selected study area were marked using GPS. The villagers in the area were also interviewed to understand the human-macaque interactions.

There were 200 garbage dumps in the study area. The movement of macaques was found to be concentrated around the garbage dumps. It was also observed that macaques spent maximum time in movement (20%-30%) and feeding (40%) of which maximum time was spent near garbage dumps.

The findings suggest that a multi-stakeholder approach, involving municipal authorities, wildlife experts, and citizens, is vital for sustainable coexistence between humans and wildlife. Integrating waste management policies with urban planning and conservation frameworks offers a long-term solution to curb the monkey menace, restoring ecological balance while enhancing public safety. The study highlights the role of decentralized waste segregation, composting, and controlled garbage disposal in reducing human-animal conflicts. Furthermore, public awareness campaigns and community involvement are essential to discourage feeding practices and ensure compliance with waste regulations.

Keywords: Waste management; Rhesus macaques; Movement; Feeding; Human-animal conflict

Paper: 097

A Mini Review on Challenges, Prospects, and Electrochemical Properties of Transition Metal Chalcogenides for Supercapacitor Application

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ABSTRACT:

With the rapid expansion of the global economy in the 21st century, traditional non-renewable energy sources such as fossil fuels are exhausting at a very fast scale. Due to environmental concerns and the fast depletion of fossil fuel reserves, the energy crisis has become a worldwide issue in the last ten years. Extensive research has been going on in the field of energy storage systems, due to the growing demand for the high- energy storage solutions that are both efficient and sustainable. Electrochemical supercapacitors are the most promising kind of energy storage technology because of their remarkable power density, wide operating temperature range, quick charge/discharge rates, fast work speed, and high cyclic stability. Nowadays hybrid supercapacitors have gained great popularity because of their increased energy density without compromising the power density. Unique structural properties, high electrical conductivity, and excellent electrochemical performance are some of the properties due to which the Transition Metal Chalcogenides have gained worldwide attention. This mini-review highlights the role of TMC-based nanostructured materials (MX; X= S, Se, Te) as favorable electrode materials asymmetric supercapacitors and also emphasizes their capacity to boost specific capacitance and improve overall device efficiency. In addition to this, the key challenges and the prospects of utilizing the TMCs in advanced supercapacitor designs are also discussed, this aims at providing an insight into the development of high-performance, sustainable energy storage solutions.

Keywords: Transition Metal Chalcogenides, Supercapacitors, Power Density, Energy Density, Cyclic Stability.

Paper: 098

The Role of Servant Leadership in Advancing Sustainable Tourism Practices.

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ABSTRACT:

Since tourism adds immensely to global economic growth, its explosive growth has sparked worries about sociocultural upheavals, environmental degradation, and economic inequality. As a result, sustainable tourism has become a crucial strategy for guaranteeing that the growth of the tourism industry is in line with long-term ecological, social, and financial objectives. Serving others, empathy, and community empowerment are the cornerstones of the servant leadership paradigm, which has become acknowledged as a useful framework for advancing eco-friendly travel. Through an exploration of its theoretical underpinnings, real-world applications, and case studies, this review paper methodically investigates the role of servant leadership in promoting sustainable tourism. The article emphasizes how the growth of socially inclusive, environmentally conscious, and financially sustainable tourism is facilitated by servant leadership concepts including stakeholder collaboration, ethical decision-making, and community involvement. It also covers the difficulties and impediments of applying servant leadership in the travel industry, such as organizational opposition, cultural disparities, and competing interests. In order to help academics, business executives, and legislators create more resilient and equitable travel destinations, the study ends by suggesting future research avenues and tactics for incorporating servant leadership into sustainable tourism practices. This review highlights the potential of servant leadership as a transformative instrument for accomplishing the more general objectives of sustainable development in the tourism industry by combining existing research.

Keywords: sustainable tourism, servant leadership, environment, organisational culture, tourism, leadership.

Paper: 099

Recent Advancements in Transition Metal Chalcogenides for Their Electrochemical Properties

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ABSTRACT:

In the 21st century, the energy crisis is an issue of major concern, there is a need for the development of efficient energy storage devices. A large number of efforts have been made in this regard such as the development of devices like lithium-ion batteries, supercapacitors, etc. Researchers are working worldwide in the field of supercapacitors due to their magnificent electrochemical properties such as high power density, fast work speed, fast charge/discharge, high cyclic stability, long life, and wide operating temperature range. In recent times the metal chalcogenides and metal oxides have gained a lot of interest in the field of research, this is due to the reason that they can be easily synthesized using different physical and chemical techniques. The Transition Metal Chalcogenides (TMCs) have provided a unique platform for next-generation energy storage devices such as potassium-ion, sodium-ion, lithium-ion, and flexible supercapacitors. TMC-based nanostructure materials such as Cu_2FeSnS_4/PVP/rGO, rGO/$SrSeO_4$, CuS@WS_2, etc. have been used as electrode materials for the supercapacitors on a much larger scale for increasing their electrochemical properties such as energy density, power density, specific capacitance, etc. Atomic-scale thickness, strong spin-orbital coupling, optoelectronic behavior, indirect bandgaps, and spectral and differential reflectance are some of the distinctive properties possessed by the TMCs. They have many applications in hydrogen evolution, thin film, biosensing, antibacterial particles, and electrocatalysis.

Keywords: Supercapacitors, Transition Metal Chalcogenides, Lithium Ion Batteries, Power Density, Energy Density.

Paper: 100

FOREST COVER classification and change detection analysis using machine learning: A Review

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ABSTRACT:

Deforestation is the biggest challenge facing the world. This has many consequences for the environment and species like floods, landslides, biodiversity loss etc. To overcome this issue, a monitoring of forest dynamics is required. The present research has aim to perform the critical review of the mapping and monitoring the forest change. Forest mapping and monitoring are essential for managing forest ecosystems. It includes several remote sensing technologies like satellite imagery, LiDAR and UAV (drone). These technologies improve land cover classification, deforestation detection, and biomass estimation, enabling predictive analytics and automated monitoring. The paper investigates process in the detection and classification of forest images, concentrating on five key areas: assessing existing methodologies, exploring challenges in object detection, analysing segmentation strategies, outlining processes for feature extraction and classification, and reviewing the effectiveness of cutting-edge techniques. It covers key approaches, identifies limits, and discusses future research methods for improving the precision and efficiency of forest dynamics. The objective of this study to find the best classifier for forest classification and change detection. For doing so, several machine learning (ML) models such as Random Forests, Support Vector Machines, Maximum Likelihood classification, and Convolutional Neural Networks employed on forest cover and its change detection has been studies. The research effort investigates the benefits of ML in providing sustainable forest management, biodiversity protection, and climate change mitigation via accurate and timely monitoring systems.

Keywords: FOREST COVER, MACHINE LEARNING, Random Forest, Image Processing, Change detection

Paper: 101

LEAF AREA INDEX RETRIEVAL FROM GROUND MEASUREMENTS COUPLED WITH SENTINEL 2 IMAGERY - A CASE STUDY IN THIRUVANANTHAPURAM DISTRICT

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ABSTRACT:

Global food security is a pressing issue, and climate change exacerbates the challenge. Precision agriculture (PA) offers a solution, empowering farmers to optimize yields, enhance efficiency, and reduce costs. Leaf Area Index (LAI) is a crucial biophysical parameter that provides valuable insights into crop health and growth. Accurate LAI estimation is essential for implementing PA practices like variable rate application and precision irrigation. This study leverages Sentinel-2 Level 1C imagery and the Random Forest (RF) algorithm to estimate LAI across different growth stages of paddy crops. By analyzing various vegetation indices (VIs) and their importance, the study identified the most influential ones for LAI estimation. The RF model exhibited strong predictive accuracy for LAI estimation during the early vegetative stage, achieving an R^2 of 0.744 and an RMSE of 0.255. In the vegetative stage, the model achieved an R^2 of 0.769 and an RMSE of 0.287. For the reproductive and maturing stages, the R^2 values were 0.804 and 0.768, respectively, with corresponding RMSE values of 0.217 and 0.334. These results highlight the potential of RF as a robust tool for operational LAI estimation. As climate change continues to pose challenges, accurate and efficient LAI estimation is crucial for ensuring food security and sustainable agriculture.

