



International Conference on
Remote Sensing, GIS and Climate Change
Applications, Strategies, Solutions & Education
13–15 March 2023, Lahore, Pakistan

Abstract Book

Remote Sensing, GIS and Climatic Research Lab (RSGCRL)
National Centre of GIS and Space Applications (NCGSA)
Association of Professionals for Remote Sensing, GIS and Climate Change (ARGC)
Centre for Remote Sensing & Institute of Education and Research (IER)
University of the Punjab, Lahore, Pakistan



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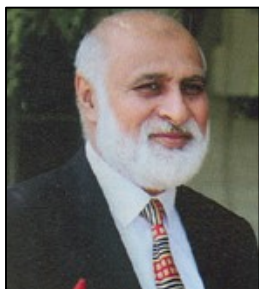
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Acknowledgements

The RSGCC-2023 organizing team would like to thank Prof. Dr. Niaz Ahmad Akhtar (SI) Vice Chancellor University of the Punjab, Prof. Dr. Abdul Qayyum, Director Institute of Education of Research, and staff from ORIC, DSA, IT, RO-I/II, Treasurer Offices for their support.

Disclaimer

Articles published in the abstract book are double blind peer-reviewed and exclusively reflect the opinions and findings of the authors. The authors are responsible for all content in their abstracts including accuracy of the facts, statements, citing resources, etc.



Welcome to RSGCC-2023

On behalf of the organizing committee, I am pleased to present to you Remote Sensing, GIS & Climate Change: *Applications, Strategies, Solutions & Education* (RSGCC-2023) abstract book. The Technical and Review Committee has compiled a good collection of abstracts of oral presentations on a broad range of topics and research areas.

I am very hopeful that this conference will provide a platform towards strengthening our relationships in knowledge sharing while at the same time provide the necessary thrust in joint research & development collaborations and product commercialization within the research society.

I would also like to thank all the presenters, exhibitors, resource persons, and conference partners & sponsors to achieve RSGCC-2023 goals.

Prof. Dr. Niaz Ahmad Akhtar (SI)
Vice Chancellor
University of the Punjab, Lahore, Pakistan



About RSGCC-2023

The International Conference on Remote Sensing, GIS, and Climate Change (RSGCC-2023) is going to be organized by the Remote Sensing, GIS and Climatic Research Lab (RSGCRL), (National Center of GIS and Space Applications, NCGSA) and the Centre for Remote Sensing, University of the Punjab, Lahore (Pakistan) from 13 to 15 March 2023. RSGCRL has been established at University of the Punjab, Lahore as an affiliated National Lab with National Center of GIS and Space Applications (NCGSA) under Government of Pakistan's Public Sector Development Programme (PSDP) sponsored by Higher Education Commission (HEC) of Pakistan. The RSGCRL aims to promote and facilitate education, research activities and collaborations to study and develop GIS and Space Applications with particular emphases on climate change and sustainable development in Pakistan.

The conference will provide registrants a golden opportunity to meet and greet with world-renowned scientists, researchers, and academicians in person to discuss research challenges and solutions, unleash and share new ideas and avenues, and initiate joint projects and collaborations with industry and research institutes working in Remote Sensing, GIS, Climate Change and allied research domains.

I feel privileged to have warm responses from researchers, professionals, students, industries, and private & public sector organizations nationally & internationally.

I wish to express my gratitude to each of our partners & sponsors who have supported us in shaping up this international conference. I wish to also take this opportunity to sincerely thank the RSGCC-2023 Organising and Technical and Review Committee, together with the officials from PU Offices for their tireless efforts in ensuring that our RSGCC-2023 becomes a success.

I very much look forward to sharing this event with you all and hope that you have wonderful experience.

Dr Zia ul Haq
Chief Organizer

1. Partners and Sponsors

1. Partners and Sponsors



University of the Punjab, Lahore



Remote Sensing, GIS and Climatic Research Lab (RSGCRL)



The conference hosted by
Institute of Education and Research (IER)



National Centre of GIS and Space Applications (NCGSA)



Higher Education Commission, Pakistan



Pakistan Space and Upper Atmospheric Research Commission (SUPARCO)



COMSTECH the Ministerial Standing Committee on Scientific and Technological Cooperation of the OIC (Organization of Islamic Cooperation)



Centre for Remote Sensing, University of the Punjab, Lahore



Association of Professionals for Remote Sensing, GIS and Climate Change (ARGC)



I3A Solutions, (Pvt.) Ltd.



