

BOOK OF ABSTRACTS

International Conference on Extreme
Weather Events: Impacts and Responses
(ICEWE-2026)



FEBRUARY
03-04
2026

Organized
by:

Abbottabad University of Science & Technology, Havelian (AUST)
Society of Economic Geologists & Mineral Technologists (SEGMITTE)
Pakistan Council of Research in Water Resource (PCRWR)
Pakistan Meteorological Department (PMD)



PRIME SCIENTIFIC
CORPORATION

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Events: Impacts and Responses
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February 3-4, 2026

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**Abbottabad University of Science &
Technology (AUST)**



**Society of Economic Geologists &
Mineral Technologists (SEGMITE)**



**Pakistan Council of Research in
Water Resources (PCRWR)**



**Pakistan Meteorological Department
(PMD)**

In collaboration with



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BOOK OF ABSTRACTS

International Conference on Extreme Weather Events: Impacts and Responses (ICEWE-2026)

February 03-04, 2026

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Table of Contents

ORGANIZING COMMITTEE	i
INTRODUCTION	iv
MESSAGE FROM CHIEF MINISTER KP	v
MESSAGE FROM VICE CHANCELLOR	vi
MESSAGE FROM MINISTER	vii
MESSAGE FROM DG PASTIC	viii
ABOUT AUST	ix
ABOUT SEGMITE	xii
ABOUT PCRWR	xvi
ABOUT PMD	xviii
ABOUT PASTIC	xix
ABOUT TCIL	xxi
ABOUT PSC	xxiii
ABSTRACTS	1
Impact of Climate Change on Livelihoods and Alternative Solutions for the People Living in Coastal and Slum Areas	1
Domestication of Non-Conventional Salt-Accumulating Plants for Simultaneous Phytodesalination and Salinization Management	2
Identifying Past and Future Vulnerable Hotspots of Weather Extremes in Bangladesh, Pakistan and Nepal	3
Effect of Climate Change and Human Destruction on Ecosystem: An Overview of its Consequences	4
Linking Western Himalayan Uplift, Sediment Provenance, and Miocene Climate Change	4
Policy-Driven Approaches for Large-Scale Land Restoration: A Case Study of Africa's Great Green Wall Initiative	6
Late Quaternary Subaerial Paleosol in the Bhola Island, Meghna Estuary (Bengal Delta): Record of Sea Level and Climatic Variabilities	7
Climate-Induced Extreme Events and Bangladesh	8
Mineralogical and Geochemical Controls on Slope Instability in the Hilly Urban Terrain of Chattogram, Bangladesh: Implications for Landslide Hazards under Extreme Weather Events	9
Integrated Assessment of Land-Cover Dynamics and Warming Trends in Northern Pakistan (1992–2025): Implications for Urban Growth, and Climate Driven Hazard Intensification	10
Spatial and Temporal Assessment of Snow Water Equivalent Variability in the Astore Basin over A Decade (2013–2023)	11

Analyzing Temperature Variability and Trend Detection in the Hindu Kush Region, Northern Pakistan	12
Quantitative Microbial Risk Assessment and Strategic Chlorination for Cholera Control in Urban Drinking Water Supply. A Case Study from Karachi, Pakistan	12
Evaluating Crop Residue as a Renewable Energy Resource: Opportunities for Reducing Greenhouse Gases, Combating Climate Change and Mitigating Extreme Weather Impacts	13
Climate Change Impacts on Agriculture and Rural Development in Pakistan ...	14
Trace and Heavy Metal Contamination in Tirah Coalfields: Geochemical Signatures and Environmental Health Risks	14
Heat, Floods and Flies: UAV-AI Early Warning and Adaptive IPM for Extreme Weather in South Punjab, Pakistan	15
Floodwater Diversion for Managed Aquifer Recharge- A Case Study at Sutlej River in Punjab.....	16
Shoreline Change Study in Northwest of Indus Delta using the Temporal Landsat Satellite Data.....	17
Engineering Geological Assessment of Seismic Hazards for Sustainable Urban Development in the Bengal Basin: Implications from Indo-Burmese Subduction Dynamics.....	17
Geo-environmental Aspects for Climate-Resilient Urban Planning in Sirajganj Town and Surrounding Areas, Bangladesh	18
Assessment of Groundwater Quality and Rising Salinity in the Kirana Hills Rabwah Region	19
Environmental Degradation Due to Unplanned Quarries for Engineering Purpose in the North-Western Part of Bangladesh	20
InSAR-Based Early Detection of Landslide Movements under Extreme Weather Conditions in the Eastern Hindukush, Pakistan.....	21
Exploring Glacier Dynamics in Shigar River Basin using Geospatial Techniques	22
Microfossils as Proxies for Past Sea-Level Variability and Coastal Hazards: Global Synthesis and Applications for Pakistan.....	23
Climate Change Impact on Hydrological Regimes of UIB: An Overview in the Context of Gilgit-Baltistan	24
Monitoring of Nitrogen Dioxide (NO ₂) over Karachi using Remote Sensing Tool: Sentinel 5P	25

Ambient Air Quality Assessment and Risk Impact due to Climate Change in Karachi	26
Machine Learning and GIS Approaches for Predicting Groundwater Salinity in Southern Indus Plain, Hyderabad District, Sindh, Pakistan	27
Evaluating Spatial Justice through Accessibility and Resource Distribution	28
Geological and Geotechnical Assessment of Landslides Triggered by Cyclone 'Remal' in Baghaichari, Rangamati District, Bangladesh	29
Geological Assessment of Surface Water and Groundwater along Malir, Lyari, and Hub Rivers, Karachi under Changing Climate Conditions and Associated Health Impacts	29
Flood Risk Assessment Mapping by Remote Sensing in District Chiniot, Pakistan	30
Marine pollution Climate Change: Nexus: Study of Harbor and Outfall Lyari River Sindh Pakistan	31
Studying the Effect of Tannic Acid on the Growth Performance of Wheat under Salt Stress	32
Comparative Evaluation of Organic Fertilizers for Mitigating Salinity Stress and Enhancing Plant Growth in Saline Soils	32
Evaluation of Salinity Eradicating Role of Gallic Acid, a Polyphenol in Wheat Plant- <i>Triticum Aestivum</i> through Priming Process.....	33

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INTRODUCTION

The Global Climate Risk Index 2026 has revealed that extreme climate events have disproportionately affected the Global South, and Pakistan is among 15 worst impacted countries. About one million people have died since 1995 worldwide and economic losses of USD 4.5 trillion directly resulted from about 10,000 extreme weather events dominated by floods, storms and heat waves. Pakistan has been experiencing long heat waves since the beginning of last decade causing torrential rains and devastating floods. Various manifestations of human induced climate change impacts in 2025 included heavy rains and floods in Pakistan, India, Sri Lanka, China, Bangladesh, Indonesia and Thailand which displaced millions of people and caused large scale destruction of crops, houses and other infrastructure.

A two-days international conference is being organized with the aim of providing a platform for geoscientists, environmentalists, engineers, climate change experts, and other stakeholders to identify causes of extreme weather events. Another objective is to suggest mitigation and adaptation measures to meet weather, water and climate related hazards in future. The response to the announcement of this international conference has been very encouraging. A large number of abstracts covering following themes have been received from all over Pakistan and some other countries including Bangladesh, China, Nigeria, Muscat, France and Canada.

Key Themes

- Extreme weather events & early warning systems
- Adaptations & resilience
- Water management
- Trans-boundary water management & climate diplomacy
- Landslides & rock fall
- Public health impacts
- Floods & droughts
- Glacier melting & GLOFs
- Sea-level rise & coastal erosion
- Groundwater depletion & salinization
- Impacts on agriculture & rural development
- Impacts on livelihoods & infrastructure
- Wetland degradation & ecosystem services
- Climate justice, loss & damage
- Urban planning & flooding
- Land use regulations & governance

It is hoped that the keynote and other technical presentations in various sessions of the conference, followed by Panel/ Recommendations session will provide a way forward to share ideas, discuss challenges and mitigation options.

MESSAGE FROM CHIEF MINISTER KP

I am pleased to extend my warm felicitations to the organizers, scholars, scientists, policymakers, and participants of the International Conference on “Extreme Weather Events: Impacts and Responses.” This timely and important forum reflects the growing global concern over the increasing frequency and intensity of extreme weather events and their far-reaching consequences for the society, economy, and the environment.



Extreme weather phenomena such as heat waves, floods, droughts, cyclones, and glacial hazards pose serious challenges to sustainable development, public health, food security, and infrastructure, particularly in climate-vulnerable regions. Addressing these challenges requires a collective and science-based approach that integrates innovative research, effective early warning systems, climate-resilient planning, and informed policy decisions.

I commend the organizers for bringing together national and international experts to deliberate on the impacts of extreme weather events and to explore practical and innovative response strategies. Such academic and policy-oriented engagements play a vital role in strengthening resilience, enhancing preparedness, and promoting adaptive capacities at local, regional, and global levels.

I am confident that the deliberations and outcomes of this conference will contribute meaningfully to climate action, disaster risk reduction, and sustainable development initiatives. I wish the conference every success and hope it serves as a platform for fruitful discussions, knowledge exchange, and long-term collaboration.

Mr. Muhammad Sohail Khan Afridi
Chief Minister KP

MESSAGE FROM VICE CHANCELLOR



Extreme weather-related events have been increasing in intensity and frequency, eventually impacting human lives, economies and ecosystems throughout the world. These events include floods, heat waves resulting in drought, wildfires and storms which are no longer isolated incidents, but constant challenges due to climate change.

Over the past decade, prolonged heat waves, erratic monsoon patterns, accelerated glacier melt, and unprecedented flooding—most notably in 2010 and 2022 have resulted in the loss of thousands of lives and caused widespread destruction to infrastructure, agriculture, and livelihoods. The year 2024, confirmed as the hottest year in recorded global history based on multiple independent datasets, underscored the global nature of this crisis, with sharply rising mortality rates. In 2025, South Asia has continued to witness severe manifestations of human-induced climate change, including intense glacial melting, cloudbursts, flash floods, landslides, and rock falls across Khyber Pakhtunkhwa, Gilgit-Baltistan, and adjoining regions. Subsequent heavy monsoon rains triggered catastrophic flooding across Punjab and parts of Sindh, devastating millions of acres of cropland, undermining rural livelihoods, and imposing significant losses on national economies.

Therefore, academia and research have a critical role to play in order to develop a better understanding so that we can predict and put into place early warning systems. The sharing of knowledge through national and international collaborations are important because extreme weather transcends countries and shared information and coordinated response is necessary. In this conference, diverse scientific expertise, knowledge and technological innovations with global partnerships will bring together evidence based sustainable solutions. This in turn helps to develop informed policies to mitigate strategies for this world-wide issue.

I extend a warm welcome to all participants and sincerely thank the organizing committee, collaborating partners, and sponsors for their dedication and efforts. It is my firm belief that the knowledge shared and collaborations forged during this conference will play a significant role in shaping effective responses to extreme weather challenges at local, regional, and global scales. Let this conference serve as a call to collective action—grounded in science, guided by equity, and driven by resilience.

Prof. Dr. Tahir Irfan Khan
Vice Chancellor, Abbottabad University of S & T

MESSAGE FROM MINISTER

Effective and efficient disaster management is of critical importance for Khyber Pakhtunkhwa, one of the most disaster-prone regions of the country. In recent years, the province has experienced significant human, social, and economic losses due to a range of natural and human-induced hazards, including earthquakes, floods, droughts, landslides, fires, industrial accidents, displacement, and complex humanitarian emergencies.



Climate change, coupled with shifting monsoon patterns, is intensifying the frequency, magnitude, and spatial extent of extreme weather events. Areas previously considered less vulnerable are now increasingly exposed, underscoring the urgent need for enhanced preparedness and adaptive capacity. Scientific evidence clearly indicates that extreme weather events will continue to occur with greater intensity and unpredictability, demanding proactive and integrated responses.

In this context, the development and implementation of effective strategies to address the impacts of extreme weather events and climate change are imperative. Disaster risk reduction, preparedness, resilient infrastructure development, robust response mechanisms, and climate change adaptation must be mainstreamed into all planning and development processes. Strengthening early warning systems, improving institutional coordination, and promoting community-based resilience are central to minimizing disaster-related losses.

The Disaster Risk Reduction initiatives of the Provincial Disaster Management Authority are aligned with international frameworks such as the Hyogo and Sendai Frameworks, as well as the Khyber Pakhtunkhwa Disaster Management Road Map. These frameworks provide a strategic foundation for reducing vulnerability and building resilience against climate-induced extreme events.

I commend the organizers of this International Conference on “Extreme Weather Events: Impacts and Responses” for creating a vital platform that brings together researchers, policymakers, practitioners, and development partners. Such forums are essential for advancing scientific understanding, sharing best practices, and translating knowledge into effective policies and actions. I am confident that the outcomes of this conference will contribute meaningfully to strengthening disaster resilience and climate responsiveness at provincial, national, and regional levels.

Mr. Aqib Ullah Khan
Minister for Relief Rehabilitation & Settlement Department

MESSAGE FROM DG PASTIC



It gives me great pleasure to extend my felicitations to the organizers on the successful convening of this scholarly event. Academic conferences serve as vital platforms for knowledge exchange, research dissemination, and collaboration among researchers, academicians, and professionals, thereby contributing significantly to national research and innovation ecosystems. In line with its mandate and the National Science, Technology, and Innovation (STI) Policy 2022, the Pakistan Scientific and Technological Information Centre (PASTIC) supports academic events by publishing and printing Abstract Books, ensuring standardized formatting, high-quality production, and enhanced visibility of scholarly contributions.

PASTIC is operating under the Pakistan Science Foundation (PSF) and the Ministry of Science & Technology (MoST), a premier national institution mandated to collect, organize, preserve, and disseminate Scientific and Technological Information (STI) for the socio-economic development of Pakistan. Through its headquarters and regional centres, PASTIC provides access to research literature, abstracting and indexing services, national S&T databases, patent and innovation information support, and reference library services, along with reprographic, publication, and capacity-building initiatives. These services collectively support researchers, industry, and policymakers, strengthening evidence-based research, innovation, and international scientific collaboration.

I sincerely appreciate the cooperation extended by the conference organizers and reiterate PASTIC's commitment to supporting academic initiatives that advance research excellence and contribute to national development. I wish the organizers and participants every success in their academic endeavors.

