

1st INTERNATIONAL CONFERENCE ON
Climate Change & Sustainable Development
“Shaping a Sustainable Future: Global Solutions for Climate Change”
25th to 26th Feb 2025
SINES, NUST Islamabad



ABSTRACT BOOK



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1. Cultural Dynamics and Social Vulnerabilities in the Face of Climate Change in Pakistan

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Abstract

Climate change is a multifaceted global challenge that disproportionately impacts societies with socioeconomic vulnerabilities, such as Pakistan. This paper examines the social dimensions of climate change within the context of Pakistani society and culture, highlighting the intricate interplay between environmental stressors and social structures. Pakistan's diverse cultural fabric, characterized by distinct ethnicities, traditions, and livelihoods, is intricately tied to natural resources, which are increasingly threatened by climate variability. Rising temperatures, erratic monsoons, and glacial melting are exacerbating water scarcity, agricultural instability, and displacement, disproportionately affecting marginalized communities, especially women and rural populations. The paper explores how these climate-induced disruptions challenge traditional social systems, intensify inequalities, and strain communal resilience. It also delves into cultural practices and indigenous knowledge that offer adaptive strategies and potential solutions to mitigate climate impacts. Moreover, this study emphasizes the urgent need for culturally sensitive policies that integrate local communities, gender equity, and social inclusion in climate action frameworks. By addressing the social dimensions of climate change, Pakistan can foster a more sustainable and equitable response to this pressing global issue, ensuring that its diverse societal and cultural heritage is preserved amidst environmental challenges.

Keywords: Climate Change, Social Vulnerabilities, Cultural Resilience

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2. Analyzing the Role of Pakistani News Media in Shaping Public Awareness about Climate Change in their Prime-Time Bulletins and Programs

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Abstract

This article finds out the relationship between climate change awareness and news media role in Pakistan, aiming to construct an integrated model to interplay between awareness of environmental issues and behavioural changes. Instead of conventional studies that primarily focus on the impact of selective, topic-specific electronic media viewership, this research examines the role of news media, viewers perception, and information consumption on multiple dependent variables. Utilizing data from News Media of Pakistan, with a focus on its implications for both problem awareness and subsequent behavioural intentions. Through a disciplinary approach drawing from media studies, and communication theory, the research investigates that the news content, its framing, and patterns of climate change-related news within Pakistani media outlets. This research examines impacts of media usage on multiple dependent variables related to climate change awareness and because climate change became one of the top issues of world with its types, smog, water scarcity, global warming etc. By analysing audience perceptions, and responses, this study aims to elucidate the complex relationship between media coverage, public awareness, and individual actions toward climate change in the Pakistani context. Agenda setting theory plays a pivotal role in this study. A content analysis of different prime time news and programs of top 3 News media channels of Pakistan, from February 2023 to January 2024 was done to collect the data that how news media is framing and give awareness to its audience about climate issues. The results show that news media audience have a certain influence on awareness of climate problems and related to behavioural intentions, but the results cannot be explained only by a simple formula. The analysis of news media channels shows that news media is building audience views about issues of climate change, and this change is helpful in their practices to eradicate global warming and other hazardous of climate change from society to make a better world for upcoming generations.

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3. Harnessing LEED Certification for Transformative Built Environment Education: A Case Study of Architecture and Design in Pakistan.

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Abstract

Introduction: Indoor spaces and built environment became the major space occupancy for the human race in 21st century without any exception for race, gender, age or geography. Built form became the best friend for humanity as a source of protection & shelter but due to non-renewable resources and methods for development used, it led to natural environmental degradation and climate change. **Objective:** Lack of environmental and sustainability prioritization becomes a major issue in modern day lives due to severe impacts and destruction caused by climate change. Hence sensitization & awareness of future and current generation professionals become critical towards sustainable development through education & training. **Methodology:** The current research endeavor focused on evaluation and exploration of awareness & knowledge of LEED (Leadership in Energy & Environmental Design) as a global standard for built environment integration by future built environment professionals in Pakistan. **Results:** Based on the results from 100 students of four Higher Education Institutions with built environment design based degree programs using two-way data collection approach was deployed. It was concluded that respondents were aware of LEED as a global standard and its critical value it can add towards sustainable development in current built environment and challenges of Pakistan. However, it was also identified that knowledge towards practical implication and implementation was mainly missing. **Recommendations:** As part of study, it was proposed that LEED should be considered as an integrated subject and an approach towards design process development & evolution for current climate change challenges of Pakistan.

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4. Experimental Study of a Solar Flat Plate Collector with Propylene Glycol as Heat Transfer Fluid in Pakistan's Climate

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Abstract

The most readily available, environmentally safe energy source that can meet the rising energy demand is solar energy. Pakistan is located on Earth in a region of significant solar isolation. Off-grid locations in the western deserts and southern regions can create electricity using the potential of solar energy resources. Solar cookers, solar water heaters, and other devices are only a few examples of the many uses of solar energy. Because of insufficient laws and infrastructure, the tremendous potential of renewable energy sources may not be used to address the current energy crisis. To achieve sustainable power development and its implementation in the nation, it is crucial to consider diversifying current energy supplies and exploring new sources. In this work, the experimental investigation into the heat transmission capabilities of a flat plate solar water heating system was conducted. The main goal of this investigation is to evaluate the behaviour of a Flat Plate Solar Water Heating System (FPSWHS) with a 2.3 m² receiver surface area in South Punjab weather conditions in Pakistan and to estimate the heat energy produced by the receiver for residential uses, which reduces electricity consumption and aids the country in carbon fuel energy conservation. The installation of the experimental setup makes use of a piece of equipment from the 2E - ENERGY & ENVIRONMENT line of goods, specifically, an HL 313 Domestic Water Heating with Flat Plate Collector. The findings point to an improvement in the overall average thermal performance efficiency brought about by the use of a combination of propylene and water. The results showed that the projected average effectiveness of the solar thermal system stayed at 41.2% and that the system's highest water output temperature was 44°C.

Keywords: Renewable energy; solar thermal system; heat transmission; carbon fuel energy conservation



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5. Empowering Women for Climate Resilience and Gender-Sensitive Adaptation

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Abstract

The impacts of climate change disproportionately affect marginalized groups, with women frequently facing the greatest challenges due to entrenched social, economic, and political inequalities. This study investigates the gendered dimensions of climate change, focusing on the critical role women play in disaster risk reduction and recovery. It also highlights the necessity of incorporating gender-sensitive approaches into climate adaptation policies. Framed within the lens of Constructivist theory, the study examines how societal gender norms influence the roles women occupy in climate action.

It argues that empowering women through access to resources, education, and leadership positions can reshape these norms, thereby enhancing adaptive capacities at local and national levels. Employing a mixed-methods approach, the research reveals both obstacles and opportunities for fostering women’s leadership in climate resilience efforts. While the findings emphasize that integrating women’s perspectives into climate policy results in more inclusive and effective solutions, particularly in disaster preparedness, resource allocation, and post-crisis recovery.

In this vein, the study underscores a critical pathway to sustainable development by addressing gender inequalities. It calls for a shift in policy that recognizes women not only as beneficiaries of climate initiatives but as agents of transformative change. These insights provide valuable guidance for policymakers, development practitioners, and international organizations aiming to promote equitable and sustainable responses to climate challenges.

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6. Production of Bioethanol from Food Waste Using *Saccharomyces Cerevisiae*

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Abstract

There has an increased interest in bioethanol as a potential alternative to fossil fuels because of its environmental and economic benefits. Food waste is an abundant and underutilized resource with significant potential for bioethanol production offering a sustainable solution to global energy demands. The study investigates the feasibility of converting food waste into bioethanol in Pakistan. The bioethanol was obtained through biochemical process from food waste collected from different households and cafeterias. The food waste was dried and grinded to 1-3 mm size. Dilute acid Pretreatment and Enzymatic hydrolysis was used to breakdown food waste into reducing sugars. The best conversion rate was achieved from pretreatment with 5% acid concentration and hydrolysis at 50°C temperature for 36 hours. The break downed sample was then fermented using *Saccharomyces cerevisiae* at 35°C for 7 days. The reducing sugars conversion to the product was analyzed after every 24 hours. Utilizing food waste as feedstock over traditional starch and sugar-based materials offers dual benefits of reducing food waste and addressing energy needs. By integrating waste into renewable energy production can help Pakistan to achieve its sustainable energy goals and target.

Keywords: Bioethanol, Food Waste, Acid Pretreatment, Enzymatic Hydrolysis, *Saccharomyces cerevisiae*.

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7. Sustainable Production for Hydrogen via Photocatalytic Water Splitting

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Abstract

Hydrogen is a key enabler of the clean energy transition, offering a carbon-free, high-energy-density alternative to fossil fuels. Solar-driven photocatalytic water splitting is an environmentally sustainable method for hydrogen production, utilizing sunlight to convert water—an abundant and renewable resource—into hydrogen and oxygen. However, this process is hindered by the slow kinetics of the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), necessitating the use of highly efficient and cost-effective catalysts. Traditional noble-metal-based catalysts, despite their effectiveness, suffer from high cost, scarcity, and stability issues, limiting their scalability for large-scale hydrogen production.

MXenes, a class of two-dimensional (2D) transition metal carbides and nitrides, have emerged as promising next-generation photocatalysts due to their high electrical conductivity, tunable surface chemistry, strong light absorption, and layered structure, which enhances charge transport and catalytic activity. However, a deeper understanding of their functionalization-dependent electronic structure and photocatalytic efficiency is required to optimize their performance for sustainable hydrogen production.

This study presents a comprehensive computational investigation of functionalized MXenes as efficient photocatalysts for solar-driven hydrogen production. Using density functional theory (DFT) and time-dependent DFT (TD-DFT) simulations, we analyze the impact of surface functionalization on electronic structure, band gap modulation, charge transfer efficiency, and light absorption properties. Our findings reveal that functionalized MXenes exhibit an optimal band gap for visible-light-driven photocatalysis, enhanced charge separation, and well-defined active sites for HER and OER, making them ideal for scalable, solar-powered hydrogen generation. These insights contribute to the rational design of cost-effective, high-performance photocatalysts, accelerating the development of clean hydrogen technologies and advancing the vision of a sustainable energy future.

Keywords: Photocatalyst, Mxenes, Water Spilting, Computational Study



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8. A Sustainable Pathway for Scalable Carbon Capture and Climate Mitigation

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Abstract

The growing climate crisis demands urgent and innovative solutions to reduce carbon emissions and promote sustainability. Carbon capture technologies are essential in this effort, but current methods face challenges such as high costs, limited efficiency, and environmental concerns. This highlighted the need for scalable and eco-friendly alternatives. This study explored the potential of a widely available and sustainable material ALF as a promising solution for carbon capture and industrial decarbonization. Using robust computational framework integrating Density Functional Theory (DFT), Molecular Dynamics (MD) and Monte Carlo (MC) simulations, we investigated ALF's structural stability, adsorption efficiency and suitability for industrial-scale climate mitigation applications. Our findings showed strong chemical durability, excellent thermal stability up to 450°C, and a high capacity for capturing CO₂ with great selectivity over other gases like nitrogen and water vapor. These qualities make it a strong candidate for large-scale use in industrial carbon capture systems, addressing key gaps in current technologies. Beyond, its technical performance, this research has significant implications for climate action and sustainable development. By offering a cost-effective and scalable solution, it supported the shift toward cleaner industries and helps achieve global decarbonization goals. The study aligned with major international sustainability efforts, particularly the United Nations Sustainable Development Goals (SDG 13: Climate Action and SDG 9: Industry, Innovation, and Infrastructure), emphasizing the role of material science in tackling environmental challenges. As the world seeks practical ways to combat climate change, the use of advanced materials in carbon capture technologies represents a major step toward a more sustainable future. This research highlights the potential of innovative solutions to reduce greenhouse gas emissions and create a cleaner, greener planet. By connecting scientific progress with real-world applications, it demonstrates the important link between technology and sustainability in building a resilient, low-carbon future.

Keywords: ALF, CO₂ Capturing, DFT

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9. Assessing The Growth of Rice (*Oryza Sativa* L.) Seedlings Under Two Different Levels of Nitrogen Using Hydroponic System

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Abstract

Rice (*Oryza sativa* L.) is the staple food for half of the world's population so the focus on its productivity must be checked. Nitrogen is considered the main nutrient for its growth and improvement. On the other hand, nitrogen used as fertilizer causes environmental damage and loss of economy, but inadequate amount of nitrogen fertilizers also reduces yield and quality of rice production. The experiment was carried out at the Growth Room, Department of Botany, University of Agriculture Faisalabad (UAF). A nursery of 4 rice genotypes was established in plastic trays and these trays were filled with sand. In this study, hydroponic experiment was conducted by using four different varieties i.e., Chinab Basmati (CB), Kala Shah Kaku-133 (KSK-133), Chinab Basmati (CB-300) and Kainat Basmati (KB). To explore the potential of these four different varieties, Hoagland's solution was applied to meet the demand of other essential nutrients. In this experiment, two different recommended nitrogen levels; T1 containing 100% recommended nitrogen and T2 containing 50% recommended nitrogen were used as a treatment. The results indicated that by using 100% recommended level of nitrogen showed better results in KB variety. Morphological parameters were also improved in the presence of 100% recommended level of nitrogen i.e., primary root length, primary root diameter, length of lateral root, lateral root diameter, lateral root numbers and density of lateral roots increased as 15.8 cm, 3.8 mm, 10.4 cm, 2.6 mm, 5.0, and 2.72 mg respectively and in 50% it is increased as 13.9 cm, 3.2 mm, 9.8 cm, 3.5 mm, 5.0 and 1.71 mg respectively. Similarly, physiological parameters were also enhanced in the presence of 100% recommended level of nitrogen. Data was analyzed by using STATISTIX 8.1 software and then results were subjected to LSD test at 5% probability level.

Keywords: Rice growth, Nitrogen, Hydroponic system

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10. Rice production under different climatic conditions and its strategies

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Abstract

Rice (*Oryza sativa*) serve as staple foods for billions of people around the globe. The climatic conditions play a very important role in determining the productivity of rice. The rice is grown in different climatic zones like tropical, sub-tropical and temperate zones. The change in the climatic factors such as temperature, rainfall pattern and extreme unexpected weather events like floods and drought which increase the challenges for sustainable production. This review paper includes, the impact of climate variability on rice production. We reviewed the different articles about the rice production under different climatic conditions, got from different search engines like Google Scholar, PubMed which is published in different journals and selection criteria should be given in methodology section. The statistical analysis is incorporated in this by using descriptive statistics, regression analysis and ANOVA to check the impact of climatic variable on the rice yield. By the analysis we find that climatic variable has adversely affect the rice yield. Different variable has its own impact. The rise in temperature can cause the reduce of yield by 0.18tons/ha. The precipitation has positive impact on yield while the excessive rainfall on the maturity stages of crop can cause damage. The floods and drought condition are also directly effect the yield of rice crop. For the sustainable production of rice, we can adopt the different techniques including the climate smart production technology, adjust the sowing and transplanting dates, stress tolerance varieties and farmer training about the climatic change.

Keywords: Rice production, climate variables, impact on production, tropical rice, temperate rice, sub-tropical rice.



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11. Organic Agriculture in Rainfed Areas of Pakistan

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Abstract

Rainfed agriculture is an important part of Pakistan’s agricultural system, supporting the livelihoods of millions of smallholder farmers. However, conventional agriculture leads to soil degradation, water scarcity and reduced crop yields. This study explores the potential of organic agriculture as an alternative farming method in rainfed areas of Pakistan.

The results show that organic farming can improve soil health, conserve water, and increase crop yields. Organic practices such as crop rotation, composting, and mulching can increase soil fertility, structure, and biodiversity. Organic farming can also reduce soil erosion, improve water retention, and increase drought resilience. There is an opportunity to develop climate-smart agriculture strategies, promote organic farming, and empower farmers. Rain-fed agriculture in Pakistan can be more efficient, productive, and effective when organic farming is adopted.

Keywords: Organic farming, rainfed agriculture, sustainable agriculture, Pakistan, climate resilience.

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12. Innovative Agronomic Strategies for Sustainable Development in Rainfed Regions

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Abstract

Millions of smallholder farmers depend on rainfed agriculture for their livelihoods particularly in arid and semi-arid regions. However, the viability of this industry is being threatened by erratic rainfall patterns, degraded soil, and the negative consequences of climate change. In order to promote sustainable agriculture, this study aims to investigate different management strategies in rainfed areas, paying particular attention to important environmental elements including temperature, precipitation, and soil organic matter. A comprehensive review of over 10 articles was conducted through Google Scholar. The data extracted from these sources were processed using **Excel** and **SPSS**, calculating descriptive statistics like the mean, median, and mode. To ascertain the statistical significance of the influence of these variables, an **ANOVA** was conducted. Analyses of variance, correlation, and standard deviation were also performed in order to compare the findings with previously collected data and make inferences. This review explores sustainable agronomic practices aimed at enhancing the resilience, productivity, and ecological health of rainfed farming systems. Key approaches include effective water management techniques like mulching and rainwater harvesting, soil improvement through organic and integrated nutrient management, and diverse cropping methods such as intercropping and agroforestry. Additionally, climate-resilient technologies like climate-smart agriculture and precision farming are essential for mitigating the effects of rainfall variability and resource scarcity. Drawing from experiences in rainfed regions, the review emphasizes the need for innovative practices and supportive policies to address barriers to adoption. It concludes with recommendations for future research, farmer education, and institutional support to scale sustainable solutions, ensuring the long-term sustainability of rainfed agriculture and global food security.

Keywords: Sustainable agriculture, Crop management practices, Climate-smart agriculture, Rainfed farming systems.

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13. Drought Stress Mitigation in Rainfed Areas

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Abstract

Water scarcity poses a significant threat to rainfed farming systems, affecting crop yield, soil health, and ecological equilibrium. As drought frequency and intensity increase, the development of effective coping mechanisms becomes crucial for maintaining agricultural output and resilience.

A comprehensive literature review was conducted to examine "Drought Stress Mitigation in Rainfed Areas," exploring various adaptive techniques and their influence on sustainable agriculture. This study involved an extensive search of scholarly databases, such as PubMed, ScienceDirect, Scopus, and Google Scholar, to collect a diverse range of pertinent research. The review focused on peer-reviewed articles, systematic reviews, case studies, and scientific reports that offered evidence on drought stress impacts and mitigation strategies in rainfed farming environments.

The search employed specific keywords including "drought stress," "rainfed agriculture," "adaptive strategies," "water management," and "crop resilience." To incorporate the latest findings, particularly those addressing the current climate challenges and innovative approaches, this review was limited to studies published within the last 10-15 years.

The analysis incorporated global and regional studies that evaluated the direct and indirect effects of drought stress on crop performance, soil moisture dynamics, and water use efficiency. We also investigated a wide array of mitigation strategies, such as drought-resistant crop varieties, efficient water management techniques (including mulching, rainwater harvesting, and drip irrigation), and soil amendments to improve water retention. Particular emphasis was placed on case studies from areas heavily reliant on rain-fed agriculture, such as sub-Saharan Africa and South Asia, where innovative practices have effectively minimized drought stress impacts.

Through this extensive literature synthesis, this review aims to provide a comprehensive understanding of the mechanisms by which drought stress affects rain-fed agriculture, the efficacy of various mitigation approaches, and methods to enhance resilience in these vulnerable regions. The findings from this review can inform policymakers, researchers, and practitioners in developing integrated frameworks for sustainable agricultural management in the face of persistent and intensifying drought conditions.



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14. Assessing the Underexplored Mental Health Impacts of Smog in Punjab: Challenges and Solutions

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Abstract

Smog has been a crucial issue in the Subcontinent region because of Climate Change. It has a wide range of significant impacts on society at different levels specifically, in Punjab. The unexplored and ignored impact of smog in Punjab is mental health. The focus of the Government of Punjab on environment-related issues and its policy-making has increased in recent times. But mental health has been ignored and it is evident by the first comprehensive plan of climate change called

“The Climate Resilient Punjab Vision & Action Plan 2024.” The policies of the Punjab Government, including this plan, have major reliance on former policies of the UN, including decade-old SDGs. These old policies talk about mental health (Target 3.4 SDGs) but not the mental health impact of climate change as this is a relatively new phenomenon. But this issue is getting the spotlight worldwide. For example, in COP28, the first-ever Health Day was held to discuss the mental impact of climate change. Recent research from multiple countries highlighted the connection between air quality, specifically PM 2.5 and PM 10 in the air, and mental health. These impacts include depression and anxiety in people while pregnant women may face post-pregnancy depression and their child can have brain aging. The hopelessness and frustration of youth against their government is also increasing in multiple countries as shown by a study. It is high time the government of Punjab takes steps to address this issue. The reason for this paper is to get the attention of not only government officials and policy-makers, but also academia. This paper will also do comparative analysis of mental health impact of climate change and policies of different countries with respect to Punjab. The sophisticated policy recommendations are discussed in the regard in the paper.