Directorate of Students Affairs, University of the Punjab, Lahore





Office of Research Innovation & Communications, University of the Punjab, Lahore

2. Conference Committees

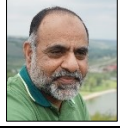



1. Organizing Committee

Patron in Chief	<u>Prof. Dr. Niaz Ahmad Akhtar (SI)</u> Vice Chancellor University of the Punjab	
Chief Organizer	<u>Dr. Zia-ul-Haq</u> Director/Principal Investigator (PI) Remote Sensing, GIS and Climatic Research Lab (RSGCRL) (National Center of GIS and Space Applications, NCGSA) Centre for Remote Sensing, University of the Punjab, Lahore. General Secretary: ARGC (http://association.rsgcrl.pu.edu.pk/)	
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Conference Technical Committee	<u>Dr. Syeda Adila Batool</u> Co-PI and Associate Professor Remote Sensing, GIS and Climatic Research Lab (RSGCRL) (National Center of GIS and Space Applications, NCGSA) Department of Space Science, University of the Punjab, Lahore. Vice President (Climate Change): ARGC (http://association.rsgcrl.pu.edu.pk/)	
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	<p><u>Dr. Salman Tariq</u> Co-PI and Assistant Professor Remote Sensing, GIS and Climatic Research Lab (RSGCRL) (National Center of GIS and Space Applications, NCGSA) Centre for Remote Sensing, University of the Punjab, Lahore. Finance Secretary: ARGC (http://association.rsgcrl.pu.edu.pk/) Guest Editor: <i>Atmosphere</i></p>	
	<p><u>Dr. Syed Muhammad Irteza</u> Senior Remote Sensing Analyst The Urban Unit, Lahore. Information Secretary: ARGC (http://association.rsgcrl.pu.edu.pk/)</p>	
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	<p><u>Dr Elanur Adar Yazar</u>, Associate Professor, Faculty of Health Sciences, Department of Occupational Health and Safety, Artvin Coruh University, Türkiye.</p>
	<p><u>Dr Franz-Josef Behr</u>, Professor of Visualization and Processing of Geospatial Data, University of Applied Sciences Stuttgart, Germany.</p>
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	<u>Dr Imran Shahid</u> , Research Associate Professor, Environmental Science Centre, Qatar University, Qatar.
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3. Conference Themes

1. Climate/Climate Change, Meteorology and the Atmosphere

- Climate change adaptation and mitigation
- Atmospheric and meteorological parameters
- Greenhouse gases, trace gases, emissions and concentrations
- Weather information and forecasting
- Carbon budgets
- El Nino and La Nina effects

2. Geohazards and Disasters

- Floods
- Droughts
- Earthquakes
- Dust Storms
- Cyclones, Tornadoes
- Forest Fires
- Land-Sliding
- Avalanches
- Understanding risks, response, and recovery
- Disaster alert, preparedness, and mitigation
- Natural hazard regulations and policymaking
- Forest fires and environmental impacts

3. Agriculture and Food Security

- Agriculture monitoring
- Crop identification
- Crop area, yield estimation and forecasting
- Food security and early warning
- Plant disease monitoring
- Combating desertification

4. Forest, Biodiversity and Ecosystems

- Forest characterization and biomass estimation
- Monitoring deforestation, degradation, and restoration
- Land cover monitoring
- Land surface dynamics
- Wetlands, Biodiversity conservation
- Wildlife monitoring
- Sustainable development through ecosystem accounting
- Impacts of climate change on ecosystems and forests

5. Water Resources and Water Cycle

- Water Resources (Surface, underground)
- Hydrological studies/applications
- Glaciology, Cryosphere studies
- Oceanography, Bathymetry
- Wetlands monitoring
- Water resource management
- Water quality and invasive species in water bodies
- Water scarcity and security in major river systems
- Water bodies as a sustainable resource for fishery, tourism and transportation
- Soil moisture, soil erosion, corrosion
- Understanding the water cycle and the major impacting factors
- Desertification and droughts