Prof Dr. Muhammad Akram Shaikh
Director General
Pakistan Scientific & Technological Information Centre (PASTIC)

ABOUT AUST

Abbottabad University of Science and Technology (AUST), located in the scenic city of Abbottabad, Khyber Pakhtunkhwa, is a public-sector university committed to academic excellence, research, innovation, and community development. With a vision to emerge as a center of excellence in science, technology, and multidisciplinary education, AUST plays a critical role in addressing the educational and socio-economic needs of the Hazara region and beyond.



Originally established as a sub-campus of Hazara University, AUST gained full university status in 2015 through an Act passed by the Provincial Assembly of Khyber Pakhtunkhwa. Since then, the university has witnessed remarkable institutional growth, diversifying its academic offerings and enhancing its research profile across various disciplines, including natural sciences, computer science, social sciences, management sciences, education, and health sciences.

The university is housed on a purpose-built campus developed with support from the Annual Development Programme (ADP) and Public Sector Development Programme (PSDP), along with contributions from the Government of China. The campus features modern academic blocks, state-of-the-art laboratories, a well-resourced library, high-speed digital infrastructure, student hostels, and green spaces—creating a conducive environment for learning and innovation.

In collaboration with the Khyber Pakhtunkhwa Information Technology Board (KPITB), AUST has established a state-of-the-art Software Technology Park on its campus. This facility serves as a hub for software development, IT entrepreneurship, and hands-on training. It provides high-speed internet, co-working spaces, and access to expert mentorship and industry linkages. The park bridges the gap between academia and industry by enabling students and faculty to engage in innovative IT projects, launch startups, and contribute meaningfully to the digital economy of the region.

AUST's mission is to nurture intellectual growth, foster innovation, and promote applied research that aligns with national priorities and addresses global challenges. The university is dedicated to producing graduates with critical thinking abilities, ethical leadership, and problem-solving skills needed in a rapidly changing world. Through the Office of Research, Innovation and Commercialization (ORIC), Business Incubation Center (BIC), and Quality Enhancement Cell (QEC), AUST has strengthened its research culture, entrepreneurial initiatives, and academic quality assurance mechanisms.

With an expanding portfolio of national and international collaborations, a dedicated faculty, and a forward-looking strategic plan, AUST continues to evolve as a vibrant institution contributing to Pakistan's knowledge economy. The university remains steadfast in its commitment to inclusive education,

community engagement, and holistic student development, preparing graduates to meet the dynamic needs of society.

Department of Earth Sciences

The Department of Earth Sciences at Abbottabad University of Science and Technology (AUST) plays a vital role in advancing geoscientific education and research in Pakistan. Established with the vision of developing skilled earth scientists capable of addressing contemporary geological and environmental challenges, the department is committed to academic excellence, scientific inquiry, and societal relevance. Through a balanced integration of theoretical knowledge and practical training, the department aims to cultivate a comprehensive understanding of Earth systems and their interaction with human activities.

The academic focus of the department encompasses the study of geological processes, Earth materials, natural resources, environmental dynamics, and geohazards. Special emphasis is placed on field-based learning, laboratory work, and analytical skills, enabling students to translate classroom concepts into real-world applications. The proximity of AUST to the geologically diverse terrain of northern Pakistan—including the Himalayan foothills, Hazara region, and adjacent structural zones—provides an exceptional natural laboratory for hands-on training, field mapping, and applied research. This unique setting enhances students' exposure to complex tectonics, stratigraphy, mineral resources, and environmental issues.

The department is supported by a team of dedicated and qualified faculty members with expertise in various sub-disciplines of Earth sciences including structural geology, sedimentology, geological mapping, mineralogy, environmental geology, hydrogeology, and geophysics. Faculty members are actively engaged in teaching, research, and academic mentoring, fostering a culture of critical thinking and innovation. Continuous curriculum development ensures alignment with national and international academic standards, while encouraging interdisciplinary approaches to problem-solving.

Research and scholarly activities form a core component of the department's mission. Faculty and students are encouraged to participate in research projects addressing issues of national importance, such as natural resource management, environmental degradation, climate variability, water resources, and geohazards assessment.

The department promotes collaboration with national and international universities, research institutions, and scientific organizations to strengthen research capacity and knowledge exchange. Seminars, workshops, conferences, and field excursions are regularly organized to enrich the academic environment and expose students to emerging trends in geosciences.

In line with its commitment to national development, the Department of Earth Sciences at AUST strives to produce graduates who are not only academically

competent but also socially responsible and professionally skilled. Alumni of the department are prepared for careers in academia, research organizations, government departments, industry, and environmental consultancies. By contributing to human resource development, scientific research, and community awareness, the department continues to play an active role in addressing the geological and environmental challenges facing Pakistan and the broader region. Through sustained academic growth, research engagement, and collaborative initiatives, the Department of Earth Sciences at AUST remains dedicated to advancing geo-scientific knowledge and supporting sustainable development at local, national, and international levels.

ABOUT SEGMITE



The Society of Economic Geologists & Mineral Technologists (SEGMITE), a non-profit scientific organization was founded in 1989 at PCSIR Peshawar with the aim of promoting sustainable development of minerals, water and clean energy resources and protection of the environment in Pakistan and other developing countries. The Society has a large number of Life members and Corporate Members associated with academia, research institutions, mining, energy and environment related industries, based in Pakistan and other South Asian countries. It is run by Members Board of Directors including the Convener and Treasurer. The Society members, professionals and other stakeholders are invited to participate in its scientific activities including national and international conferences, symposia, workshops, training courses, awareness seminars and lecture series. These events are organized regularly in collaboration with leading national and international research and teaching institutions, industries, government and other development organizations to exchange and advance knowledge in the fields of economic geology, mining geology, mineral based industries, clean energy resources and disaster management etc.

About 50 SEGMITE Conferences, Symposia, Seminars, field workshops and Training courses have been organized in Pakistan and abroad on sustainable development of minerals, water and energy resources and natural hazards during last 35 years. Besides, a large number of technical lectures, and group discussions organized by SEGMITE have helped creating awareness among public and policy makers about the need for modern scientific practices and capacity development for efficient utilization of natural resources and protection of the environment. SEGMITE offers membership to geoscientists and environmentalists and those engaged in mining, mineral processing and other related industries.

International Journal of Economic & Environmental Geology (IJEEG) (<https://www.econenviron-geol.org>) SEGMITE publishes an Open-access, Quarterly International Journal of Economic and Environmental Geology (IJEEG) with ISSN: 2223-957 X. It is a peer-reviewed multidisciplinary, international journal published regularly since 2010. This online international journal publishes research articles and review papers related to Economic and Environmental Geology fields. It is widely indexed (DOAJ, CrossRef, Google Scholar) and HEC recognized “Y” Category international journal.

SEGMITE Events held during 1989-2025

- **Seminar on Prospects and Problems of Minerals based Industries in Pakistan** organized in collaboration with Mining Engineering Department, KP University of Engineering, Peshawar (1989).
- **First SEGMITE National Conference on Industrial Minerals** in collaboration with PCSIR, Peshawar (1990).
- **First SEGMITE Symposium on Export Promotion of Mineral Products**, organized in collaboration with Export Promotion Bureau (EPB), Sarhad Chamber of Commerce and Industry and PMDC in Peshawar (1991).
- **SEGMITE Training Course on Mine Safety**, Swabi (1992)
- **SEGMITE Business meeting** was held during 29th International Geological Congress, Kyoto, Japan (1992).
- **Workshop on Gems and Minerals Scientific Mining** was held in collaboration with Export Promotion Bureau in Mingora (1993).
- **Second SEGMITE International Conference & Exhibition on Export Oriented Development of Mineral Resources and Mineral based Industries** organized in collaboration with EPB, Geological Survey of Pakistan, Asian Development Bank and Association of Geoscientists for International Development (AGID) in Karachi (1994).
- **First National Mineral Policy of Pakistan 1995 and launching of Annual International Gems and Mineral Exhibitions** by the Govt. in Peshawar were the direct outcomes of the Recommendations of the Second SEGMITE Conference.
- **International Symposium & Field Workshop on rock Phosphate & other Industrial Minerals** held in collaboration with UNESCO-IGCP Project 395, Geological Survey of Pakistan, Pakistan Science Foundation (PSF) and AGID in Abbottabad (1995).
- **International Training Course on Groundwater & Potable Water Supply to Rural Areas** held in association with AGID and PSF in Peshawar (1996).
- **International Workshop on Industrial Minerals for International Development** held in association with British Geological Survey in Peshawar (1997).
- **Third SEGMITE International Symposium and Exhibition on Sustainable Development of Water Resources** organized in association with National Institute of Oceanography, EPB and AGID in Karachi (1999).

- **International Conference on Natural Resources & Environment** in association with Geological Survey of Bangladesh and AGID in Dhaka, Bangladesh (2003).
- **Razi Memorial Annual Technical Lecture Series** held during 2004-2010 in Karachi.
- **National Seminar on Renewable Energy** held in association with Federal Urdu University and Sindh Environment Protection Agency in Karachi (2008).
- **International Conference on Water, Minerals and Energy Resources**, held in association with PCRWR, AGID, Higher Education Commission and Pakistan Petroleum Limited in Karachi (2013).
- **International Conference on Mining and Fuel Minerals** was organized in association with Mining Engineering Department, Kutahya University, Inspectorate of Mines, Govt. of Sindh, Pakistan Council for Science and Technology, HEC and PSF in Karachi (2017).
- **World Water Day** organized in association with PCRWR and Geology Department, Federal Urdu University in Karachi (2018).
- **Symposium on Industrial Minerals, Coal & Mineral based Industries** organized in association with PCSIR and PSF in Karachi (2019).
- **Training Course on Gem Cutting and Polishing** organized in association with PSF in Karachi (2020).
- **World Water Day** held in association with PCRWR and PCSIR in Tandojam (2021).
- **Sindh Government Climate Policy, Karachi** (2021) was prepared by SEGMITE team.
- **International Conference on Climate Change Impacts & Responses** held in association with Geology Department, University of Karachi, PMD, PRCS Sindh, PCRWR, and PSF in Karachi (2022).
- **Seminar on Devastating Floods in Pakistan** held in association with Federation of Pakistan Chambers of Commerce & Industry (FPCCI) in Karachi (2022).
- **International Conference on Mineral Processing** held in association with Pak-Austria University, and PSF in Haripur (2023).
- **Protection of Groundwater Resources** held in association with PCRWR, in Karachi (2023).
- **Disaster Risk Management** held in association with PCRWR and PSF, in Tandojam (2023).

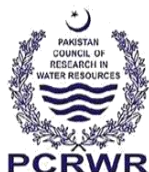
- **Seminar on Tropical Cyclone & Tsunami Threat to Pakistan Coast: Our Preparedness**, held in association with PMD and PCRWR in Karachi (2023).
- **Two-days National Symposium on Renewable Energy & Sustainability** was organized in collaboration with Sindh HEC, PSF, Hamdard University and Geology Department, University of Karachi in Karachi (2024).
- **World Water Day** was held in association with PCRWR in Karachi (2025).
- **Seminar on Recent Earthquake Events in Karachi: Causes, Impacts and Mitigations** was organized in collaboration with Department of Geology, University of Karachi in association with Pakistan Petroleum Ltd. (PPL) in Karachi (2025).

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ABOUT PCRWR



Pakistan Council of Research in Water Resources (PCRWR) was established in 1964 and is working as a body corporate vide PCRWR Act 2007 under Ministry of Water Resources. PCRWR is mandated to conduct, organize, coordinate and promote research on all aspects of water, specifically irrigation, drainage, surface & groundwater management, groundwater recharge, watershed management, rainwater harvesting, desertification control, water quality and overall environment. Therefore, the organization promotes partnerships with national and international research to deal with the emerging issues and future challenges in water sector especially under climate change scenario. Since its inception, PCRWR has played its role, as a leading water sector R&D organization through a well-established state of the art research and dissemination infrastructure, having its Headquarter in Islamabad along with eight Regional Research Centers located at Tandojam, Quetta, Bahawalpur, Lahore, Peshawar, Karachi, Muzaffarabad and Gilgit. The management of the Council consists of the Board of Governors, the Chairman and the Executive Committee.

Mandate

The PCRWR is mandated to conduct, organize, co-ordinate and promote research in all fields of water resources engineering, planning and management, so as to optimally use the available land and water resources and to help achieve sustainability in the agricultural sector.

Governance Structure

Under the PCRWR Act 2007, the overall control, direction and superintendence of the affairs of the Council shall vest in a Board of Governors which may exercise all powers, perform all functions and do all acts and things which may be exercised, performed or done by the Council. The BOG is headed by Federal Minister for Science & Technology as its President and Federal Secretary as Deputy President besides representation from Federal and Provincial Departments, Technical Institutions, Professionals and Farmers all over the country. Further Technical and Executive Committees assist the BoG in its operation and decision making.

Chairman

Chairman PCRWR is the Chief Executive of the Council. He also acts as Secretary of the BoG.

Statutory Functions

- Conduct, organize, coordinate and promote research on all aspects of water resources, including irrigation, drainage, reclamation, navigation, drinking water, industrial water, and sewerage management and to set up national centers, wherever necessary.

- Advise the government and submit policy recommendations regarding quality, development, management, conservation and utilization of water resources.
- Develop and maintain national water resources database, for use by the planning, implementing agencies and public.
- Design, develop and evaluate water conservation technologies for irrigation, drinking and industrial water.
- Commercialize its research and development results by the sale of products, patents and services.
- Undertake contractual research and provide consultancy services to the private and public sector.
- Establish liaison and collaborate with other related national and international research and development organizations, universities and NGOs.
- Publish scientific papers, reports and periodicals, and arrange seminars, training workshops and conferences on water- related issues.
- Initiate national water quality monitoring programme, in the urban and rural areas of Pakistan and develop technologies for providing safe drinking water to the public.
- Conduct and coordinate research on desertification, drought and flood mitigation.
- Provide financial and technical support to universities and research institutions for collaborative research projects and fellowships.
- Design and develop water related technologies and items of utility for various users according to market demand and undertake design and development projects on contract.
- Undertake human resources development, through training skills related to the specialized functions of the Council.

ABOUT PMD



Pakistan Meteorological Department (PMD) is both a scientific and a service department, and functional under the Ministry of Defense. PMD is responsible for providing meteorological services throughout Pakistan to wide variety of interest and for numerous public activities and project which require climatic information.