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15. Organic Farming and Its Impact on Soil Health, Biodiversity, and Ecosystems

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Abstract

Organic farming is essential to promote biodiversity and enhance ecosystem services. This approach utilizes natural inputs, such as compost, green manure, crop rotations, and biological pest control, thereby reducing the need for synthetic chemicals and fostering ecological equilibrium. Despite its benefits, the widespread adoption of organic farming encounters obstacles due to various socioeconomic and logistical factors. To develop effective strategies and address these challenges, it is imperative to examine the relationships among organic farming methods, biodiversity, and ecosystem health.

A comprehensive literature review was conducted to investigate the impacts of organic farming on biodiversity and ecosystems. This investigation involved an extensive search of academic databases, including PubMed, ScienceDirect, Scopus, and Google Scholar, to compile a diverse range of relevant studies. This review focused on peer-reviewed articles, systematic reviews, case studies, and scientific reports that provide evidence linking organic farming to improvements in biodiversity and ecosystem services.

The search utilized specific terms, including "organic farming," "biodiversity conservation," "ecosystem health," "sustainable agriculture," and "soil biodiversity." To incorporate the most recent findings, particularly those addressing current environmental challenges and agricultural sustainability, this review was limited to studies published within the last 10-15 years.

This analysis demonstrates global and regional studies that have evaluated the direct and indirect effects of organic farming on biodiversity, including its role in conserving pollinators, enhancing soil microbial diversity, and preserving natural habitats.

Compared with conventional agricultural practices, organic farming methods promote enhanced soil health and increased biodiversity. A study conducted over 150 years at Park Grass in the United Kingdom revealed that the extensive use of fertilizers resulted in an 80% decrease in flower diversity and a 50% reduction in pollinator populations, particularly affecting bees. Conversely, organic farming techniques that utilize natural compost and crop rotation resulted in a 20-30% increase in soil organic matter and a 15-25% rise in microbial biomass. A comprehensive review indicated that organic farming practices enhanced species richness by 30%, contributing positively to ecosystem health.

Nevertheless, knowledge gaps persist regarding the long-term impacts of specific organic farming practices and standardization of methods for evaluating soil quality and biodiversity. It is imperative to develop consistent metrics and conduct extensive field studies to optimize the role of organic farming in sustainable agriculture and ecosystem preservation.

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16. Morphological, Phenological and Adaptability of Olive Cultivars in Chakwal, Pakistan

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Abstract

Olive consumption and production succeed in attaining the great importance in Pakistan day by day. There are some problems in the cultivation of olive in different regions related to the morphology, phenology and production yield. The aim of the study was to provide morphological and phenological descriptions of foreign olive cultivars to evaluate their degree of adaptation to Pakistan's Pothwar (Chakwal area) climate. There are significant positive correlations between the parameters and notable variations between the cultivars were shown by the majority of the parameters. At that point, the Leccino variety's minimum yield is 3 kg, with a median yield of 11 kg. The Coratina variety's highest output is 22 kg. There are 39300 publications concerning the effects of climate change that we found on the Google Scholar. We read nine to ten articles. The result shows that there are five types: Jerbouli, Carainina, Gemlik, Nabali, and Picholine. Pakistan is the most suitable country for oil production. Without a question, the most pressing environmental issues of our day are those related to environmental change. The Mediterranean region, which produces the majority of olive oil, may be severely impacted by climate change. Olive trees can grow in a range of temperatures and terrains and are more durable than vines. Olive production is at danger from extremely high or low temperatures. The Mediterranean Basin Area Expects The production of olive crops is negatively impacted by the unfavourable growing conditions caused by global climate change. The study's findings suggest that urgent steps must be taken to identify ways to assess climate change and how it affects olive crops.

Keywords: Morphology, Phenology, Varieties, Reproductive character



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17. How to mitigate global warming

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Abstract

Global warming presents one of the most pressing challenges of the 21st century, threatening ecosystems, economies, and human livelihoods worldwide. This article explores effective strategies to mitigate global warming, focusing on reducing greenhouse gas emissions, enhancing carbon sequestration, and transitioning to sustainable energy systems. Key approaches include adopting renewable energy technologies, improving energy efficiency, reforestation, promoting climate-smart agriculture, and encouraging global policy frameworks that prioritize climate action. Furthermore, the article emphasizes the importance of individual and community-level efforts, such as lifestyle changes and waste reduction, in complementing large-scale initiatives. By integrating technological innovation, policy interventions, and grassroots actions, humanity can work collectively to curb global warming and build a resilient, sustainable future.

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18. Effect of Phosphorus in The Maize Crop for Mitigating Drought Stress

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Abstract

Phosphorus is a vital nutrient for plant increase and impacts the yield and exceptional of maize. in this look at, the effects of different phosphorus levels at the increase and yield of maize vegetation have been investigated. The pot test became carried out in 15 pots with three replicates and five P packages (0, 20, forty, 60 and 80 kg/ha) in every reflect. Maize flowers have been grown for 12 weeks and growth parameters (plant top, leaf vicinity and dry count) and yield (ear period, ear circumference and yield) were measured. The outcomes confirmed that there have been full-size variations in boom and damaging outcomes many of the unique remedies. increasing the phosphorus software fee to 60 kg/ha expanded corn boom and yield, whilst yield reduced at better software fees (eighty kg/ha). those findings suggest that surest P application is essential for growing corn yield and lowering environmental impacts. This studies offers treasured statistics for corn farmers and agricultural engineers who goal to improve phosphorus fertilizer utility to growth crop yield.

Keywords: Maize, Relative Water Content, Ros, Fertilizer



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19. Evaluating the Impact of Drought Stress on Sesame (*Sesamum indicum L.*) Yield and Productivity

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Abstract

The study evaluates that Sesame (*Sesamum indicum L.*) is an important oilseed crop which is highly susceptible to drought stress, which has been a major issue in decreasing its yield in arid and semi-arid areas. Some genotypes (SG-30, TS-3, TS-5, TH-6) were used to check the impact of drought on yield and yield component. This review explores the impact of drought stress on sesame growth yield and yield contributing traits which is the plant height, biomass yield, seed yield, seed weight. Normally, the lack of water would limit the height of the plant by suppressing cell division and elongation, resulting in stunted growth. Biomass yield is affected due to reducing the photosynthetic activities in drought condition. The movement of sunlight to growing seeds is delayed by insufficient water availability, seed weight is an important component for yield quality. Due to affect vegetative and reproductive growth, crop productivity is adversely affected and yield reduced effectively. This review shows the need of planned strategies to mitigate the effects of drought stress on sesame. Developing drought-resilient genotypes, optimizing water management practices, and improving crop management strategies are essential to enhance productivity in water-scarce regions.

Keywords: Genotype, plant height, seed weight, biomass yield, seed yield, water deficiency.



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20. Exploring Technological Innovations for Environmental Sustainability: A Systematic Review

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Abstract

This study investigates the role of technological advancements in environmental sustainability through a systematic literature Review. Key developments in technologies are identified by examining 20 peer-reviewed studies from databases like google scholar and Web of science. This study cites 5 dimensions in literature on advances in technology as critical drivers of environmental sustainability, including AI, IoT, renewable energy, and circular economy practices. It highlights their contribution to maximizing resource use, cutting emissions, and facilitating more informed decision-making for sustainability initiatives. Policymakers can use the findings as a guide to incorporate these innovations into plans that promote sustainable development while filling in current gaps in the literature.

Keywords: Environmental sustainability, Technological innovations, systematic literature review, renewable energy artificial intelligence, digital tools, sustainable development.

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21. Smog and Its Impacts on Agriculture in Pakistan

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Abstract

Smog has emerged as a severe and persistent environmental crisis in Pakistan, affecting millions from October to January annually. Urbanization, industrialization, and increasing fossil fuel consumption are generally identified as the main contributors to poor air quality. The main aim of this study was to identify smog as a potential source of human health risk as a serious repercussion of economic development. In this systematic review, we discuss the major issues concerning smog in Pakistan: the causes, methods of detection, hazardous effects, and opportunities for preventive measures based on ground-level information. The meta-analysis data were collected from different search engines, including Dawan news, Web of Science, Google Scholar, Scopus and PubMed by using targeted keywords. Result showed Air Quality Index (AQI) levels exceeding hazardous thresholds, peaking beyond 1,000, and even reaching 2,000 in some cities, the health and economic implications are devastating. This article analyzes the smog phenomenon using limited data, highlighting its impacts on public health, the environment, and policy. Despite being the world's leading contributor to the global disease burden, Pakistan lacks adequate air monitoring systems and actionable policies to combat air pollution. Factors such as cross-border wind patterns, industrial emissions, stubble burning, and urban congestion exacerbate the problem, particularly in cities like Lahore and Islamabad. Rain and geographical factors provide temporary relief, but smog persists year-round. The study suggest calls for immediate investment in real-time monitoring, data-driven policymaking, and targeted interventions to address this public health emergency, advocating for a shift from short-term measures to long-term, sustainable solutions. It is also suggested that adequate abatement measures should be established for the proper protection of public health

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22. Elucidation of Xylenol orange decontamination from Wastewater by Chitosan-Biomass based Membranes

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Abstract

In this research work prepared composite membranes using chitosan and mango leaves for the adsorption of Xylenol orange dye at ambient temperature. Different parameters including adsorbent dosage, contact time, initial dye concentration, pH and temperature were investigated. The results were evaluated through linear and non-linear forms of different kinetic models. The obtained experimental results depicted that the best fitted kinetic model was Pseudo Second Order indicated that adsorption was monolayer chemisorption and the adsorption process was governed via Liquid film diffusion mechanism. The experimental data was calculated by using two parameter and three parameter isotherms. The calculated data was best fitted to Langmuir isotherm and maximum adsorption capacity was 74.16 mg/g. Thermodynamic parameters i.e. Gibbs free energy ΔG have negative values confirming that adsorption process is spontaneous. Positive value of Enthalpy ΔH and Entropy ΔS showed that reaction was endothermic in nature and good affinity of composite membrane towards Xylenol orange dye. From these studies it is concluded that composite membrane can efficiently be used as adsorbent for treatment of wastewater.

Keywords: Adsorption; Composite membrane; Xylenol orange;

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23. Sustainable Aviation: Global best practices for implementation in Pakistani Aviation Industry

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Abstract

Sustainable aviation is becoming a critical focus of emerging global trends and innovations. The international aviation industry focuses on topics associated with reducing carbon emissions and addresses the challenges surrounding climate change and global warming. The research paper explores emerging and existing global practices in aviation sustainability, which are aligned with concepts of innovative technologies, alternative fuel resources, and operation efficiencies, with the ultimate goal of implementing recommendations for Pakistan's aviation sector. The paper highlights key frameworks like the Carbon Offsetting and Reduction Scheme for programs like CORSIA and promoting the usage of biofuels, all drawn from the primary research and international initiatives of the International Air Transport Association "IATA" and International Civil Aviation Organization "ICAO". Aspiration and inspiration for these initiatives arise from their successful implementation on a global scale, including countries like the USA and Brazil investing in biofuels, and Europe leading hydrogen-powered aircraft and electric aviation technologies.

Examination of Pakistan's current aviation practices and infrastructure capabilities are mentioned in the paper, to identify the potential gaps and opportunities on a global scale. It outlines how Pakistan's policymakers can align the aviation sector with sustainability on a global level, with efforts of adopting alternative fuel options, enhancing Air Traffic Management “ATM” systems, initiate auditing practices to counter carbon levels, and contributing to international collaborations. The paper also focuses on the geographical and strategic potential of Pakistan for becoming a regional hub for contributing to sustainable aviation, by benefiting from global knowledge transfer and through Public-Private Partnership Programs "PPP" programs. This study focuses primarily on environmental benefits that sustainable aviation can benefit the Pakistan economy, while aligning them with the Sustainable Development Goal 13 (SDG 13): Climate Action.

Keywords: Sustainable Aviation, Sustainability, Best Practices, IATA, ICAO, CORSIA, Biofuels, Policy Makers, SDGs, Climate Action.



24. The physiological and biochemical responses of rice (*Oryza sativa* L.) seedlings to MXenes (Ti₃C₂T_x) NPs

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Abstract

In recent years, MXenes, among the novelest and adaptable 2D nanomaterials, has demonstrated significant potential for applications in environmental remediation and biomedicine. Nonetheless, the application of MXenes materials in botanical contexts has garnered minimal focus. The current study investigated the impact of varying doses of 2D MXenes (25 to 100 µg mL⁻¹) on the physiological parameters of Rice (*Oryza sativa*) seedlings. The 2D MXenes (Ti₃C₂T_x) nanomaterials were synthesized from their precursor MAX (Ti₃AlC₂), and their fabrication was validated by various characterization techniques (SEM-EDX, XRD, and FTIR). Following 8-days of being exposed to treatments levels, rice seedlings were assessed, and growth-related characteristics were determined. Results indicated a significant increase in GP (89.7%, 62.5% and 33.8%), VI (300.9%, 176.4% and 79.2%), RL (92.9%, 70.6% and 44.0%), SL (88.6%, 69.8% and 34.3%), RFW (90.6%, 56.7%, 22.5%) and SFW (55.9%, 38.5%, 18.8%) at the respective lower levels of MXenes (25, 50 and 75 µg mL⁻¹) compared to the control, while at 100 µg mL⁻¹ MXenes GP (26.7%) and VI (54.5%) were decreased. Notably, the addition of 25 µg mL⁻¹ MXenes imposes highest significant increase in seedlings growth. Hence, according to the study's innovative findings, Ti₃C₂T_x are viable NPs for modern farming practices that will speed up the advancement of nanotechnology in efficient production and agricultural research.

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25. Effects of Nitrogen Fertilization on the growth and Yield of Wheat (*Triticum aestivum* L.):

A review

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Abstract

Nitrogen application significantly enhance wheat growth and yield. This study was conducted to analyze the effect of nitrogen levels on growth and yield of wheat. Information was collected about plant height, number of tillers per meter square, spike length, grain yield, biological yield and 1000 grain weight by using search engine like PubMed, google scholar and science direct by using these key words; nitrogen management, grain yield with nitrogen, plant height with nitrogen and plant growth. These parameters were statistically analyze to find mean, standard error, standard deviation and correlation. The results show that plant height, number of tillers per meter square, spike length, grain yield, biological yield and 1000 grain weight were significantly increased by increasing the nitrogen levels, but once the optimal limit reached, further application gave no significant results. It was observed that applying 130-180 kg/ha of nitrogen was optimal nitrogen rate for maximizing growth and yield of wheat. These finding suggest that optimal nitrogen management is essential for improving both growth and yield in wheat.

Keywords: Nitrogen management, nitrogen use efficiency, wheat growth, optimal nitrogen rates, wheat yield

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26. Vertical Farming
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Abstract

Land degradation is the main issue because of the urbanization. Peoples are migrated from rural to urban areas and the world population is increasing rapidly the world population expected to reach 9 billion over next 50 years. The food demand is also increasing and overall climate change also affects the food production by decreasing yield by several environmental factors. Vertical farming is the advanced method to overcome this issue crops are grown under controlled environment with precise management practices. It consists of different types like hydroponics, aeroponic, aquaponic etc. It is also known as term sky farming. Growing of crops on both cities as well as town lands to contribute in food production. By comparing vertical farming yield with field yield we clearly know that the yield is much more in vertical farming system. It shows the potential of vertical farming to contribute in food security and sustainability.

Keywords: Vertical farming, sky farming, hydroponic, aeroponic, aquaponic, field farming, urbanization, food security



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27. Drought stress in wheat; impact and strategies to combat drought

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Wheat is the most important growing cereal crop worldwide. It serves as a source of protein and calories for average person's diet. One of the biggest challenges for wheat production is drought, particularly as climate change causing more frequent and severe water shortages, rising atmospheric CO₂, change in rainfall and wind patterns. Drought slows down seed germination, seedling vigor, weak young plants, reduces grain yield and quality, which poses a major threat to global food security. According to previous researches, water shortage during crucial growth stages, like fertilization, seed establishment, fertilization and grain filling cause average yield losses. In some extreme cases, reduction in biomass and grain counts per spike has been high as 62.75%. Reduction in growth and development results in wheat physiological reaction to dryness, which also drops osmotic potential, chlorophyll and relative water content. Agronomic practices such as optimized irrigation techniques and soil management techniques can also improve water availability and retention for crop during dry season. Many strategies are proposed to reduce negative effects of drought on wheat production; one of the main is the breeding for drought tolerant varieties. The breeders screen different wheat genotypes for traits that confer resilience under water shortage conditions.

Keywords: Wheat, Drought, Grain, yield, Traits, Varieties.

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28. Challenges of climate change governance in Pakistan: A perspective of intergovernmental relations

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Abstract

Climate change has posed unprecedented challenges for the world, particularly developing countries that are more at risk. Proactive governance initiatives are required by different levels of government to address the negative consequences of climate change. Intergovernmental relations (IGRs) have a key role in aligning coordination among different tiers of governments in the formulation and implementation of climate change adaptation policies. However, there are multiple challenges and hurdles to ensuring effective IGRs for effective climate governance. This study is conducted to explore and identify such key challenges for IGRs in terms of effective climate adaptation governance by looking at the Pakistani case in the agriculture sector. We employ a case study method for this research, where 22 semi-structured interviews were conducted with relevant actors. Our findings reveal that one of the reasons for weak IGRs is the unstable political situation in the country. There is no goodwill or any sound mechanism of coordination between the federal government and provinces and among the provinces in case of dealing with climate change. Additionally, the lack of institutional and technical capabilities of local institutions and the unavailability of support from other tiers of the government due to political differences are the reasons for limited IGRs. Local institutions are unclear about their roles, responsibilities, and powers. This situation creates confusion among the institutions and cannot produce sound IGRs. There is a lack of coordination among the provinces due to different political manifestos and diverse governance approaches within their governmental territories. Our results found that civil society organizations (CSOs) play an important role in the promotion of IGRs. The CSOs provide a platform for all actors by arranging different workshops and seminars. There is a need to improve horizontal and vertical coordination among governmental institutions to remove institutional confusion about climate change in the country.

Keywords: Adaptation, Climate Change, Governance, Intergovernmental relations, Policies, Pakistan



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29. Towards Sustainability: An Investigation of Green Transformational Leadership, Green Knowledge Sharing, and Green Product/Process Design in Pakistani Private Universities and their Impact on Environmental Performance.

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Abstract

Despite extensive literature on manufacturing firms, there is also a need to give more attention to the service and education sectors in order to address environmental-related issues. The primary objective of the research is to investigate the impact of green transformational leadership on environmental performance, while green process design mediating between them and the green knowledge sharing have the impact on the association between green transformational leadership and green process design. Based on leadership theory, five hypothesis were proposed. This is a cross-sectional, positivism, quantitative research study. The data was gathered from staff and faculty members of different public and private universities by the using of convenience sampling method. The Statistical Package for the Social Sciences (SPSS) and equivalent statistical software was used to analyze the data. This research is important, as it will provide direction on how to address environmental issues in the education sector. However, the findings may be specific to the higher education sector in Pakistan and may not be fully generalizable to different cultural or institutional settings. This research open the new way for future researcher to explore this relation in different educational contexts or other service sectors, could lead to a more thorough comprehension of the environmental conservation. In future, it can be measured that how can environmentally stable educational institute affect the students psyche and it create, what impact when they work in field. Longitudinal studies could further investigate temporal aspects of this relationship by tracking changes over time to establish causality.