6. Marine and Coastal Environment Resources and Dynamics

- Understanding and monitoring marine and coastal environments and resources
- Healthy Coastal Economy
- Operational monitoring of Illegal, Unreported, Unregulated (IUU) fishing
- Offshore operations and marine pollution
- Ship traffic
- Ocean state and dynamics
- Marine forests
- Marine ecosystems
- Marine landuse/landcover change assessment

7. Urbanization, Sustainable/Smart Societies and Industrialization

- Urban planning (town, city, and regional planning)
- Urban heat island
- Urban sprawl and its impacts
- Industrialization and impacts
- Infrastructure and transportation
- Infrastructure planning
- Smart cities
- 3D Building Information Management Systems
- Sustainable development goal indicators
- Socio-economic development
- Smart cities
- Improving Connectivity
- Archaeology and Culture heritage

8. Public Health

- Monitoring infectious disease outbreaks
- Vector-borne diseases
- Water-related diseases
- Air quality and health
- Smog and its impacts
- Impact of extreme weather conditions
- Geospatial data for developing resilient and sustainable public health systems
- Heatwaves and impacts
- Monitoring and tracking of heatwaves

9. Change and Adaptation in Deltaic and High Mountain Systems

- Impact of climate change on food and feed, Impact on water scarcity, natural hazards regulation
- How climate change affects spirituality and cultural identity, aesthetics, and recreation
- Building technical capacity to analyze, visualize, interpret, and integrate data from observations into services
- Use of optical data from one or multi-channel spectral imagers or RGB cameras, image processing, computer vision, and machine learning; also interested in medical and bio-medical image problems, underwater species especially in Coral reefs and other endangered areas
- Permafrost hydrology
- Paleo-permafrost features and their climatic relevance

10. Geological studies, mineral resources and applications

- Structural Geology and Tectonics
- Sedimentology and Stratigraphy
- Geomorphology
- Geological Engineering
- Mineralogy
- Petrology & Volcanology
- Seismology

11. Data and Information Systems and Spatial Data Infrastructures

- Remote Sensing and Photogrammetry [Sensors (optical, microwave, thermal, hyperspectral, LIDAR), and their applications]
- Digital Earth, current & future Earth observation missions & programmes, observation data, data products & models
- Multi-sensor data processing techniques, interoperability, and analytics
- GIS and its applications
- Android, Desktop, and Online geospatial applications
- Standards, interfaces, and systems for spatial data
- Big data challenges and solutions
- Real-time operational systems

12. Educating on Climate Change and Sustainable Development

- Climate change education for sustainable development

13. Capacity building, networking, resource sharing

- Capacity building, education, and outreach
- Sharing of geospatial resources (data, software, labs, computing machines, human resources)
- Networking, collaboration, and its importance
- Open source and software/algorithms/models, data, services, etc.

14. Other related fields

- Other field(s) relevant to the field of Remote Sensing, GIS and Climate Change.

4. List of Accepted Abstracts for Oral Presentations

(According to Conference Themes)