Apart from Meteorology, the department is also extending services in the fields of Hydrology, Seismology and Geomagnetism. PMD operates under World Meteorological Organization (WMO) umbrella as 198 member states of the world and act as National Meteorological and Hydrological Service of Pakistan. WMO has divided the globe in to 8 meteorological regions and Pakistan lies in Region #2 known as Regional Association II (RA-II) which includes Asia and Pacific. Director General of PMD is vice president of RA-II and permanent Representative of Pakistan.

Our Objectives

Main objectives are to provide information on weather, climate and geophysical phenomenon with the aim of traffic safety in air, on land and sea, early warning for mitigation of disasters, agriculture development based on climatic potential of the country, climate change, impact assessment, future projection of climate and adaptation options in different sectors.

Our Responsibilities

- In pursuance of its objectives and responsibilities, the department is contributing in:
 - Aviation Meteorology Services.
 - Hydro-Meteorological Services and flood forecasting.
 - Agro-meteorological services.
 - Climatological Services.
 - Geophysical and Seismological Services.
 - Weather forecasting Services to public through electronic and print news media.
 - Astronomical Information Services.
 - Met-forecast for mountaineering expedition.
 - Marine Meteorological Services.
 - Climatological data processing for scrutinizing, comparing and publishing
 - Safety of civil, armed forces aviation operations, VVIP flights and marine activities
 - Early Warning of natural hazards such a Tropical cyclones, Heavy Rains, Heat Waves, Flood & Earthquakes etc.
 - Astronomical information like sighting of moon, solar and lunar eclipse.
 - Glacier Monitoring and Research.
 - Glacier Lakes Outburst Flood (GLOF) warning.

ABOUT PASTIC

The Pakistan Scientific & Technological Information Centre (PASTIC) is a constituent organization of the Pakistan Science Foundation (PSF) operating under the Ministry of Science and Technology (MoST), Government of Pakistan. PASTIC is a premier national institution specialized in the collection, organization, management, and dissemination of Scientific and Technological Information (STI) to support research, development, and industrial innovation across the country.



The PASTIC National Centre is located at the Quaid-e-Azam University Campus, Islamabad, with a nationwide network of six Sub-Centres in Karachi, Lahore, Peshawar, Quetta, Faisalabad, and Muzaffarabad, ensuring broad regional outreach.

Since its inception, PASTIC has played a pioneering role in supporting Pakistan's research community, particularly during the early stages of national S&T infrastructure development. Its services historically included the supply of scientific and technical literature, abstracts and indexes, bibliographies, translations, patent information, science reference library services, technological information transfer, computer-based information dissemination, and reprographic and publication services.

For further information, please visit www.pastic.gov.pk

Objectives of PASTIC

- Development and management of National Scientific & Technological Information (STI) resources and databases
- Dissemination of STI through modern and contemporary information tools
- Collaboration and cooperation with institutional libraries and repositories for resource sharing
- Promotion of R&D-based industrial development
- Printing and publication of S&T and R&D literature
- Capacity and skill development of researchers, information professionals, innovators, and entrepreneurs
- Establishment of national and international collaborations with information networks

S&T Publications

- *Technology Roundup*: A bi-monthly bulletin featuring repackaged global trade and technology information
- *Conference Abstract Books*: Publication and printing support for abstract books of national S&T conferences (on request)

Online Databases and Information Systems

- Pakistan Science Abstracts (PSA): Abstracts of research published in Pakistani S&T journals and conference proceedings
- National Digital Archive (NDA): Full-text digital repository of Pakistani scholarly journals
- PakCat – Union OPAC of scientific and technological libraries in Pakistan
- Digital Repository of Indigenous S&T Literature
- Directory of Scientific Periodicals of Pakistan
- Database of R&D Projects Executed in Pakistan
- Database of Books Published by Pakistani Authors
- National Scientists Directory (NSD)
- Industry-related databases (industries, industrial challenges, and related information)

Promotion of Commercializable Technologies

PASTIC organizes STEM and IT Expos to promote indigenous R&D outputs, SMEs, technologies, products, and services, while empowering youth and the general public with modern information access and dissemination practices.

National Science Reference Library

A state-of-the-art Library facilitating the researcher through following services: Reference & Referral Services; Reader Service; Internet Service, Journal Listings; Photocopying & Scanning Services and Digital Library services.

Skill Development and Capacity Building

- Young researchers (data analysis, reference management, research tools)
- Women entrepreneurs (e-marketing and e-business skills)
- Library professionals (library automation and digitization)
- Journal publishers and editors (e-journal management and publishing)
- Researchers and innovators (intellectual property rights and media & information literacy)

ABOUT TCIL

The Tufail Chemical Industries Limited/TCIL (Est. 1993) is among the largest manufacturers of industrial chemicals in Pakistan and is involved in fulfilling the needs of diversified industrial chemicals, with quality and responsibility. Established in 1953 as a trading company, our history is spread over almost seven decades. We Initiated business as an imports/indenting house for chemicals, metals & minerals with the World's renowned organizations like Sumitomo, Mitsubishi, Mitsui, and Sinochem.



We also introduced European plastic raw materials, industrial chemicals, aluminum products, and polymers from Hyundai & Samsung. After getting a sound knowledge and developing expertise in the field of chemicals and its allied products, Tufail Chemicals launched its first project to manufacture Formic Acid and Sodium Sulphate and commenced production in 1995 with strong research & development setup to enhance these innovations.

So far Tufail Chemical's collective production capacity is 150,000 Metric Tons per Annum (Karachi complex contributes 80% and Lahore complex 20%). We are also Pakistan's leading chemical products provider with care and responsibility with the help of technology, excellent human resources, and outstanding R&D.

The production of 150,000 metric tons includes Sulphonic Acid 96%, Sulphonic Acid 90%, Formic Acid, Sodium Sulphate Anhydrous, Acetex Plus, Sulphuric Acid (DCDA), Aluminium Sulphate and Sodium Lauryl Ether Sulphate – SLES. With this production capacity, Tufail Chemicals is satisfying needs domestically and the surplus is being exported to North & South America, China, Africa and the Middle East. Also, we are aware of our responsibility as a corporate company and invest in a safer, healthier and greener environment and eventually, a prosperous Pakistan.

As a company, we are committed to investing in our people, facilities, and machinery. Along with continual improvements driven by TUFAIL's principles we are well placed to provide for the needs of a growing customer base. Another state-of-the-art LABSA & SLES plant is due to be installed in late 2025 which will bring further efficiencies to the factory With TUFAIL's commitment to manufacturing excellence we can expect further exciting investments in the future.

At present, our production replaces imports by the US \$160 million per year and our future projects are in the field of chemicals and other products which will be replacing the imports and surplus quantities will be exported. Since 1993, we have significantly expanded our manufacturing base to include multiple new products and are now supplying to customers all over Pakistan and abroad including some of the leading multinational companies. The sectors we supply

include; Detergent, Textile Dyeing & Processing, Leather Processing, Fertilizers, Paper Industry, IPPs, Water Treatment, Distilleries, etc.

Exporting Over 25 Countries

Since 1993, we have significantly expanded our manufacturing base to include multiple new products and are now supplying to customers all over Pakistan and abroad including some of the leading multinational companies. The sectors we supply include; Detergent, Textile Dyeing & Processing, Leather Processing, Fertilizers, Paper Industry, IPPs, Water Treatment, Distilleries, etc.

Our Vision

Transforming the Chemical Industry of Pakistan through Innovation, Import Substitution & Global Expansion and to make Pakistan self-reliant on basic chemicals with state-of-the-art technology and achieve import substitution. To capitalize and optimize all available domestic resources. To develop quality human resources at par with the international standards and make them well abreast for all times. To be actively involved in adopting & developing a green revolution in turn healthier & safer environment for the generations to come.

Our Principles

- Satisfy the customers with the best services, quality, and timely delivery
- To meet international quality standards and environmental laws
- Invest in new industries to replace imports of Raw materials
- Export our products in the international markets
- Growth in the chemical industry and diversification into the energy field
- To strengthen research and development, and reduce energy consumption

For more details visit us at <https://tufailgroup.com/>

ABOUT PSC

The Prime Scientific Corporation (PSC) is a recognized leader in providing comprehensive laboratory solutions to the Pharmaceuticals, Textile, Research and Development, Power, Cement, Petrochemical industries and Education sector in Pakistan. From our headquarters in Karachi and our regional offices in Lahore and Islamabad we are able to efficiently serve the growing laboratory clientele in all regions.



Dedicated and knowledgeable sales team which understands the customers' needs and their business challenges and provides the most optimum and economical solutions. Highly experienced and expert team of service specialists at locations close to customers. The product specialists have extensive technical knowledge and experience garnered through intensive trainings at the manufacturing locations of partners worldwide.

Committed to constantly creating excellence, we are successfully forging ahead with the expansion of our services in the analytical industry both quantitatively and geographically. Beyond gathering a rich heritage of excellence in the domain of analytical sciences, we are now swiftly progressing to become an unrivalled facilitator in the field of Environment, Bulk Weigh and Monitoring.

Prime Scientific Corporation is the leading authority in scientific innovation, serving as the sole authorized distributor and service provider for the esteemed Thermo Fisher Scientific in Pakistan. We specialize in delivering exceptional scientific analytical instruments and tailored solutions for quality control laboratories and industries.

Our History

Prime Scientific Corporation has been a stalwart in the scientific industry since its establishment in 2012. Our journey began with a clear vision to excel in the field of scientific innovation and serve as a beacon of excellence for quality control labs and industries.

From our inception, we have nurtured a deep and enduring partnership with Thermo Fisher Scientific. Our collaboration with Thermo Fisher dates back to a time when scientific excellence was at the heart of our shared vision. Over the years, this partnership has flourished, strengthening our commitment to delivering exceptional scientific solutions. Today, with nearly a decade of expertise and a strong foundation in scientific instrumentation, Prime Scientific Corporation continues to evolve and innovate, remaining at the forefront of scientific progress in Pakistan. Our history is a testament to our unwavering dedication to quality, precision, and the advancement of scientific knowledge.

Prime Scientific Corporation engineers are experienced, certified and trained on your instrumentation. We have developed a technical and sales team, who are always seeking new challenges, tasks and queries to finish, fulfill and answer

them. The team goal is to satisfy the customers need as quickly as possible. Training is very important to increase the productivity.

Prime Scientific Corporation engineers are experienced, certified and Prime Scientific Corporation offered trainings typically cover basic instrument theory, proper operation, technical specification, troubleshooting tips, product adjustments, optimization, and routine user level maintenance. Service level training is available to teach maintenance and troubleshooting skills to system operators or in house maintenance technicians.

At Prime Scientific Corporation, we invite you to be part of a community dedicated to pushing the boundaries of scientific exploration. Together, we can shape the future of research and discovery.

We offer a diverse range of scientific analytical instruments tailored to the unique needs of quality control labs and industries. Our product portfolio includes advanced instruments for precise measurement, analysis, and quality assurance, all backed by the expertise and reliability of Thermo Fisher Scientific. At Prime Scientific Corporation, we place you, our valued customer, at the core of everything we do. Our customer-centric approach is driven by a deep understanding of your unique needs and challenges. We work closely with you to tailor solutions that not only meet but exceed your expectations.

Our Mission

Our mission is to establish and maintaining customers for life. At Prime Scientific Corporation, our mission is to empower quality control labs and industries with cutting-edge scientific analytical instruments and customized solutions. We are proud to represent Thermo Fisher Scientific, a global leader in scientific technology, and are committed to enhancing the precision, efficiency and reliability of your operations.

For more details visit us at <https://primescicorp.com/>

CONFERENCE PROGRAM

DAY-01 (February 3rd, 2026)	
09:00-10:00	Registration
10:00-11:00	Inaugural Session (Hall A): Opening, Welcome address, Conference overview
11:00-11:30	Tea Break
Plenary Session (Hall A): Keynote Addresses (1-3)	
11:30-12:00	Impact of Climate Change on Livelihoods in Coastal & Slum Areas Abdullah Harun Chowdhury (<i>Bangladesh</i>)
12:00-12:30	Domestication of Non-Conventional Salt-Accumulating Plants Kashif Hayat (<i>China</i>)
12:30-01:00	Identifying Vulnerable Hotspots of Weather Extremes Shaukat Ali (<i>Pakistan/ Toronto, Canada</i>)
01:00-02:00	Lunch Break
02:00-04:00	Technical Session-I (Hall A): Technical Paper Presentations
02:00-02:15	Policy-Driven Land Restoration (Great Green Wall) Mohammed Abubakar Mohammed (<i>Russia</i>)
02:15-02:30	Late Quaternary Subaerial Paleosol in the Bhola Island, Meghna Estuary (Bengal Delta) Md. Ahsan Habib (<i>Dhaka, Bangladesh</i>)
02:30-02:45	Climate-Induced Extreme Events and Bangladesh Md. Bazlar Rashid (<i>Dhaka, Bangladesh</i>)
02:45-03:00	Cholera Risk & Chlorination, Karachi Ghulam Murtaza Arain (<i>Islamabad, Pakistan</i>)
03:00-03:15	Spatial and Temporal Assessment of Snow Water Equivalent Variability in the Astore Basin Bushra Zia Khan (<i>Lahore, Pakistan</i>)
03:15-03:30	Mineralogical & Geochemical Controls on Slope Instability in Chattogram, Bangladesh Md. Sohel Rana (<i>Dhaka, Bangladesh</i>)
03:30-03:45	Shoreline Change Study in NW of Indus Delta using the Temporal Landsat Satellite Data Mahar Gohar Ali (<i>Karachi, Pakistan</i>)
03:45-04:00	InSAR-Based Early Detection of Landslide Movements under Extreme Weather in Hindukush Mohib Ur Rehman (<i>COMSATS, Abbottabad, Pakistan</i>)
02:00-04:00	Technical Session-I (Hall B): Technical Paper Presentations
02:00-02:15	Asses of Groundwater Quality and Rising Salinity in the Kirana Rabwah Region Mirza Naseer Ahmad (<i>Rabwah, Pakistan</i>)
02:15-02:30	Integrated Assessment of Land-Cover Dynamics & Warming Trends in Northern Pakistan Muhammad Amar Gul (<i>Saudi Arabia</i>)
02:30-02:45	Climate Change Impacts on Agriculture and Rural Development in Pakistan Zulfiqar A Dhakan (<i>Karachi, Pakistan</i>)
02:45-03:00	Evaluating Crop Residue as a Renewable Energy Resource Jawad Abdullah Butt (<i>Karachi, Pakistan</i>)
03:00-03:15	Trace and Heavy Metal Contamination in Tirah Coalfields Muhammad Sajid (<i>Peshawar, Pakistan</i>)
03:15-03:30	Climate Change Impact on Hydrological Regimes of UIB Nudurat Zahra (<i>Gilgit, Pakistan</i>)
04:00-04:30	Tea Break (Closing of Day-I)