Keywords: sustainable agriculture, integrated farming, cover crops, chemical fertilizer, diversified income

Paper: 102

A Review on Production of Hydrogen Utilizing Renewable sources

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ABSTRACT:

The worldwide shift towards sustainable energy frameworks has established hydrogen as an essential strategic response to the challenges posed by climate change and the need for decarbonization. This comprehensive review of existing literature provides an in-depth analysis of hydrogen production methods utilizing renewable energy sources, including solar, wind, biomass, geothermal, and hydropower technologies. This research offers an in-depth review of the extensive technical, economic, and environmental aspects associated with different hydrogen production methods, thereby enhancing our understanding of both the present advancements and future possibilities in renewable hydrogen generation. The study provides a thorough exploration of the core principles that govern various production methods, assessing their technological readiness, efficiency, scalability, and environmental impact using a comprehensive analytical approach. The review presented here focuses on the detailed connection between renewable hydrogen production and advanced energy storage systems. It underscores the essential need for the development of refined energy management strategies that can adeptly reconcile the variability of renewable energy generation with the processes of hydrogen production and its subsequent use. This review presents a comparison of hydrogen production methods derived from both renewable and non-renewable sources, providing detailed insights into the associated challenges and opportunities within sustainable hydrogen technologies. The study thoroughly evaluates the economic viability, state of technology, and possible environmental consequences, exploring wider socio-economic effects, policy structures, and strategic factors essential for promoting extensive implementation. It highlights significant research deficiencies, new technological advancements, and possible future directions, thereby making a meaningful contribution to the current discussions in both academic and industrial spheres regarding sustainable energy transitions. The results highlight the importance of ongoing interdisciplinary collaboration, focused research funding, and cutting-edge technological advancements to address current challenges and realize the full potential of hydrogen as a crucial element in meeting global decarbonization goals.

Keywords: Renewable hydrogen production, sustainable energy, decarbonization, clean, solar hydrogen, wind hydrogen, biomass hydrogen, geothermal hydrogen

Paper: 103

Mitigating Climate Change through Sustainability and Integrated Approaches

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ABSTRACT:

Climate change adaptation alludes to measures that help mitigate the impacts of climate change such as food and water insecurity, rising sea levels, declining biodiversity, etc. The capability of sustaining a process over an extended period of time is sustainability. It is crucial to align the Sustainable Development Goals with climate change to frame the policies, analyze environmental dimensions and enhance the resilience to degrading climate while effectively promoting sustainable livelihoods. This paper explores the potential of combining nature-based solutions with scientific approaches in achieving environmentally friendly solutions for the future. The adoption of green energy and encouragement of sustainable consumption of goods can be helpful in the long term environmental sustainability. Integrated approaches to climate change adaptation emphasize on the interconnectedness of human, environmental and economic systems and aims to develop solutions that address multiple vulnerabilities. These approaches including the role of Blue Carbon ecosystems which helps in sequestration of carbon, climate smart agricultural practices, community based approach and urban climate resilience are essential for building long term resilience to climate change, requiring specialization, preparation, co-operation and forethought. Adaptation to the climate risks is unavoidable because of the continuously rising temperature and this study emphasizes how crucial it is to consider knowledge gaps and vulnerable areas while focusing on the economic development. The methodical alternations of climate change can help build resilience not just to climate change but also to other aspects of economic as well as environmental challenges.

Keywords: Climate change, adaptation, sustainability, approaches

Paper: 104

Entrepreneurship and Sustainable Development for Environmental Modelling

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ABSTRACT:

The amalgamation of entrepreneurship with sustainable development offers transformational prospects to tackle global environmental issues. Entrepreneurs, as catalysts of transformation, are crucial in promoting sustainable ideas and practices. Environmental modelling has concurrently become an essential instrument for comprehending, forecasting, and alleviating environmental repercussions, so facilitating sustainable decision-making. This paper examines the convergence of these fields, highlighting how entrepreneurs utilize environmental concepts to create sustainable solutions in agriculture, energy, and waste management. Significant technical breakthroughs, such as IoT, AI, and blockchain, improve the precision and relevance of environmental modeling, facilitating more effective resource management and transparent supply chains. The review analyzes legislative frameworks and financial mechanisms, including green incentives and impact investing, that facilitate sustainable entrepreneurship. The emerging phenomena, such as the proliferation of the circular economy and breakthroughs in predictive environmental modelling, are examined to underscore future trajectories. This synthesis highlights the possibility of integrating entrepreneurial endeavors with environmental modeling to provide significant, scalable solutions for sustainable development. It culminates with suggestions for promoting multidisciplinary collaboration among entrepreneurs, legislators, and environmental scientists to enhance the efficacy of these integrated initiatives.

Keywords: Entrepreneurship, Sustainable Development, Environmental Modeling, Green Innovation, Policy Frameworks, Emerging Technologies.

Paper: 105

Study of Agrobiodiversity Status using RS and GIS analysis in Mandakini Valley of Uttarakhand

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ABSTRACT:

Agriculture has been the major occupation of people from the mountainous region of the Indian Himalayan Region (IHR) for millennia, which helps to feed the people of the region and ensures their well-being. A total of 9500 species are present in the country, of which 7900 are for ethnobotanical purposes and 3900 are edible species in the Himalayas (NAAS, 1998). Mandakini valley is located in Rudraprayag district of Uttarakhand. The methodology included a detailed survey of the area at an altitudinal gradient of 500-2000 meters. This included surveys, questionnaires, and group discussions with ground truthing of the entire field area. The results show that the area is enriched with a high range of agricultural biodiversity. This terrain also faces the challenges of adverse climate conditions and other natural calamities. Further, the use of remote sensing techniques and mapping has helped assess the situation and categorize them as hotspots in the region.

The majority of the population in the state either directly relies on agriculture or agriculture-related activities. The major crops grown during the seasons of Rabi and Kharif are Wheat and rice, which cover 30.8 percent and 23.9 percent of the total cropped area. The remaining area is covered by Manduwa 10.9%, Sugarcane 9.1%, Sawa 5.4%, Maize 2.7%, Pulses 2.5%, Oilseed 1.9% and others 12.8%. The major millets grown in various state regions are Manduwa (Eleusine coracana), and Jhangora (Echinochloa frumentaceae). The oilseeds grown in the various regions of the state are Groundnut, Soybean, Sunflower, Mustard, Flax Seeds, etc. Practices such as Barahnaja (a combination of 12 varieties of seeds) have helped the farmers gain nutritional security over time and it aims to provide farmers with 'sustainability'. The state has a great scope for the development of various sectors about agriculture.