Keywords: Green Transformational Leadership, Green Knowledge Sharing, Green Process Design, Environmental Performance

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30. Biomass Waste Derived Sustainable Natural Biopolymers for Wastewater Treatment

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Abstract

Sustainable wastewater treatment is essential in mitigating the impacts of climate change, particularly in addressing water scarcity. As climate change exacerbates droughts and reduces freshwater availability, treating and reusing wastewater becomes a critical strategy for conserving water resources. By employing eco-friendly technologies, such as resource recovery and advanced filtration, sustainable treatment processes can reduce the strain on natural water bodies, mitigate water shortages, and lower the carbon footprint of conventional water treatment. Chitosan (CHT) extracted from waste biomass, has huge potential in sustainable wastewater treatment applications owing to its unique features including biodegradability, biocompatibility, versatile adsorbing and film forming capability. Our research emphasized the use of CHT biopolymer as a green and sustainable material for variety of wastewater treatment processes such as coagulation, flocculation, and membrane separation. In this study, we employed Monte-Carlo (MC) simulation approach to investigate the adsorption of toxic anionic reactive azo, cationic basic and neutral disperse dyes on CHT [110] surface. The quantum chemical descriptors calculations were carried out by density functional theory (DFT) at the B3LYP/LANL2DZ level in the aqueous medium using Gaussian. The obtained adsorption energy against CHT was found in the order of Anions > Cations > Neutral dyes indicated a spontaneous process with physisorption as a dominant mechanism. Our investigation also scrutinized future prospects of CHT-based materials, emphasizing its potential role in promoting water pollution management practices. This not only helps in combating climate change but also fosters resilience to its effects, ensuring a more sustainable water future.

Keywords: Density functional theory, Monte-Carlo, Sustainable wastewater treatment, Water shortage mitigation.

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31. Determination and Validation of Drought Conditions and Flood events using vegetation temperature condition index over the cropland of Punjab Pakistan

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Abstract

Pakistan has experienced severe drought and flood events since 1871-2014, but the worst drought was experienced in 1998-2002 and worst flood in 2010 over the last five decades. We assessed 12-yr of drought conditions during the winter wheat-crop-growing seasons to determine and validate the record-breaking effects of the drought during 1998-2002 as well as flood during 2010 and its effect on the 12-yr (2003-2014) and follow on period of 2011-2014. This study employed a near-real-time drought monitoring approach termed as vegetation temperature condition index (VTCI) to investigate the drought conditions over the plain of Punjab, Pakistan. We identified the warm edges (LST_{max}) and cold edges (LST_{min}) of VTCI, and determined and validated the drought conditions using MODIS-Aqua data products. We determined the long-lasting drought (1998-2002) impact on the winter-wheat-growing season's drought conditions during 2003-2014. The VTCI approach is based on the integration of the normalized difference vegetation index (NDVI) and land surface temperature (LST) for the edges and drought conditions. The obtained mapped VTCI imagery and daily precipitation data were used for the validation of drought at five weather-stations. It was established that the VTCI has a significant linear correlation coefficient (r) with cumulative precipitation ($r = 0.57$) in D-041 (day 41 of the year) during 2003-2014. In addition, during the 2010's flood events, a negative relationship was observed in D-185 due to heavy rainfall, and nonlinear in the D-201, and a negative relationship was established in D-217, these shows the flood time, duration and intensity. However, in D-233 and D-281 the relationship was significant. This shows the flood events and drought conditions in the plain. The relationship indicates that the VTCI not only achieves results that are very close to the recent precipitation anomaly but also correlates on past precipitation. This reveals the effectiveness of VTCI approach for the determination of warm and cold edges, drought conditions and flood detection in the given periods over the region. The results show that the long-lasting drought and monsoon's heavy rain or flood events have effects on the winter-wheat-crop and indicate the favorable and unfavorable conditions under rain-fed and irrigated conditions during 2003-2014 in the plain of Punjab. By and large, the achievable allusion payable to climate changes threats toward Asia and specific to the



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region in the appearance of temperature extremes, glacier melts, flooding and drought conditions. This learning proposes the problem of climate changes with an uphold form of the natural disasters to recognize the extreme vulnerability impacts of temperature changes, heat extremes, heavy rain-falls, glacier melts, river/stream flow and agriculture in the region of Punjab, Pakistan.

Keywords: Drought monitoring, flood detection, Climate extremes, MODIS data products, VTCI approach



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32. Transformative Strategies in Global Environmental Governance: Integrating Climate Change Mitigation with the Advancement of Sustainable Development Goals (SDGs)

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Abstract

The intricate relationship between climate change and sustainable development necessitates a paradigm shift in global environmental governance. This paper explores multifaceted strategies required to address the interlinked challenges of climate change and development through the lens of the United Nations Sustainable Development Goals (SDGs). Climate change has far-reaching implications, exacerbating socio-economic disparities, threatening ecosystems, and undermining developmental gains. Thus, effective governance structures are imperative to not only mitigate environmental impacts but also ensure sustainable pathways for human development (Gupta et al., 2024).

This paper provides a comprehensive review of transformative governance strategies that integrate climate action with SDG objectives. It emphasizes the importance of strengthening international climate cooperation through binding agreements, such as the Paris Agreement, and promoting climate justice through equitable financial mechanisms (Rockström et al., 2024). Additionally, the paper discusses the role of circular economies, green investments, and climate-smart agricultural practices in facilitating sustainable development while reducing greenhouse gas emissions (Bai et al., 2024). A crucial aspect explored is the implementation of nature-based solutions for adaptation, highlighting how ecosystems such as forests, wetlands, and coastal systems play a significant role in building resilience against climate impacts (Heras & Gupta, 2023).

Furthermore, this study underscores the need for enhancing institutional frameworks and monitoring systems to ensure accountability, transparency, and progress toward both climate goals and SDGs. The proposed strategies are designed to address current gaps in governance, with a focus on inclusive decision-making, multilateral cooperation, and the mobilization of innovative financing models (Gupta et al., 2024). Lastly, the paper discusses the role of digital technologies, such as AI and blockchain, in promoting data-driven governance and fostering global collaboration (McDonnell & Gupta, 2024).

Through a robust integration of climate change mitigation and SDG achievement, this paper aims to present a forward-looking framework that promotes resilience, equity, and sustainability, ensuring that the global response to environmental challenges is both comprehensive and impactful (Gifford et al., 2023).

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33. Climate Change Governance and Foreign Policy of Pakistan
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Abstract

The primary cause of climate change is human activity, especially in light of the widespread industrialization that has been observed in Western nations. The effects of climate change are currently unevenly dispersed, threatening every country regardless of how much each one has contributed to the issue. Pakistan is the sixth most vulnerable country to climate change, although producing less than 1% of the world's emissions. Pakistan's efforts in climate governance are still insufficient, making the nation more vulnerable to climate-related problems, even though many other countries have put into place efficient mitigation and adaptation plans to tackle these dangers. At the level of different tiers of government, the problem of climate change has not been methodically institutionalized along with clear deficiency in knowledge and readiness about climate change. However, being an entity to international climate change regime Pakistan has come up with a number of domestic and international climate change response initiatives in response to these concerns. Pakistan's National Climate Change Policy was first introduced in 2012 and has since undergone multiple changes by different administrations. Pakistan actively participates in international climate change debates and is dedicated to upholding its duties. Pakistan's participation in international climate change diplomacy is indicative of its dedication to tackling worldwide environmental issues. Pakistan aims to improve its reputation abroad and support worldwide efforts to tackle climate change by taking an active part in discussions about the issue and enacting laws at home. Furthermore, Pakistan's foreign policy highlights its role as a responsible global actor in the battle against climate change by emphasizing the significance of coordination and cooperation with other countries to effectively handle climate-related challenges.

Keywords: Climate Change, Climate Governance, International Regime of Climate Change Foreign Policy, Pakistan



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34. Impact of Nano composite electrode materials of advanced SOFC for sustainable energy future

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Abstract:

The increasing population and expanding industrialization seek for green and sustainable future energy. Fuel cell technology is an innovative energy conversion system that generates electricity through electrochemical reactions, typically involving hydrogen and oxygen. Solid Oxide Fuel Cell (SOFC) received substantial attention in fuel cell family, owing higher efficiency, fuel flexibility and low carbon emission. Electrodes are key components for good performance of SOFC, which need to be porous, sustainable and compatible with electrolyte. Graphene incorporated Nanocomposite anode materials have been synthesized by solid state method, characterized by X-Ray Diffractometer (XRD) and Scanning Electrode Microscopy (SEM). Electrical measurements were carried out by four probe method, and fuel cell performance was tested with hydrogen fuel. Enhanced values of DC conductivity and power density were obtained with graphene composite, which could be suggested as good choice as anode material for low temperature SOFC and positioning them as a key technology in the transition to sustainable energy systems.

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35. Impact of green HRM on employees’ pro-environmental behavior
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Abstract

Purpose: This research study examines the impact of green HRM on employees pro-environmental behavior with respect to green culture as mediator and green transformational leadership as a moderator construct.

Design/methodology/approach: The data was collected from middle tier employees of hospitality sector, AJK. Non-probability sampling type with convenient sampling technique was applied to collect feedback through adopted and adapted questionnaire. SPSS was used to analyze the feedback of respondents.

Implications: The Green Human Resource Management plays a critical role in hospitality sector to resolve environment related problems through appropriate management philosophy, HR policies, practices, training and implementation of laws related to environmental safety.

Originality value/Novelty: This study addressed the conceptual gap to investigate the impact of green HRM on employees’ green behavior with the mediating role of green culture and moderating role of green transformational leadership.

Keywords: Green HRM, Green culture, green transformational leader, employee’s green behavior, employees’ pro-environmental behavior



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36. Evaluating the Policy Capacity of Climate Change Policy Professionals in Pakistan
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Abstract

Climate change poses a severe threat to all countries, but developing countries like Pakistan are more at risk despite contributing the least to this global problem. Pakistan contributes just 0.9% of global greenhouse gas emissions is ranked as the eighth most vulnerable country according to the Climate Risk Index. In this context, the effectiveness of climate change policies is crucial, and such policies depend on the policy capacity of governments at both national and sub-national levels. Specifically, policy professionals’ capacity is critical for designing and implementing policies based on their skills, knowledge, and expertise relevant to climate change. This study provides an in-depth analysis of the policy capacity of policy professionals of Pakistan’s Ministry of Climate Change and its affiliated departments at national and sub-national levels, focusing on three core dimensions: analytical capacity, operational capacity, and political capacity.

The study provides a comparative analysis of policy capacity at two levels of governance (federal and provincial) by utilizing survey data collected from 123 policy professionals. Data analysis was conducted using descriptive statistics and inferential testing, with t-tests employed to identify differences between federal and provincial capacities. Findings suggest that national institutions exhibit higher levels of policy professionals’ capacity. In contrast, policy professionals at sub-national departments face constraints in policy capacity because of limited bureaucratic autonomy, resource shortages, and weak intergovernmental coordination.

The study highlights critical challenges in achieving coherent and effective governance-level climate policies. The results show the importance of strengthening policy capacity at the provincial level through targeted training programs, resource allocation, and structural reforms. Furthermore, enhancing collaboration between the national and sub-national levels is essential for developing and implementing climate adaptation and mitigation strategies. By providing the capacity gaps, this study contributes actionable recommendations for policymakers to improve climate policy design and implementation, ultimately fostering sustainable development and effective climate governance in Pakistan.

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37. Effect of Potassium in The Sunflower for Mitigating Drought Stress

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Abstract

Drought stress is an important constraint in sunflower production worldwide. Potassium (K) plays an important role in the resistance of plants to stress. In this study, the effects of potassium on stress response in flowering plants were investigated. The pot experiment was carried out in a total of 15 pots with three replications and five applications (0, 50, 100, 150 and 200 mg/kg K). Sunflower plants were stressed by not watering for 14 days. The results showed that potassium application effectively improved plant growth, water balance and antioxidant system under drought stress. The highest potassium application (200 mg/kg K) caused an increase in plant height, leaf area, chlorophyll content and an increase in antioxidant enzyme activity. These findings suggest that K application may be a good strategy to reduce stress-induced drought stress in flowering plants and may provide insight into the mechanisms of K-mediated drought resistance.

Keywords: Drought stress, potassium, sunflower, antioxidant defense, water relations.

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38. A review on Locust Problem Management in Pakistan in Context with Climate Change
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Abstract

The locust outbreak of 2019-2020 was so severe in terms of the damage that it was declared as a locust emergency in Pakistan, India, and East Africa. International organizations have warned these countries (Southwest Asia Region) about persistent outbreaks for the oncoming years. A rare and irregular disaster of the past is set to become an annual concerning situation for Pakistan. The looming threat raises questions about Pakistan's capacity and strategies to deal with the control of these pests. Experts are updating information on recent plagues and the reasons why they have become a problem. There are few scientific studies to establish links between climate change and locust outbreaks. Still, the fact remains that environmental changes, rising temperatures, and climatic variabilities have directly or indirectly contributed to the exponential increase in locust outbreaks. The synergistic effects of climate change and locust swarms spell disaster for Pakistan regarding food security, infrastructure development, livelihood, and economic losses. To address the information gap in Pakistan, this article aims to provide comprehensive reasons behind the recent outbreaks, establish the relationship between these outbreaks and climate factors, outline the strategies Pakistan has employed in the past, and what improvements must be made. Moreover, to efficiently address any issue exacerbated by climate change, a smart and integrated approach is essential to reorient agricultural and pest management systems.

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39. Impact of climate variation on different canola genotype growth and yield

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Abstract

Climate variability has adverse effect on the growth, productivity, and quality of *Brassica napus* (canola). This review examines the physiological, morphological, and yield-related responses such as seed yield, water use efficiency, oil content, plant growth rate of different canola genotypes to climatic variations including changes in temperature, rainfall, and water availability. This review emphasizes the necessity of adopting targeted agronomic practices, selecting high-performing genotypes, and implementing location-specific management strategies to maximize canola production and decrease reliance on edible oil imports. This review examined based on measured parameters and different canola Genotypes. This review underscores the need for further research aimed at developing climate-resilient canola genotypes and sustainable agricultural practices



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40. Growing ice-reservoirs: A local solution to climate change effects

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Abstract

The major impact and concern of climate change is the rapidly melting glaciers particularly in the Himalayas and the Karakoram regions of northern Pakistan known as the Third Pole. The local communities have indigenous techniques of growing ice-reservoirs that on one hand address the water shortage for early spring irrigation and on the other hand it aspires to create microclimate in the valleys favorable for biodiversity and control other meteorological elements in the catchment areas. During observation of an irrigation scale ice-tower it was observed that within 300 meters radial area of the ice-tower of around 2 million cubic feet, the temperature varies up to 2 Celsius. Similarly, a study of biodiversity around the ice-reservoirs, found that the biodiversity (both fauna and floral population) varies up to 20% in the surrounding as compared to adjacent areas of similar topography and same altitude. If scaled up these ice-reservoirs and sustained/continued for decades, can potentially change the meteorological indicators at valley and regional levels that can create microclimate regions which will ultimately contribute to global impact. Hence acting locally in indigenous ways could be the best option toward climate change. Changing atmospheric condition near glaciated regions matters more than change of similar scale variations elsewhere. Therefore, such concentric initiatives and efforts in the neighborhood of glaciated valleys would be highly rewarding.



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41. Exploring the Potential of Pakistan’s Carbon Market Policy for Climate Resilience and Sustainability

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Abstract

Pakistan launched its first policy guidelines for trading in carbon markets in 2024, with the objective of reducing greenhouse gas emissions (GHGs) and advancing sustainable development. This research seeks to evaluate the framework of this policy, with a focus on its alignment with international carbon trading standards, its implementation mechanisms, and its potential impact on priority sectors such as agriculture, forestry and energy. A secondary data based approach will critically analyze the policy’s key elements, including governance, benefit sharing frameworks, Measurement, Reporting, and Verification (MRV) systems. The study also compares Pakistan’s approach with international best practices to highlight its strengths, identify gaps and explore opportunities. The research aims to contribute to the discourse on carbon markets and their role in achieving climate resilience and sustainability by providing actionable recommendations.

Keywords: carbon markets, climate resilience, carbon trading, sustainability



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42. Sustainable water purification through advanced polymeric membrane technology

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Abstract

Membrane processes play an important role in water purification due to their ability to clean contaminated water through different separation techniques. Polymeric membranes have emerged as highly effective solutions for reverse osmosis (RO) desalination. The global water crisis, due to climate change and population growth, necessitates innovative solutions like desalination by RO. This study focuses on developing both synthetic and natural polymer-based RO membranes and detailed systematic investigation of permeation properties by RO. Polyurethane membranes were synthesized using aliphatic isocyanates and polyethylene glycol (PEG) of different molecular weights which improved hydrophilicity, water flux, and antimicrobial properties, though higher molecular weights of PEG slightly reduced salt rejection. Meanwhile, sodium alginate and guar gum membranes, cross-linked with 3-glycidoxypropyltrimethoxysilane, demonstrated enhanced hydrophilicity, mechanical strength, thermal stability, and salt rejection, achieving up to 95.3 % NaCl and 98.8 % Na₂SO₄ removal. Both membrane types exhibited strong potential for sustainable water purification, offering promising pathways to address global water scarcity.



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43. Assessing Climate Vulnerability, Risk Perception & Adaptation among High Mountain Farmers: A Case Study of Hisper Valley, Pakistan

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Abstract

Climate change is the most obvious phenomenon in the remote high mountain Hisper Valley, Gilgit-Baltistan, Pakistan due to fragile mountain ecosystem. Framers in this remote valley are high vulnerable to climate change and its induced risks owing low adaptive capacity. Given this rational, this study was carried out in the Hisper Valley located in the Central Karakoram part of Pakistan. This study employed a quantitative approach, data were collected with the help of a structured household survey questionnaire from a randomly selected 124 households. Data were analyzed with help of MS Excel and SPSS and results were presented through tables and figures. Additionally, the study employed the vulnerability component analysis approach from the IPCC to assess the vulnerability of selected farmers. This approach encompasses three main indicators of vulnerability: exposure, susceptibility, and adaptive capacity, each further divided into three sub-indicators. Descriptive results show that 97.5% of farmers in the study area reported changes in the climatic conditions. As far as variations in the major climatic variables are concerned 63.7 % of farmers reported that temperature as slightly increased and 46.8 % have reported that annual rainfall has slightly decrease while 83.3 % have reported that snowfall has significantly decreased. Results of vulnerability index show that farmers in the Hisper Valley are high vulnerable to climate change (CCVI 0.77) with a high level of exposure (EVI 0.69) and susceptibility (SVI 0.57) to the climate induced risks with the least adaptive capacity (AVI 0.49). The descriptive results show that farmers employ various adaptation strategies to cope with climate issues, such as using chemical fertilizers (97.6%), migrating to urban areas for off-farm work (69.4%), changing crop types (67%), and planting trees (61.3%). However, a significant majority (96%) identified poor infrastructure as a major barrier to climate change adaptation, followed by limited market access (92.7%). The study recommends that government and non-governmental organizations support farmers in this remote region by providing subsidies for farm inputs and enhancing market access. This can be achieved by improving infrastructure, which will ultimately strengthen the farmers' adaptive capacity at the farm level.

Keywords: Climate Change, Vulnerability, Risk Perception, Adaptation, Farmers



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44. Carbon Footprint of Agricultural Crop Cultivation: Pathway to Climate-Resilient and Sustainable Farming

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Abstract

Agriculture plays a critical role in both contributing to and mitigating climate change, with crop cultivation practices significantly impacting “greenhouse gas (GHG) emissions”. The present study assesses the greenhouse gas (GHG) emissions from crop cultivation in District Khanewal, Pakistan over the past two decades. GHG emissions have shown an upward trend, primarily driven by increased use of inputs, including nitrogen fertilizer, irrigation and carbon intensive machinery. Among the major crops, Wheat, Rice, Sugarcane, Cotton and Maize, Sugarcane exhibited the highest carbon footprint due to intensive use of irrigation and plowing requirements, while cotton showed significant emissions linked to nitrogen fertilizer use. The emissions level peaked in 2007- 2008, followed by gradual stabilization. Geospatial analysis reveals distinct emission patterns for major crops, with cotton and rice showing high emissions from plowing in the southeast and water-intensive irrigation in central and northeastern areas. Targeted mitigation, such as conservation tillage and efficient irrigation, is recommended for high-emission regions. Over the study period, the dominance of wheat, which consistently covered over 50% of the cultivated area, contrasted with a notable decline in cotton's share among non-cereal crops. Emissions began to decline around 2012, coinciding with national efforts to reduce agricultural emissions, aligning with Pakistan’s target to cut GHG emissions by 50% by 2030. Statistical analysis reveals that cultivated area expansion significantly correlates with increased carbon footprint, while improvements in yield have a lesser impact. Land cover analysis from 2000 to 2020 highlights a reduction in cropland due to urbanization, stressing the need for sustainable land management to balance development with agriculture. Recommendations for emission reduction include the adoption of crop-specific, low-emission practices, with particular focus on high-impact crops like sugarcane and cotton. These measures will support sustainable agriculture and broader climate resilience in Khanewal District.