1. Climate/Climate Change, Meteorology and the Atmosphere

S.No	Author Name & Affiliations	Abstract Title
1.	*Derk Bakker, Zonia Prem Benjamin <i>Department of Environmental Sciences, Forman Christian College (A Chartered University), Lahore</i>	ASSESSMENT OF THE EFFECT OF LAND-USE ON WEATHER IN AN ARID REGION USING REMOTE SENSING
2.	*Yılmaz YILDIRIM <i>Department of Environmental Engineering, Zonguldak Bülent Ecevit University, Türkiye</i>	ENVIRONMENTAL POLLUTIONS AND REMOTE SENSING STUDIES AT ZONGULDAK REGION
3.	*Muhammad Fahim Khokhar ^{1,2} ¹ <i>Institute of Environmental Sciences and Engineering (IESE),</i> ² <i>National University of Sciences and Technology (NUST) Islamabad, Pakistan</i>	ROLE AND CHALLENGES OF LOW-COST SENSORS IN AIR POLLUTION MONITORING
4.	*Rashid Mahmood <i>Climate Variability and Change, Barcelona Supercomputing Center, Barcelona, Spain.</i>	CONSTRAINING VARIABILITY IN LARGE ENSEMBLES OF CLIMATE MODEL SIMULATIONS TO PROVIDE SKILLFUL PREDICTIONS AND ATTRIBUTE PREDICTABILITY ON MULTI-DECADAL TIMESCALES
5.	*Imran Shahid ¹ , Muhammad Imran Shahzad ² ¹ <i>Environmental Science Centre, Qatar University PO BOX 2713, Doha Qatar</i> ² <i>Earth & Atmospheric Remote Sensing Lab (EARL), COMSATS University, Islamabad, Pakistan</i>	SEASONAL VARIABILITY OF PARTICULATE BLACK CARBON AND IMPACT OF PLANETARY BOUNDARY LAYER IN HAZE SMOG FORMATION OVER LAHORE PAKISTAN
6.	Muhammad Shahid ¹ , Shoaib Salim ² , Usman Ali ¹ , *Muhammad Waseem ³ ¹ <i>Department of Civil Engineering, University of Engineering and Technology, Lahore 54890, Pakistan</i> ² <i>National University of Sciences and Technology (NUST) H-12, Islamabad, Pakistan</i> ³ <i>Center of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore 54890, Pakistan</i>	APPLICATION OF REMOTE SENSING TO IDENTIFY CLIMATE AND LAND USE CHANGE IMPACTS ON SURFACE RUNOFF IN THE HARO RIVER BASIN
7.	*Shazia Pervaiz ¹ , Safdar Ali Shirazi ² ¹ <i>Environmental Protection Agency, Lahore, Punjab, Pakistan</i> ² <i>Department of Geography, University of the Punjab, Lahore, Pakistan</i>	GREENHOUSE GAS EMISSIONS AND AEROSOL DISTRIBUTION IN THE BRICK KILN ZONES: AN APPRAISAL USING SPATIAL INFORMATION TECHNOLOGY
8.	*Hasan Nawaz ^{1,3} , Fazzal Qayyum ^{2,3} , Ayesha Azhar ³ ¹ <i>Centre for Atmospheric Chemistry, University of Wollongong, NSW, 2522, Australia</i> ² <i>Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, 999077, China.</i> ³ <i>Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore</i>	REMOTE SENSING OF ABSORBING AND SCATTERING AEROSOLS OVER PAKISTAN
9.	*Khadija Shakrullah ¹ , Salman Tariq ² , Safdar Ali Shirazi ³ ¹ <i>Forman Christian College (A Chartered University), Lahore</i> ² <i>Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore</i> ³ <i>Institute of Geography, University of the Punjab, Lahore</i>	INVESTIGATING THE RELATIONSHIP OF SOIL MOISTURE CONTENT, PRECIPITATION AND AEROSOLS WITH ENHANCED VEGETATION INDEX IN PAKISTAN
10.	*Sundas Liaquat ¹ , Khalid Mahmood ^{1,2} , Ejaz Hussain ³ ¹ <i>Institute of Geographical Information System, National University of Sciences and Technology, Islamabad</i> ² <i>Department of Space Science, University of the Punjab, Lahore</i> ³ <i>Institute of Geographical Information System, National University of Sciences and Technology, Islamabad</i>	ROLE OF LAND USE/LAND COVER AS DETERMINANT OF LOCAL THERMAL PRINT USING GOOGLE EARTH ENGINE
11.	*Muhammad Khan ¹ , Salman Tariq ² , Zia Ul Haq ²	VARIATIONS IN THE AEROSOL INDEX AND ITS RELATIONSHIP WITH METEOROLOGICAL PARAMETERS OVER PAKISTAN USING REMOTE SENSING

	¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), Centre for Remote Sensing, Department of Space Science, University of the Punjab, Lahore ² Remote Sensing, GIS and Climatic Research Lab (NCGSA), Centre for Remote Sensing, Department of Space Science, University of the Punjab, Lahore	
12.	*Ayesha Azhar ¹ , Salman Tariq ² ¹ Remote Sensing, GIS and Climatic Research Lab (RSGCRL), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore	VALIDATION AND ASSESSMENT OF PRECIPITATION FROM TROPICAL RAINFALL MEASURING MISSION AND GROUND-BASED DATA OVER PAKISTAN
13.	*Ayesha Mariam ¹ , Salman Tariq ^{1,2} ¹ Remote Sensing, GIS and Climatic Research Lab (National Center of GIS and Space Applications), Centre for Remote Sensing, University of the Punjab, Lahore, Pakistan ² Remote Sensing, GIS and Climatic Research Lab (National Center of GIS and Space Applications), Department of Space Science, University of the Punjab, Lahore, Pakistan	USING SATELLITE REMOTE SENSING TO UNCOVER THE SPATIOTEMPORAL VARIATIONS IN METHANE EMISSIONS IN LAHORE PAKISTAN
14.	*Kanwal Javid ¹ , Shazia Pervaiz ² , Filza Zafar Khan ³ , Maria Mumtaz ⁴ ¹ Department of Geography, Government College University, Lahore, Punjab, Pakistan ² Environmental Protection Agency, Lahore, Punjab, Pakistan ³ Pakistan Council of Scientific and Industrial Research, Lahore, Punjab, Pakistan ⁴ Higher Education Department Punjab Pakistan	DISTRIBUTION OF PARTICULATE MATTER IN SMOG PRONE CITY: AN ANALYSIS USING SENTINEL-5P DATA
15.	*Hafsa Shahzad ¹ , Salman Tariq ^{1,2,3} ¹ Remote Sensing, GIS and Climatic Research Lab (RSGCRL), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore ³ Department of Space Science, University of the Punjab, Lahore	LINEAR AND WAVELET ANALYSIS OF CARBON MONOXIDE (CO) OVER PAKISTAN DURING 2019-2022 USING REMOTE SENSING
16.	*Haleema Azeem ^{1,3} , Salman Tariq ^{1,2,3} ¹ Remote Sensing, GIS and Climatic Research Lab (RSGCRL), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore ³ Department of Space Science, University of the Punjab, Lahore	TIME AVERAGED AND SEASONAL ANALYSIS OF NDVI OVER PAKISTAN DURING 2005 TO 2022 USING REMOTE SENSING
17.	*Shafqat Ali ¹ , Hasan Nawaz ^{1,2} ¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ² University of Wollongong, Australia	PROJECTIONS OF TEMPERATURE, EVAPORATION, AND PRECIPITATION IN PAKISTAN UNDER A CHANGING CLIMATE: IMPLICATIONS FOR WATER RESOURCES MANAGEMENT AND FOOD SECURITY
18.	*Muhammad Raees Ahmad ¹ , Salman Tariq ² ¹ Department of Space Science, University of the Punjab, Lahore ² Remote Sensing, GIS and Climate Research Lab (NCGSA), University of the Punjab, Lahore	NO2 OVER PAKISTAN DURING 2018 TO 2023 USING TROPOMI
19.	*Akif Rahim, Hafiz Muhammad Tayyab Bhatti, Hafiz Hassan Tariq, Bilal Ahmed Munir, Raja Rehan Flood Risk Assessment Unit, Irrigation Department, Lahore	LEVERAGING OF DATA-DRIVEN MODELS AND REMOTE SENSING FOR TRANSBOUNDARY RESERVOIR OPERATION
20.	*Muhammad Adnan ¹ , Waqas A Qazi ^{1,2} , Hammad Gillani ^{1,3} ¹ Department of Space Science, Institute of Space Technology, Islamabad ² Offshore Monitoring Limited Islamabad, Pakistan ³ International Water Management Institute (IWMI) Lahore, Pakistan	SEA LEVEL VARIATIONS AND GEOMORPHOLOGICAL CHANGES IN MAKRAN COASTAL BELT AND INDUS DELTAIC REGION
21.	*Shoaib Shafique, Arifa Lodhi Space Applications Research Center, Space and Upper Atmosphere Research Commission (SUPARCO), Lahore	SIMULATION OF HYPERSPECTRAL INFRARED AND MICROWAVE RADIANCES FOR RETRIEVAL OF ATMOSPHERIC PROFILES IN CLEAR-SKY AND CLOUDY CONDITIONS