DAY-02 (February 4th, 2026) Hall A Keynote Address (4-5)	
09:30-10:00	Effect of Climate Change and Human Destruction on Ecosystem: An Overview of its Consequences Mohammed Abubakar Mohammed (Russia)
10:00-10:30	Linking Western Himalayan Uplift, Sediment Provenance, and Miocene Climate Change Muhammad Qasim (Muscat, Oman)
10:30-11:00	Tea Break
11:00-01:00	Technical Session-I (Hall A): Technical Paper Presentations
11:00-11:15	Engineering Geological Assessment of Seismic Hazards for Sustainable Urban Development Md. Faruk Hasan (Dhaka, Bangladesh)
11:15-11:30	Geo-environmental Aspects for Climate-Resilient Urban Planning in Sirajganj Town Md. Shamsuzzaman (Dhaka, Bangladesh)
11:30-11:45	Environmental Degradation Due to Unplanned Quarries for Engineering Purpose Mohammed Masum (Dhaka, Bangladesh)
11:45-12:00	Microfossils as Proxies for Past Sea-Level Variability and Coastal Hazards Mubariz Hassan (France)
12:00-12:15	Analyzing Temperature Variability and Trend Detection in the Hindu Kush Region, Muhammad Dawood (Multan, Pakistan)
12:15-12:30	Flood Risk Assessment Mapping by Remote Sensing in District Chiniot Pakistan Tariq Ahmad Shahzad (Rabwah, Pakistan)
12:30-12:45	Geological Assessment of Surface and Groundwater along Malir, Lyari, Hub Rivers, Karachi Shella Bano (Karachi, Pakistan)
01:00-02:00	Lunch Break
02:00-03:00	Technical Session-II (Hall A): Technical Paper Presentations
02:00-02:15	Machine Learning and GIS Approaches for Predicting Groundwater Salinity in Southern Indus Plain, Hyderabad District, Sindh, Pakistan Sadaf Naseem (Karachi, Pakistan)
02:15-02:30	Evaluating Spatial Justice through Accessibility and Resource Distribution Sajida (Karachi, Pakistan)
02:30-02:45	Geological and Geotechnical Assessment of Landslides Salma Akter (Dhaka, Bangladesh)
02:45-03:00	Heat, Floods and Flies: UAV-AI Early Warning Farrukh Baig (Multan, Pakistan)
03:00-03:15	Floodwater Diversion for Managed Aquifer Recharge Ghulam Zakir Hassan (Punjab, Pakistan)
03:15-03:30	Exploring Glacier Dynamics in Shigar River Mubashra Bashir (Abbottabad, Pakistan)
03:30-03:45	Monitoring of Nitrogen Dioxide (NO ₂) over Karachi using Remote Sensing Tool Muhammad Irfan (Karachi, Pakistan)
03:45-04:00	Ambient Air Quality & Climate Risk Yasmin Nergis (Karachi, Pakistan)
04:00-04:30	Closing Ceremony followed by Tea

ABSTRACTS

Impact of Climate Change on Livelihoods and Alternative Solutions for the People Living in Coastal and Slum Areas

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The people of coastal areas of Bangladesh are facing different climate change vulnerabilities as a result some people already migrated to different municipality areas and living in different slum areas. Due to increasing climatic vulnerabilities, some villagers are living under threats of displacement from their birthplace and sufferings lack of livelihoods. Impact of climate change on livelihoods and alternative solutions for the people living in coastal and slum areas in Bangladesh was conducted to identify the existing climate vulnerabilities and the most suitable adaptive livelihood options for the communities. Different standard research tools were used to complete this study. The data showed that the people of the study areas have been forced by the disasters and climate change for applying different strategies individually to survive. Due to loss of all assets and livelihoods by the disaster, people are being engaged in negative coping strategies such as reducing their daily meal intake to survive. More or less 30% people not only reduced intake of their meal but were also unable to afford food items beyond rice and lentils. Damage caused by Sidr, Aila and other cyclones to shrimp, rice farms and the fisheries industry were extensive. As a result, daily labor opportunities on farms and fishing boats were severely affected and people were forced to migrate to other areas to find work, alternative income and employment as a brick maker, rickshaw driver and unskilled labor. Average duration of yearly economic migration is of 6 to 8 months, fragmenting families and increasing the number of female headed households. The very common problems of the study areas are - (i) shortage of jobs in locality, (ii) poor agriculture productivity due to salinity in soil and lack of irrigation, (iii) scarcity of drinking and domestic water, (iv) sanitation and hygiene problems for women-girls and health hazards for all, and (v) improper embankment. The migrated people suffer from (a) poverty due to poor income, (b) lack of proper drainage system and water logging, (c) insufficient toilets, sanitation and hygiene facilities, (d) scarcity of water, and (e) child labour and loss of education in the slum areas. The findings of the research indicate that (1) saline tolerant agricultural practices and climate change adapted local varieties for farming, (2) ensuring adaptation and improving of different livelihoods for men and women both, (3) WASH programme and emergency health facilities, (4) establishment of green belt (plantation) besides the river, (5) land zonation and reducing saline water intrusion, (6) mitigate the waterlogging, (7) ensure education support to combat child labor, (8)

awareness, motivation and training for the villagers and slum dwellers, (9) ensure community participation in the all activities, (10) continuous monitoring and evaluation and (11) more integrated research on the sustainable adaptation mechanism of climate change vulnerability can reduce the climate vulnerabilities or disaster risk.

Keywords: Impact, climate change, livelihood, alternative solutions, coastal areas, Bangladesh.

Domestication of Non-Conventional Salt-Accumulating Plants for Simultaneous Phyto-desalination and Salinization Management

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Soil salinization, driven by geogenic and anthropogenic factors, affects over 830 million hectares globally, severely compromising agricultural productivity, food security, and ecosystem stability. Salinity impedes plant growth via hyperosmotic stress, Na⁺/Cl⁻-induced ionic toxicity, and oxidative damage, particularly in arid, semi-arid, and coastal zones where irrigation and evaporation intensify salt accumulation. Conventional remediation methods (e.g., gypsum amendment, leaching) are often costly, energy-intensive, and ecologically unsustainable. In contrast, biosaline agriculture harnesses salt-tolerant halophytes for phytodesalination, a scalable, eco-friendly strategy that rehabilitates degraded soils while enabling resource-efficient production of food, fodder, bioenergy, and phytochemicals. This abstract focuses on the genus *Pennisetum* (Poaceae), including *P. glaucum* (pearl millet) and *P. giganteum* (Giant Juncao), as model dual-purpose systems. Though halophytes constitute <1% of terrestrial flora, they deploy sophisticated adaptations: osmotic adjustment via proline and glycine betaine, ion compartmentalization by *SOS1* and *NHX* transporters, and salt excretion through specialized glands. *Pennisetum* species thrive on marginal saline soils, improve soil structure, and yield high biomass for fodder, bioenergy, and biorefineries, while producing bioactive compounds with nutraceutical potential. Their C₄ photosynthetic efficiency, rapid growth, and genetic plasticity make them ideal for climate-resilient agriculture. We advocate a multidisciplinary framework integrating agronomy, soil science, and biotechnology to accelerate halophyte domestication, support farmer-centered policies, and apply genomic tools to enhance salinity resilience. This approach can convert saline lands into productive agroecosystems, advancing UN Sustainable Development Goals (SDG 2, 13, 15). Ultimately, redefining salinity from a constraint

to a resource heralds a transformative, nature-based paradigm for 21st-Century sustainable agriculture.

Keywords: Soil salinity, phyto-desalination, biosaline agriculture, *Pennisetum* species, sustainable intensification.

Identifying Past and Future Vulnerable Hotspots of Weather Extremes in Bangladesh, Pakistan and Nepal

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This study is the part of the APN-funded project “Towards Robust Projections of Climate Extremes and Adaptation Plans over South Asia,” and structured around four major components: (1) preparation of a high-resolution (5 km) reference climate dataset, (2) validation and ranking of 48 CMIP6 global models, (3) downscaling of selected CMIP6 models to 5 km resolution, and (4) identification of climate extreme hotspots in Bangladesh, Pakistan and Nepal. The overarching goal is to deliver robust, localized information to support climate risk management and national adaptation planning. In the first step, observed temperature and precipitation data from regional meteorological stations were subjected to stringent quality control procedures. These were merged with ERA5 reanalysis and interpolated using ordinary kriging to create a 5 km reference dataset. For topographically complex regions, temperature adjustments were applied using the Lapse Rate of Temperature (LRT), informed by GTOPO30 elevation data and observational gradients. Second, a set of 48 CMIP6 models were validated against the 5 km reference dataset using multiple performance metrics. Models were ranked based on their skill in reproducing historical climatology and extreme indices, and the top-performing three models were selected for further analysis. In the third phase, the selected CMIP6 models were statistically downscaled using the Spatial Disaggregation Quantile Delta Mapping (SDQDM) method, which overcomes the assumption of stationarity and preserves projected changes across the full distribution of values. The result was a 5 km resolution dataset of future climate projections (1981-2100) for the three countries. Finally, using both the reference and downscaled future datasets, climate extreme events were computed using ETCCDI indices. Hotspot analysis revealed that northern Pakistan and parts of Nepal are likely to face intensified warming and heavy precipitation events, while southern Pakistan emerges as a vulnerable region to increasing heatwaves and dry spells. These findings provide a scientific basis for targeted adaptation strategies and regional cooperation in addressing climate risks.

Keywords: 5 km climate dataset, cmip6, sqdm, statistical downscaling, weather extremes, hotspot analysis, South Asia.

Effect of Climate Change and Human Destruction on Ecosystem: An Overview of its Consequences

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Climate change, driven by increased greenhouse gas emissions, has led to shifts in temperature, precipitation patterns, and extreme weather events, significantly impacting biodiversity and ecosystem functions. These consequences are made worse by human activities like urbanization, pollution, and deforestation, which lead to the loss of habitat, the extinction of species, and the disruption of natural processes. The Convention on Biological Diversity (CBD) addresses the interplay between climate change and ecosystems, aiming for biodiversity conservation, sustainable use, and equitable benefit sharing from genetic resources. Collaborating with entities like the United Nations Framework Convention on Climate Change (UNFCCC), the CBD promotes ecosystem resilience and adaptation strategies. The review emphasizes the dire consequences of climate change and human activities on ecosystems, calling for integrated conservation strategies and policy interventions. It emphasizes how crucial it is for nations to work together and practice adaptive management in order to successfully address these global issues.

Keywords: Climate change, biological diversity conservation, ecosystem, deforestation, urbanization, pollution.

Linking Western Himalayan Uplift, Sediment Provenance, and Miocene Climate Change

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The Himalayan foreland basin preserves essential evidence of orogenic exhumation, sediment routing, and crustal deformation following the India–Eurasia collision—processes that played a pivotal role in shaping Miocene climatic evolution. Within this archive, the Oligocene–

Miocene Murree Formation of Pakistan represents a key depositional system that records both the tectonic uplift of the western Himalaya and the climate-driven erosion patterns that intensified during the Miocene. Integrating sandstone petrography with detrital zircon U–Pb geochronology, recent studies delineate sediment provenance and unroofing histories that correspond to major climatic and tectonic transitions during this interval. Petrographic data reveal quartz-rich, feldspar-bearing sandstones derived from recycled orogenic belts, indicating enhanced erosion of Higher Himalayan (HH), Tethyan Himalayan (TH), and Lesser Himalayan (LH) crystalline sources. These elevated erosion rates align with the early Miocene strengthening of the South Asian monsoon, a climatic shift widely linked to the uplift of Himalayan crustal blocks. The presence of ferruginous matrix and fluvial fining-upward cycles further reflects deposition in oxidizing river systems responsive to climatically modulated sediment supply into an actively subsiding foreland basin. Detrital zircon age populations (~1200–400 Ma; ~1900–1400 Ma; ~2600–2300 Ma) reinforce strong contributions from HH and TH rocks, while the appearance of ~1600–1700 Ma and ~550–450 Ma grains signals erosion from inner LH terranes uplifted along the Panjal Thrust. These provenance shifts parallel Miocene climatic intensification, which accelerated denudation of rising Himalayan blocks. Limited <200 Ma zircons suggest reduced influence of Asian arc terranes as the growing topography increasingly isolated the foreland from northerly sediment sources. Along-strike comparisons across Hazara–Kashmir, Muzaffarabad, and Murree areas show consistent detrital signatures with local variations tied to differential unroofing during propagating fold–thrust deformation. The inferred depositional age (~34–22 Ma) captures the transition from marine to fully continental foreland environments—a change coincident with the onset of stronger Miocene monsoonal systems and a shift to more vigorous continental weathering regimes. Together, these datasets support a model in which the early Miocene Murree Formation records not only the southward advance of Himalayan deformation but also the co-evolving climate system, where intensified monsoonal precipitation enhanced erosion of TH, HH, and LH crystalline blocks. Thus, the Murree Formation provides a crucial link between Himalayan uplift, sediment dispersal, and Miocene climate change, documenting how tectonic growth of the range fed back into global climatic processes through enhanced erosion, sediment flux, and chemical weathering.

Keywords: Detrital Zircon, U-Pb dating, provenance, uplift, Miocene climate.

Policy-Driven Approaches for Large-Scale Land Restoration: A Case Study of Africa's Great Green Wall Initiative

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Land degradation is a growing global concern, with severe impacts on biodiversity, agricultural productivity, and climate resilience. These problems are getting worse in Africa, especially in the Sahel region due to desertification and deforestation. The Great Green Wall Initiative (GGWI), which aims to rebuild damaged 8,000 kilometers long landscapes, from Senegal to Djibouti. This initiative, was launched by the African Union in 2007 as Africa's response to increasing negative effects of droughts on rural development and communities' livelihoods. This case study highlights the importance of sustainable development practices to reverse land degradation and restore ecosystems, offering a framework for other regions grappling with similar environment. The Pan-African Agency of GGWI was established by the 11 Sahelian countries on 17 June 2010 to co-ordinate, mobilize resources and monitor progress on its implementation. The success of GGWI relies on policy-driven approaches that promote regional cooperation, sustainable land management, and community engagement. The Food and Agriculture Organization of the United Nations (FAO) has been implementing a participatory approach to implement large-scale restoration of degraded land in the Sahel, by placing rural communities at the center. FAO's activities are concentrated on assisting six African nations (Burkina Faso, Ethiopia, Gambia, Niger, Nigeria, and Senegal) in carrying out their GGW National action plans through the EU-funded Action against Desertification (AAD) initiative. This has resulted in on-the-ground interventions in an estimated 12,000 hectares of degraded lands between 2015 and 2017 thanks to a holistic approach for large-scale land restoration that puts rural people at its core. The impact has persisted because local communities have been given the tools, they need to become self-sufficient in technical areas like biodiversity conservation and improved production system management, as well as in socioeconomic areas like the production and processing of forest products that improve their standard of living.