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45. Groundwater quality assessment for sustainable development through geophysical investigations in the western part of Pakpattan district, Punjab, Pakistan

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Abstract

The sustainable management and development of groundwater resources is a fundamental key to develop an area and it also necessitates the effective exploration of quality groundwater. Unfortunately, the groundwater-related issues are adversely escalating locally as well as globally. The impacts of climate change coupled with population growth stimulate the desire to manage the known groundwater resources and explore the additional ones. Punjab province is facing acute groundwater issues due to the erratic rainfall, rivers water depletion and urbanization. Consequently, the depletion of water table and deterioration of water quality is being observed especially since the last decades. Pakpattan is a densely populated district in Punjab Province of Pakistan and represents the central part of Bari Doab. Its various parts are prone to substantial groundwater issues related to its quality especially. This study aims to assess the current groundwater resources and delineate distinct groundwater quality zones in the western part of Pakpattan district. The results of present study would be helpful to rescue and develop such a precious gift of almighty. To achieve the research objectives, geophysical investigations were employed using electrical resistivity survey (ERS) with vertical electrical sounding (VES) approach. A total of 31 VES probes were conducted in the study area deploying the Schlumberger electrodes arrangement. Borehole lithology revealed the presence of intermixed fine to coarse Quaternary alluvium. The software-based modeling interpreted 3 to 5 geo-electric layers with a resistivity range of 0.2–500 Ω -m, categorized as very high to very low resistivity. Below the water table conditions, saline/brackish groundwater zones are interpreted due to salinity within coarser lithology mainly of sand-gravel with admixing of clay/silt. Marginally fit groundwater zones are also delineated and interpreted to be associated with low resistivity zones within sand-gravel bands with more intermixing of clay/silt. The promising groundwater zones of fit (good/fresh) quality are interpreted within medium to very high resistivity zones below the water table reflecting sand-gravel in dominance. 2D/3D maps are developed depicting the spatial variation of distinct groundwater quality zones. At some locations, saline/brackish groundwater quality zones appear at 50 m depth but try to expand up to 300 m. At shallow depths (<50 m), 22 VES out of 31 characterize fit groundwater quality and recommended for water-wells installation. However, groundwater quality degrades with the increase in depth. Marginal groundwater quality is also interpreted at shallow depths at 7 different VES locations. Water-wells installation at these sites should be kept as a last resort.

Keywords: Groundwater, Salinity, Bari Doab, Vertical Electrical Sounding (VES), Water table

46. Application of TiO₂-Doped Nanocoated Fertilizers: Effects on Wheat Productivity

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Abstract

Phosphorous (P) is a major nutrients required by plants with other nutrient. High-energy phosphate compounds are involved in almost every metabolic reaction in plants. Most of the P applied in the form of fertilizers is adsorbed by the soil with little or no solubility and is not available adequately for plants. This low availability and inadequate amounts of phosphorous fail to support BNF (biological nitrogen fixation), which causes a significant reduction in yield. As a result of this, more phosphorous fertilizer is used that contributes to runoff losses resulting in eutrophication. As the mineral phosphorous resources are non-renewable, therefore, there is a need to enhance P use efficiency. Current practices of phosphorous applications are not efficient, and no phosphorous-based nano-fertilizer is currently available in the market. Nano-fertilizers may offer a solution to improve phosphorus phytoavailability, improved fertilizer use efficiency, crop productivity, and environmental protection. Titanium dioxide nanoparticles have emerged as biocompatible nanomaterials which enhance chlorophyll content, photosynthesis, and improved the ability of nutrient uptake. So, the present study was designed considering the information from the previous studies that showed a positive response of the crop to titanium dioxide nanoparticles. The main objective of this study was to check the growth and nutrient response of wheat upon application of TiO₂ nanoparticles in coated form with DAP (Diammonium Phosphate). First of all TiO₂ was doped with Fe and Zn and then the DAP was coated with Fe, Zn, Fe+Zn doped TiO₂ nanoparticles. The experiment was carried out in a completely randomized design in plastic pots in an outdoor environment with continuous monitoring. The initial results of the study revealed a clear difference in early growth and length of plants applied with coated DAP than that of noncoated ones. Plus, there was a clear increase in the number of seeds too. The details of the results would be presented in the full paper.

Keywords: DAP (Diammonium Phosphate), TiO₂ (Titanium dioxide), Nano-fertilizer

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47. Promoting Sustainable Construction through Waste-Derived SCMs: A Comparative Study of Silica Fumes-Fly Ash and Brick-Marble Powders

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Abstract

The cement industry is a significant contributor to global greenhouse gas emissions, driving the need for sustainable alternatives to mitigate its environmental impact. This study explores the use of locally sourced waste materials, such as brick and marble powders, as sustainable supplementary cementitious materials (SCMs) to replace traditional options like silica fumes and fly ash. By promoting a circular economy, these alternatives reduce landfill waste, minimize transportation emissions, and align with global efforts to combat climate change and resource depletion. This research evaluates the performance of two SCM combinations—silica fumes with fly ash and brick powder with marble powder—used as partial cement replacements in a 1:3 cement-sand mortar mix with a water-to-cement ratio of 0.7. Both combinations were incorporated as a 10% addition (5% each). The silica fumes-fly ash combination demonstrated superior performance, achieving a 7% higher compressive strength at 7 days and a 17% better flow value compared to the brick-marble powder mix, while also being 2.5% lighter. The control mortar exhibited a compressive strength of 7.5 MPa and a flow value of 60 mm. However, the availability of silica fumes and fly ash may face future constraints due to environmental regulations on industrial byproducts. The study highlights that waste-derived SCMs, while slightly inferior in performance, offer a sustainable pathway for reducing the environmental footprint of construction activities. These findings support the integration of climate-conscious practices in the construction industry, contributing to a sustainable future in line with global climate action goals.

Keyword: Sustainable construction, SCMs, climate change, waste utilization, performance.

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48. Potential of Nano-Biofertilizers to Improve Phosphorus Use Efficiency for Enhanced Lettuce Growth

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Abstract

Climate change and overpopulation significantly impact soil and plant systems, affecting plant productivity, soil quality, and environmental quality. Phosphorus deficiency in soil is a significant challenge in agricultural ecosystems, limiting crop growth and yield. This research aims to improve phosphorus availability for lettuce by combining phosphate-solubilizing microbes (PSMs) with Titanium dioxide-coated green Graphene oxide nanoparticles (TiO₂-GO) in conjunction with diammonium phosphate (DAP) fertilizer. Detailed experiment will investigate the interplay between PSMs and TiO₂-GO on lettuce growth and physiology. The study will analyze the individual and synergistic impacts of all three components, focusing on the synthesis of biofertilizer using phosphate-solubilizing microbes such as (*Pseudomonas Spp*, *Bacillus Spp* and *Acinetobacter Spp*) and the preparation of pure TiO₂ nanoparticles TiO₂-GO nanocomposites using Sol-gel method. Results will show the potential value of applying PSMs and TiO₂-GO as a nano-biofertilizer to improve DAP efficiency and provide maximum phosphorus for plant growth and development.

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49. Electrocoagulation for Seawater Desalination: Assessing TDS Removal Efficiency.

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Abstract

Freshwater scarcity in coastal regions demands the exploration of sustainable desalination technologies. This study investigated the electrocoagulation (EC) technique for seawater desalination, emphasizing its efficiency and potential for integration into hybrid systems. Electrocoagulation applies an electric current across electrodes to generate coagulants in situ, aiding the removal of dissolved solids and ions. The methodology involved preparing synthetic seawater to replicate natural seawater composition. The recipe included 27,100 mg/L NaCl, 5,100 mg/L MgCl₂, 3,700 mg/L CaSO₄, and 1,000 mg/L KCl, simulating ocean salinity. Laboratory-scale experiments utilized a batch reactor with an inter-electrode distance of 2 cm. Aluminum (Al), graphite, stainless steel (SS), and galvanized iron (GI) electrodes were tested at voltages ranging from 2V to 15V, while maintaining an optimized pH of 6. A retention time of 1 hour and 30 minutes was determined to be optimal through preliminary trials. Total dissolved solids (TDS) removal efficiency was measured as the primary performance metric. Results revealed significant variations in electrode performance. Aluminum electrodes achieved the highest TDS removal efficiency of 22.22% at 2V. Graphite electrodes at 15V achieved 7.53%, while stainless steel and GI electrodes recorded efficiencies of 2.51% at 3V and 7.8% at 2V, respectively. The voltage range of 2–15V was identified as ideal for effective TDS reduction, balancing performance and energy consumption. Optimization of retention time, inter-electrode distance, and pH further enhanced system efficiency. However, the standalone EC process showed limited effectiveness for significant salinity reduction, underscoring its limitations as a primary desalination method. Nonetheless, its ability to reduce fouling makes it a valuable pre-treatment step for hybrid desalination systems. When integrated with advanced methods like reverse osmosis, EC can improve overall system performance and lower operational costs. To validate these findings, the next phase of this research will apply the optimized EC process to real seawater from Karachi’s coastal regions. This step will address challenges such as high pollutant loads and variable salinity, refining EC parameters for large-scale application. The aim is to evaluate the feasibility of EC as part of an integrated desalination approach tailored to the needs of coastal communities. This study highlights the potential of electrocoagulation as a sustainable solution when used in combination with other technologies. By addressing the limitations of standalone EC, this research contributes to the development of cost-effective and scalable methods for freshwater production in coastal areas, advancing efforts to combat water scarcity.

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50. Heritage Under Siege: Crisis Communication Strategies for Erosion of Mohenjo Daro

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Abstract

Mohenjo Daro, an important archaeological site of the ancient Indus Valley Civilization, is undergoing serious erosion, highlighting the need for effective crisis communication strategies to preserve it. Thus, present study aims to identify crises communication strategies to preserve cultural heritage sites. Correspondingly, this study performs a systematic literature review of twelve articles gathered from the Scopus database and Google Scholar. The study highlights 4 essential communication techniques for vulnerable heritage sites: (1) community engagement; (2) site monitoring; (3) interinstitutional cooperation; and (4) digitalization. These findings are crucial to address the current preservation demands of Mohenjo Daro. The findings present a taxonomy of crisis communication in cultural heritage conservation to policymakers and future researchers in the field.

Keywords: Mohenjo Daro, crisis communication strategies, erosion

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51. Impact of Rainfall pattern on Groundnut yield

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Abstract

Groundnut (*Arachis hypogaea*), play a vital role in food consumption and oil production. This crop is primarily grown in areas that rely on natural rainfall, making it particularly vulnerable to changes in precipitation patterns. Growing unpredictability and variations in rainfall have become major obstacles to sustaining stable groundnut yields in these regions. To create effective approaches and tackle these issues, it is essential to investigate the relationship between the rainfall characteristics and groundnut productivity. To investigate the Impact of Rainfall Patterns on Ground Yield," a thorough literature review was conducted to explore how diverse precipitation trends affect the agricultural output. This investigation involved a comprehensive search of academic databases including PubMed, ScienceDirect, Scopus, and Google Scholar to gather a wide range of relevant research. The review focused on peer-reviewed articles, systematic reviews, case studies, and scientific reports that provide evidence linking rainfall variability to crop production. The search utilized specific terms, such as "rainfall patterns," "Groundnut yield," "precipitation variability," "agricultural productivity," and "groundnut yield." To incorporate the most recent findings, particularly those addressing contemporary climate trends and the impact of precipitation changes on agricultural output, this review was limited to studies published within the past 10-15 years. The analysis encompassed both global and regional studies that assessed the direct and indirect effects of rainfall variability on crop performance, water availability, and soil moisture content. It also examines potential adaptive agricultural practices to mitigate the negative consequences of erratic precipitation patterns. Special attention was given to case studies from areas most affected by changing rainfall distributions, particularly in rain-fed agricultural systems. Research conducted in India and Pakistan has consistently demonstrated the effects of unpredictable rainfall and climate variability on groundnut yield. In Indian regions, such as Bundelkhand, decreasing rainfall trends (0.49–2.16 mm/year) have resulted in reduced crop production. Moderate rainfall (16–32 mm/day) positively influenced productivity, whereas heavy rainfall (>64 mm/day) and late monsoons negatively affected plant growth. Analogous patterns have been observed in Pakistan, particularly in rain-dependent areas, such as the Potohar Plateau and northern Punjab. Groundnut yields in Attock have significantly decreased from 160 to 20 kg per kanal due to extended dry periods and irregular rainfall. The Potohar region is especially susceptible to delayed monsoon arrival and insufficient precipitation, which interfere with critical growth phases, including germination and pod formation. However, compared with India, Pakistan lacks area-specific research, resulting in substantial knowledge gaps regarding the comprehensive effects of rainfall variability on groundnut cultivation.



52. Role of Biofertilizers in agriculture

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Abstract

The increasing need for environmentally sustainable agricultural practices has drawn attention to biofertilizers as a means of enhancing crop yields and improving soil conditions. These natural fertilizers, composed of microorganisms, such as nitrogen-fixing and phosphate-solubilizing bacteria, as well as mycorrhizal fungi, offer an ecologically viable alternative to synthetic fertilizers. They promote plant Growth and development by enhancing nutrient accessibility, augmenting soil fertility, and promoting beneficial interactions between plants and soil microorganisms. This summary examines the critical role of biofertilizers in agriculture, emphasizing their potential to increase crop production while mitigating environmental effects.

A comprehensive literature review was conducted to assess the efficacy of biofertilizers in various agricultural contexts, particularly rain-dependent and resource-limited environments. The review encompassed peer-reviewed articles, systematic analyses, and case studies from databases, including PubMed, ScienceDirect, Scopus, and Google Scholar. The search terms included "biofertilizers," "sustainable agriculture," "microbial inoculants," and "soil fertility enhancement," focusing on research published within the last 10-15 years to capture recent advancements.

Research has demonstrated that biofertilizers can exert varying effects on crop productivity and nutrient utilization efficiency. An analysis of multiple studies revealed that in lowland rice production, biofertilizers could substitute 23–52% of nitrogen-based fertilizers without adversely affecting yields. In the case of lettuce, the application of microbial fertilizers resulted in a 6.71% increase in overall yield compared to conventional chemical fertilization methods. However, some investigations have indicated minimal effects on crop output when employing biofertilizers, suggesting that the efficacy of biofertilizers may vary based on factors such as crop type, environmental conditions, and specific biofertilizer composition.

Despite these observations, there is a significant scarcity of extensive long-term field trials evaluating the consistent performance of biofertilizers across various agro-ecological regions. Furthermore, the underlying mechanisms governing plant-microbe interactions in biofertilizer applications have not yet been fully elucidated. To maximize the potential of biofertilizers in sustainable farming practices, it is imperative to address these knowledge gaps through comprehensive, extended research efforts and standardized assessment protocols.

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53. Electric Vehicles: A Revolutionary Approach for The Growth of Pollutionfree Climate

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Abstract

The world is facing a very big problem in the form of pollution and greenhouse effect in the recent years. Government agencies have worked tirelessly to minimize the effect of pollution. This problem is pretty dominant in developing countries like Pakistan. At present, cities like Karachi and Lahore are facing a very high index of Air pollution caused by vehicular emissions. In this frame work, the current research proposes the optimized design of student electric vehicles to attenuate the environmental pollution. Electrical vehicles produce zero tailpipe emissions which mean no toxic gasses. Carbon Footprint Analysis is conducted in the proposed study to measure the effect of greenhouse gases over the various phases of a vehicle's life. To simulate the long-term impacts of electric vehicles on environment, Agent-based Modelling is performed. It mainly includes the analysis technological advancement in battery recycling. The idea of student electric vehicle is based on many key points including using AGS (Automatic Gear system) and Self Driving mode so that it can make it easy for students to Navigate. Further, sensing mechanism is developed for the predictive maintenance and diagnostics. Hence, the proposed idea of student electric vehicle may be a game changer for the students by providing them with a safe and pollution-free climate.

Keywords: Greenhouse effect; electrical vehicles; Carbon Footprint Analysis; predictive maintenance; pollution-free climate

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54. Genome-Wide Association Studies (GWAS) to Identify Salt Tolerance Loci in Walnut

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Abstract

The increasing salinization of agricultural lands due to climate change and unsustainable irrigation practices poses a significant threat to walnut (*Juglans regia*) cultivation, a globally important nut crop valued for its nutritional and economic benefits. Developing salt-tolerant walnut varieties is critical to sustaining productivity in salt-affected soils. Genome-Wide Association Studies (GWAS) offer a powerful approach to identifying genetic loci associated with salt tolerance, enabling precision breeding for climate-resilient walnut cultivars. This study aims to uncover the genetic architecture underlying salt tolerance in walnut using GWAS. A diverse panel of walnut genotypes, including commercial cultivars and wild relatives, was evaluated under controlled saline conditions for key physiological and morphological traits, such as leaf chlorophyll content, ion homeostasis (Na⁺/K⁺ ratio), root architecture, and yield stability. High-throughput phenotyping methods and biochemical assays were employed to assess stress tolerance and associated adaptive traits. Genomic DNA from the panel was genotyped using high-density single nucleotide polymorphism (SNP) arrays, yielding a comprehensive dataset of genetic variants. GWAS was conducted to associate phenotypic traits with SNP markers, identifying quantitative trait loci (QTLs) significantly linked to salt tolerance. Candidate genes within the QTL regions were annotated and analyzed for their roles in salt stress responses, including ion transporters, transcription factors, and stress-responsive signaling pathways. Functional validation of key candidate genes was performed using gene expression analysis (qRT-PCR) and transgenic approaches in model plants and walnut tissue culture systems. Additionally, haplotype analysis was conducted to pinpoint favorable alleles for introgression into breeding programs. Preliminary results identified several promising loci associated with improved salt tolerance, including genes involved in regulating ion transport and oxidative stress mitigation. These findings provide a foundation for marker-assisted selection (MAS) and genomic prediction to accelerate the development of salt-tolerant walnut varieties. The integration of GWAS with functional genomics and advanced breeding techniques holds great promise for addressing the challenges of soil salinization and ensuring sustainable walnut production in climate-impacted regions.

Keywords: Genome-Wide Association Studies (GWAS); Salt tolerance; Quantitative trait loci (QTLs); Marker-assisted selection (MAS)

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55. Shared Air, Shared Responsibility: A Comparative Study of Climate Policy Development in Indian and Pakistani Punjab
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Abstract

The Punjab region, divided between India and Pakistan, faces serious environmental challenges, especially air pollution (smog) caused by shared activities like stubble burning, industrial emissions, and vehicle pollution. Despite the interconnected nature of these issues, the climate policies in Indian and Pakistani Punjab remain separate and uncoordinated. This research compares the climate policies of both regions to identify gaps, similarities, and opportunities for collaboration. It focuses on how collaboration between the two Punjabs can help tackle these shared issues through joint climate policies.

Using a mix of policy analysis, interviews with policymakers, and public surveys, this study explores how political tensions, economic differences, and governance issues affect joint climate action. It also looks at successful examples of cross-border environmental agreements from other regions to suggest practical solutions for Punjab.

The findings aim to highlight areas where policies differ such as air quality standards, and where they can align such as shared air monitoring and renewable energy projects. This research emphasizes the need for cooperation to create effective and sustainable climate policies that benefit both sides of Punjab and the environment they share.

Keywords: Punjab, India, Pakistan, Climate policy, Air pollution, smog, stubble burning.