Keywords: Agriculture, Crops, Diversity, Himalayas, Remote sensing

Paper: 106

Thermal Performance Analysis of a Solar Thermochemical Reactor Using Discrete Ordinate and P1 Radiation Models

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ABSTRACT:

The increasing demand for alternative fuels and the immediate need for reducing emissions have made hydrogen production one of the primary topics of research in sustainable energy. Hydrogen due to its high density of energy and zero-emission profile, has emerged as the most promising substitute for fossil fuels. Steam methane reforming is the most common method of hydrogen production for its efficiency and ease in incorporating itself in existing infrastructure. This process, however requires high temperatures that are often provided by combustion of fossil fuel contributing significantly to carbon emissions. Solar energy is a clean alternative of heat source that reduces the consumption of fossil fuels and consequently greenhouse gas emissions. This study explores the thermal performance of a solar thermochemical reactor by investigating the comparative analysis of DO and P1 radiation models at different conditions of velocity, porosity, and heat transfer coefficients. Results showed that the DO model surpasses the P1 model in terms of radiative heat transfer capture, especially for high porosities and in turbulent flow regimes, based on its sensitivity to directional effects. Furthermore, the LTNE model gives a smoother distribution of temperature than LTE with which it is supposed to be used in applications operating at high temperatures. Hence, the paper concludes that the DO model can be implemented in conjunction with LTNE as well as Wu's heat transfer coefficient to ensure effective thermal performance and provides some input toward improving design configurations for solar thermochemical reactors for efficient production of hydrogen.

Paper: 107

Role of plant- based biochar to enhance the sewage treatment efficiency of constructed wetlands

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ABSTRACT:

Globally, over 380 billion m3 of wastewater is generated annually but only 20% of this is treated through available technologies. Improper release of such wastewaters, causes toxicity of chemicals, pathogens and emerging contaminants. These contaminants are responsible to cause environmental degradation in terms of eutrophication, biodiversity loss and also pose health risks. Traditional sewage treatment methods such as STPs, activated sludge processes and trickling filters are efficient in removing the common pollutants from wastewater but are expensive, energy-extensive, high maintenance, require skilled labour. Moreover, these treatment facilities are unable to remove emerging contaminants like pharmaceuticals, antibiotic resistant bacteria and microplastics etc. These limitations have been compelling to adopt more efficient and sustainable alternatives for wastewater since many years. Nature-based alternatives specially constructed wetlands have gained popularity as they are efficient in removal of complex pollutants and require less resources to operate. CWs mimic the processes of natural wetlands and treat wastewater through various mechanisms such as filtration, adsorption, biodegradation and nutrient uptake. Despite their efficiency and wide applicability, they face challenges like clogging, substrate saturation and limited removal of emerging contaminants. To tackle these challenges, new approaches such as integration of biochar have paved their way to become more efficient and sustainable alternative. Biochar provides larger surface area and high porosity to facilitate adsorption, microbial activities and nutrient cycling. This review highlights the use of biochar amended CWs for wastewater treatment focusing on role of biochar in enhancing the pollutant removal efficiency of CW systems.

Keywords: Constructed wetlands, Wastewater, Biochar, Sustainable Technology, Nature based systems

Paper: 108

SUSTAINABLE METHODS FOR CONSERVATION AND MANAGEMENT OF WATER IN DEHRADUN, UTTARAKHAND

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ABSTRACT:

Despite the overwhelming scarcity of water supply in the district, many citizens fail to contribute to water conservation and responsible usage. Larger houses, with all of their expensive gardens, huge bungalows, many amenities and numerous vehicles, require more water but often fail to put the rainwater for proper use by rainwater harvesting. Citizens use rivers for recreational and industrial purposes without taking on the responsibility of keeping them clean. Dehradun, the picturesque city nestled in the foothills of the Himalayas, is under a severe water scarcity crisis, particularly during the sultry summer months. Managing water resources in the city is under significant strain, with the burden falling largely on smaller consumers with a low-income scale while larger users often remain unchecked. A notable contributor to the building water crisis is the surge in tourism, particularly during peak seasons, which temporarily inflates the city's population and people in demand for water, especially at all the pilgrimage sites. The existing infrastructure of hotels and guesthouses struggle to meet this increased need, often operating without adequate regulation and neglect their responsibilities towards water conservation. Dehradun's water scarcity requires a comprehensive approach that includes stringent regulations, increased public awareness, and the implementation of sustainable water management practices. Urban planners play a crucial role in devising strategies for efficient water use. They emphasise the development of green infrastructure, such as rain gardens, permeable pavements, and green roofs, to manage stormwater effectively. Water-Sensitive Urban Design (WSUD) further enhances water efficiency by incorporating wetlands, recycling systems, and rainwater harvesting, especially in residential and commercial buildings, to reduce dependency on municipal supplies. Water conservation demands a unified approach where urban planners, local administration, water supply agencies, and citizens all play crucial roles and we all must play our part.

Keywords: water conservation, scarcity

Paper: 109

Traditional Health Practices Used by Gujjar and Bakarwals, Tribal Community of Jammu and Kashmir

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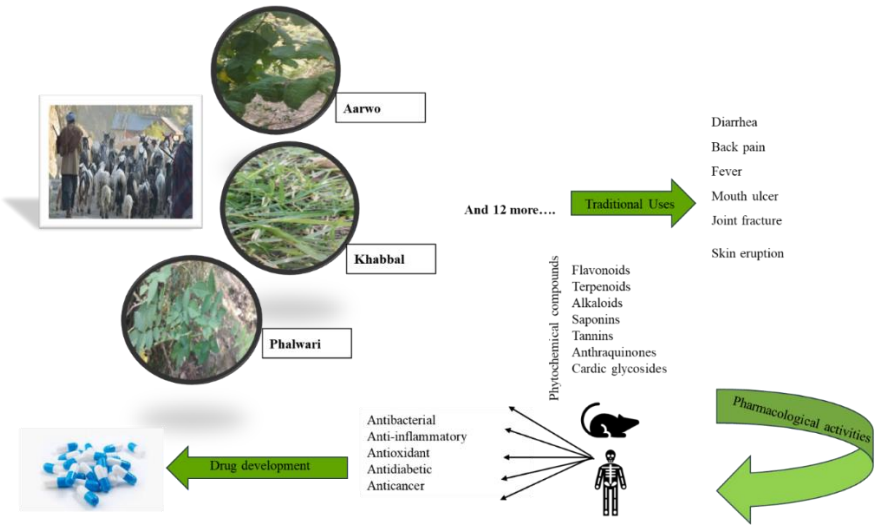
ABSTRACT:



Himalayas are the richest and youngest mountain ecosystems and are home to a wide range of plant and animal species. Diverse climatic conditions, in conjunction with distinct terrain and altitudinal gradients, give rise to distinct forest types, ranging from tropical to temperate, alpine, and timberline zones to snow-covered meadows.

Despite several developments in recent times, the indigenous people of Jammu and Kashmir, particularly the Gujjars-Bakarwals, continue to live nomadic lives. But they have traditionally been the primary keepers of priceless traditional and indigenous knowledge about Jammu and Kashmir's native ecosystem, herb shrub, forest agriculture, and biodiversity. Gujjars possess knowledge of animal rearing and herbal healing. They use naturally occurring herbs to treat both humans and animals which also reduces their economic burden. They inherited these practices from their forefathers and still maintain a balance of old and new practices.

A total of 15 species from 11 families of trees, shrubs, and herbs were identified and examined in published materials that were utilized to cure various illnesses in the area. Out of the fifteen species in total, eight were herbaceous plants, one was shrubs, and six were trees. The purpose of the current study was to determine whether the medicinal plants that grow in the Doda district's valleys and mountains could cure a variety of tribal people's problems. It may also assist in identifying and discovering plants linked to a variety of ethnobotanical applications, which can be extremely helpful to researchers carrying out phytochemical investigations.