Keywords: Great green wall initiative, land degradation, sustainable land management, policy-driven restoration, biodiversity conservation.

Late Quaternary Subaerial Paleosol in the Bhola Island, Meghna Estuary (Bengal Delta): Record of Sea Level and Climatic Variabilities

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The Late Quaternary subaerial paleosol preserved within the stratigraphic sequence of the fluviotidal-deltaic setting of the dynamic Ganges–Brahmaputra–Meghna (GBM) system provides critical insights into past landscape stability, sedimentation breaks, and climate–sea-level interactions in one of the world’s most dynamic deltas. Bhola Island (estuarine mouth bar depocenter for delivered sediments accumulation) is in the central part of the estuarine coastal region of Bangladesh, which is strongly influenced by tidal dynamics and seasonal cyclicity. The weathered paleosol horizon (sand 611%, silt 56–78%, clay 12–30%) with grain-size modes at 2.0–3.9 ϕ (sand), 6.0–7.9 ϕ (silt), and 8.0–9.9 ϕ (clay) typically occur (depth: ~ 38–50 m, thickness: ~ 1–3 m, age: > ~ 11 ka BP) embedded within fine- to very fine-grained delta-front and floodplain successions. The paleosol marks an important stratigraphic discontinuity near the Holocene–Pleistocene boundary. It unconformably overlies the eroded Plio–Pleistocene Dupi Tila Formation, later concealed under thick Holocene alluvium during transgressive and highstand phases. The deeply oxidized buried soil (weathered overbank mud) unit is dominated by sticky-stiff greenish gray, olive gray, very dark grayish brown, dark brown, yellowish brown, light yellowish brown, moderately consolidated/compacted (SPT N value: 14–23) silty clay to clayey silt matrices with occasional fine sand lenses, reflecting episodic overbank deposition prior to prolonged subaerial exposure. Plant roots, root traces, mottles, and incipient Fe–Mn concretions/nodules (soft-hard), rootlets and traces of decomposed vegetal matter and burrows (bioturbation) filled with very fine sand and pedogenic structure/signatures are present. These records are direct evidence of aerobic soil-forming conditions and oxidation/dissolution-leaching of Fe-minerals. It is moist, feels soapy with few patches of yellowish brown/ brown patches of Fe-oxyhydroxides (goethite and/or hematite). This oxidized layer must have formed during a hiatus due to regression and accumulated during the last interglacial of the Pleistocene period. It contains illite (65%) and kaolinite (35%) with huge mixed layering. The computed elemental ratios for the examined clastic samples (n = 36) were found to be of SiO₂/Al₂O₃ 3.0–8.3,

K_2O/Na_2O 1.0-1.7, Al_2O_3/TiO_2 17.3-40.5, Rb/Sr 0.47-1.3, Zr/Al 16.1-48.9, Th/U 6.1-7.0, chemical index of alteration 70-77, $\sum REE$ 234-323. Provenance indicators show the sediments were derived mainly from felsic-dominated Himalayan and Indo-Burman sources, with contributions from metasedimentary rocks, granites, rhyolites, and granodiorites, reflecting large-scale delivery of first-cycle siliciclastic material to the GBM delta.

Keywords: Paleosol, lithology, geochemistry, sediments, estuary, climate variability.

Climate-Induced Extreme Events and Bangladesh

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Globally, extreme events such as floods, droughts, wildfires, heat waves, cyclones, and storm surges are pressing issues driven by climate change. At least one in five people worldwide experienced strong climate-induced stress every day from June to August 2025. The present study attempts to analyze and review existing documents including published articles, electronic and print media reports from national and international sources to highlight the situation of undesired extreme events in Bangladesh. Earth's temperature has been amplified primarily due to the combustion of fossil fuel, causing global temperatures to rise by approximately 1.3 °C compared to pre-industrial levels (1850-1900). Consequently, many countries have experienced extreme events more frequently. Between 2000 and 2019, the country experienced 185 severe weather events and lost 0.41% of its GDP. Bangladesh is among the three countries most affected by extreme events in 2024, for example the Feni flood in August 2024 through cloudbursts, 3.7 million people were affected, 41 people died, and 237,672 shelters were damaged. The frequency and intensity of cyclones and floods in the country has also increased which disrupt the socio-economic activities, particularly power/energy production, distributions as well as other regular activities. From June to August 2025, about 955 million people globally experienced 30 or more days of dangerous heat, including 30 million people in Bangladesh (~ 18% of the total population of the country). Nearly half of global cities have also experienced at least 30 days of unusual, climate-driven heat, with more severe conditions in megacities. In 2024, the country experienced an intense heat wave (43.8°C) that affected more than 33 million people. Dhaka alone faced around 52 or more days of dangerous heat during June-August 2025. Bangladesh rank in extreme weather events is 13th in the Long-Term Climate Risk Index based on data from the past 30 years (1995-2024). Along the Bangladesh

coast, sea levels are rising at a rate of 1-9 mm/yr, contributing to increased tidal inundation. A 1 m rise in sea level by 2050 could result in the loss of 17% of country land and displace around 20 million people. Therefore, multi-sectoral collaboration across borders and sectors engaging a wide range of global actors (geoscientists, engineers, social workers, planners, policy makers, and regional/local people) is essential, and aligns with the key goals of COP30.

Keywords: Climate change, Climate Risk Index, COP30, extreme weather, sea level rise.

Mineralogical and Geochemical Controls on Slope Instability in the Hilly Urban Terrain of Chattogram, Bangladesh: Implications for Landslide Hazards under Extreme Weather Events

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Slope instability in hilly urban environments represents a critical geohazard, particularly within the Chattogram City Corporation (CCC) area of southeastern Bangladesh, where rapid urbanization, unregulated hill cutting, and deforestation have intensified landslide risks. This study integrates geological, mineralogical, and geochemical hazard-assessment approaches to evaluate slope-forming materials from five landslide-prone sites Akbor Shah Hill (ASH), Motijhorna (MJ), Kathalbagan (KLB), Lehubagan (LB), and Kusumbag (KMB) to identify the key factors governing slope failure. Representative Tertiary rock samples were examined using polarizing optical microscopy, while bulk sediment samples were analysed using wavelength-dispersive X-ray fluorescence (XRF) spectroscopy. Quartz dominates the slope materials, imparting mechanical competence but offering limited cohesion when saturated. Feldspars occur in relatively low proportions, reflecting moderate chemical weathering, whereas micas and amphiboles introduce anisotropic structural weaknesses that enhance shear failure. Accessory heavy minerals including illmenite, garnet, zircon, kyanite, and sillimanite provide insight into the provenance of the slope deposits. XRF data indicate silica-rich compositions with moderate alumina and iron oxides, consistent with weathered felsic to metamorphic source materials. Mineralogical and geochemical variability correlates closely with slope stability. ASH, which exhibits higher feldspar and clay content, is the most susceptible to failure. LB, dominated by quartz and characterized by minimal clay fractions, shows the highest degree of stability. MJ, KLB, and KMB display intermediate stability conditions influenced by the orientation and abundance of micaceous and amphibolitic minerals. The findings suggest that hydrological forcing particularly during extreme rainfall events acts in

conjunction with mineralogical and geochemical controls to regulate shallow landslide initiation in the CCC region. This study demonstrates that integrating petrographic and geochemical diagnostics into landslide hazard assessment substantially improves the capacity for early warning, informed urban planning, and site-specific slope-stabilization strategies in humid tropical hilly terrains increasingly affected by extreme weather events.

Keywords: Slope instability, landslide hazard, quartz-rich sediments, clay minerals, extreme rainfall.

Integrated Assessment of Land-Cover Dynamics and Warming Trends in Northern Pakistan (1992–2025): Implications for Urban Growth, and Climate Driven Hazard Intensification

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Quantifying long-term shifts in land systems alongside evolving climatic conditions is essential for understanding regional susceptibility to extreme weather events. This study presents an integrated assessment of land-cover transformations and maximum temperature trends across Islamabad Capital Territory and Rawalpindi District using ESA-CCI land-cover datasets (1992–2022) and ERA5Land thermal records (1992–2025). The results demonstrate profound land-system reconfiguration driven by rapid urban expansion—exceeding +3,000% in Islamabad and +2,300% in Rawalpindi—accompanied by substantial reductions in rainfed cropland (−27% to −70%), irrigated cropland (−23%), mosaic agro-vegetation (−40% to −46%), and grasslands (−14%). While selective forest categories exhibit modest gains, these increases are insufficient to offset the large-scale decline in agricultural and natural vegetative cover. Simultaneously, maximum annual temperatures show a statistically robust warming trajectory of approximately +1.5–2.0 °C over three decades, with pronounced interannual oscillations superimposed on a persistent upward trend. The convergence of land-cover degradation and thermal intensification indicates escalating exposure to compound climate hazards, including heightened heatwave occurrence, enhanced urban heat island effects, increased hydrological instability, and greater flash-flood sensitivity linked to declining infiltration and rising surface runoff. The emergence of new water bodies and altered hydromorphological signatures further reflects landscape destabilization under combined anthropogenic and climatic pressures. Collectively, these findings underscore the urgent need for climate-informed urban development, restoration of ecological buffers, and integrated land-use planning to enhance resilience within one of Pakistan's most rapidly transforming socio-environmental

regions. The study provides a robust empirical foundation for policymakers, planners, and climate-risk practitioners seeking to anticipate and mitigate the cascading impacts of land-system change in a warming climate.

Keywords: Land-cover dynamics, urbanization, warming trends, climate hazards, landscape vulnerability, Pakistan.

Spatial and Temporal Assessment of Snow Water Equivalent Variability in the Astore Basin over a Decade (2013–2023)

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Traditional techniques for Snow Water Equivalent (SWE) measurement are costly, require significant labor, and are limited in their geographical challenging terrain and limited accessibility. The present study was carried out to explore the SWE in Astore Basin from 2013 to 2023 and associated challenges to measure SWE precisely using web-based measurement (WBM) in the remote and difficult area of Gilgit-Baltistan, Pakistan. To tackle these issues, advanced web-based tools in conjunction with contemporary remote-sensing technologies provide a more efficient and comprehensive approach to monitor the SWE. By merging ground-level observations with satellite-derived data, the study navigated the logistical obstacles posed by the geography of the basin. Through Geographic Information Systems (GIS) and Climate Engine tools, the snow cover and snow depth maps were generated, presenting the partial and temporal assessments. This integration of technology yields insights that were difficult to achieve through conventional methods, facilitating a more accurate comprehension of snow dynamics in the challenging regions of northern Pakistan. The temporal analysis revealed notable trends, particularly a continuous decline in SWE over the past decade. SWE measurements dropped from 150 mm in 2014 to 120 mm in 2019, followed by a further decrease to 90 mm in 2023. This decline indicates that the area's snowpack is increasingly affected by climate change, which has significant implications for water availability and the overall hydrological cycle in the near future. The findings emphasized the importance of real-time monitoring systems for effective water resource management, especially in the light of ongoing environmental changes. The research highlights the crucial role of modern technological tools in understanding climatic and ecological shifts in high-altitude regions. Ultimately, it contributes to informed decision-making, enhances regional resilience to climate change, and provides valuable perspectives for developing sustainable water management strategies.

Keywords: Climate engine, GIS, SWE, LST, snow cover, snow depth, terra climate, Astore Basin.

Analyzing Temperature Variability and Trend Detection in the Hindu Kush Region, Northern Pakistan

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Present study explores the spatio-temporal analysis of temperature by using Mann-Kendall test and Sen's Slope Estimator (SS) in the Hindu Kush (HK) region of north Pakistan. Globally, climate change has a strong association with trend in temperature and resultant changes in rainfall pattern. In the current study, temperature is selected as a meteorological parameter for trend analysis and also to find out the magnitude of the predicted temperature. In order to attain objectives of study, temperature data were collected from Pakistan Meteorological Department (PMD) for all the seven meteorological stations. The temperature data were analyzed and simulated using Mann-Kendall test and Sen's Slope (SS), for the determination of temperature trend and slope magnitude. The analysis reveals that a positive (increasing) trend in mean maximum temperature has been detected for Chitral, Dir and Saidu Sharif Met stations. Similarly, the trend in mean minimum temperature has also been recorded for meteorological stations of Saidu Sharif and Timergara. The analysis further reveals that the variation in temperature trend and slope magnitude is attributed to climate change phenomenon in the region.

Keywords: Climatic change, temperature, trend, magnitude, Mann-kendall test, Sen's slope.

Quantitative Microbial Risk Assessment and Strategic Chlorination for Cholera Control in Urban Drinking Water Supply. A Case Study from Karachi, Pakistan

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A risk assessment of *Vibrio cholerae* contamination in Karachi's drinking water revealed alarming levels of bacterial presence across five districts, based on 1,468 analyzed samples. Total coliforms (TC) were detected in 62% to 92.3% of samples, with the highest levels in Korangi. Fecal contamination, indicated by *E. coli*, ranged from 36.7% in South to 74% in Korangi. Most concerning was the presence of *V. cholerae*, the cholera-causing bacterium, in 8% to 24% of the samples. Notably, all samples prior to the disinfection activities lacked free residual chlorine (FRC), a critical disinfectant, underscoring the heightened risk

of pathogen transmission. To mitigate this crisis, secondary chlorination using sodium hypochlorite (NaOCl) was introduced at 16 water pumping stations and one reservoir in high-risk areas. The intervention targeted FRC levels of 1.0–2.5 mg/L at the source and 0.1–0.5 mg/L at the consumer end to ensure effective disinfection. Post-intervention analysis showed a dramatic decrease in contamination. All samples displayed the presence of FRC and tested negative for *V. cholerae*. Pre-chlorination, contamination was highest in Korangi (Total coliforms median: 1236, *E. coli* median: 611.5) and Malir (Total coliforms median: 1154, *E. coli* median: 40). Post-chlorination, bacterial levels dropped to near zero across all districts. This improvement was further supported by the interquartile range (IQR) difference between pre and post-chlorination samples.