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56. Protecting the Rights of Victims in Climate Change Induced Disasters; Integrating Restorative Justice Principle in Climate Change Resilience Legislation of Khyber Pakhtunkhwa

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Abstract

Climate Change induced disasters are causing significant threats to human rights of vulnerable populations of Malakand Division in Khyber Pakhtunkhwa. Climate Change is perhaps the most serious threat to the fundamental rights of the people in Pakistan as it is adversely affecting their right to life and above all their right to dignity under Articles 9 and 14 of the Constitution.¹ Having failed to learn from the past floods, as has become apparent from the magnitude of the destruction caused by the recent floods, it is pivotal that effective steps are need to be taken to prevent such catastrophes in the future. Khyber Pakhtunkhwa in general and Malakand division in particular is prone to climate-related disasters such as floods, heat waves and droughts while the existing legal framework in Khyber Pakhtunkhwa focuses on response and relief only, completely neglecting the rights of victims as guaranteed under the Constitution of Pakistan 1973 and the root causes of vulnerability. The study argues that by integrating Restorative Justice Principles in climate change resilience legislation can effectively protect the rights of victims in climate change induced disasters. The proposed framework will prioritize victim’s rights support, community engagements, and sustainable development, making sure that the rights of victims of climate based disasters are protected and the root causes of vulnerability are addressed. Since the proposed study will examine the climate change resilience legislation of Khyber Pakhtunkhwa it is expected that it can set a precedent for other provinces and countries to follow, adopting and promoting a rights-based approach to climate change adaptation and resilience.

Keywords: Climate Change, Fundamental Rights, Sustainable Development, Climate Change Legislation.

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57. Numerical Analysis on Drag-based Wind Turbines for Optimal Tip-speed Ratio

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Abstract

Vertical Axis Wind Turbines (VAWTs), particularly drag-based Savonius designs, offer a promising alternative for small-scale renewable energy applications due to their simplicity and effectiveness in low wind speeds. This study investigates the optimum tip-speed ratio (TSR) of drag-based Savonius wind turbines through computational fluid dynamics (CFD) analysis on several TSRs, supported by experimental validation using open-access data from Sandia National Laboratories USA. The research focuses on the aerodynamic behavior of the turbine, particularly examining separation effects and the influence of 2D CFD model fidelity on validation accuracy. Additionally, the study explores the impact of TSR on the wake dynamics of the turbine, providing insights into its performance under varying operational conditions. The findings emphasize the significance of selecting an appropriate TSR to enhance turbine efficiency and wake stability. Future directions are discussed, including applying optimization algorithms to the design space to determine the optimal TSR and improved geometric configurations through novel design space exploration algorithms. This study highlights advanced design methodologies for Savonius wind turbines, offering insights that enhance their realworld performance and contribute to sustainable development and climate change mitigation.



58. Optimizing HVAC Efficiency with Vertical Closed Loop Geo-Exchange Retrofit: A Sustainable Approach to Energy Management in Buildings

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Abstract

The rising need for energy management in buildings has boosted the use of sustainable technologies, where geothermal systems are one of the best options. This paper looks at the installation of a Vertical Closed Loop Geo-Exchange Retrofit System for HVAC (Heating, Ventilation, and Air Conditioning) system of a building. The proposed geothermal solution is compatible with 4 ton heating and cooling split-type units and provides great energy benefits and comfort. The project design involves the installation of 7 inches diameter bores of 300 ft. depth in sub-soil, which is connected to the HVAC system with underground piping. The geothermal loop system is expected to achieve net efficiency gains of 25-45 %. Controlled microclimates improve the system's Coefficient of Performance (COP), and maintaining the temperature in range between 22-26 °C. The custom-built heat transfer jackets will help increase the COP of the system. The system's COP is expected to increase from 2.5 at a temperature differential (ΔT) of 20°C to 4.5 when the ΔT is reduced to less than 5°C. The process comprises sub-soil boring, loop installation, development of the heat exchanger, and testing/commissioning. The estimated project cost is around Rs. 1.392 million with an estimated payback period of 5 years. It demonstrates the possible benefits of the application of geothermal technology for reduction in the carbon footprint of buildings and for the improvement in the performance of the HVAC systems. It details the practical applicability of geothermal systems within energy management while retrofitting current buildings to attain sustainability goals. The results will be useful as they will yield insights into whether geothermal energy is cost-effective or efficient in producing long-term savings in the HVAC sector.

Keywords: Geothermal, Energy management, HVAC, Buildings, Sustainability

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59. Aligning Economic Growth in Sharda with SDG 8: Challenges and Opportunities in a Changing Climate

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Abstract

This study explores the economic profile of Sharda, Azad Jammu and Kashmir (AJK), with a particular focus on the impacts of climate change on local economic conditions and how these effects intersect with the United Nations Sustainable Development Goals (SDGs) 8: Decent Work & Economic Growth. The aim of this research is to assess how the economic landscape of Sharda, including income levels, job market dynamics, and business ownership patterns, is being influenced by climate change, while also proposing SDG-aligned policy recommendations for fostering sustainable economic growth. The purpose of this study is to provide a comprehensive understanding of the local economy being affected by climate conditions by analyzing income distribution, employment types, tax compliance, and shop ownership, exploring the role of climate change in shaping these economic patterns and identifying key areas for policy intervention to align with global sustainability goals. A mixed-methods approach is used, combining primary survey data from local businesses in Sharda with secondary data from academic literature. The analysis includes descriptive statistics to evaluate income levels, tax compliance, and ownership patterns, alongside qualitative insights into the perceived effects of climate change on the local economy. The data were supplemented by graphical representations such as pie charts and income tax compliance graphs to highlight key findings. The results highlight that a significant portion of Sharda's workforce earns less than 5,000 PKR monthly, suggesting economic vulnerability within the local labor market. The majority of businesses in Sharda are shop owners, with 77% owning their shops compared to 23% renting, mostly at low rates, while a noticeable gap in tax compliance exists, as only 32% of shops pay income tax, highlighting potential issues with tax administration or business formalization. The findings suggest that while Sharda's local economy faces significant challenges, particularly in terms of low-income levels and tax compliance, there are opportunities for sustainable growth through climate adaptation strategies and SDG-aligned policies. Enhanced climate resilience and economic diversification could strengthen Sharda's economy, mitigate disparities, and promote sustainability, providing valuable insights for developing climate-resilient strategies in AJK and comparable regions.

Keywords: SDG 8, Economic profile, Job market dynamics, Business ownership patterns, Climate Change

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60. Real-Time Air Quality Monitoring Device for Asthma Attack Prevention and Management

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Abstract:

Air pollution significantly impacts public health, especially for individuals with asthma, as exposure to harmful air quality can exacerbate symptoms and increase the risk of asthma attacks. Existing asthma management tools often lack real-time monitoring of environmental air quality, limiting the ability to prevent or manage these attacks proactively. This study aimed to develop an Air Quality Indicator for Asthma Attack Prevention that continuously monitors air quality, including particulate matter, harmful gases, temperature, and humidity, to provide real-time alerts and help individuals with asthma take preventive actions. The device integrates several sensors air quality sensor, Gas Sensor, Temperature and Humidity Sensors and a Heart Rate Sensor. These sensors collect data on particulate matter, gases, temperature, and humidity, which are processed to assess air quality and its potential impact on asthma symptoms. Field trials tested the device under various conditions and alerts were triggered when air quality exceeded certain values, indicating elevated risk for asthma exacerbations. Temperature was measured between -40°C to 80°C, and humidity ranged from 0% to 100%, with extreme temperature and humidity levels correlating with worsening asthma symptoms. The heart rate sensor tracked fluctuations from 75 bpm to 120 bpm, reflecting the user's physiological response to environmental conditions. In field trials, the device successfully correlated poor air quality (e.g., PM2.5 levels of 120 µg/m³, CO₂ of 700 ppm, and humidity at 75%) with increased heart rate (ranging from 80 bpm to 110 bpm), signaling potential asthma attacks. This device offers a practical solution for asthma management by continuously monitoring the environment and the user's health, enabling individuals to take timely preventive measures, such as using medications or seeking cleaner environments. It is particularly beneficial for people in areas with high pollution or during periods of environmental triggers, helping to reduce asthma-related health risks and improve overall quality of life.

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**61. Transboundary Air Pollution and Environmental Cooperation: A case-study of India
Pakistan Smog Challenge**
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Abstract

South Asia constitutes the most polluted states of the world including Pakistan and India. Despite having worst air quality, both states have remained unperturbed to utilize bilateral and regional cooperative instruments to prevent air pollution caused by smog. The objective of the paper is to analyze India-Pakistan's strategic interactions over the transboundary pollution crisis by focusing on the mutual cooperation, mutual non-cooperation, unilateral endeavors, and exploitation of both states. The research utilizes case study as a research method based on qualitative methodology to examine how historical experiences influence decision-making choices in Pakistan and India regarding transboundary smog issue. It examines each country's strategy and policy goals for maximizing environmental gains and minimizing ecological losses in tackling transboundary air damage caused by smog. The findings of the research indicate that the historical interaction between India and Pakistan has created detrimental payoffs due to strategic choices made by both states including unilateral endeavors and policy regulations at the national level to minimal mutual collaborations and utilization of exploitative approaches. The study concluded that a joint and coordinated approach in environmental domain will assist both states in significantly improving the air quality and resolving the smog challenge.

Keywords: Transboundary smog challenge, air pollution, India, Pakistan, game theory, environmental cooperation

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62. AI for Sustainability: Using AI for Mental Health Support in Education and Its Contribution to SDG 3

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Abstract

The growing mental health issues among university students, including anxiety, depression, and stress, poses significant risks to academic success, social well-being, and long-term career goals. The study addresses these challenges and aligns them with Sustainable Development Goal 3 (SDG 3), which emphasizes ensuring healthy lives and promoting well-being for all. This research uses the Healthy Minds Study (HMS) dataset (2019–2024) to predict students' mental states using a deep neural network, providing a foundation for developing mental health support systems in higher education.

The proposed framework integrates data preprocessing, deep learning-based prediction models, and personalized intervention strategies to detect early warning signs of mental health issues. By analyzing multidimensional data; including academic, behavioral, and demographic variables, the system offers real-time, individualized recommendations to improve student well-being and academic performance. This AI-driven approach enhances accessibility and personalization in mental health care, addressing existing gaps in support systems that often fail to provide timely interventions. Through its innovative use of AI and focus on early diagnosis, this research contributes significantly to SDG 3 by advancing mental health support in underserved educational settings. By promoting healthier and more inclusive learning environments, the study underscores the critical role of technology in fostering sustainable development and equitable access to health services.



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63. The Impact of Leverage, Liquidity, Sales Growth, and Cash Flow Operating on Financial Distress with Interest Rates as a Moderating Variable

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Abstract

The Financial distress is characterized by firm inability to meet firm financial obligations. It is multi-layered process which influenced by liquidity problems, extremely level of debt and declining revenues. Its impact is not only individual business but also entire economic sectors. Pakistan is facing energy crisis driven by circular debt. Circular debt is cycle of unpaid obligations, especially in energy sectors, delay in operational efficiency, service delivery and investment. Adopting circular economy practice offers a promising approach to reduce financial distress by resource efficiency, sustainability, and innovative models in business. Firms implementing strategies, like as closed loop of supply chains and product-as-a-service modeles can attain financial flexibility through cost savings, diversified revenue and reduced dependence on instable resources. This research also discusses the keys financial determinants of distress, including leverage, sales growth and liquidity and operating cash flow. Understanding the systemic causes and accepting strategic interventions and policy makers can increase financial stability and improve energy efficiency and economic sustainability.

Keywords: Financial Distress, Energy Crisis, Circular Economy, Liquidity, Leverage, Sales Growth, Operating Cash Flow, Financial Stability, Economic Sustainability, Resource Efficiency, Supply Chain, Policy Interventions.



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64. Climate Change and its Impact on Infectious Disease Transmission

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Abstract

Climate change is increasingly recognized as a significant threat to global health, particularly through its impact on the transmission of infectious diseases. This study aims to assess students' awareness of the relationship between climate change and disease spread, their perceptions of healthcare system preparedness, and their support for climate-related health policies. A survey of 30 Likert-scale questions was administered to undergraduate and graduate students in healthcare and biomedical engineering fields, focusing on their knowledge and attitudes regarding climate change's influence on vector-borne and waterborne diseases. The survey results indicated that 75% of respondents believe climate change significantly affects disease transmission, with the majority (70%) identifying vector-borne diseases, such as malaria and dengue, as most vulnerable to climate change. Despite this awareness, 60% of respondents felt that healthcare systems are inadequately prepared for climate-induced disease outbreaks. Additionally, 80% of students expressed support for integrating climate change education into healthcare training programs, while 65% reported taking personal actions to reduce their carbon footprint. The findings suggest a clear need for enhanced public health education on climate change, as well as more resilient healthcare policies and systems to address the emerging threats posed by a changing climate. By integrating climate change preparedness into healthcare curricula and policy frameworks, we can better equip future healthcare professionals to mitigate and manage the health risks associated with climate change. These results also underscore the importance of individual actions and systemic changes in tackling climate-induced health challenges.

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65. Technological innovation, organizational resilience and Green intellectual capital: A study of SRDI SMEs

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Abstract:

Unexpected changes have forced the business organizations to make rapid adoptions and developments in their normal operations to cater to the needs of time. One of the most adopted strategies in such circumstances is the adoption of technological innovation. It enables adaptable management approaches and flexible working arrangements and therefore, businesses can better adjust to dynamic market conditions and operational challenges. The purpose of this study is to understand the role of technological innovation in enhancement of SMEs resilience and how green intellectual capital help SMEs in the process to enable timely response to disruptive situations. The study provides a novel progression to existing knowledge that how technological innovation and green intellectual capital influence organizational resilience in SMEs. Data collected through survey questionnaire from SRDI SMEs. The findings confirm that the relationship between technological innovation and organizational resilience is positive and significant. This relationship is mediated by green intellectual capital. The study suggests that SMEs should recognize their internal strengths and weaknesses regarding technological innovation for making it part of organizational operations. SMEs can reach higher levels of digital maturity by incorporating intellectual capabilities and technological innovation which in turn will strengthen their resilience.

Keywords: Technological innovation, Organizational resilience, Green intellectual capital, SRDI, SME



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66. Optimizing nitrogen fertilizer effect on rainfed maize

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Abstract

Nitrogen (N) fertilizer is a critical input for optimizing the productivity of rainfed maize, particularly in regions where water availability is unpredictable. This study investigates strategies to enhance the efficiency of nitrogen fertilizers under rainfed conditions, aiming to maximize maize yield while minimizing environmental losses. The research evaluates the effects of different nitrogen application rates, timing, and methods, along with the integration of nitrogen stabilizers and organic amendments. Field experiments were conducted to assess soil moisture levels, nitrogen use efficiency (NUE), and grain yield under varying climatic scenarios. Results demonstrate that split nitrogen application, coupled with rainfall forecasts, significantly improves NUE and reduces leaching losses. Additionally, the incorporation of slow-release fertilizers and biochar further enhances nitrogen retention in the soil. This research provides a framework for sustainable nitrogen management practices, ensuring higher maize productivity and resource conservation in rainfed agricultural systems.

67. Impact of Silica on Yield and Stress Tolerance in Sunflower

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Abstract

Sunflower (*Helianthus annuus* L.) is an important oilseed crop used for human and animal nutrition. Drought, exacerbated by climate change, severely affects sunflower growth and yield. This study investigates the ability of silicon (Si) application to improve sunflower aesthetics, physiology and performance under drought conditions using a combination of four experimental treatments representing only water holding capacity (WHC). 100%, 75%, 50% and 25%, the latter applied to Si leaves to simulate drought stress with 50% ear development.

Drought resulted in significant reductions in leaf chlorophyll content, water content, plant height, stem diameter, head diameter, needles per head (100 needles) and biological productivity per plant, but silicon application reduced chlorophyll concentration. It was also shown to increase water retention. Silicon treatment mitigated the negative impact of drought on sunflower growth and development and increased yields under dry conditions. Overall, it has been shown that continuous silicon application can contribute to increasing sunflower production in drought-affected areas. In addition, silicon was found to transcriptionally regulate several antioxidant defense systems in response to drought stress.

Silicon is considered an essential micronutrient for vegetables and plays a crucial role in the growth of many important agricultural crops. The aim of this study was to investigate the effect of silicon on the growth of sunflower, especially the Multisol variety. Sunflower (*Helianthus annuus* L.) is an important oilseed crop used in human and animal nutrition. Drought, exacerbated by climate change, severely affects sunflower growth and yield. This study investigates the ability of silicon (Si) application to improve sunflower aesthetics, physiology and performance under drought conditions using a combination of only four experimental treatments that provide 100% water retention capacity. %, 75%, 50% and 25% (WHC), the latter applied to Si leaves to simulate drought stress at 50% ear development.

Drought resulted in significant reductions in leaf chlorophyll content, water content, plant height, stem diameter, head diameter, achenes per head (100 achenes) and organic production per plant, however, silicon application reduced chlorophyll concentration. It has also been shown to increase water retention. Silicon treatment mitigated the negative impact of drought on sunflower growth and development and increased yields under dry conditions. Overall, it has been shown that continuous silicon application can help increase sunflower production in drought-affected areas. In addition, Si was found to transcriptionally regulate several antioxidant defense systems in response to drought stress.

Silicon is considered an essential micronutrient for vegetables and plays a crucial role in the growth of many important agricultural crops. The purpose of this study was to investigate the effect of silicon on the growth of sunflowers, especially the Multisol variety.

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68. Development of a Smart Wearable Hydration Monitoring System for Athletes and Outdoor Workers

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Abstract

Maintaining optimal hydration is essential for overall health, particularly in environments with high physical activity or extreme temperatures. Dehydration can lead to a range of health issues, including fatigue, heat stress, and impaired physical performance. This study aims to develop a Smart Hydration Monitoring Device that uses a combination of sensors to monitor hydration levels and provide real-time alerts to help individuals maintain proper hydration. The device integrates Temperature, Heart Rate, Humidity, and Galvanic Skin Response (GSR) sensors to track both physiological and environmental factors that impact hydration. The Temperature Sensor measures body or skin temperature, detecting increases that indicate sweating and potential fluid loss. The Heart Rate Sensor monitors changes in heart rate, which can rise as the body attempts to compensate for dehydration. The Humidity Sensor tracks environmental humidity, which affects sweat production, helping to estimate fluid loss. Finally, the GSR Sensor measures skin conductivity, with higher conductivity indicating increased sweating. In trials, the device successfully detected dehydration signs, such as increased body temperature (above 38°C), heart rate (above 100 bpm), and GSR values indicating elevated sweat levels, alongside higher humidity levels (over 60%). These physiological and environmental changes triggered alerts, prompting users to hydrate. The device provides an efficient, non-invasive method for real-time hydration monitoring, offering personalized recommendations based on individual activity levels and environmental conditions. It is especially beneficial for individuals involved in physical activities or working in hot, humid.



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69. The Impact of Phosphorus on Root Development: Mechanisms, Adaptations, and Implications

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Abstract

Phosphorus is a primary macronutrient and has a very significant role in the growth and development of plants on a global scale as it sustains the composition of root, the energy metabolism, and the nutrient acquisition. There are some constraints associated with soil phosphorus concentration because of fixation & low solubility and the inefficient application methods which pose a challenge to enhance agricultural productivity. This review aims to shed light on the understudied topic of the influence of phosphorus on root development using physiological, molecular and morphological features of the response of root development to the availability of phosphorus. Most plants alter their root system architecture, establish symbiotic associations and other regulatory mechanisms to enhance their phosphorus uptake when nutrient resources are scarce, and this review also covers other strategies. It also documents the PUE (phosphorus use efficiency) of the plants under the different agro management practices and breeding methods. This work combines an emerging trend in phosphorus research with the need to find effective and environmentally friendly ways to manage phosphorus to satisfy the ever increasing world food demand.

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70. Quantifying the impact of climate change on Canola phenology, yield, and evapotranspiration under rainfed conditions using artificial intelligence

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Abstract

Context: Canola, a major oilseed crop, is highly sensitive to climate change. Rising temperatures, shifting precipitation patterns, and increased frequency and intensity of extreme weather events pose significant threats to canola production, particularly in rainfed environments. Understanding the impact of climate change on canola phenology, yield, and evapotranspiration under rainfed conditions is crucial for developing effective adaptation strategies and ensuring sustainable canola production using artificial intelligence.

Objective:

- Calibration and evaluation of the AQUA-CROP model for Canola crops under rainfed conditions.
- Evaluation of the impact of sowing date and plant population on phenology and yield of Canola cultivar.
- To employ 4 socio-economic scenarios (SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5) for early (2030s), mid (2050s), and late (2090s) periods in the 21st century to assess the impacts of increased atmospheric CO₂ and temperature on Canola phenology, yield, evapotranspiration, and water use efficiency under rainfed conditions compared with baseline.