Keywords: Gujjar and Bakarwals, Medicinal plants, Phytochemistry, Traditional Knowledge

Paper: 110

Biochar: A Solution towards Environmental Sustainability

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ABSTRACT:

Biochar is a carbon-rich material produced by pyrolysis of biomass in limited oxygen supply. Preparation temperature ranges between 300-800oC with enormous physic-chemical properties like large surface area, porous structure, bulk density, high adsorption capacity etc. Biochar acts as carbon sequestration, providing offset the carbon emission form different sectors. It also helps in monitoring and mitigating climate change. It effectively helps to bind away carbon that would otherwise be released into the atmosphere as CO2 also participates in reduction of greenhouse gas emission. Biochar also known as "Black Gold" contributes in soil structure improvement, enhancing nutrient retention, increasing soil microbial community. Biochar potency also extends towards management of organic waste. By improving soil fertility and nutrient retention, biochar can reduce the need for synthetic fertilizers, which are energy-intensive to produce and can lead to environmental issues like nutrient runoff and soil degradation. This not only lowers the environmental footprint of farming but also makes farming more cost-effective and sustainable. Biochar is also applied for the removal of pollutants such as heavy metals, nutrient from water as well as other pharmaceutical product residues from soil and water. Various types of adsorbents (BCs), such as pristine and engineered BC, are utilized for the separation or remediation of heavy metals (HMs), polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and organochlorine pesticides from polluted areas to promote sustainable development. In conclusion, biochar plays a critical role in environmental sustainability by mitigating climate change, improving soil health, managing waste, purifying water, and reducing the use of chemical fertilizers. With proper management, biochar offers a promising solution for advancing sustainable agricultural practices, cost-effective and combating global environmental challenges.

Keywords: Biochar, Environment, Sustainable, Remediation, Soil.

Paper: 111

Isolation and Characterization of Bacterial isolates from treated wastewater for exploring their role in plant growth promotion and biocontrol agent against different fungal pathogens

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ABSTRACT:

The increasing interest in sustainable agriculture has highlighted the potential of using microorganisms for biocontrol and plant growth promotion. This study investigated the isolation and characterization of bacteria from treated wastewater for their ability to promote plant growth and suppress the growth of fungal pathogens. A total of 114 bacterial isolates were isolated from the treated wastewater and were screened for key plant growth-promoting (PGP) traits, including nitrogen fixation, phosphate solubilization, indole-3-acetic acid (IAA) production, and siderophore production. Additionally, their antagonistic activity against plant pathogens such as Fusarium, Rhizopus, Culvularia, and Aspergillus species was evaluated. Several isolates exhibited multiple PGP characteristics and demonstrated significant biocontrol potential, effectively inhibiting the growth of pathogens in vitro. Notably, Bacillus and Proteus spp. significantly enhanced the growth of plants under controlled conditions, promoting root and shoot development. These results suggest that bacteria isolated from treated wastewater have considerable potential as biocontrol agents and biofertilizers. This study emphasizes the untapped value of environmental bacteria in promoting sustainable agricultural practices. It highlights the role of treated wastewater as an important reservoir of beneficial microorganisms for plant health.

Keywords: Biocontrol agents, Biofertilizers, Plant Growth promotion, Treated wastewater, Wastewater treatment plants.

Paper: 112

INTEGRATING 3D IMMOBILIZED NOVEL MICROBIAL CONSORTIUM ON ACTIVATED BIOCHAR FOR GREEN TREATMENT OF BIOHYDROGEN PRODUCTION

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ABSTRACT:

Immobilization of bacteria on or into a polymer support is a common method for the utilization of bacteria. A study was conducted to investigate the effects of alginate and chitosan as encapsulating agents on biofilm formation and microbial adhesion to activated carbon, with the goal of enhancing biohydrogen production. The experiment involved five separate batch fermentations in a bioreactor, maintained at 60°C and pH 6.0. Coconut shell activated carbon (CSAC) served as the foundation for cell attachment and growth. Alginate (Alg) was used in varying concentrations to create CSAC-Alg beads. The optimal hydrogen production rate (HPR) of 2.47 ± 0.47 mmol H_2/L·h and a hydrogen yield of 2.09 ± 0.22 mol H_2/mol sugar were achieved using an Alg concentration of 2 g/L. Additionally, chitosan (C) was applied as an external polymer coating on the CSAC-Alg beads (forming CSAC-AlgC beads) to offer extra protection for the microbial community in harsh conditions. The CSAC-AlgC beads yielded an HPR of 0.93 ± 0.05 mmol H_2/Lh and a hydrogen yield of 1.11 ± 0.35 mol H_2/mol sugar at a chitosan concentration of 2 g/L.The results suggest that biofilms attached to CSAC, especially those utilizing Alg as an immobilization medium, establish ideal conditions for hydrogen-producing bacteria. This method improves microbial adhesion and colonization, resulting in consistent hydrogen production rates even at elevated temperatures, thus offering a promising strategy for biohydrogen production.

Keywords: biohydrogen production, immobilised cells, entrapment, alginate, chitosan, activated carbon

Paper: 113

WRF-CHEM Simulation of Transport of aerosols and trace gases in Northern India throughout summer and winter

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ABSTRACT:

This study looks at how aerosols and trace gases change throughout the course of the summer and winter in Northern India's atmosphere. The purpose of the study is to comprehend the mechanisms and patterns of pollution transfer in this area. The study clarifies the impact of meteorological factors on aerosol dispersion by examining seasonal fluctuations. The research advances our knowledge of Northern India's regional atmospheric dynamics, climate impacts, and air quality. In this study we have configured WRF-CHEM (version 3.8.1) using two nested domains to simulate the regional chemical weather over the North Indian region. Aerosol concentrations are simulated using the Weather Research and Forecasting Model combined with Chemistry (WRF-Chem). WRF-Chem simulation is being run for a time period of 1 year from 1 Jan 2015 - 31 Dec 2015. Transported aerosols, primarily from IGP, were found to be responsible for the bulk of the aerosol mass over North India of near-surface PM10 concentration, thus primarily responsible for air pollution as climatic impacts over the region during pre-monsoon season. The simulation differentiates and quantifies the impacts of aerosols emitted locally within North Indian region and those transported from outside this region to ascertain whether local or transported aerosols are more impactful in influencing this region’s atmosphere. Validation of aerosol concentrations (PM10) and (PM2.5) with available ground-based observations over the Northern Indian region has been done.

Keywords:

Paper: 114

Isolation of Ciprofloxacin degrading bacteria from river water and determination of CIP breakdown by-products by HPLC-MS/MS.

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ABSTRACT:

CIP degradation metabolites were determined using UPLC-QTOF-MS/MS. Although ciprofloxacin was not identified in the water extracts, three possible degradation products (BP) linked to CIP were identified and were grouped into two pathways. Pathway One proposes BP1 (m/z 303.14; $C_{16}H_{18}FN_3O_2$) resulting from substituting the carboxyl group in C-3 through hydroxylation. Pathway Two, reported for the first time in this study, is proposed to occur in two ways. First, the biodegradation product BP2 (m/z 289.12; $C_{15}H_{16}FN_3O_3$) resulting from the removal of the -OH group at the carboxyl group and the removal of the C_2H_4 at the piperazine ring via ethylation. Second, biodegradation product BP3 ($[M+H]^+$ at m/z 275.11, suggests that BP2 was further transformed to $C_{15}H_{15}FN_2O_2$ by the removal of the -NH molecule from the piperazine ring (BP3). High-throughput sequencing (NGS) was used to determine the bacterial community with potential CIP degrading capacity and the findings suggests that bacteria belonging to the genus Pseudomonas, Bacilli, Novosphingobium, Paenarthrobacter, and Escherichia-Shigella have CIP degrading properties.

Paper: 115

Molecular identification of potential CIP-degrading bacterial community in Bloukrans and Kowie Rivers.

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ABSTRACT:

High-throughput sequencing (NGS) was used to determine the bacterial community with potential CIP degrading capacity and the findings suggests that bacteria belonging to the genus Pseudomonas, Bacillus, Novosphingobium, Paenarthrobacter, and Escherichia-Shigella have CIP degrading properties. Overall, the bacterial community in the current study was dominated by classes Gammaproteobacteria and Actinobacteria. Generally, it can be concluded that the aim of the study was achieved, however, extensive research has to be conducted for a specific bacterial strain(s) and the determination of the toxicity of these degradation products.