Keywords: Microbial risk, chlorination, cholera, urban drinking water, Karachi.

Evaluating Crop Residue as a Renewable Energy Resource: Opportunities for Reducing Greenhouse Gases, Combating Climate Change and Mitigating Extreme Weather Impacts

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Due to growing demand, a heavy reliance on fossil fuels, and increased vulnerability to climate-related extreme weather events including heatwaves, floods, and droughts, Pakistan's energy industry is under increasing strain. The energy crisis should be tackled through alternative renewable energy sources. One of the most easily available feedstocks for the generation of renewable energy crop residue is rice husk, which can help resolve both issues of energy shortage and serves as a sustainable resource that can improve climate resilience and lower greenhouse gas (GHG) emissions. A comprehensive knowledge of the physicochemical characteristics of rice husk is important for the use of combustion schemes. This study provides information on the heating values and proximate and ultimate analyses of rice husks obtained from various locations in Sindh, Pakistan. The results showed that the moisture content ranged from 12.76% to 13.50%, the volatile matter was higher from 55.77% to 62.88%, and the amount of ash particles ranged from 14.50% to 16.48%. From an environmental perspective, the reduced quantities of sulfur, 0.02% to 0.19%, and nitrogen, 0.37% to 1.31%, indicate more suitable fuel qualities. The mean calorific value of rice husk was 5,859.87 Btu/lb, with a range of 5,276.33 to 6,237.13 Btu/lb. The analysis shows that bioenergy derived from crop residues rice husk can greatly reduce the use of fossil fuels and support national decarbonization objectives. By reducing atmospheric CO₂ concentrations, the shift to residue-derived energy not only provides a low-carbon pathway but also lessens the long-term climatic causes of

extreme weather. Overall, the study emphasizes agricultural residues rice husk as a key renewable energy source that offers both immediate GHG reduction and enhanced resilience to Pakistan's increasingly severe weather events. This study aligns with Sustainable Development Goal 7 (Affordable and Clean Energy).

Keywords: Alternative energy, crop residue, rice husk, power generation, climate change, eco-friendly.

Climate Change Impacts on Agriculture and Rural Development in Pakistan

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Pakistan is highly vulnerable to climate change due to its diverse geography and strong dependence on agriculture. Rising temperatures, shifting monsoon patterns, floods, droughts, and accelerated glacial melt are increasingly affecting crop productivity, livestock health, water availability, and soil quality. This study examines the impacts of climate variability on agricultural performance and rural livelihoods, with a focus on arid, semi-arid, and flood-prone regions. The findings reveal that heat stress, salinity, and water scarcity are major drivers of declining yields and food insecurity, particularly among small farm holders. Climate-related risks are also intensifying pest outbreaks, rural poverty, and migration. The study reviews adaptation strategies including climate-smart agriculture, improved irrigation methods, resilient crop varieties, and community-based resource management. Policy implications emphasize the need for integrated climate action, improved extension services, and investment in agricultural innovation. Strengthening climate resilience is essential for ensuring food security and sustainable rural development in Pakistan.

Keywords: Pakistan, climate change, agriculture, rural development, food security, adaptations.

Trace and Heavy Metal Contamination in Tirah Coalfields: Geochemical Signatures and Environmental Health Risks

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Coal deposits often contain trace and heavy metals that may be mobilized during mining and combustion processes. This study investigates the concentration and distribution of selected trace and heavy metals in coal samples collected from different locations of the

Tirah coalfields, Khyber Pakhtunkhwa, Pakistan. Ten representative coal samples were subjected to physicochemical and geochemical analyses. Parameters including moisture content, volatile content, ash content and sulfur content were determined, while concentrations of trace and heavy elements were measured using Atomic Absorption Spectrometry (AAS). The analytical findings indicate that multiple coal samples exhibit higher concentrations of sulfur, volatile matter, and trace elements such as Cd, Pb, Mn, Cr, Cu, Zn, and Ni when compared to the average composition of coal in the United States and the world. These elements are mainly associated with mineral matter such as sulfides and clay minerals present within the coal matrix. Coal samples with higher sulfur and ash contents show relatively higher concentrations of toxic metals, suggesting a strong relationship between metal enrichment and mineral impurities. The presence of such elevated metal concentrations indicates that Tirah coal may represent a potential environmental and public health risk when used as a fuel source, because toxic elements can be released in the form of ash particles and gaseous emissions during combustion. The findings emphasize the importance of detailed coal-quality assessment before utilization and highlight the need for improved management practices in coal mining and usage in the Tirah region.

Keywords: Tirah coalfield, coal geochemistry, heavy metals, trace elements, environmental risk.

Heat, Floods and Flies: UAV-AI Early Warning and Adaptive IPM for Extreme Weather in South Punjab, Pakistan

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Escalating heat waves, erratic monsoon bursts, and flood–drought whiplash are reshaping pest and vector ecology across South Asia, with cascading impacts on crop productivity and public health. This presentation introduces an integrated early-warning and response framework that couples unmanned aerial vehicles (UAVs), satellite remote sensing, in-field microclimate sensing, and machine learning risk models to anticipate and manage pest outbreaks and mosquito vector surges triggered by extreme weather. Working across the cotton–wheat landscape and mango–citrus orchards of South Punjab (Pakistan), we combined weekly UAV multispectral/thermal imaging, smart trapping and ovitrap networks, and IoT loggers to generate features such as canopy temperature depression, NDVI/NDRE anomalies, soil-moisture proxies, and degree-day/relative humidity excursions. These data feed gradient-boosted and spatiotemporal models to produce field-scale outbreak probabilities and a simple, actionable Risk Index for extension

workers and growers. Pilot deployments during heat waves, dust storms, and post-monsoon flooding demonstrate operational gains: Earlier detection of crop stress than visual scouting, targeted interventions that replace blanket sprays, and coordinated vector responses (source reduction and larval habitat management) aligned to short-lead weather forecasts. The framework also supports per-tree delineation in orchards for precision nutrition and hotspot suppression, as well as variable-rate UAV applications when chemical or bio controls are warranted. We discuss model generalization across events, safeguards to limit false positives/negatives, and the role of ground-truthing to maintain scientific rigor. Finally, we outline a pathway for scaling through open workflows, district-level dashboards, and policy linkages to disaster-risk reduction and climate adaptation programs. By integrating climate analytics with agro-entomology and public-health surveillance, the approach offers a practical, scalable blueprint for protecting yields and communities under intensifying extreme weather.

Keywords: Extreme weather, UAV, AI/ML, integrated pest management, vector surveillance, remote sensing, cotton, mango, Pakistan.

Floodwater Diversion for Managed Aquifer Recharge- A Case Study at Sutlej River in Punjab

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Groundwater plays a vital resource in irrigated agriculture in Indus River Basin. Presently this resource is under threat and is depleting at an alarming rate and becoming out of bound for irrigators. In district Vehari in South Punjab area groundwater levels are dropping at an average rate of about 0.5 ft. per year. Irrigated agriculture contributes about 22% GDP of the country and groundwater contributes about 50-60% towards irrigation water requirements. Pakistan is blessed with plenty of surface water resources and a large groundwater reservoir of more than 300 m depth. Irrigation Research Institute of Punjab Irrigation department has executed a managed aquifer recharge (MAR) project by diverting flood water from Islam Head works at Sutlej River into the bed of Old Mailsi Canal. To accelerate the recharge rate 144 recharge wells have been constructed in the bed of canal. During flood 2025, around 9500 acre-feet of water from these wells has been recharged through 15 km long and 150 ft wide canal section. This is milestone achievement in the history of Pakistan. The project has shown positive impacts including up to 10 ft rise in water table in a period of around two months. Such projects, being a success story, can be up scaled in other parts of the region.

Keywords: Groundwater recharge, irrigated agriculture, flood MAR, Vehri, Panjab, Pakistan.

Shoreline Change Study in Northwest of Indus Delta using the Temporal Landsat Satellite Data

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Indus deltaic coast located on the south eastern boundary of Pakistan is rich in biodiversity with prominent features found along the coast. Till early 20th century, delta used to grow seaward naturally, with the support of continuous flow of Indus River carrying sediments towards delta. After the development of irrigation system, natural flow towards delta started to decrease and by the end of 20th century, negligible level of water flow was recorded from Kotri barrage (last barrage of river Indus). This phenomenon distorted many geomorphic features of delta, particularly the shoreline. A temporal study was conducted based on the oldest bathymetry map of the offshore Indus Delta and land sat satellite imageries for the years 1978, 2000, 2007 and 2013. Average retreat rate from 1895 to 2013 is calculated to about 25.35 m/year while within the available data of satellite from 1978 to 2013, the calculated retreat rate is 22.92 m/year. It shows that at the end of the last century the retreat rate was accelerated. Similarly, total submergence area measured for the period 1895 to 2013 was about 331.30 km² at the rate of 2.80 km²/year but submergence area measured from 1978 to 2013 was 125.24 km² that was submerged at the rate of 3.47 km²/year, reflecting the same scenario of higher submergence in the period of satellite data.

Keywords: Shoreline, Indus Delta, satellite data, submergence, emergence, Pakistan.

Engineering Geological Assessment of Seismic Hazards for Sustainable Urban Development in the Bengal Basin: Implications from Indo-Burmese Subduction Dynamics

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Bangladesh's accelerating urban growth, particularly in Dhaka, Chattogram, and Sylhet, is occurring atop a geologically complex and seismically active deltaic environment. The Bengal Basin, composed largely of unconsolidated Holocene alluvial sediments with low shear-wave velocity (< 200 m/s in many urban subsoils), exhibits high site amplification potential during seismic events. Tectonically, the eastern margin of the basin is bounded by the Indo-Burmese subduction zone, where geodetic observations (Steckler et al., 2016) indicate strain accumulation equivalent to the potential for Mw 8.2–9.0 earthquakes.

Historical events, such as the 1762 Cheduba Island earthquake ($M_w > 8$) and four $M_w > 7$ earthquakes between 1822-1918 highlight the seismic sensitivity of the region. The subsequent century-long seismic quiescence suggests a potential seismic energy deficit, which, if released abruptly, could have catastrophic impacts on urban areas. From an engineering geological perspective, urban seismic vulnerability in Bangladesh is exacerbated by unplanned land use, inadequate building code enforcement, and insufficient geotechnical site characterization. Microtremor and MASW (Multichannel Analysis of Surface Waves) surveys conducted in parts of Dhaka and Sylhet reveal fundamental site resonance frequencies in the range of 0.6–1.5 Hz, coinciding with the natural period of many mid-rise urban structures—an alarming condition for structural stability. Additionally, liquefaction susceptibility mapping in the Chattogram–Cox’s Bazar urban corridor indicates high risk zones where loose, saturated sandy layers underlie critical infrastructure. This study integrates historical seismicity, GPS-based crustal deformation data, and engineering geological investigations to produce refined seismic hazard zonation for urban planning. Using high-resolution remote sensing and GIS based multi-criteria analysis, urban growth patterns are overlaid on hazard maps to identify priority intervention zones. The results underscore the necessity of incorporating detailed subsurface geotechnical parameters, site-specific seismic response modeling, and long-term environmental monitoring into urban development frameworks. To ensure climate-change-resilient and disaster-safe urbanization in Bangladesh, it is imperative to: Strengthen institutional and cross-border scientific collaboration on active fault mapping, mandate engineering geological assessments in municipal planning approval processes, and integrate seismic hazard and environmental assessment into national urban planning policies. The outcomes of this research provide a foundation for evidence-based urban development strategies that harmonize engineering geology, hazard mitigation, and sustainable city growth in one of the world’s most densely populated and geologically sensitive regions.

Keywords: Subduction, urban seismic vulnerability, unplanned land use, poor building codes.

Geo-environmental Aspects for Climate-Resilient Urban Planning in Sirajganj Town and Surrounding Areas, Bangladesh

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Sirajgonj town is expanding rapidly without any proper land-use planning. New structures are being developed everywhere, without consideration for proper planning and potential impact on the geo-

environment. Many low-lying areas in both the peri-urban and urban centers are being filled improperly for construction purposes, which is disrupting the natural geo-environmental setting. This reckless development is harming the environment and causing various health issues for residents. This study provides an integrated framework for incorporating geo-environmental data into future climate resilient urban land-use planning for Sirajgonj. The Sirajgonj covers the Jamuna and Karatoya floodplain, having six morphogeological units, viz; (i) active channel, (ii) abandoned channel, (iii) natural levee, (iv) crevasse splay, (v) floodplain and (vi) flood basin deposits. The aquifers in the areas are unconfined to semi-confined type, with an average annual groundwater fluctuation of 4 m. The area has been divided into four engineering geological map units based on the engineering properties of the soil, including the Atterberg limit, Standard Penetration Test (SPT) results, consistency, and compressibility. Several natural hazards have been identified, such as riverbank erosion, floods, subsidence, earthquakes, dust storms, soil erosion, expansive soil, foundation failure, and waterlogging, alongside some human-induced hazards. This area is significantly affected by river bank erosion and dust storm hazards. Considering morpho-geological, hydrogeological, geotechnical, geo-environmental factors, and various hazards, the western and southwestern parts of Sirajgonj are considered the most suitable for future urban development, whereas the eastern side presents challenges for urbanization. Due to severe erosion along the western bank of the Jamuna River, any future urbanization to the east of Sirajgonj town is not recommended. Therefore, it is essential for authorities to prioritize these geoenvironmental factors in sustainable and long-term climate resilient urban planning and development. This approach will help to mitigate risks, improve environmental conditions, and support sustainable urban development in the area.

Keywords: Urban geology, engineering geology, geo-environment, climate resilient, development.