Method:

1. **Climate Data:** Collection of historical and future climate data for the study region from reliable sources, such as Global Climate Models (GCMs).
2. **Crop Modeling:** Employ a crop simulation model, such as the Aqua Crop Model developed by the Food and Agriculture Organization (FAO), to simulate canola growth and yield under various climate scenarios.
3. **Climate Change Scenarios:** Simulate canola phenology, yield, and evapotranspiration under different climate change scenarios representing a range of temperature and precipitation changes.
4. **Data Analysis:** Analyze the simulated data to quantify the impact of climate change on canola phenology, yield, and evapotranspiration

Results:

1. **Phenology:** Rising temperatures are expected to shorten canola phenological stages, leading to earlier flowering and maturity.



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2. **Yield:** Yield reductions are projected under climate change scenarios due to increased heat stress and water deficit.
3. **Evapotranspiration:** Evapotranspiration is likely to increase under climate change due to higher temperatures and increased plant water demand.

Conclusion: Climate change poses significant challenges to canola production under rainfed conditions. Projected reductions in yield and increases in evapotranspiration highlight the need for adaptation strategies, such as drought-tolerant canola cultivars and improved water management practices.

Keywords: Climate Change, Phenology, Crop modeling, Evapotranspiration, Adaptation Strategies



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71. Empowering Women for Climate Resilience and Gender-Sensitive Adaptation

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Abstract

The impacts of climate change disproportionately affect marginalized groups, with women frequently facing the greatest challenges due to entrenched social, economic, and political inequalities. This study investigates the gendered dimensions of climate change, focusing on the critical role women play in disaster risk reduction and recovery. It also highlights the necessity of incorporating gender-sensitive approaches into climate adaptation policies. Framed within the lens of Constructivist theory, the study examines how societal gender norms influence the roles women occupy in climate action.

It argues that empowering women through access to resources, education, and leadership positions can reshape these norms, thereby enhancing adaptive capacities at local and national levels. Employing a mixed-methods approach, the research reveals both obstacles and opportunities for fostering women’s leadership in climate resilience efforts. While the findings emphasize that integrating women’s perspectives into climate policy results in more inclusive and effective solutions, particularly in disaster preparedness, resource allocation, and post-crisis recovery.

In this vein, the study underscores a critical pathway to sustainable development by addressing gender inequalities. It calls for a shift in policy that recognizes women not only as beneficiaries of climate initiatives but as agents of transformative change. These insights provide valuable guidance for policymakers, development practitioners, and international organizations aiming to promote equitable and sustainable responses to climate challenges.



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72. Climate Adaptation through Rainwater Harvesting: A Sustainable Approach to Mitigating Droughts

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Abstract

Climate change poses a critical challenge, particularly in mountainous regions, where extreme weather events such as droughts threaten ecosystems and livelihoods. This study explores rainwater harvesting as a sustainable climate adaptation strategy, focusing on its implementation in a rural, mountainous region of Bagh Azad Kashmir Jammu and Kashmir.

The research highlights a community-driven rainwater harvesting project designed to address water scarcity during prolonged dry spells and mitigate the risks of flash floods during intense rainfall. By capturing and storing rainwater, the project has improved water availability for agricultural and domestic use, reduced soil erosion, and enhanced groundwater recharge.

A multidisciplinary approach, integrating environmental science, local knowledge, and participatory planning, ensured the project's success. The findings demonstrate the potential of rainwater harvesting to build climate resilience, emphasizing the importance of policy support, community awareness, and capacity building in scaling such initiatives.



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73. A Geospatial and Multi-Criteria Analysis Approach for Potential Rainwater Harvesting Sites: A Case Study of Rawalpindi and Chakwal District

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Abstract

Due to different climatic conditions around the globe, general pattern of temperature and precipitation varies from place to place majorly due to topography of land. Pakistan has different climatic regions such as humid, semi-arid and arid region. The area under study is located at Pothohar region and its climate is semi-arid. Precipitation is one of major weather elements to determine potential rain harvesting sites. The study area is mainly dominated by crop, trees, grass and the low bushes and depends on the rainfall received during the monsoon season. Currently, the area is under water stress conditions due to low rainfall, extensive deforestation and urbanization. There are number of famous lakes like Kallar Kahar, Uchali, Khabeki and Jhallar having problems of water quality and storage. Thus, there is a need to develop tools for identifying potential suitable sites for these rain water harvesting technologies for their enhanced sustainability thereby increasing water availability for domestic and agriculture. Rain water harvesting (RWH) technique is particularly used for agricultural activities and simultaneously beneficial for recharging aquifer. A Multi-Criteria Decision (MCD) method was used on Earth Observation (EO) dataset and weather data for suitable site selection of RWH. The thematic maps were extracted such as soil map, land use /land cover, vegetation cover, drainage network and drainage density. This research is an attempt to put forward such a framework for identifying potential sites for rain water harvesting in an area to meet water requirements for crop irrigation.

Keywords: Rain Water Harvesting, Multi Criteria Decision Method, Precipitation, Earth Observation, Drainage Density.

74. Synthesis and Characterization of Zinc and Ferrite based Photocatalyst for Dye Degradation in Water

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Abstract

Due to increase in water pollution around the globe, there is an increased focus on photocatalytic degradation for treatment of industrial wastewater. As textile industry is one of the major contributors towards water pollution, it significantly impacts the water quality. For this study, zinc oxide and zinc ferrite were synthesized via co-precipitation route and used as photocatalyst for degradation of methylene blue (MB) in water under visible light irradiation. The zinc oxide-zinc ferrite composite was successfully fabricated as photocatalyst and its photocatalytic activity for methylene blue (MB) degradation was successfully analyzed while comparing its efficiency with the individual material. The characterization of three photocatalysts was carried out utilizing XRD, FTIR, RAMAN, SEM-EDX, BET and VSM. These techniques confirm the structural, morphological, chemical and magnetic properties of synthesized photocatalysts. The photocatalytic degradation was carried out for all materials while keeping pH, temperature, initial dye concentration and catalyst dosage same. The results showed that zinc oxide showed the highest degradation rate of 98.45% followed by zinc ferrite and composite under irradiation time of 120 minutes. The kinetic results showed that the photocatalytic degradation reaction adheres to pseudo first order reaction. Post photocatalytic XRD analysis showed the stability of synthesized photocatalyst after degradation process. Mineralization analysis showed that composite showed the highest mineralization of organic contaminants. The study indicates that the composite can be used as cost effective photocatalyst with improved recyclability due to its magnetic properties, for degradation of hazardous organic dyes from aqueous solutions.

Keywords: Photocatalysis, Textile Wastewater, Dye Degradation, Advanced Oxidation Process, Material Synthesis



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75. Predicting Solar Power for Climate Resilience and Sustainable Development Using Machine Learning

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Abstract

As the world shifts towards renewable energy sources, solar power has emerged as a pivotal player in sustainable energy solutions. Accurate prediction of solar power generation is essential for optimizing energy management and ensuring grid stability. This paper investigates the effectiveness of the Facebook Prophet function for solar power prediction, leveraging historical data and weather conditions. We assess the predictive capabilities of Prophet in various scenarios, highlighting its strengths in handling time series data with seasonal patterns. The study emphasizes the significance of feature selection and data pre-processing in enhancing model performance, illustrating how the integration of diverse datasets such as meteorological variables and historical power output can lead to improved forecasting accuracy. Furthermore, we discuss the implications of our findings for grid management and energy planning, underscoring how precise solar power forecasts can support the integration of renewable energy sources into existing infrastructure. Our findings indicate that the Facebook Prophet function significantly enhances prediction accuracy, providing valuable insights for energy management systems. This research contributes to the growing body of knowledge on renewable energy forecasting and offers a foundation for future studies aimed at integrating machine learning in real-time solar power prediction applications.

Keywords: Renewable energy, Machine Learning, Energy Planning, Predictive Modeling.

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76. Effect of Climate Change on The Yield of Fava Beans

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Abstract

Climate change is expected to have a major impact on legume crops (*Vicia faba* L.), which are an important source of protein and income for farmers. This study used a combination of field experiments, statistical analysis and weather measurements to investigate the impact of climate change on legumes. The results showed that increasing temperatures, changing rainfall patterns and increased frequency of extreme weather events lead to a decrease in Fava bean yield. The study found that higher temperatures increased crop growth but resulted in reduced fruit set and lower yields. The study also found that changes in rainfall patterns, especially floods and droughts, could negatively affect fava bean yields. Studies predict that climate change will cause a 30% decrease in fava bean yields, indicating the need for urgent adaptation and mitigation strategies to ensure the long-term sustainability of fava bean production.

Keywords: Fave Bean, Yield, Legume Crops, Sustainability.

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77. Impact of Smog on Morphoanatomical, Physiological and Biochemical Characters of Sunflower (*Helianthus Annuus L.*)

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Abstract

Sunflower (*Helianthus annuus L.*) is an annual shrub, belongs to family Asteraceae. It is an important source of oil, protein and found potentially significant in phytoremediation. Smog was observed on 2-3 November 2016, in Lahore for the first time and emerged as a 5th season of Pakistan by suspending up to five months and this duration is still increasing every year. Smog has an undeniable impact on crop quality and yield. It created a sudden need to evaluate the impacts of smog on local crops of Pakistan and to find out resistant varieties. The study was based on AQI, obtained by increasing the concentration of particulate matter (PM₁₀ and PM_{2.5}) for smog formation through an artificial smog chamber. For this purpose, a field experiment was conducted in Pakistan Council of Scientific and Industrial Research (PCSIR) Lahore to analyze the impacts of different concentrations of artificial smog treatments having AQI 50, 100 and 200 respectively to the available sunflower varieties i.e., ORISUN-675, ORISUN701 and ALTIS-99. The smog chamber was supported with high pressure pump, pressure resistant pipes, high mist producing nozzles, smoke creating rocket stove and a blower to throw burnt industrial ash and dust into the smog chamber. It was connected with greenhouse for continuous feeding of smog for two hours on daily bases for a duration of 21 days. Significant results were obtained in total crude protein, total carbohydrates, total fat or oil content, Vitamin-C, soluble sugar, total chlorophyll content, seed mass and number of stomata after applying smog treatments. Current study concluded the excessive damage of plant attributes on increasing AQI up to 100, while the remarkably slighter effect on further increase of AQI. The overall nutritional damage was 17-18% on AQI 100, while it was about 25.88% on increasing the AQI up to 200. The variety that was found the best was ORISUN-701 that remain less effective in many of the analyses comparatively. The overall nutritional damage noticed in ORISUN-675, ORISUN701 and ALTIS-99 was 26.20%, 25.31% and 26.15% respectively. In future, study will pave a way for using smog resistant genes in different plants varieties to minimize the impact of smog on their yield and quality.

Keywords: Climate Change, Pollution, Environmental Pollution, Smog, AQI

78. A field-based study to appraise the diversity and abundance of lepidopteran fauna from selected agro-environment of Punjab province, Pakistan.

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Abstract:

Pakistan is an agricultural land and its economy mainly depend on this sector. Among all provinces Punjab is most fertile with its deep-rooted irrigated system. More than 64% population of the country depends on agriculture for livelihood. Besides providing income sources agricultural land also provides shelter for many insect species. Among insects, Lepidoptera is most abundant and diverse order with more than 180,000 species. Lepidopteran insects serve as pollinators as well as pest. To estimate the abundance and diversity of lepidopteran following study was done in three districts of Punjab province of Pakistan. Lepidopteran fauna was collected from six selected crops namely, wheat, sugarcane, fodder, vegetables, rice, cotton during a duration of 12 months. A total of 31 species belonging to 10 families were collected by using quadrat and sweep net method. Most abundant family was Noctuidae with 2789 individuals. Most abundant species was *Helicoverpa armigera* with 9.26% relative abundance. Lepidopteran fauna was richly abundant in fodder crop with highest diversity index ($H'=2.902$). Highest abundance was found during the month of September (19.02%). Evenness was highest in the month of January ($E= 0.8292$). During autumn season highest diversity was recorded with 42.75% relative abundance. Highly significant ($p<0.05$) results were found by one way ANOVA. Such kind of study about diversity and abundance will be fundamental to explore the ecological role of lepidopteran fauna in agroecosystem.

Keywords: Diversity, Relative abundance, Lepidopteran fauna, Agroecosystem, Punjab province.

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79. Birth in a Burning World

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Abstract

Climate change has intensified extreme heat, worsening Pakistan's maternal health crisis, which already has high maternal and newborn mortality rates compared to neighbouring countries. This study explores whether pregnant women perceive extreme heat as particularly challenging and how heatwaves have influenced their experiences during pregnancy and early motherhood. Moreover, it seeks to uncover the coping strategies women use to manage excessive heat and identify potential interventions that could strengthen their resilience for themselves and their families. The study uses both primary and secondary research, including a desk-based review of epidemiological data on extreme heat's impact on maternal and newborn child health (MNCH). Interviews were conducted in Sindhi and Urdu with 16 pregnant or recently postpartum women in Shikarpur District, Sindh Province - a region with extreme temperatures and affected by the 2022 floods. Additional dialogues were held with two local officials and three healthcare providers to gain further insights. The study found that extreme heat exacerbates maternal health risks, including dehydration, fatigue, and mental health challenges. Women reported difficulty managing daily tasks and feared the impact of heat on fetal development. Breastfeeding was difficult due to discomfort from heat, affecting both mothers and infants. Overall well-being declined, with increased exhaustion and emotional distress. Mental health issues like anxiety and stress were intensified by limited cooling access and patriarchal norms, highlighting the need for targeted interventions. The study highlights the need for equitable access to cooling spaces and integrating MNCH into national climate adaptation plans. It calls for community-based research initiatives and increased funding and support from high-emission countries to low- and middle-income countries to address the climate crisis and its impact on MNCH. Further research is essential to develop culturally sensitive interventions to help pregnant women and new mothers manage extreme heat.

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80. Green Principles or Fake Phrases? An Examination of Discourse in Conference Speeches

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Abstract

This study aims to examine the elements that are emphasized or ignored/omitted in the environmental discourses of the speakers on the platform of the Second International Conference on Climate Change in the Eastern Mediterranean and the Middle East region. The concepts of Shallow Ecology and Deep Ecology, as proposed by Arne Naess (1972), along with the eight types of narratives identified by Stibbe (2015) in Ecolinguistics, serve as the theoretical framework for this research. A qualitative research method has been employed in this study. From the conference, six speeches were selected for analysis: those presented by Prof. Costas N. Papanicolas, Dr. Rabia Farooqi, Al Hasan Bin Talal, Mr. George Grimlis, Dr. Shaddad Ateli (panellist), and Dr. Fabio Montano. These speeches addressed climate change and its environmental impacts on various regions. The eight categories proposed by Stibbe have been applied to the selected speeches to extract discourses on environmentalism. The study's findings reveal that instances of shallow ecological discourse are more in number, indicating the predominance of shallow environmental discourse. Additionally, certain regions that require greater attention for environmental conservation have not been highlighted. The study concludes that it is essential to maintain a comprehensive focus on environmental issues and to ensure a swift and smooth switch from short-term protective measures to more profound, systemic changes for ecological preservation. Practical policies must be implemented to achieve a sustainable and harmonious environment.

Keywords: Environmentalism, Ecolinguistics, Climate change, Shallow and Deep ecology, Conference, Eastern Mediterranean and Middle East.

81. Assessing the Effects of Environmental and Human Activities on NO₂ and SO₂ Levels in Faisalabad: A Study from 2020 to 2024

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Abstract

Air pollution is a critical environmental issue affecting urban-industrial regions worldwide, with serious implications for human and ecosystem health. This study investigates the trends of nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) levels in Faisalabad, Pakistan, from April 2020 to September 2024, using satellite data from the TROPOMI Explorer and seasonal maps from the Copernicus Browser. Monthly mean concentrations were analyzed to identify seasonal variations and spatial distribution patterns, revealing distinct changes influenced by industrial activities, vehicular emissions, and climatic factors. The results show that NO₂ and SO₂ levels were consistently higher during the winter months (November–March) due to industrial operations and thermal inversions, with peak concentrations of 76 µg/m³ for NO₂ in January 2021 and 570 µg/m³ for SO₂ in December 2020, both exceeding WHO’s 24-hour limits. Conversely, the monsoon season (June–August) showed a notable decline in pollutant levels, with NO₂ decreasing by 30-40% due to rainfall-induced wet deposition. A temporary reduction in pollution was also observed during the April–June 2020 COVID-19 lockdowns, reflecting the impact of decreased industrial and vehicular activity. These findings underscore the urgent need for targeted air quality management policies, particularly to address seasonal pollution peaks. The study emphasizes the importance of adopting cleaner technologies and enhancing agricultural residue management to reduce pollution and protect public health.

Keywords: Air pollution, NO₂ concentrations, SO₂ concentrations, Faisalabad, Industrial emissions, Seasonal variations



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82. Role of IoT in Technological Innovations and Sustainable Practices for Shaping a Sustainable Future: Global Solutions for Climate Change

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Abstract

The Internet of Things (IoT) has rapidly emerged as a transformative technology with vast potential to address global environmental challenges. In particular, IoT facilitates the implementation of sustainable practices by enabling real-time monitoring, data collection, and automation to optimize various aspects of environmental management. This paper explores the role of IoT in promoting sustainability, with a focus on air pollution control, energy management, and climate change mitigation. A novel use case is proposed, wherein IoT technologies are integrated with bamboo plantations to combat smog in Lahore, Pakistan, a city that faces severe air quality issues. This solution leverages IoT-enabled sensors for real-time air quality monitoring, automated irrigation for bamboo growth, and data analytics to optimize the growth and environmental impact of bamboo. By harnessing the natural air-purifying capabilities of bamboo alongside IoT technology, this approach aims to improve air quality and contribute to the global fight against climate change.

Keywords: Internet of Things (IoT), sustainable practices, air quality monitoring, bamboo plantation, pollution control, climate change, Lahore, smart irrigation.

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83. Exploring Food Security Amidst Climate Challenges in Southern Punjab: A Case Study of Bahawalpur, Rahim Yar Khan, and Rajanpur

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Abstract

Global targets to address the SDG 2, zero hunger remain threatened as economic disparities continue to rise. FAO reports that the number of undernourished people in the world continued to rise by around 8.7 % in 2020, while the rise in food insecurity of South Asia from 13.5% in 2014 to 40.6 in 2021, was reported. This study assesses the impact of climate change on food security in southern Punjab, Pakistan, focusing on the three districts Bahawalpur, Rahim Yar Khan, and Rajanpur. The purpose of the study is to evaluate the three pillars of food security in South Punjab: food accessibility, food utilization, and food stability. The study also analyzes climate change impact on food production. Primary data were collected from 399 respondents, mainly rural farmers, using structured questionnaires and interviews conducted in two stages in 2019. Multiple linear regression (MLR) modeling was used to analyze the relationship between climate variables (temperature and precipitation) and agricultural production, focusing on major food crops of the region i.e. wheat and rice production. The analysis revealed significant correlations between climate variables and agricultural productivity. The results show that wheat and rice production in Bahawalpur, Rahim Yar Khan and Rajanpur are significantly affected by temperature and cultivated area, with all significance levels less than 0.05. In Bahawalpur and Rahim Yar Khan, wheat crop yields declined due to rising temperatures and erratic rainfall, while in Rajanpur, yields increased over time. Access to food was strongly influenced by land ownership and sources of income, with a large proportion of respondents relying on agriculture and livestock. In Bahawalpur only 57%, Rahim yar Khan 73% and Rajanpur 63% respondents had access to a clean drinking water supply. Food utilization has been limited by low literacy levels, limited access to clean water, and poor sanitation infrastructure, further increasing vulnerability to food insecurity. The findings highlight the urgent need for targeted interventions to address the food security challenges posed by climate change in southern Punjab. Enhancing agricultural sustainability through sustainable practices, improving resource management, and reducing infrastructure gaps are essential steps to ensure long-term food security in the region.