Keywords:

Paper: 116

Exploring Antioxidant, Antibacterial and Antidiabetic potential of Costus igneus mediated Silver Nanoparticles

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ABSTRACT:

This study uncovers the remarkable biological potential of silver nanoparticles (Ag-NPs) synthesized using *Costus igneus* leaf extracts, emphasizing their versatile applications in antimicrobial activity and therapeutics. The synthesized Rs-Ag-NPs were characterized using UV-visible spectroscopy, Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and scanning electron microscopy (SEM), confirming their nanoscale morphology, crystalline structure, and surface functional groups. Phytochemical analysis identified bioactive compounds responsible for nanoparticle formation. Antioxidant assays (DPPH and ABTS) demonstrated significant radical scavenging activity, with IC_{50} values of 18.41 µg/mL and 25.78 µg/mL, respectively. Antibacterial evaluations showed broad-spectrum activity against *Listeria monocytogenes*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*, with dose-dependent inhibition. Furthermore, antidiabetic potential was observed through α-amylase and α-glucosidase inhibition assays, with IC_{50} values of 180.34µg/mL and 150.58 µg/mL, respectively. The biological activities of Ag-NPs, including their antioxidant, antibacterial, and antidiabetic properties, highlight their potential for therapeutic applications. These findings demonstrate the multifunctional nature of *Costus igneus* derived Ag-NPs and their promising role in biomedical and environmental applications.

Keywords: *Costus igneus* , Ag-NPs, antioxidant, antidiabetic.

Paper: 117

The Future of Electric Vehicles: Supercapacitors as Key Energy Storage Systems

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ABSTRACT:

The desire to eliminate fossil energy emissions has led to an increasing emphasis on finding alternative sources, which has driven the development and integration of electric vehicles (EVs). Nevertheless, one of the greatest worries for EVs still exists – the search for reliable and eco-friendly energy storage mechanisms. In this regard, supercapacitors are already considered one of the optimal technologies due to their high-power density, short charge-discharge responses, and long-life span. This article addresses the state-of-the-art technologies of supercapacitors and provides advances in the field of new electrode materials and mechanics toward improving energy storage systems for future EVs. Such focus is primarily on the promised performance of supercapacitors because carbon-based materials, metal oxides, and conducting polymers possess certain characteristics that enhance noticeably the energy density and performance of the supercapacitors. The article also discusses the integrated design of hybrid supercapacitors and batteries in order to create a supercapacitor-battery hybrid energy storage system with adequate energy and power density. Lastly, this paper discusses future possibilities and complexities in contributing to the next generation of supercapacitors and how they will facilitate enhanced EVs cause. These insights underline the potential for breakthroughs in energy storage technologies, paving the way for greener and more reliable electric mobility.

Keywords: Hybrid energy storage; Next-generation Supercapacitors; Power density; Storage technologies.

Paper: 118

Impact of Pesticide Exposure on Gut Microbiome and Health Concerns

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ABSTRACT:

The impact of pesticide exposure on the gut microbiome is profound and far-reaching, influencing a key aspect of human health. The gut microbiome, a complex community of microorganisms residing in our digestive tract, is vital for numerous bodily functions. It plays an essential role in maintaining a robust immune system, facilitating the digestion of food, and regulating metabolism. However, this delicate balance can be severely disrupted when exposed to pesticides. Scientific studies have demonstrated that such exposure can drastically alter the composition and functionality of the gut microbiome. Beneficial microorganisms, which help thwart infections and promote digestive health, may dwindle in number, while harmful, pathogenic microorganisms can multiply. This imbalance can lead to many health issues, encompassing diminished immune response, increased levels of inflammation throughout the body, and metabolic disturbances that can affect weight and energy levels. Furthermore, pesticides can interfere with the intricate communication pathways between the gut microbiome and the host. These pathways often rely on producing short-chain fatty acids and various neurotransmitters, which play critical roles in regulating mood, cognitive abilities, and behaviour. Disruptions in this communication can lead to alterations in mental health and behaviour patterns, further complicating the health landscape. The ramifications of pesticide exposure extend beyond immediate health concerns, as research has linked it to an elevated risk of various chronic diseases, including obesity, diabetes, and neurological disorders. Understanding these effects is crucial given the significant impact of pesticide exposure on the gut microbiome. Developing effective strategies to mitigate the influence of pesticides on our health and well-being should be a priority in both public health and agricultural practices.

Keywords: Pesticides, Gut Microbiome, Communication Mechanisms, Immune System, Digestion, Metabolism, Short-Chain Fatty Acids, Neurotransmitters, Human Health.

Paper: 119

Computational Insights into the Anticancer Potential of *Citrus pseudolimon*: A Bioinformatics Approach

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ABSTRACT:

Biodiversity conservation plays a pivotal role in the discovery of novel therapeutics, particularly in the fight against drug-resistant cancers. This study explores the anticancer potential of bioactive compounds derived from *Citrus pseudolimon*, an underutilized citrus species, against drug-resistant gastric cancer targets. Using molecular docking we evaluated the binding affinities and stability of *Citrus pseudolimon* phytochemicals against key proteins implicated in gastric cancer resistance, such as HER2, EGFR, and VEGFR2. Our docking results revealed several high-affinity interactions, suggesting potential inhibitory effects on cancer progression pathways.

The findings underscore the immense therapeutic potential of *Citrus pseudolimon*, a species often overlooked in biodiversity conservation efforts. The loss of such biodiversity could significantly hinder access to unique bioactive compounds, thereby limiting advancements in cancer treatment. This study not only highlights the importance of preserving plant biodiversity but also establishes *Citrus pseudolimon* as a promising resource for combating drug-resistant gastric cancer, emphasizing the integration of conservation and pharmaceutical innovation.

Keywords:

Paper: 120

Building disaster resilience in schools: Educating Teachers and Students Through Collaborative Emergency Preparedness in Port Alfred, Eastern Cape.

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ABSTRACT:

This project, conducted in the Ndlambe Municipality of Port Alfred, Eastern Cape, focused on enhancing disaster resilience in schools through education and practical preparedness measures. Recognizing schools as critical centers for community safety, the initiative aimed to reduce vulnerabilities to fire and flood risks by fostering awareness, collaboration, and actionable preparedness strategies. The project involved conducting detailed risk assessments, developing tailored mitigation plans, and organizing practical evacuation drills in partnership with local emergency services.

Teachers and students were equipped with essential knowledge and skills, while local businesses supported the acquisition of safety equipment such as fire extinguishers and emergency signage. The program culminated in a school-wide clean-up campaign, reinforcing the importance of a safe and clutter free environment while promoting a sense of community ownership. By integrating disaster risk management into school operations and fostering partnerships among key stakeholders, the project demonstrated a sustainable, replicable model for reducing disaster risks in vulnerable areas. This abstract highlights the project's objective, methodologies, outcomes, and its broader implications for disaster risk reduction in educational settings.

Keywords: Disaster resilience, schools, risk assessment, fire drills, flood preparedness, mitigation plans, community collaboration, Ndlambe Municipality, emergency services, disaster risk reduction.