Assessment of Groundwater Quality and Rising Salinity in the Kirana Hills Rabwah Region

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This study synthesizes field surveys and laboratory analyses conducted across Rabwah to evaluate groundwater quality, groundwater-use practices, and salinisation risk in District Chinioot. A total of 352 groundwater samples from private wells and tube wells (depths 35–300 ft) were analyzed for major ions, trace elements and microbiological quality. Results show widespread deterioration of groundwater: Mean

TDS across the district was ~780 mg/L (well above WHO drinking guidelines in many localities) with extreme values near the Kirana Hills averaging ~2,505 mg/L and maximum >12,000 mg/L. Electrical conductivity, chloride, sulfate, calcium and hardness show strong spatial variability, with chloride and sodium particularly elevated near shallow basement exposures. Trace elements (arsenic, manganese) exceed recommended limits in several locations, largely due to natural water-rock interactions, while sulfur and microbial contamination in shallow sources indicate septic and waste-water impacts. The evidence points to a twofold problem: (1) natural geogenic contamination in areas of exposed pre-Cambrian rocks and (2) anthropogenic salinisation aggravated by intensive groundwater extraction and poor sanitation practices. These combined hazards reduce potable water availability, damage plumbing and impose economic and health burdens on local communities. The study recommends an integrated response: Improve monitoring, regulate extraction, protect shallow aquifers from seepage, implement community water treatment, and prioritize safe supply to homes, schools and health centers.

Keywords: Groundwater quality, salinity, Kirana Hill, water treatment, monitoring, regulate extraction.

Environmental Degradation Due to Unplanned Quarries for Engineering Purpose in the North-Western Part of Bangladesh

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The study area occurs in different parts of Pangram Upazila, Lalmonirhat district, in the northwestern part of Bangladesh, where many quarries were identified for engineering purpose. The study area encompasses about 55 km along the banks of the Dharla and Saniazan rivers near the India-Bangladesh border. The main objective of the study was to delineate the environmental degradation due to unplanned gravel extraction in the study area. The field data were collected with the help of augers, field observations, digging and GPS, and also collected information from the local statistical office. A major portion of the mapped area is occupied by the Tista Fan and covered by the floodplain deposits of the Holocene age. Tista alluvial fan deposits are generally composed of sand and stone (gravel) at various percentages, which are working as the main raw materials of construction throughout the country. The source of the gravel is exposed in various overthrust sheets of the Darjeeling Himalaya of Nepal, Tibet, India, and Bhutan. Large amounts of stones (gravel) and sand were extracted unconditionally from the riverbed, riverbank, and surroundings by using the mechanical dredgers and excavators. The unplanned way of extraction is increasing

the river bank erosion and destroying the surrounding agricultural lands, landscapes, river navigation, and biodiversity. Sound and dust are created in the quarry areas due to unplanned use of dredgers and stone crushers, which is aggravating the environmental pollution. Many kinds of environmental pollution might be faced in the surveyed as well as surrounding areas of Lalmonirhat district due to this unplanned extraction/quarry. Environmental degradation might be enhancing the negative impact of the climatic conditions of the country. Stones (gravel) and sand are part of mineral resources, and are needed for construction around the country. Sand and stone should be extracted for engineering purpose in an environmentally planned way so that agricultural lands, biodiversity, landscapes, and other negative environmental impacts are reduced to prevent future environmental degradation of the country.

Keywords: Quarry, gravel, sand, sustainable extraction, environmental degradation, Bangladesh.

InSAR-Based Early Detection of Landslide Movements under Extreme Weather Conditions in the Eastern Hindukush, Pakistan

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Landslides are among the most destructive natural hazards in Pakistan's mountainous regions, frequently triggered by extreme weather events such as intense rainfall, rapid snowmelt, and prolonged wet periods. The Lower Chitral district, situated within the tectonically active Hindu Kush range, is highly susceptible to such hazards due to its steep terrain, active faults, fragile lithology, and increasing anthropogenic pressures. This study integrates multi-temporal SAR imagery (2020–2023), SBAS-InSAR analysis, GIS-based modeling, and field observations to detect active ground deformation and evaluate landslide susceptibility in the region. More than 50 active landslides were identified, with deformation velocities typically ranging from 20 mm/year to over 100 mm/year and reaching up to 175 mm/year in critically unstable areas. Key conditioning factors influencing slope instability include elevation, slope angle, aspect, curvature, NDVI, lithology, fault density, and proximity to roads. Results show that slopes between 5° and 45°, barren lands with NDVI values of 0.00–0.10, and south to northwest-facing aspects (180°–360°) exhibit significantly higher susceptibility. Weak geological units such as the Wakhan, Atark, and Sarikol Shale formations recorded the highest deformation rates, highlighting their vulnerability under extreme weather stressors. Two Landslide Susceptibility Maps (LSMs) were produced: One using a traditional weighted overlay approach and another enhanced by integrating SBAS-InSAR-derived deformation data. Both maps consistently identify

Mudan Valley, Garam Chashma, and Kareem Abad Valley as zones of very high susceptibility, largely due to their proximity to active faults and steep geomorphic settings. This study demonstrates the effectiveness of combining InSAR time-series analysis with GIS-based susceptibility modeling for monitoring weather driven slope instabilities. The findings provide crucial insights for early warning systems, climate resilience planning, and targeted disaster risk reduction initiatives in northern Pakistan.

Keywords: Landslide, InSAR, Remote Sensing, Hindukush, early warning, disaster risk reduction.

Exploring Glacier Dynamics in Shigar River Basin using Geospatial Techniques

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Glacier melting has a major impact on water resources, as 70% of Pakistan's fresh water comes from these glaciers and used for agricultural purpose, industrial, domestic as well as for hydroelectric power generation. This study is aimed to explore the glacier dynamics for the last 23 years in Shigar River Basin using geospatial techniques and its relation with climatic variations for better understanding of glacier dynamics in northern Pakistan. The objectives of this study are to estimate the glacier facies dynamics, climate trends and their impact on studied glaciers named as Chogo lungma, Biafo, Panmah and Baltoro. Methodology used for this study is the measurement or the estimation of mass balance, estimation of equilibrium line altitude (ELA), snout positions, DEM difference and climate trend assessment. For this purpose, Landsat images and sentinel 1 images were used to identify Normalized Difference Snow Index (NDSI), Normalized Difference Debris Index (NDDI), Normalized Difference Glaciers Index (NDGI), Band ratio and Band composite to find out the snout position, mass balances and ELA. For DEM difference, two different Digital Elevation Models were utilized i.e. Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) and Shuttle Radar Topography Mission (SRTM). For climate trend assessment, the Mann Kendall's trend test, and Sen's slope analysis were applied. Results revealed that the mean mass balance with standard deviation of studied glacier with respect to reference year 2000 is 0.2674 ± 0.0815 m w.e. a⁻¹ whereas Mean \pm SD of snout position is -118.092 ± 26.057 m. Moreover, the ELA results show the average Mean \pm SD 4778.77 ± 109.988 m asl. The overall mass balance, snout position and ELA results indicate the receding status of the studied glacier. DEM difference also shows some areas are highly elevated and some are low elevated, it ultimately contributes in

the melting of glaciers. Climate trend assessment results of Skardu rainfall station shows the increasing trend of temperature and insignificantly decreasing trend of precipitation, which play a major role in the retreating of studied glaciers. The findings of this study contribute to the overall understanding of glacier dynamics of Shigar River Basin for climate change, environmental management, water resources and natural hazards.

Keywords: Glacier dynamics, Shigar River Basin, Geospatial techniques, Sentinel-1, climate trend analysis.

Microfossils as Proxies for Past Sea-Level Variability and Coastal Hazards: Global Synthesis and Applications for Pakistan

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Coastal regions are increasingly threatened by sea-level rise, erosion, and high-energy inundation events. Pakistan's low-lying coasts, particularly the Indus Delta and the tectonically active Makran Coast, face this type of risk. Understanding this process is crucial for assessing these hazards and strengthening long-term coastal resilience. Shelf environments are inhabited by diverse organic assemblages, including foraminiferal and diatomic. Their modern distribution are closely linked to tidal elevation, salinity, and inundation frequency. They have a high fossilization potential and are common in coastal deposits providing valuable material for paleoenvironmental studies. Statistical transfer functions convert microfossils into quantitative estimates of past sea-level positions, enabling precise reconstructions of sea-level changes. Microfossils record environmental changes associated with climate variability. Studying both living and past assemblages can reveal the response to extreme climate events. These microfossils serve as robust paleo-archives, and applying such approaches in Pakistan could offer new insights for climate and environmental monitoring. This study synthesizes global research on microfossil-based sea-level reconstructions, highlighting advanced analytical approaches and evaluating their potential application along Pakistan's coasts. The Indus Delta influenced by rapid erosion, subsidence, and sea-level rise, offers a valuable setting for developing modern microfossil training sets and shoreline shifts paleo reconstructions. Along the Makran Coast, microfossil assemblages have potential to document land-level changes and contribute to identifying past high-energy inundation events.

Establishing such reconstructions would provide critical scientific evidence to strengthen early-warning systems, improve coastal management strategies, and support national climate adaptation planning. Published datasets and records from open-access repositories, including PANGAEA, NOAA Pale climatology, and Neotoma Paleoecology, were reviewed to examine quantitative techniques such as transfer functions, multivariate statistical analyses, and geochemical proxy methods. By synthesizing these approaches, this work highlights existing methodological frameworks and identifies opportunities to apply microfossil-based reconstructions in Pakistan. This provides a foundation for geoscientific studies of historical and contemporary coastal dynamics.

Keywords: Microfossils, Foraminifera, transfer functions, sea-level change, coastal hazards, Pakistan.

Climate Change Impact on Hydrological Regimes of UIB: An Overview in the Context of Gilgit-Baltistan

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This study offers a comprehensive overview of the profound impact of climate change on the hydrological regimes of the Upper Indus Basin (UIB), with a specific focus on the Gilgit-Baltistan region. As global temperatures continue to rise, implications for hydrology in this vital region are far reaching and complex. Gilgit-Baltistan, situated within the UIB, is experiencing many changes in its hydrological systems. The UIB is home to a number of glaciers, but their rapid retreat is evident and alarming. This phenomenon has led to an increased volume of meltwater during warmer seasons, subsequently affecting river discharge and overall water availability. Furthermore, current climatic variations have triggered alterations in precipitation patterns, including changes in the timing and intensity of rainfall and snowfall. These shifts have significant consequences for water resources and the overall hydrological balance of the region. Climatic changes have disrupted the traditional timing of snowmelt and glacier runoff, impacting water availability for agricultural purpose, hydropower generation, and daily consumption. Consequently, water scarcity can occur during critical periods (February to June). Similarly, the retreating behaviors of the glaciers have enhanced the risk of Glacial Lake Outburst Floods (GLOFs), posing a severe threat to downstream communities and their livelihood. GLOFs can lead to catastrophic floods, loss of life, and extensive damage to infrastructure in the region. In response to these challenges, the region is actively implementing various adaptation strategies, including constructing water storage reservoirs, improving indigenous water management practices, and adopting climate-resilient

agricultural techniques through GLOF-II project, funded by the United Nations Development Programme (UNDP), and ETI (Economic Transformation Initiative), financed by the International Fund for Agricultural Development (IFAD) which are long term development programs of Government of Gilgit-Baltistan. However, these interventions alone may not mitigate the risks associated with climate-induced hazards. Effective governance and robust policy frameworks are vital to address the multifaceted challenges posed by shifting hydrological regimes. Collaborative efforts at regional and international levels are essential for effectively managing transboundary water resources. In conclusion, the hydrological regimes of the UIB, particularly within Gilgit-Baltistan, are undergoing significant transformations due to the impacts of climate change. Understanding these changes and implementing adaptive measures are critical for sustainable water management, protecting livelihoods, and reducing vulnerability to climate-related hazards.

Keywords: Upper Indus Basin (UIB), GLOF, climate change induced hazards, hydrological regimes.

Monitoring of Nitrogen Dioxide (NO₂) over Karachi using Remote Sensing Tool: Sentinel 5P

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Air pollution is one of the important environmental issues that is becoming a serious threat now. The environment and human health can be adversely affected by a variety of air pollutants emitted from industry and other activities. The combustion of fossil fuels, especially vehicle exhaust, is a major source of nitrogen dioxide (NO₂), one of the most important air pollutants. For many years, satellite remote sensing data has been used to track air pollution. Rising NO₂ levels are putting everyone's health at risk. Karachi is ranked 4th among the most polluted cities in the world. We need to address this issue seriously. In this study we have significantly monitored NO₂ by using GIS remote sensing tool Sentinel5P, and data of past 5 years from January 2019 to May 2023 in Karachi and have observed the gradual changes in concentration of NO₂ due to rainfall, humidity, temperature, COVID and other economic reasons. Furthermore, main sources of NO₂ and monitoring devices are discussed with its effect on environment and health of humans. The concentrations exceed the WHO standard levels for NO₂ in ambient air. The study also revealed that the NO₂ concentrations measured for Karachi was higher above the WHO's yearly limit threshold, which is 53 ppb/year. Thus, it is crucial to take action to address this issue before it poses a severe risk to the local people.

Keywords: Sentinel 5P, Karachi, NO₂, remote sensing, human health, fossil fuels, environment.

Ambient Air Quality Assessment and Risk Impact due to Climate Change in Karachi

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This study highlights the pervasive issue of air pollution within Karachi, the nation's most densely polluted and populous urban center. Focused on industrial zones, residential neighborhoods, and commercial districts, this research employs the Haz-Scanner HIM-6000 instrument to assess ambient air pollutants. Carbon monoxide (CO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), total suspended particulate matter (TSPM), particulate matter with a diameter of 10 micrometers (PM₁₀μ), and particulate matter with a diameter of 2.5 micrometers (PM_{2.5}μ) are measured across 24 distinct sampling locations. Data were collected during both pre-monsoon (May to June) and post-monsoon (October to November) periods over a span of three years (2024 -2025). The findings reveal that during the post-monsoon season, concentrations of particulate matter (TSPM, PM₁₀μ, PM_{2.5}μ), carbon monoxide, and nitrogen dioxide are moderately reduced compared to the pre-monsoon period. This attenuation might be attributed to the influence of seasonal monsoons. Levels of PM₁₀μ and PM_{2.5}μ persistently exceed national standards. Notably, the North Karachi industrial area, characterized by fewer and smaller industrial units, exhibits relatively lower risk levels. The substantial presence of air pollutants has dire health implications, contributing to both acute and chronic illnesses. Consequently, there emerges a compelling necessity to enact localized environmental benchmarks for ambient air pollutants. Such measures are pivotal in ameliorating the adverse impact on human health and economic activities. This study underscores the urgency for targeted focus and rigorous implementation of these standards, thereby fostering a healthier and sustainable environment.

Keywords: Air pollutants, health effects, industrial zones, pre-and post-monsoon, Karachi.