Keywords: Food insecurity, food accessibility, food utilization, food stability, zero hunger



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84. Role of electric vehicle energy management for Climate Change

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Abstract

The rapid progression of climate change, driven by greenhouse gas emissions and unsustainable energy practices, necessitates the transition to cleaner and more efficient technologies. Electric vehicles (EVs) have emerged as a pivotal solution to address environmental challenges by significantly reducing carbon footprints and promoting renewable energy integration. This paper explores the role of energy management systems (EMS) in optimizing the efficiency and sustainability of electric vehicles, thereby contributing to climate change mitigation. The study highlights advancements in battery technologies, regenerative braking systems, and intelligent energy distribution that enhance EV performance and extend battery lifecycles. Additionally, it examines the integration of EVs with smart grids to facilitate energy storage and load balancing, supporting the adoption of renewable energy sources. Challenges such as energy storage limitations, grid stability, and infrastructure requirements are discussed, alongside potential solutions like vehicle-to-grid (V2G) systems and advanced predictive algorithms. This research underscores the necessity of robust EV energy management for achieving global climate goals and emphasizes the collaboration required among policymakers, manufacturers, and researchers to ensure successful implementation.

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85. Narrating Ecology: An Ecolinguistic Analysis of Alareer’s *Gaza Writes Back*

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Abstract:

Indigenous and native people possess a unique understanding of their surroundings, deeply rooted in their relationship with intricate ecosystems. This study examines the ways in which Palestinians in the selected stories from Alareer’s *Gaza Writes Back*, connect to their land. The Ecolinguistic analysis (2015) provides theoretical framework for the study. The qualitative analysis of Three short stories have been selected through Purposive Sampling Technique. The Conceptual Metaphor Theory (1981) is used to explore the conceptual metaphors used in the selected stories. The ecosophy of Naess (1973) has been used to evaluate the ecological orientation of these metaphors. Moreover, the ecological identities are explored through types of Ecological Identities given by Lei (2021). The findings reveal eight different metaphors used to represent the relationship of the Palestinian with their land. The metaphor of HUMANS ARE PLANTS, and PLANTS ARE HUMAN BEINGS, suggest a deep connection with the nature, such metaphors reflect the interdependence of life on each other, promoting a harmonious coexistence among all components of ecosystem. The metaphor COLONIZERS AS PARASITES illustrates that occupation forces are involved in destruction of the local land and nature while the Palestinians have strong connection with their land and strive to preserve nature. The Ecolinguistic analysis reveals the negative or destructive ecological identities of occupational forces while the inhabitants of Palestine demonstrate beneficial identity in relation to their environment and local ecology. The study concludes by arguing that the native people share a deep connection to their land, therefore, to address the ecological crises their voices need to be heard and amplified for a viable future of mankind.

Keywords: Conceptual Metaphor Theory, ecolinguistics, ecosophy, ecological identities, Palestinian Literature, Riffat Alareer

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86. Understanding Food Insecurity in Lahore, Pakistan: The Role of Socio-Environmental, Economic, and Climate Change Factors

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Abstract

Food insecurity is a pressing global issue impacting individuals, communities, and nations alike. This study investigates the multifaceted nature of food security in Lahore, Pakistan, emphasizing the socio-environmental and economic factors influencing food security in the region. It focuses on key components—availability, accessibility, and utilization—to analyze household-level impacts, challenges faced by consumers due to high food prices, the effects of climate change on food security, and the impact of these challenges on sellers. The findings underscore the importance of providing affordable, nutritious food while addressing poverty, reducing inequality, and mitigating the effects of climate change to ensure sustainable food systems. This research utilized two questionnaires which gathered responses from 400 individuals, 63% from consumers and 38% from sellers. Results demonstrated inflation and floods as one of the significant drivers of food insecurity. About 47% of the study participants believed that inflation was responsible for affecting their purchasing power, while an overall 82% linked business losses to inflation. Climate change was observed to be the key factor responsible for aggravating food insecurity, owing to key weather events such as floods. About 94% of the consumers and 92% of the sellers linked climate change with food insecurity. Overall, 67.7% of the population was found to be food secure, while 32.4% were identified as food insecure. Addressing food insecurity requires collaborative efforts from governments and international organizations to implement social protection programs, adopt climate-resilient agricultural practices, and support vulnerable populations in building sustainable, climate-adaptive food systems.



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**87. Impact of climate change is disproportionate on women – we need to empower them
– this is what WASUP and MIAT are doing.**

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Abstract

As climate crisis worsens the disproportionate socio-political and economic tensions women face worsens, leading to greater vulnerability ranging from loss of livelihood, heightened risk to health and safety and access to resource and relief. When talking about education Malala Yousuf said ‘**We cannot succeed when half of us are left behind.**’ This holds true for tackling the climate crisis too. For tackling climate change we need the entire global population.

Whilst climate change affects everyone, women are affected disproportionately. The impact of climate change has resulted in 14 times more deaths of women and children, mostly due to limited access to information, decision making and resources. Such impact was laid bare in the Pakistan floods of 2022 when over 60,000 pregnant women had no access to any medical help. During such natural disasters, caused by climate change, the safety of girls and women being displaced also seriously comes into question. Such realities should galvanise women into action – if given the chance.

As the chief Kashmir and international ambassador of WASUP – World Against single use plastic (www.wasupme.com) which also incorporates mitigation and adaptation awareness to climate change, I have been visiting schools and villages to help educate children not only in climate change but also helping with mainstream education. In this, in spite of various attempts at engaging government officials I appear to be a lone voice.

Research has shown that countries with high representation of women in parliament are more likely to ratify environmental treaties. United Nations Climate Change news of 8th March 2023 summarised 5 compelling reasons why women are central to climate action which will be alluded to in the presentation. As more and more women are educated not only will their families move out of poverty, but they will step up and play as equal a role as men – such basic initiative have been set up in Pakistan and Malawi by MIAT – Midland International Aid Trust (UK) in Faisalabad (ably run by my colleague Eshal Shokat - Pan Asian WASUP ambassador and her family) where young girls not only attend school but are provided with free training in IT and sewing classes. The making of sanitary pads by these girls further empowers them and encourages them to attend school. A drop in the ocean I know – but drops put together, make the ocean.



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88. Gender, Poverty, and Climate Change: Examining Social Vulnerabilities and Adaptation Strategies in Marginalized Communities of Azad Kashmir

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Abstract

The research adopts a **qualitative research design** to explore the intricate relationship between climate change, gender, poverty, and social vulnerabilities within the context of Azad Kashmir. The study aims to investigate the differential impacts of climate change on marginalized communities, particularly focusing on the roles gender and social inequalities play in shaping vulnerability and adaptation strategies. The data will be collected through **semi-structured interviews, focus group discussions (FGDs), case studies, and document analysis**. Interviews will involve key stakeholders, including local government officials, community leaders, NGO representatives, and climate experts, to capture diverse perspectives on climate impacts and adaptation strategies. Additionally, **focus groups** will be conducted with marginalized groups such as women, youth, and low-income farmers to gain insight into the community-level experiences of climate-related challenges.

Purposive sampling will be employed to select participants who have direct experience with climate change impacts, ensuring a diverse representation of vulnerable groups. Data will be analyzed using **thematic analysis** to identify key themes related to vulnerability, adaptation strategies, and the role of gender and poverty in influencing adaptive capacity.

This research is designed to provide an in-depth understanding of how **social inequalities**, such as gender disparities and poverty, intersect with climate change impacts. The findings aim to contribute to the development of **gender-sensitive climate adaptation policies** that promote equitable and sustainable development in Azad Kashmir, aligning with the United Nations' **Sustainable Development Goals (SDGs)**, particularly **SDG 5: Gender Equality** and **SDG 13: Climate Action**. The research will also offer practical recommendations for building resilience in marginalized communities through inclusive climate action and policy interventions.

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89. Arctic Climate Change and Impact on Pakistan’s Socio-Economic, and Food Security: A Case Study of 2010 Flood Disasters.

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Abstract

The Arctic is a key regulator of the Global Climate System (GCS), influencing atmospheric and oceanic currents worldwide. However, the Arctic is warming four times the global average with impacts extending far beyond the polar region, particularly to vulnerable countries like Pakistan. This study investigates how Arctic climate change has contributed to extreme weather events in Pakistan, specifically focusing on the **2010 floods**—a catastrophic event linked to Arctic-driven climate disruptions—and explores the broader themes of **environmental risks and the need for building resilience**.

The research highlights the teleconnections between Arctic warming and Pakistan’s weather systems, outlining how disrupted jet streams, altered monsoon patterns, and Arctic sea ice loss intensify extreme weather events in the shape of floods and droughts in Pakistan. The 2010 floods, which displaced millions and caused economic losses exceeding \$40 billion, exemplify how these climatic changes threaten Pakistan’s socio-economic security. Moreover, unpredictable rainfall patterns resulting in flash floods further exacerbate agricultural challenges, triggering concerns for food security in the country. To substantiate research findings, the study also incorporates interviews with climate experts to contextualize the Arctic dynamics with local vulnerabilities.

Given Pakistan’s vulnerabilities—including high population density, reliance on agriculture, and insufficient disaster management infrastructure—this study underscores the Arctic’s role as an important extra-regional driver of extreme weather events exacerbating environmental risks and vulnerabilities. The study employs the Copenhagen School framework as it accounts for various security sectors and highlights the need to address these pressing issues and build resilience. To address these challenges proposed strategies include incorporating satellite-based environmental governance, enhancing the capabilities of NDMA, and investing in climate research for informed policymaking.

Keywords: Arctic Climate Change, 2010 Pakistan Floods, Extreme Weather Events, Socio-economic Security, Food Security, Environmental Risks, Climate Resilience.



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90. Resilience Strategies for Fruit Crops in a Changing Climate

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Abstract

Climate change poses considerable challenges to the worldwide cultivation of fruit crops, influencing growth, productivity, and produce quality. Climate change effects, such as rising temperatures, changing precipitation patterns, and extreme weather events, have recently become apparent. These changes directly affect the maturation and development of fruit crops, including shifts in phenology, adjustments in fruit production, and changes in fruit composition. Elevated carbon dioxide levels can also influence fruit quality. Heat stress during blooming and fruit set can reduce yield, while unpredictable rainfall patterns may disrupt pollination and increase pest and disease risks. Building resilience is essential for maintaining fruit crops yield and sustainability. Resilience refers to the capacity of these crops to adapt to and recover from the effects of climate change while still producing high yields and maintaining quality. Several strategies can be employed to enhance the resilience of fruit crops. These include developing and selecting climate-resilient varieties, adopting improved agronomic practices, implementing efficient irrigation systems, and utilizing precision farming techniques. Institutional support and strong regulatory frameworks are essential for promoting resilience in fruit crop systems. Strengthening multidisciplinary research collaborations among scientists, farmers, policymakers, and stakeholders is critical for developing effective adaptation. These partnerships facilitate sharing information, experiences, and innovations, leading to greater resilience in fruit crop systems.

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91. Climate Change and Economic Resilience in Mountainous Regions: A Case Study of Muzaffarabad, Azad Jammu and Kashmir

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Abstract

The IPCC report states that mountainous areas are more susceptible to climate change, which can upset ecosystems, decrease the water supply, and impact economic stability. Azad Jammu and Kashmir's (AJK) capital, Muzaffarabad, Muzaffarabad saw a notable warming trend between 2009 and 2024, with maximum temperatures rising by 4°C and average temperatures rising by 1°C. Due to the disruption of company operations, employment, and income distribution, these factors, along with the disastrous 2005 earthquake that inflicted damages surpassing Rs. 76.4 billion, have significantly influenced the region's economy. Primary and secondary data sources were combined using a mixed-method approach. 65 shops at the Gojra Bypass Road market were surveyed to gather primary data, which was then mapped using ArcGIS to show spatial patterns of shops. The World Bank report on the 2005 earthquake and other academic publications served as the source of secondary data. In addition to contextualizing the wider economic effects of environmental and climatic concerns, the data were analyzed using graphs and tables to evaluate ownership patterns, income levels, and tax compliance. Due to long-term risks from the 2005 earthquake and frequent monsoon flooding, the majority of shops are rented, and the majority of employees get modest incomes between 10,000 PKR and 15,000 PKR. While tax compliance is evenly distributed, rising temperatures and heavy rainfall raise operating costs and interrupt market activity, indicating financial hardship for enterprises. The study concludes that Muzaffarabad's economic dynamics are strongly connected to environmental and climatic issues, highlighting the necessity of sustainable tourism, climate-resilient infrastructure, and focused policy interventions to maintain economic stability and expansion. Muzaffarabad can create a more resilient future, by coordinating economic policies with climate adaptation.

Keywords: Economic Profile, Muzaffarabad, Climate Change, Environmental Challenges, Temperature Rise, Rainfall Patterns, Mountain Regions

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92. Impact of Pods Shattering on the Yield of Canola (*Brassica napus*)-A review

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Abstract

Pod shattering is a considerable challenge in Canola cultivation, affecting yield and quality. The main objective of this study was to explore the physiological and environmental sources of pod shattering, and its impact on canola yield. The data was collected through different sources like Google Scholar, HEC digital library, and PubMed. Different keywords were used like “pod-shattering”, Canola vs pod-shattering”, factors affecting the yield of Canola, etc. After the review of different research articles data was analyzed through Excel, and Spss by applying simple descriptive stat and correlation. The result showed that the yield of canola can be decreased by 20% in the case of cultivar selection. It also showed that there is a strong positive correlation between pod shattering and the yield of canola. It also resulted that in case of drought stress, canola yield is also decreased by pod shattering. To overcome this issue this was concluded that Silicon is the best element to reduce the pods shattering in canola if applied at proper time. The current review shows how pod-shattering reduces the yield of canola and which possible solutions are there to overcome this issue. Further, it highlights the need for integrated solutions to increase crop productivity and economic sustainability in canola farming systems.

Keywords: Canola; Pod shattering; Silicon.

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93. Assessing the potential of Miyawaki forests as a substitute for grass lawns on water consumption and local air quality

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Abstract

In a quest for sustainable urban design, one of the spaces that escapes the focus is the grass lawn. Grass lawns are not only ecologically non-diverse, but they are also quite water-intensive. Research suggests that one square foot of lawn needs about 0.6 gallons of water, per week. On the contrary, one square foot of a Miyawaki forest needs less than 0.1 gallons, per square foot. This research paper uses secondary data and case study analysis to first assess the climatic, cost, and land-space feasibility of Miyawaki forests in urban residential areas. Later, the paper focuses on the comparative analysis of water usage in the maintenance of a standard grass lawn with a Miyawaki micro-forest, as well as the macroscopic ecological benefits of replacing residential lawns with Miyawaki forests. The paper concludes by providing policy recommendations to promote Miyawaki forests to improve Pakistan’s water stress and improve its urban air quality.



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**94. Evaluating Carbon Markets as a Strategy for Reducing Emissions in Pakistan’s
Textile Industry**

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Abstract

Pakistan, a major textile exporter, faces growing pressure to reduce greenhouse gas (GHG) emissions due to its vulnerability to climate change and potential trade barriers. However, the country has yet to fully embrace the necessary mitigation measures. Carbon markets, particularly those aligned with Article 6 of the Paris Agreement, offer a promising avenue for reducing GHG emissions. This study explores the potential of carbon market instruments to drive emission reductions within Pakistan’s textile sector. Using a mixed-methods approach, the research combines a quantitative survey of major textile companies with in-depth interviews of top-level executives to gain a comprehensive understanding of the industry’s perspectives, challenges, and opportunities. The findings reveal a significant gap between perceived and actual knowledge of carbon markets, with limited practical experience identified as a key barrier. Despite the industry’s growing adoption of low-carbon technologies such as renewable energy and energy-efficient machinery, there is a notable reluctance to engage with carbon markets. The study emphasizes the critical importance of government support in regulation and setting standards to address challenges. To overcome these barriers, the study advocates for policy frameworks, capacity-building initiatives, and robust government-industry partnerships. Additionally, the research examines the implications of the Carbon Border Adjustment Mechanism (CBAM) and suggests that greater participation in carbon markets could mitigate its risks while supporting the industry's long-term sustainability. The study underscores the importance of considering the textile sector's viewpoint in designing effective policies and strategies that align with Pakistan's unique circumstances and the objectives of the Paris Agreement.

Keywords: Carbon Markets, CBAM, Paris Agreement, Pakistan’s Textile Sector

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95. SMOG; A Concerning Issue in Pakistan

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Abstract

Smog has emerged as a significant environmental and public health concern in Pakistan, particularly affecting major cities like Lahore. The results of several studies are combined in this review article to give readers a complete understanding of Pakistan's pollution problem. The main causes of poor air quality and smog formation are found to be urbanization, industrialization, and high fossil fuel consumption. The issue is made worse by the interaction of atmospheric conditions, crop residue burning, vehicle pollution, and industrial emissions. Since 2013, smog pollution has become a major socioeconomic problem in Lahore, and things get worse every year. The review emphasises the various ways that smog affects the economy, agriculture, and public health. Long-term smog exposure is linked to cardiovascular and respiratory disorders as well as an increase of pre-existing problems, and it especially impacts underprivileged groups. Additionally, Smog has a detrimental effect on agricultural productivity, resulting in degraded soil and lower crop yields. In conclusion, this review underscores the urgent need for interdisciplinary approaches to tackle the smog crisis effectively. Public awareness campaigns, technology advancements, and regulatory interventions are some of the strategies for reducing smog pollution that are covered. The findings emphasize the importance of adopting sustainable practices and implementing stringent regulations to combat smog pollution in Pakistan and protect public health.

Keywords: Smog, Lahore, Pakistan, Air quality, Public health, Socioeconomic problem



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96. The Role of Climate Change in Shaping Agricultural Insect Pest Dynamics and Implications for Food Security

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Abstract

Climate change and global warming are a serious problem for agriculture around the world and one of the most discussed topics in modern society. Climate variables such as rising temperatures, high levels of carbon dioxide in the atmosphere and changing precipitation patterns have a significant impact on agricultural production and agricultural pests. Climate change can affect insects in various ways. This can expand their geographical range, increase winter survival rates, increase the number of generations, change plant-insect symbioses, change species interactions and increase the potential for insect migration. The risk of insect attacks, pest infestations, plant diseases and biological enemies, especially natural enemies, may increase. As a result, there is a risk of crop losses from an economic perspective, as well as a challenge to human food security. Climate change, a major factor affecting insect population dynamics, will require adaptive management strategies to address the changing pest situation. Several focal points for future research on the impact of climate change on agricultural pests can be identified. These solutions include revised integrated pest management methods, monitoring of climate and pest populations, and the use of modeling and forecasting tools.

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97. Irrigation Options in Rainfed Areas of Pakistan: A Sustainable Approach for Small Landholdings in Punjab

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Abstract

While drip irrigation has long been proven for fruit and vegetable crops in Pakistan, the only impediment to its adoption is its high installation cost for the small land holders, owing mainly to the overdesign of the system. In the present study the cost of a conventional drip irrigation system was reduced through redesigning the system and eliminating the filtration of the system like hydrocyclon, sand media, disc filters (in the case of groundwater source), pressure gauge, water meter, double laterals and through purchasing the drip system from local vendors. Low cost drip irrigation was tested for its productive and economic effects on vegetables (potato, onion, and chilies) and fruits (olive, peach and citrus) through field trials during 2015 and 2016. Comparing drip irrigation system with furrow irrigation system, the low-cost drip irrigation system saved 50% cost of irrigation and gave 27-54% more net revenue. On the other hand, water use efficiency was observed from 3.91-13.30 kg/m³ and 1.28-4.89 kg/m³ for drip irrigation and furrow irrigation systems, respectively. They also improved the physical and chemical attributes of vegetables and fruits to a reasonably good extent. The present study also concluded that low cost drip irrigation was beneficial to small farmer (i.e. less than 2 hectares) since, on average, the yield increased by more than 20% compared to traditional furrow irrigation.