Paper: 121

Experimental investigation of modified diesel engine operated on lean producer gas generated from wood waste

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ABSTRACT:

The increasing demand of energy has shifted the focus of power production from conventional fuels to alternative fuel. Producer gas generated from wood waste through gasification process can be a good alternative fuel for power production via IC engine. In rural areas, the agriculture residue waste can be utilized in biomass gasifier to generate producer gas to be utilized in IC engine in single fuel mode. Gasifier engine system in single fuel mode in rural areas is an attractive choice for small scale power production through IC engines. In this study, a 10 hp diesel engine was modified to spark ignited engine by adopting battery ignition system followed by spark plug, ignition coil and distributor assembly. The modified engine was connected to the downdraft gasifier which was loaded with wood waste (i.e. Acacia Nilotica). Producer gas was generated from downdraft gasifier and fed to the modified engine in spark ignited mode and various performance parameters were evaluated. The maximum brake thermal efficiency of 19.8 % was obtained at 3.99 kW brake power. Producer gas, due to its low calorific value and lean nature, exhibited the lowest brake power and highest BSFC and BSEC. The utilization of producer gas in IC engines in single fuel mode can eliminate the use of conventional fuel.

Keywords: waste wood, single fuel mode, producer gas, biomass gasification, green energy

Paper: 122

Tree Transplantation: A Sustainable Solution for Urban Development and Biodiversity Conservation

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ABSTRACT:

Expanding urban areas along with infrastructure projects such as the construction of highways, metro rail, and flyover development, often necessitate the removal of old established trees from that area. This resulted in significant loss of green cover, change in macro and micro climatic conditions, and loss of species associated with trees, such as birds, ants, bees, and other organisms. These organisms are important for the ecosystem to work properly and are interdependent for example flowers of trees provide food to bees or birds and in return bees or birds act as a pollinators for trees. Trees play an important role in regulating the local area climate and the removal of large-size trees leads to problems like an increase in temperature and change in rainfall pattern.

Tree transplantation protects trees by transplanting them from the construction site to the surrounding location. The process involves unearthing a tree while protecting the root ball, pruning extended roots, secondary branches, and main branches so they can be lifted with the help of a crane and then transported to a new location. The whole process involves detailed scientific study, like conducting a survey of both sites and checking parameters like soil condition, moisture level, and distance between two sites. Tree transplantation is an emerging field, particularly in India, with spacious potential for urban development and environment. In this review paper, we aim to explore the latest advancements, current trends, and future possibilities in tree transplantation. By examining tree transplantation's role in sustainable development, urban forestry, and biodiversity conservation, this paper seeks to provide a comprehensive understanding of this innovative practice and its applicability in addressing environmental challenges.

Keywords: Tree transplantation, Biodiversity, Sustainable development, Urban forestry

Paper: 123

Digitalization and Carbon Footprint: Balancing Environmental Benefits and Challenges for a Sustainable Future

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ABSTRACT:

The last few decades have witnessed unprecedented growth in digitalization, which has not only emerged as a major transformative force but has profound implications for addressing climate change. By introducing and integrating advanced technologies like AI, big data, IoT, and cloud computing into our daily and business activities, digitalization offers significant opportunities to reduce resource consumption at diverse levels thus mitigating environmental degradation on the one hand while posing challenges like increased energy consumption and e-waste generation. Key benefits include transitioning to electronic communication to save paper and ink, virtual meetings that lower fuel consumption and carbon emissions, and online education that reduces commuting needs while enhancing learning accessibility. However, this transformation also poses environmental challenges, such as the high energy demands of electronic hardware, data centres and the growing problem of e-waste. This study aims to highlight digitalization's ability to promote eco-friendly practices while highlighting the need to manage its ecological footprint. The need of the hour is to have a balanced approach that integrates technological innovation, crafting and implementing various supportive policies along with fixing corporate accountability, and spreading consumer awareness to maximize the environmental benefits of digitalization. Other recommendations include adopting greener digital practices, enhancing energy efficiency, improving e-waste recycling, and fostering open innovation to achieve sustainable development goals. By ensuring that technological advancements, especially in green technology, are accessible to all without discrimination, we can ensure that the benefits of innovation reach everywhere, transcending geographical and socioeconomic boundaries across the globe. Responsible digitalization, coupled with equitable access to sustainable technologies, can pave the way for a more inclusive, resilient, and ecologically balanced future.

Keywords: Digitalization, Technology, Climate change, Carbon footprint, Sustainability

Paper: 124

The Indian Knowledge System: A Path for Holistic and Sustainable Living

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ABSTRACT:

The Indian Knowledge System (IKS) represents a highly structured and systematic knowledge transfer process across generations, rooted in the ancient Vedic tradition. The Knowledge system encompasses the vast wealth of Upanishads, Vedas, and Upvedas, Richas, which collectively represent the strong foundation of India's intellectual and cultural heritage. *The concept of Vasudhaiva Kutumbakam*—a vision of universal kinship articulated in the Maha Upanishad is central to IKS. Indigenous knowledge, intrinsic to specific cultures and societies, embodies local wisdom developed through keen observation, experimentation, and adaptation to environmental and socio-economic conditions. This age-old and time-tested traditional wisdom has sustained communities globally for centuries, serving as the foundation for administration, agriculture, healthcare, education, governance, and overall in the modern era where the world is after physical possessions, IKS emphasizes a holistic and spiritual approach to life, offering an antidote to materialism and extravagance. By integrating IKS into modern development paradigms, India can not only foster sustainable development rooted in conservation and ecological harmony but also re-establish itself as a Vishavaguru. This time-tested knowledge system offers invaluable insights for framing development plans prioritizing natural resource preservation while addressing contemporary challenges. Reviving and invoking the Indian Knowledge System is not merely a tribute to rich traditions and heritage but a competitive strategic imperative for building a sustainable and harmonious future not only for India but the entire world.

Keywords: Indian Knowledge System, conservation, natural resource preservation

Paper: 125

Green Chemical Science for A Sustainable Future

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ABSTRACT:

Green chemical science is an innovative and dynamic field that aims to create sustainable and environmentally friendly chemical processes and products. As our planet confronts critical challenges such as climate change, escalating pollution, and the depletion of natural resources, the principles of green chemistry emerge as a beacon of hope for achieving a sustainable future. This discipline focuses on the design and implementation of chemical processes that not only reduce waste but also minimize energy consumption and eliminate hazardous substances from production cycles. Encompassing various scientific domains, including organic chemistry, materials science, and biotechnology, green chemical science fosters interdisciplinary collaboration to tackle pressing environmental issues. Recent breakthroughs in this field have resulted in the advent of groundbreaking technologies such as biomass conversion, carbon capture and utilization, and sustainable catalysis. These innovations possess the potential to revolutionize numerous industries, ranging from energy to agriculture and manufacturing, by promoting cleaner and more efficient production methods. The implications of green chemical science extend beyond industrial applications; they profoundly affect human health and environmental sustainability. By substituting toxic chemicals with safer alternatives and significantly reducing waste output, green chemistry plays a crucial role in alleviating environmental pollution and fostering sustainable development practices. Ultimately, green chemical science is a vital and transformative field that holds the promise of significantly contributing to a more sustainable future. Ongoing research and development in this area are paramount to effectively address the multifaceted challenges facing our planet today.

Keywords: Green Chemical Science, Sustainability, Environmental Benignity, Biomass Conversion, Carbon Capture, Sustainable Catalysis, Human Health, Environmental Sustainability.