Machine Learning and GIS Approaches for Predicting Groundwater Salinity in Southern Indus Plain, Hyderabad District, Sindh, Pakistan

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Groundwater quality assessment is critical for sustainable water resource management, particularly in southern Indus Plain, where groundwater is primary source of drinking and irrigation water. Due to climate change, surface water resources have been depleted and farmers rely on saline groundwater for irrigation. High salinity in the groundwater of study area, poses serious threat to local agricultural production. This study applies the GIS based geospatial mapping and machine learning techniques to predict groundwater salinity. Statistical and geospatial mapping revealed that groundwater salinity is mainly associated with anthropogenic input near Hyderabad city, while agricultural areas have been affected by natural sources. Piper and Gibbs diagrams showed that cation exchange and weathering are important natural contributors of salinity. Machine learning models were generated to predict the salinity in the study area. Salinity was predicted using linear regression, Random Forest (RF), Artificial Neural Network (ANN) and decision trees, using pH, sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), bicarbonate (HCO_3^-), sulfate (SO_4^{2-}), chloride (Cl^-), and nitrate (NO_3^-) variables. Results, showed that Cl and NO_3^- are the most important parameters to predict the salinity. Random Forest model provided robust performance ($R^2 \approx 0.89$) and showed that Na^+ , Cl^- , SO_4^{2-} , and Mg^{2+} are dominant drivers of EC. In addition, Linear Regression also showed strong explanatory power ($R^2 \approx 0.79$). Artificial Neural Network (ANN) with two hidden layers (5–3 neurons) was trained using scaled inputs and revealed high accuracy ($R^2 \approx 0.75$), while decision trees showed moderate accuracy ($R^2 \approx 0.67$). The combined geochemical, statistical, GIS and machine learning techniques have provided high accuracy and interpretability and baseline framework for groundwater quality assessment. These results are helpful for initiating monitoring programs for sustainable use of groundwater for agriculture and water management in semi-arid regions affected by extreme climate change.

Keywords: Groundwater modeling, water salinity, machine learning, GIS, Sindh, Pakistan.

Evaluating Spatial Justice through Accessibility and Resource Distribution

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Every individual has some universal rights and necessities. These are the rights to life applying to anyone, anywhere. To protect people's mental and physical well-being, the space must provide for their necessities. For everyone's requirements and rights to life, public utilities should be available to all. Among the core ideas of urban sustainability, justice originates from the notion of equity, which means arranging everything properly. Extensive studies addressed equitable accessibility on public green spaces, schools and playgrounds, and healthcare centers. Urban spatial justice may be shaped by factors like educational, physical, medical, and economic. This study focuses on 11 union councils of Lyari town. For physical features (public parks, sports grounds, general hospitals, and government schools), spatial analysis is conducted through the kernel density tool in the GIS domain. To analyze patterns, spatial autocorrelation (Moran's I) was utilized. Transportation accessibility was mapped via network analysis in ArcMap. Pattern analysis reveals clustering for schools, whereas public parks, banks, ATMs, and general hospitals showcased a random distribution. These patterns may lead to unfair access and indicate inadequate urban planning. Lyari town lacks an adequate urban transit system. This work analyzed that every second parallel major road is deprived of public transportation. According to the questionnaire, residents mostly depend on multimodal transportation, which may be due to an inconsistent transit network system. Economic criteria considered in this study include education, employment, the working women ratio, the standard and cost of living, the crime rate, and satisfaction with the neighborhood. Over the past few years, after cutting the roots of local gangs, the area seemed to be safe with low crime rates.

Keywords: Spatial justice, equity, accessibility, public transportation, GIS, network analysis.

Geological and Geotechnical Assessment of Landslides Triggered by Cyclone ‘Remal’ in Baghaichari, Rangamati District, Bangladesh

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Bangladesh’s location and exposure to extreme weather make it highly vulnerable to cyclones and intense rainfall, which often trigger landslides in its south eastern hilly regions. Numerous slope failures brought on by Cyclone Remal's torrential rainfall at Baghaichari upazila of Rangamati hilly district, resulted in fatalities and substantial property damage. The purpose of this study was to determine the geological and geotechnical causes of these landslides and suggest ways to lower the danger in the future. For this purposes a total number of 10 landslides areas were investigate. Elevation, slopes, dimension of the rupture surfaces and type of movements and Lithologies of the slide materials were examined. Disturbed and undisturbed soil samples were collected for measuring the geotechnical properties. From the study it has been observed that landslides occurred between 174 ft and 880 ft elevation. Slope failures most frequent on slopes steeper than 60°. Maximum landslides occurred in the sandstone formations of Dupi-Tila, Boka Bil and Bhuban sandstone Formations. Grain size data reveal that rocks are mostly consist of silt while some sample consists of sand and clay. Liquid Limit (LL), Plasticity Limit (PL) and Plasticity Index tests indicate very plastic clay-rich soil. Consolidation test results relatively moderate to high compressibility. However, intense rainfall from Cyclone Remal, weathered soil, high slope angle and elevations of the slide area, deforestation, and human activities are the prime contributing factor that cause landslides of the area. A combination of ecological restoration, cautious land-use control, and community preparedness may reduce the risk of landslides. A community based early warning system can enhance local preparedness.

Keywords: Cyclone Remal, geotechnical, landslide, early warning, land use.

Geological Assessment of Surface Water and Groundwater along Malir, Lyari, and Hub Rivers, Karachi under Changing Climate Conditions and Associated Health Impacts

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Karachi is facing severe shortage of quality water because surface water is highly contaminated and groundwater is saline and also polluted with toxic elements and fecal organics. These issues are being intensified by

climate-driven changes such as declining recharge, rising temperatures, reduced river flows, and frequent droughts which accelerate pollutant transport and saltwater intrusion. However, heavy rain water is wasted through urban flooding rather than contributing to groundwater recharge. Excessive groundwater extraction has further lowered the water table by approximately 250–300 ft in many parts of the city. This study evaluates the quality of groundwater and surface water along Malir, Lyari and Hub Rivers under changing climatic conditions and assesses the associated health risks. A total of eighty groundwater samples were collected from eastern and western banks of Malir and Lyari and Hub rivers at the depths of 4-1000 feet along with five surface water. Physicochemical data reveal that the groundwater quality is severely deteriorated with exceeding TDS content ranging between 342 to 62784 mg/l, and t 95% samples exceeded WHO limit. Major ions exceeded the WHO limits due to combined geogenic processes (calcite/carbonate dissolution, cation exchange), industrial discharge, and climate-related reductions in fresh water recharge. The dominating NaCl water facie indicates seawater intrusion due to reduced freshwater recharge and over-extraction in the area. The microbial analysis shows, 89% samples are affected by total coliforms while 21% contaminated by E. coli bacteria indicating sewerage infiltration. Overall, the deteriorating groundwater quality, further intensified by climate-related changes pose serious health risks due to chemical and microbial pollution. There is urgent need for climate-adapted groundwater management, better sanitation systems, and strong public health measures.

Keywords: Groundwater quality, Malir, Lyari, Hub rivers seawater intrusion, climate change, Karachi.

Flood Risk Assessment Mapping by Remote Sensing in District Chiniot, Pakistan

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Floods are among the most destructive natural hazards in Pakistan, causing severe loss of life, infrastructure damage, and widespread environmental impacts. District Chiniot, located along the Chenab River in Central Punjab, has experienced several major flood events over the past decades. This study applies remote sensing and GIS techniques to assess historical flood patterns and delineate flood prone areas within the district. Maximum flood peak discharge records from Marala, Khanki, and Qadirabad headworks (1973–2016) were analyzed to characterize flood severity, while Landsat satellite imagery was used to map the spatial extent of past flood events. Unsupervised ISO Cluster classification in ArcGIS 10.5 enabled identification of overflow zones

and inundated regions during key flood years. Results show that significant flooding occurred in 1992, 1996, 1997, and 2014, with affected areas covering 26%, 26%, 27%, and 39% of the district, respectively. The 2014 flood, with discharges exceeding 900,000 cusecs, caused extensive inundation along the Chenab corridor and severely impacted agricultural land, settlements, and transportation networks. Elevation analysis further revealed that areas below 180 m above mean sea level are highly susceptible to flooding, while elevated terrains of the Kirana Hills provide natural protection to Chiniot city and Rabwah town. The integration of hydrological data with satellite-derived flood extent maps demonstrates the effectiveness of remote sensing in early flood warning and hazard preparedness. These findings provide essential insights for local planners and disaster management authorities to strengthen mitigation strategies and enhance community resilience. A web-based simulation is also prepared to timely address the flood prone areas.

Keywords: Chenab River, ArcGIS, remote sensing, Kirana Hills, Landsat, Chiniot, mitigations.

Marine pollution Climate Change: Nexus: Study of Harbor and Outfall Lyari River Sindh Pakistan

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Marine pollution remains a critical global concern, with the coastline of Sindh, Pakistan, emerging as a significant pollution hotspot due to inadequate regulatory enforcement. This study investigates the status of marine water quality along the Sindh coastline by analyzing key physicochemical parameters- including temperature, turbidity, total dissolved solids (TDS), salinity, chemical oxygen demand (COD), and biological oxygen demand (BOD) as well as trace metal concentrations (Pb, Cd, Ni, Hg). Water samples were collected at high and low tides from Harbor and outfall of Lyari River from surface and ten feet depth to evaluate spatial pollution gradients. The results revealed pollutant levels exceeding internationally recognized safety thresholds, indicating a high risk to both marine ecosystems and human health. The study further explored the relationship between observed contamination levels and the efficacy of existing environmental regulations, identifying critical gaps in enforcement and policy implementation. Based on these findings, the study highlights the urgent need for regulatory reform, enhanced enforcement mechanisms, and integrated coastal management strategies. Recommendations include strengthened monitoring programs, stakeholder engagement, and public awareness campaigns to promote sustainable practices. The study underscores the importance of

long-term data collection to inform evidence-based policymaking and contribute to national and global efforts in marine conservation and sustainable ocean governance.

Keywords: Marine pollution, Lyari River, sustainable practices, climate change, coastal management.

Studying the Effect of Tannic Acid on the Growth Performance of Wheat under Salt Stress

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Current study was designed to evaluate the effect of tannic acid on the germination and growth performance of *Triticum aestivum* L. (wheat) under salt stress using two application methods: Seed priming and soil mix method and a control series to compare. In the experiment, wheat seeds were primed with 2mM concentration of tannic acid solutions prior to sowing, while in the soil mix method, tannic acid was directly blended into the growth substrate to provide continuous exposure during seedling establishment. The 3mM saline solution was prepared and subjected to the soil. Growth and developmental traits including germination percentage, mean germination time, seedling vigor index, root and shoot length, fresh and dry weight, and biomass partitioning were systematically assessed. Biochemical tests for MDA, APX, Catalase activity, protein and hydrogen peroxide contents were also conducted. Results indicate that application of tannic acid through the soil mix method caused in comparatively moderate changes, with physical and biochemical growth of wheat than in seed priming. Soil salinity mainly affects the growth and germination more in seed priming method than in soil mix method. Soil acidification through tannic acid increased the growth of roots and shoots as well as the germination rate.

Keywords: *Triticum aestivum*, tannic acid, salinity, seed priming, soil mix method, wheat growth.

Comparative Evaluation of Organic Fertilizers for Mitigating Salinity Stress and Enhancing Plant Growth in Saline Soils

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To evaluate the impact of organic fertilizer on plant growth under saline conditions, a research study was conducted at the Botany Department, Nusrat Jahan College, Rabwah. The experiment was designed in a Completely Randomized Design (CRD) with three treatments. In the first phase, pea plants were germinated, after which organic fruit-based fertilizer was applied in one set of pots, while in other set added

inorganic fertilizer, one set was of control. Seedlings were allowed to grow to maturity, after which plants were harvested, and growth parameters including fresh weight, dry weight, and biochemical indicators were analyzed. The comparative assessment revealed that pea plants grown in saline soils supplemented with organic fertilizer exhibited significantly better growth performance than those grown without fertilizer or with inorganic fertilizer. Organic amendments effectively alleviated the adverse effects of salinity by improving soil structure, enhancing nutrient availability, and reducing salt-induced stress. In contrast, the application of inorganic fertilizers in saline soils did not improve crop yield and further contributed to environmental pollution. The findings demonstrate that organic fertilizers serve as an efficient, eco-friendly strategy for mitigating salinity stress and improving plant productivity in salt-affected soils. This study highlights the importance of sustainable agricultural practices to enhance crop resilience, soil health, and overall productivity in saline environments. Moreover, saline areas can be used for crop production.

Keywords: Salinity stress, enhanced plant growth, organic fertilizers, pea plants, reducing soil salinity.

Evaluation of Salinity Eradicating Role of Gallic Acid, a Polyphenol in Wheat Plant- *Triticum Aestivum* through Priming Process

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Despite various efforts being made to reduce salinity in the environment, equal attention must be given to mitigation strategies within agriculture. Strengthening plant tolerance is essential to minimize the harmful effects of salinity and ensure improved crop growth and productivity. Soil salinity is one of the major abiotic stresses negatively affecting seed germination, plant growth, and crop yield worldwide. Developing cost-effective and sustainable methods to enhance plant resilience under salt stress is therefore crucial. Seed priming with natural compounds is emerging as a promising approach for improving stress tolerance in crop plants. The present research was conducted at the Department of Botany, to evaluate the effects of Gallic acid in alleviating salinity stress in wheat seedlings. Seeds were primed for 24 hours in Gallic acid solution, while the control group was primed in distilled water. After priming, Gallic-acid-treated seeds were exposed to salt stress levels of 200 mM, 300 mM, and 500 mM NaCl in treatments S1, S2, and S3 respectively, and their growth performance was observed. Seedlings were harvested 30 days after sowing for biochemical analysis. Biochemical parameters such as MDA content,

APX activity, catalase activity, total protein and hydrogen peroxide concentrations were examined to assess physiological responses under stress. The results demonstrated that gallic acid priming significantly enhanced germination rate, as well as root and shoot growth. The biochemical findings further indicated that Gallic acid acts as a protective antioxidant agent, reducing oxidative damage and mitigating the negative effects of salt stress. Overall, the research suggests that Gallic acid priming improves wheat tolerance to salinity, thereby supporting healthier plant growth and contributing to sustainable cereal production under saline conditions.

Keywords: Salinity mitigation, agriculture, salt stress, wheat plant, Gallic acid, sustainable production.



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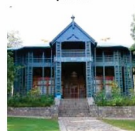
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