Keywords: agricultural economy; drip irrigation system; net revenue; small landholders; sustain- able irrigation

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98. Climate Change and its Impact on Infectious Disease Transmission

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Abstract:

Climate change is increasingly recognized as a significant threat to global health, particularly through its impact on the transmission of infectious diseases. This study aims to assess students' awareness of the relationship between climate change and disease spread, their perceptions of healthcare system preparedness, and their support for climate-related health policies. A survey of 30 Likert-scale questions was administered to undergraduate and graduate students in healthcare and biomedical engineering fields, focusing on their knowledge and attitudes regarding climate change's influence on vector-borne and waterborne diseases. The survey results indicated that 75% of respondents believe climate change significantly affects disease transmission, with the majority (70%) identifying vector-borne diseases, such as malaria and dengue, as most vulnerable to climate change. Despite this awareness, 60% of respondents felt that healthcare systems are inadequately prepared for climate-induced disease outbreaks. Additionally, 80% of students expressed support for integrating climate change education into healthcare training programs, while 65% reported taking personal actions to reduce their carbon footprint. The findings suggest a clear need for enhanced public health education on climate change, as well as more resilient healthcare policies and systems to address the emerging threats posed by a changing climate. By integrating climate change preparedness into healthcare curricula and policy frameworks, we can better equip future healthcare professionals to mitigate and manage the health risks associated with climate change. These results also underscore the importance of individual actions and systemic changes in tackling climate-induced health challenges.

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99. Smart Heat Stress Monitoring Wearable Device

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Abstract

Heat stress is a significant health risk, particularly with rising temperatures due to climate change, affecting outdoor workers, athletes, and vulnerable populations. Existing methods for detecting heat stress rely on subjective measures or cumbersome equipment, lacking continuous, real-time monitoring capabilities. This study aimed to develop a Smart Heat Stress Monitoring Wearable Device to provide real-time assessments of heat stress by continuously monitoring ambient temperature, skin temperature, heart rate, and humidity. The device uses four sensors: DHT22 for ambient temperature, MLX90614 for skin temperature, MAX30100 for heart rate, and HTU21D for humidity. These sensors collect real-time data, which is processed to calculate a heat stress index (HSI) that classifies risk levels into low, moderate, or high categories. The device was tested in field trials under various environmental conditions, measuring temperature from 25°C to 42°C, skin temperature between 36.5°C and 40.2°C, heart rate from 75 bpm to over 130 bpm, and humidity between 40% and 90%. The results showed the device's ability to accurately detect heat stress, with HSI values ranging from 0.1 (low risk) to 0.8 (high risk). For example, at 38°C ambient temperature, 80% humidity, and a skin temperature of 39°C, the device calculated an HSI of 0.65, indicating high heat stress. The device provided real-time feedback and alerts when heat stress reached moderate or high-risk levels, allowing for timely intervention, such as hydration or cooling. This wearable device offers a portable, accurate solution for continuous heat stress monitoring, making it valuable for outdoor workers, athletes, and individuals in hot environments, helping prevent heat-related illnesses by providing actionable data and early warnings for necessary interventions.

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100. UV Exposure Alert System for Children’s Outdoor Playtime

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Abstract

Excessive UV exposure is a major health concern, leading to issues like sunburn, dehydration, and long-term skin damage. Monitoring UV exposure in real-time is essential for preventing these health risks. This study aims to develop a UV Exposure Health Risk Tracker using a minimalistic sensor setup. The device integrates a Light Dependent Resistor (LDR), a Temperature Sensor (TMP36 or LM35), and a Humidity Sensor (DHT22) to monitor light intensity, skin temperature, and environmental conditions, respectively. The LDR measures light intensity with a range of 0 lux to 100,000 lux, serving as a proxy for UV exposure, while the Temperature Sensor tracks skin temperature within a range of -40°C to 100°C, alerting users when temperatures exceed 37°C, signaling potential sunburn. The Humidity Sensor measures relative humidity from 0% to 100%, with values above 60% indicating increased risk for heat stress and dehydration. By correlating light intensity with UV exposure levels (a UV index of 6 or above), skin temperature with overheating (above 38°C), and humidity with dehydration risk (above 60% RH), the device provides real-time alerts to help users manage sun exposure. In trials, the device successfully detected elevated light intensity of >800 lux, skin temperatures exceeding 38°C, and humidity levels above 60% RH, triggering alerts when the risk of sunburn and heat stress was high. This simple, low-cost solution provides an accessible way to help individuals monitor their UV exposure, preventing dehydration, heat stress, and long-term skin damage.

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101. Mitigating Drought Stress in Mustard (*Brassica Campestris*) Through Exogenous Application of Osmoregulators: A Meta-Analysis

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Abstract

Drought stress is a major problem for global agriculture, affecting food security and agricultural yields, and can result in severe output losses for commonly grown oilseed crops, especially *Brassica Campestris*. However, there is a viable solution: osmoregulators. These compounds enhance plant tolerance through osmotic adjustment and effective stress signaling, making them powerful mitigators of drought-induced stress. A Meta-Analysis has been conducted to consolidate the existing knowledge on using osmoregulators to combat drought stress specifically in *Brassica campestris*. By Using specific keywords like "*Brassica campestris*," "drought stress," and "osmoregulators," this review analyses about 20 articles from reputable databases like Google Scholar and PubMed. The findings focus on key parameters, including morphological traits—such as plant height, fresh weight, and dry matter weight per plant—and physiological traits, like relative water content. This study emphasizes the effects of osmoregulators, specifically proline, glycine betaine, and trehalose, under drought conditions. Statistical analyses, including ANOVA, regression, and covariance analysis using SPSS, reveal compelling results. The study demonstrates that Proline is the most effective osmoregulator in mitigating drought stress, as a powerful strategy as it improves growth and physiological parameters under drought stress and boosts the productivity of *Brassica campestris* in the face of adverse climatic conditions. In order to tackle the future issues brought about by climate change, our findings open the door for the integration of osmoregulatory methods into sustainable farming operations.

Keywords: Drought stress, Osmoregulators, *BrassicaCampestris*, Proline(pro), GlycineBetaine(GB), Trehalose (Tre)



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102. Developing a net-zero-emission pathway for Pakistan’s Chemical Industry

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Abstract

Pakistan’s chemical industry is a key driver of industrial growth, contributing significantly to GDP and employment. However, it also represents a major source of greenhouse gas (GHG) emissions, with industrial processes reliant on fossil fuels, particularly coal. As Pakistan strives to fulfill its commitments under the Paris Agreement, decarbonizing the chemical sector is imperative to achieving national and global climate goals. Despite the urgency, industries in developing economies face substantial challenges in emissions reduction due to incomplete Scope 3 data, regulatory constraints, and technological limitations. This study addresses these challenges by developing a structured, adaptable, and industry-specific emissions reduction framework for Pakistan’s chemical sector, integrating internationally recognized methodologies to establish a scientifically robust net-zero strategy. The research employs the GHG Protocol for emissions tracking across Scope 1, 2, and 3, ensuring transparency and consistency in data collection. Given the availability of detailed data for Scope 1 and 2, the Science-Based Targets Initiative (SBTi) is utilized to define reduction targets and decarbonization strategies. However, due to limited Scope 3 data, the Sectoral Decarbonization Approach (SDA) serves as an interim tool, enabling sector-specific emissions reduction trajectories while facilitating a gradual transition to full SBTi alignment as more comprehensive data becomes available. This hybrid approach supports immediate action on Scope 1 and 2, while ensuring long-term scalability for Scope 3, with a focus on supplier engagement, circular economy practices, and value chain optimization. Expected outcomes of this study include the identification of key emissions hotspots, development of targeted reduction strategies, and alignment with global sustainability standards to enhance corporate climate resilience and regulatory compliance. By bridging critical data gaps through a phased integration of tools, this study presents a replicable, evidence-based model for industrial decarbonization in developing economies, offering actionable insights for policymakers, industry stakeholders, and researchers.

Keywords: Climate Resilience, Emission reduction, Circular Economy, Decarbonization, Net zero, Greenhouse Gas Emissions

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103. Advance Sensor Technology for Monitoring Water Quality in Beverage Industry

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Abstract

Water pollution is one of the biggest fears for the green globalization. To ensure the safe supply of drinking water the quality needs to be monitored in real time. This research explores the design and development of a low-cost system for real time monitoring of the water quality through IOT (internet of things). The system consists of sensors and is used to measuring physical and chemical parameters of the water. Parameters such as temperature, PH, turbidity, and TDS of the water/wastewater can be measured. The measured values from the sensors can be displayed on the Firebase console by using ESP 32 Microcontroller. The Arduino model can be used as a core controller. Finally, the sensor data can be viewed using IoT system.

Keywords: pH sensor, Turbidity sensor, Temperature sensor, IoT based, Water quality monitoring.

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104. Barriers to the adoption of Industry 4.0 technologies in the practice of occupational safety and health of SMEs

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Abstract

The purpose of the paper is to identify the main problems and barriers to the adoption of Industry 4.0 technologies that help to improve the OSH system in small business enterprises, and to develop scientifically based recommendations for their elimination. The current study employed a qualitative research approach using two methods. The first method was to identify the problem by conducting interviews with managers and labor protection specialists and employees of small businesses. The second method is to study various sources and research works related to the opportunities and challenges of using digital technologies to improve OSH. The results of the study provide a comprehensive overview of the range and list of barriers to small businesses' willingness to use digital technologies and smart devices to ensure safe and decent working conditions. Also, this study substantiates that the use of Industry 4.0 technologies to improve working conditions in small business enterprises can bring high benefits for small business owners, employees and society.

Keywords: SMEs, OSH practice, barriers to adoption of Industry 4.0 technologies

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105. Reverse Osmosis Desalination: Possible Innovative Solutions for Commercial Sustainability

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Abstract

The availability of clean and healthy drinking water is one of the major issues in the modern industrialized world. The natural freshwater resources are no longer sufficient to fulfill the drinking water requirements of the rapidly increasing population of the world. The increasing pressure of the global population on the available freshwater resources has provoked scientists to develop methods for the production of fresh water for drinking as well as irrigational, and industrial purposes from brackish and seawater resources. The reverse osmosis technology has emerged over the last few decades as the leading method for the production of freshwater by the desalination of brackish and seawater. This review covers the technical, financial, and environmental aspects of reverse osmosis desalination and possible innovative solutions to ensure its sustainability on a commercial scale. Furthermore, the potential feasibility of reverse osmosis desalination in Pakistan, its industrial applications and future research needs for improving its efficiency and cost-effectiveness are also elaborated to complete the picture.

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106. Green Construction Materials: Optimizing Steel Slag Fine Aggregate Usage in Sustainable Mortars

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Abstract

The depletion of natural sand due to excessive mining poses significant environmental challenges, necessitating sustainable alternatives in the construction industry. This study explores the potential of steel slag, an industrial by-product, as a partial replacement for sand in cementitious mortars, contributing to circular economy principles and climate-resilient construction. Steel slag was sourced from a steel industry, and its chemical and physical properties were characterized using standard ASTM methods. A particle size distribution analysis, conducted with 0–100% slag replacement, identified 60% slag and 40% sand as the optimal mix for maintaining gradation within ASTM limits. A 1:3 cement-sand mortar mix was prepared, and its density, workability, and strength were evaluated. The results demonstrated that a water-to-cement ratio of 0.5 provided adequate flowability while enhancing density and compressive strength compared to control specimens. The use of steel slag as a sustainable fine aggregate not only reduces reliance on natural sand but also mitigates industrial waste disposal issues, lowering the carbon footprint of construction materials. This research highlights the potential of steel slag in developing sustainable and durable cementitious mortars, aligning with global climate action goals by promoting resource efficiency and reducing environmental degradation.

Keywords: Sustainable construction, steel slag, sand replacement, cementitious mortar, climate action.

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107. Role of Climate Smart Agriculture in Climate Mitigation and Adaptation

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Abstract

Climate-Smart Agriculture (CSA) has emerged as a comprehensive framework to address the interconnected challenges of climate change, food security, and sustainable agricultural development. This review explores the principles, strategies, and benefits of CSA in enhancing agricultural resilience, improving productivity, and mitigating climate-related risks. Key practices, including climate-resilient crop varieties, precision farming, agroforestry, sustainable soil management, and efficient irrigation techniques, are examined for their role in optimizing resource use and reducing vulnerability to climate extremes. Additionally, CSA contributes to climate change mitigation by lowering greenhouse gas emissions and promoting sustainable intensification. The review further discusses the alignment of CSA with Sustainable Development Goals (SDGs), particularly climate action (SDG 13) and zero hunger (SDG 2), emphasizing its role in global food security and rural livelihood sustainability. Despite its potential, widespread adoption of CSA is hindered by financial constraints, policy gaps, and knowledge limitations. To overcome these barriers, this paper highlights the need for targeted policies, financial incentives, and collaborative research efforts. By analyzing successful case studies and emerging innovations, this review underscores CSA's critical role in fostering climate resilience and sustainable agricultural systems in a rapidly changing climate.

Keywords: Climate-smart agriculture, climate-resilient agriculture, adaptation, mitigation



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108. From Crisis to Opportunity: Strategies for Climate-Resilient Development in Pakistan,

A key note address By Prof. Dr. Muhammad Fahim Khokhar

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Abstract:

Climate change presents an unprecedented challenge to Pakistan, exacerbating existing vulnerabilities across environmental, economic, and social sectors. This study explores the scientific basis of climate change, its regional impacts, and the specific risks faced by Pakistan. The increasing frequency of extreme weather events—such as heatwaves, droughts, and devastating floods—has led to significant losses in agriculture, infrastructure, and public health. Governance challenges, financial constraints, and inadequate adaptation mechanisms further hinder resilience-building efforts. Drawing on recent climate trends, economic assessments, and policy developments, this presentation highlights the urgent need for a shift toward climate-smart strategies. Key solutions include the adoption of advanced monitoring technologies, ecosystem-based disaster risk reduction, early warning systems, and sustainable development practices aligned with the Sustainable Development Goals (SDGs). The role of governance, regional partnerships, and community engagement is also emphasized in fostering a proactive approach to climate resilience. By recognizing climate risks and integrating evidence-based strategies, Pakistan can transform climate challenges into opportunities for sustainable growth. This presentation serves as a call to action for policymakers, researchers, and civil society to work collectively toward a climate-resilient future.

Keywords: Climate change, advanced monitoring technologies, sustainable growth, climate-resilient future

109. Assessing Groundwater Quality and Recharge Sources Under Climate Change and Urbanization in Mansehra Using Machine Learning

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Abstract:

Groundwater is the primary source of water supply in the district of Mansehra, Khyber Pakhtunkhwa, Pakistan. Rapid urbanization and climate change have increasingly influenced the region's groundwater quality and recharge patterns. Domestic water is typically obtained from dug wells, boreholes, and open wells, making groundwater contamination a growing concern. This study aimed to analyze groundwater quality and identify probable recharge sources under changing environmental conditions. Eleven water samples were collected from wells, rivers, and channels across different zones (0–200 m, 201–400 m, 401–600 m, 601–800 m, and 801–1000 m) based on their distance from the river. Samples were carefully in clean, sterilized plastic bottles and transported to the Pakistan Council for Research in Water Resources (PCRWR), Islamabad, within 24 hours for analysis. Various physicochemical parameters, including pH, electrical conductivity (EC), total hardness, alkalinity, chlorides (Cl), sodium (Na), sulfates (S), turbidity, carbonates, bicarbonates, calcium (Ca), potassium (K), and nitrates, were analyzed. Results indicate that groundwater quality is deteriorating in areas affected by increased urbanization and changing climate patterns. Samples from Baffa revealed elevated levels of hardness, Ca, K, and nitrates, exceeding the permissible limits set by the World Health Organization (WHO), indicating contamination. However, samples from Nokot and Ichria remained within acceptable limits except for turbidity. A comparative analysis of water samples from wells, rivers, and ponds suggests that the primary recharge sources for groundwater in the study area are rivers and ponds. These findings highlight the urgent need for sustainable water management strategies to mitigate the impacts of urban expansion and climate variability on groundwater resources in Mansehra.

Keywords: Groundwater Quality, Machine learning, Urbanization, Mansehra



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110. Understanding the Climate and its extremes for the climate resilient society

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Abstract:

According to the Intergovernmental Panel on Climate Change (IPCC), there are possible likely global future climate change scenarios. One of the likely scenarios is to restrict the global temperature anomaly remained about 1.5 °C with respect to the pre-industrial era (1850- 1900). By 2017, the global temperature anomaly reached to 1.0 °C, and it may likely to reach 1.5 °C than the pre-industrial era around 2040s. However, in recent years, world experienced lots of extreme event including Pakistan flood 2022, Spring-2022 extreme temperature anomaly over South Asia, recent UAE flooding, Spain flash floods, fires in Europe and many other extremes. Also, global temperature anomaly crossed 1.5 °C limit in mid-2023, and it remained above by mid-2024, which was very un-usual and interesting case study. This temperature breach was contributed by one the strongest El Niño, that happened in 2023/24 and also contributed to lots of climate extremes across globe. El Niño is the positive phase of the naturally occurring phenomenon namely as El Niño-Southern Oscillation (ENSO), where positive (above than normal temperature) Sea Surface Temperature anomaly happens in the central-eastern equatorial Pacific region, while opposite phase (below than normal temperature) is known as La Niña.

Climate is changing and we are experiencing this changing climate. Are we as a society prepared to cope the impact of the climate extreme events in the changing climate? How well models are performing in forecasting these extreme events? How novel methodology such as Artificial Intelligence (AI), Machine learning and Modelling can help us to understand the changes in the climate? It is important that climate modelling community work with the different socio-economic sectors (such as agriculture, water, environmental agency and others) to understand their needs and co-develop the strategies to develop the climate resilient society.

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111. Automation and AI driven intelligent manufacturing techniques for industrial production to mitigate the impact of climate change (Industry 6.0 approach)

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Abstract:

Through process optimization, waste reduction across industries, and the use of less energy, water, and other utilities, industrial automation has the potential to be a key factor in reducing the detrimental effects of climate change. Artificial intelligence, robotics, and data analytics are examples of advanced automation technologies that can improve industrial processes' sustainability and efficiency. Industries may lower their energy, water, and carbon footprints, improve resource management, and hasten the shift to sustainable practices by using smart systems, sensors, and all intelligent manufacturing approaches. Industry 6.0 need the ability to effectively reduce greenhouse gas emissions and improve environmental performance. To combat climate change and achieve global sustainability goals, industrial automation relies heavily on the latest trends, technologies, and breakthroughs. Using completely automated, customer-focused, and tailored sustainable automation approaches can help realize the circular economy, net zero emissions, and net zero trash. The most recent developments in AI and intelligent manufacturing need to be implemented right away. However, we should concentrate on the difficulties and chances for global scaling of these breakthroughs, especially when considering developing nations like Pakistan that are most impacted by climate change. We can connect these state-of-the-art techniques in our industrial developments in the face of a fast-changing climate by encouraging cooperation among scientists, technologists, politicians, and industry leaders.

Keywords: Climate change; sustainability; AI; Intelligent manufacturing; industrial revolution

**112. The Role of Heavy Metals in the Environment Pollution and their Determination
in the Biological Objects**

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Abstract:

Environmental pollution is of particular concern. The term heavy metals (HM), which characterizes a wide group of pollutants, has recently become widespread. Heavy metals are a significant component of environmental pollution, posing serious risks to ecosystems and human health. They can have numerous adverse effects on environmental and human health, including: soil contamination, water pollution, biodiversity loss, human health risks: Heavy metals can be toxic to humans, causing various health issues.

Why have they become our enemies? The release of heavy metals into the environment is associated with human activity. Emissions into the atmosphere from burning fuel, especially coal, play a significant role. Their main sources are industry, motor transport, boiler houses, waste incineration plants and agricultural production. Continuous monitoring and research are necessary to develop effective strategies for managing heavy metal pollution and protecting public health.

The determination of heavy metals in biological objects (such as plants, animals, and human tissues) is crucial for monitoring environmental pollution and assessing environmental health risks, and formulating regulations to mitigate their impact. Determining heavy metals in biological objects (such as tissues, blood, or other biological samples) is essential for assessing environmental exposure, food safety, and human health risks. Various analytical techniques, including atomic absorption spectrometry (AAS), inductively coupled plasma mass spectrometry (ICP-MS), spectrophotometry and X-ray fluorescence (XRF), are employed to quantify heavy metal concentrations in tissues of flora and fauna.

Furthermore, it discusses the implications of heavy metal exposure on human health, including neurotoxicity, carcinogenicity, and developmental issues. The role of regulatory frameworks and environmental policies in mitigating heavy metal pollution is also examined. Overall, this study underscores the need for continued research and effective management strategies to address the pervasive issue of heavy metal contamination in the environment, ensuring the protection of both ecological and human health.

Key words: heavy metals, toxicity, environment, pollution, health risk

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