Paper: 126

Nature-based solutions for filtration of organic dyes from wastewater

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ABSTRACT:

Organic dyes are primarily discharged from textile, food, cosmetic, leather and paper industries and agricultural runoff. While many organic dyes are biodegradable, some may persist in the environment and may cause toxicity and carcinogenicity to aquatic animals, eventually affecting their growth, reproduction and survival. These dyes not only increase the biological and chemical oxygen demand of water reservoirs, but also disrupt photosynthesis of aquatic plants. Therefore, proper treatment is critical for mitigating organic dye contamination into wastewater and their impact on ecosystems. Physical methods like adsorption and chemical processes such as oxidation and coagulation are often employed as organic dye removal strategies. However, these techniques are associated with high operational costs, elevated energy inputs and more often generates toxic by-products, further causing environmental hazard. These shortcomings extend the need for more eco-friendly and sustainable solutions. In this context, biofiltration arises as a promising nature-based alternative, that exploits the microbial consortia for absorption and degradation of organic dyes from wastewaters without generating harmful by-products. Microbes including bacteria (*Pseudomonas*, *Bacillus*, and *Rhodococcus)*, fungi (*Trametes versicolor* and *Phanerochaete chrysosporium)* and actinomycetes (*Streotomyces* spp.) are known to degrade complex dye compounds through enzymatic activity. Key parameters affecting the efficiency of the biofiltration system are pH, temperature, hydraulic retention time, flow rate and type of biofilter media. Thus, optimization of these parameters is essential to ensure optimal microbial activity, improved dye removal efficiencies and better overall performance of biofilter systems, making it a more effective and sustainable nature-based solution for wastewater treatment.

Keywords: Biofiltration, bioremediation, microbes, water pollution, organic dyes, wastewater

Paper: 127

Assessing Land Dynamics in the Doon Valley with Machine Learning technique: Implications for Sustainable Urban Planning

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ABSTRACT:

Land Use Land Cover (LULC) analysis plays a pivotal role in understanding the dynamics of land transformation and its environmental implications. The Doon Valley, a critical ecological and urban hub in northern India, has witnessed unprecedented urbanization since Dehradun became the capital of Uttarakhand in 2000. This study employs Random Forest (RF), a robust supervised classification machine learning algorithm, to classify and assess LULC changes over three decades (1993–2024) using satellite imagery from Landsat 5, 7, and 8. LULC was categorized into five major classes: Forest, Bareland, Agriculture, Built-up, and Waterbodies. Accuracy assessment was conducted using a confusion matrix derived from 100 randomly selected points, achieving an overall classification accuracy of 92.8% with a kappa coefficient of 0.89. Results highlight significant land transitions, including a reduction in Bareland from 352 km² in 1993 to 288 km² in 2024, and an increase in Built-up areas from 211 km² to 259 km² during the same period. These changes underscore the impact of rapid urban expansion on natural and agricultural landscapes. The findings emphasize the need for targeted policies to manage urban growth sustainably while mitigating adverse environmental impacts. This research demonstrates the potential of RF in accurately mapping complex landscapes and provides valuable insights for integrating ecological sustainability into urban planning for the Doon Valley.

Keywords: Land Use Land Cover (LULC), Doon Valley, Supervised Classification, Random, Sustainable Urban Planning.

Paper: 128

Novel Gene Mining Approaches in Contaminated Soil Environment

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ABSTRACT:

Metatranscriptomics, a specialized branch of 'omics', offers unparalleled insights into the gene expression profiles of complex microbial communities within diverse ecosystems. While metagenomic studies primarily focus on identifying the genomic content and microbial diversity in a community, metatranscriptomics goes a step further by exploring the active genes, their expression patterns, and their dynamic responses to environmental changes.

This powerful approach has been successfully applied to various environments, ranging from human microbiomes to plant and animal systems, as well as soils and aquatic ecosystems. By leveraging mRNA isolated from environmental samples, metatranscriptomics serves as a vital tool for uncovering genes with significant biotechnological potential. However, interpreting the vast datasets generated by this method necessitates the development and application of robust bioinformatic pipelines.

The importance of application of metatranscriptomics in soil environments to examine functional diversity needs to be understood. It highlights the methods used to isolate genes associated with organic matter degradation and metal tolerance, explores the role of metatranscriptomics in advancing microbiome research, and discusses the bioinformatics tools required for data analysis. Additionally, it addresses the technical challenges of transforming metatranscriptomic data into meaningful biological insights, paving the way for further innovation in this field.

Keywords:

Paper: 129

How do we learn, how do we proceed, how do we act, if we accommodate the synergies and trade-offs of all the targets within the 17 SDGs, following the theme of Interlinkage in order to attain transformation for the stakeholders?

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ABSTRACT:

A close look at the UN Sustainable Development Goals and targets, we find the presence of such words like abuse, access, adopt, affordable, appropriate, biological, build, capacity, characteristics, climate, communication, consumption, develop, disaster, diversification, economics, education, eliminate, employment, encourage, ensure, environmental, equitable, facilitate, flexibility, framework, fossil fuel, functioning, gender, global, health, holistic, impact,improve, infrastructure, innovation, knowledge, lactating, marginalized, migrant, mitigation, natural, negotiating, operationalize, policy, pollution, population, prevent, productivity, promote, reduce, resource, resilience, sensitize, support, sustainability, trade, training, transaction, universal, urbanization, upgrade, voice, volatility, vulnerable, warning, yield and this clearly reflects that whatever goal we choose, whatever target we want to attain, intermingling of SDGs and the all-inclusive approach in terms of synergies and trade-offs can lead us to achieve 17 SDGs. The process of reinventing the relationship between man and environment can best be attained through the process of transformation mechanism following the 2030 agenda of Sustainable Development Goals by understanding the synergies and trade-offs of the SDGs. Transformation should be the key word for Sustainability issues under the broad theme of Governance. It depicts the intriguing energy within global sustainability discourse for moving from 'describing problems' to 'identifying solutions', and for better understanding the possible pathways of sustainable environmental issues. Thus, the present author envisages to promote INTERLINKAGE of 17 SDGs and eventually, the above-mentioned words (ABUSE to YIELD) find their right meanings among the stakeholders.

Keywords: SDGs, Transformation, Interlinkage, Synergies & Trade-offs, Stakeholders.

Paper: 130

Advancing Sustainable Bioelectricity Production from Wastewater Using Microbial-Based Nano-Electrigen Technology

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ABSTRACT:

The waterbodies with diverse biodiversity are critical for drinking and irrigation. Although the water has been considered clean and safe for domestic use, the growth of water contaminants from anthropogenic activities and poor sewerage and drainage systems have degraded the water quality over time. Wastewater, if untreated, will lead to deleterious impacts on the environment and human health and to mitigate its effects proper treatment is a must. Utilization of organic matter by some electrogenic microorganisms that generate bioelectricity has been reported. Although research in this field is still going on. Many microorganisms have been identified that use wastewater as a substrate for their growth and development, produce bioelectricity. Our study aims to characterize and check the potentiality of selected electrigens for their ability to generate electricity and to develop a peculiar Microgen-Based Electrochemical Cell. The wastewater treatment techniques conventionally employed are energy-demanding and are ineffective in utilizing the wastewater's potential energy. The carbonaceous compounds present in wastewater are recovered by a biochemical conversion system that generates bioelectricity. The generated conducting electrons will then be transferred to the electrode to conduct electricity with the help of MFC. The isolated bacterial and fungal species utilize wastewater as a substrate and generate bioelectricity. The organic substrates include saccharides, amino acids, fatty acids, and organic acids (acetic acid, butyric acid, propionic acid), present in wastewater, are utilized by these species of bacteria and fungus for their growth and development, thus generating electrons and producing bioelectricity.

Keywords: Microbial Fuel Cell, Electrigen, Wastewater, Nanotechnology, Bioelectricity

Paper: 131

Biochemical and Molecular View of Biofilms formation by thermohalotolerant Plant Growth Promoting Bacteria Bacillus subtilis J35 and its role in mitigation of biotic and abiotic stress

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ABSTRACT:

With the ongoing global climate change, desertification and aridification have emerged as one of the major environmental challenges. According to recent estimates, arid or semi-arid regions cover ~27% of global terrestrial regions. These regions are characterized by extremes of topographical and climatic conditions that induce a very strong biotic and abiotic stress. Therefore, plant growth and survival within these regions are rather challenging. Plant-growth promoting bacteria (PGPB) isolated and characterized from arid and semi-arid regions are projected to mitigate the hazards of both biotic and abiotic stress. Previously, we had carried out isolation and characterization of several PGPBs from arid and semi- arid regions of Rajasthan. These strains are bestowed with multi-faceted plant growth promotion characteristics including ACC-deaminase activity and biofilm formation. Interestingly, PGPB strains with the capability of forming biofilm are found to mitigate the harmful effects of simulated biotic stress and allow the plant growth. However, the putative mechanism for plant growth-promotion by biofilm forming PGPBs remained unexplored. To address the same, we generated deletion mutants in different components of the molecular cascade of biofilm formation in Bacillus sp. strain.

Keywords:

Paper: 132

Variability of buried soil organic carbon: Differences along eroding and depositional transects

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ABSTRACT:

Soil is essential to Earth's ecosystems, supporting plant growth, regulating water cycles, and acting as a key carbon reservoir. With climate change concerns rising, understanding soil carbon sequestration—where carbon is stored in soil for long periods—has become crucial. Accurately assessing soil carbon dynamics is vital for developing effective climate change mitigation strategies.

Paleosols are formed when the topsoil gets buried by the lateral distribution of soil and can store large quantities of soil organic matter (SOM) that may persist over millennial timescales due to its detachment from the disturbances at the surface. We studied buried SOM dynamics in the Brady paleosol, a deep loess (aeolian) deposit in Nebraska, USA, where climate has historically driven varying rates of loess deposition during the late Pleistocene and Holocene, burying soils up to 50m below the surface. Soils were sampled along the depositional and erosional transects at depths from 0.2 to 5.5m to understand the variability in the physical and chemical composition of the soils. We used elemental and isotopic compositions of C, N,13C, and15N, along with radiocarbon, base cation concentrations, and Fourier Transformed Infrared Spectroscopy (FTIR) to determine the distribution, stabilization, and composition of SOM and organic carbon in the soil profiles. Our results show a general decreasing trend of d13C and d15N values with depth, suggesting root input to soil carbon pools and the presence of less decomposed SOM in the deeply buried soil layers. Radiocarbon analysis of bulk soil indicated a loss of ancient carbon and incorporation of new organic carbon in the eroding transect. Our study highlights the need for furthering our understanding of how a predicted increase in precipitation quantity and intensity coupled with accelerated erosion has the potential to release large quantities of greenhouse gases by mineralization of previously protected old carbon stocks.

Keywords: Paleosol, Carbon sequestration, Fourier transformed infrared spectroscopy (FTIR), Stable isotope, Radiocarbon

Paper: 133

Waste Biomass from Phytoremediation of Heavy Metal Contaminated Soil – A Biorefinery Feedstock for Biofuels

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ABSTRACT:

Population growth has increased resource demand and technological advancements, leading to higher material and energy consumption. This unsustainable exploitation, especially reliance on fossil fuels, drives environmental degradation and climate change. Awareness of sustainability has grown, prompting the pursuit of eco-friendly alternatives.

Biofuels from biomass are emerging as substitutes in transportation, offering reduced greenhouse gas emissions. However, industrial practices like mining and intensive agriculture contaminate soil with heavy metals, affecting food production and ecosystem health. A holistic approach is needed—combining renewable energy adoption with sustainable agriculture and resource extraction. Policymakers, industries, and communities must collaborate to protect soil, ensure food security, and support sustainable development.

Phytoremediation is a low-cost, in-situ method for removing soil contaminants. Yet, biomass from this process, containing heavy metals, is often discarded, wasting resources. This study explores corn and sunflower plants for phytoremediation of cadmium- and zinc-contaminated soils. These plants, known for heavy metal tolerance, are integrated into a biorefinery process to produce bioethanol, biodiesel, and biogas.

A Life Cycle Assessment (LCA) compared biofuels from contaminated and non-contaminated soils, evaluating emissions, energy use, and sustainability. Preliminary results show biofuels from contaminated soils are viable, though heavy metals affect lifecycle emissions. Despite this, combining soil remediation with biofuel production supports the biorefinery model.

In conclusion, integrating phytoremediation and biofuel production addresses soil contamination and promotes sustainable energy. Further research and optimization will improve efficiency and feasibility.

Paper: 134

Circular Economy Adoption for the next Generation

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ABSTRACT:

Significant interest has been seen in recent part to curb the use of fossil fuels in different nations while the installation and use of the renewable electricity generation by energy sources are increasing year by year. The extraction of natural resources has to be reduced while the use of renewables needs to be increased. The need of effective waste management and implementation of circular economy strategies are significant in today's global requirements. Technologists, Scientists, policy makers, industries, and other stakeholders have been trying to achieve the sustainable environment while a group of nations are involved in damaging the environment by their power. The huge amount of wastes, the emission generated and damage to the mankind impacting significantly on the eco system from the war. It has to be stopped for the interest of the people and environment as a whole in a broader prospective having a paradigm shift from own interest. We are rapidly approaching dangerous tipping points for every aspect of human life, from our health and safety, our natural environment, our economies, to our property and infrastructure. We have to act for achieving. epcd2 (Extract-Produce-Consume-Dispose-Deplete) in the concept of linear economy has been creating enormous adverse impact on the natural resources reserve. A few countries used to ship tons of waste to China and a few other countries every year making it a dump yard, while India and China recently ban these activities and no longer import discarded plastics, yarn, cotton, ash, waste wool, slag from steelmaking, or paper etc. Traditional disposal methods fail miserably to adequately and properly handle the increasing load. Waste dumped into our oceans is polluting the planet and harming marine, animal, and human life. Circular Economy is the way of life. We need to have the pathway to move forward for sustainable development. There are a number of initiatives, concepts, best practices, legislations which are the endeavour of coming out of the crisis and leave in less pollutes or no polluted globe. Following is a few of those.

- Sustainable development Goals 2030
- Circular Economy and 3Rs models,
- Zero waste models

- Pathways to waste prevention
- Pathways to Prioritising Waste
- Waste management business models
- Data and digitalisation to strengthen the waste management value chain
- Pathways to delivering societal change & adopting behavioural science
- Ensuring inclusion and representation
- Building national capacity
- Educate and involve the school children on waste management, Circular Economy & business models

This is the time when the concept of circular economy and the waste management have to be injected among the school in the society. The first of its kind, the mission, "Catch Them Young: Zero Waste and Circular Economy in Campus" conceptualized and started its operation in India very recently in which more than 200,000 school children and their teacher have been working and growing at an increasing rate. Circular Economy may be defined as, "Circular economy is a paradigm shift from the traditional concept of linear economy of extract-produce-consume-dispose-deplete (epcd2) to an elevated echelon of innovative resource conservation through changed concept of design of production processes and materials selection for higher life cycle, conservation of all kinds of resources, material and/or energy recovery all through the processes, and at the end of the life for a specific use of the product will be still fit to be utilized as the input materials to a new production process in the value chain with a close loop materials cycles in a sustainable business model that improves resource efficiency, resource productivity, creates employment opportunities, and provides environmental sustainability" (Ghosh, S. K. 2020). The circular economy may help in reducing the extraction of natural resources by using secondary raw materials (SRM) developing regenerative process, reduces process cost and cycle time while and enhances life cycles, generates employment, generates economy, leading to a sustainable development.

We have to strengthen cultural adoption of circular economy among the in Schools Children in schools, encourage the MSMEs to adopt circular economy in their processes, encourage the municipal administration to practice circular.

Keywords: School Children, Industry, Resource Utilisation, secondary raw materials, epcd2

Our collaborators

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Government of India

USERC
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Department of Science & Technology
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Our International Partners

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