22.	*Abdullah Bin Zafar ¹ , Salman Tariq ^{1,2} , ¹ Department of Space Science, University of the Punjab, ² Centre for Remote Sensing, University of the Punjab, Lahore	THE SPATIAL AND TEMPORAL VARIATIONS IN DUST MASS SURFACE CONCENTRATION OF PM _{2.5} IN PAKISTAN USING REMOTE SENSING
23.	*Liaqat Ali Waseem, Muhammad Muddassar Department of Geography, Government College University Faisalabad, Faisalabad 38000, Pakistan.	IMPACT OF DEFORESTATION ON CLIMATE CHANGE: THE CASE STUDY OF MURREE HILLS
24.	*Muhammad Zeeshan ¹ , Sayed Muhammad Sohail Gilani ¹ , Salman Tariq ² and Hasan Nawaz ² ¹ Department of Physics, University of Okara, Okara, Pakistan ² Remote Sensing, GIS and Climate Research Lab (National Center of GIS and Space Applications), Centre for Remote Sensing, University of the Punjab, Lahore, Pakistan	A STUDY ON AEROSOLS DISTRIBUTION OVER KARACHI USING AERONET
25.	*Muhammad Umar Aslam ^{1, 2} ¹ Remote Sensing, GIS and Climatic Research Lab (RSGCRL), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore	INTEGRATING REMOTE SENSING AND SOCIO-ECONOMIC DATA SETS FOR A COMPREHENSIVE ANALYSIS OF AIR POLLUTION RISK IN SOUTH ASIA.
26.	*Fatima Imran ¹ , Sana Akhtar ¹ , Asim Duad Rana ² , Syed M. Irteza ² ¹ Kinnaird College for Women Lahore. ² Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore Centre for Remote Sensing, University of the Punjab, Lahore	GEOSPATIAL ASSESSMENT OF SMOG PATTERNS AND ITS RELEVANT ECONOMIC VALUATION IN PUNJAB
27.	*Muhammad Adeel, Muhammad Usman, Sawaid Abbas Smart Sensing for Climate and Development, Center for Geographical Information System, University of the Punjab, Lahore	A SPATIO-TEMPORAL ANALYSIS OF TRENDS IN SNOW COVER IN THE CHITRAL BASIN
28.	*Atifa Nadeem, Salman Tariq Remote Sensing, GIS and Climatic Research Lab (National Center of GIS and Space Applications), Centre for Remote Sensing, University of the Punjab, Lahore, Pakistan	SEASONAL AND TIME-AVERAGED ANALYSIS OF TOTAL COLUMN OZONE (TCO) OVER PAKISTAN FROM 1989 TO 2022 USING REMOTE SENSING
29.	*Filza Zafar Khan ¹ , Shazia Pervaiz ² , Kanwal Javid ³ ¹ Pakistan Council of Scientific and Industrial Research, Lahore, Punjab, Pakistan ² Environmental Protection Agency, Lahore, Punjab, Pakistan ³ Department of Geography, Government College University, Lahore, Punjab, Pakistan	INTERVENTION OF CRITERIA AIR POLLUTANTS IN URBAN AIR: A MULTI-SECTORAL GUIDE TO COMBAT ENVIRONMENTAL SMOG
30.	*Nabiha Khan ¹ , Salman Tariq ² ¹ Department of Space Science, University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore	SPATIOTEMPORAL VARIATIONS IN TOTAL SURFACE MASS CONCENTRATION OF PM _{2.5} IN PAKISTAN USING REMOTE SENSING
31.	*Rabia Majeed ¹ , Naveed Ahmad ² , Muhammad Fahim Khokhar ¹ ¹ Institute of Environmental Science and Engineering, National University of Science and Technology, Islamabad-44000, Pakistan ² Division of Environment and Sustainability, Hong Kong University of Science and Technology, Hong Kong	SEASONAL AND WEEKLY NO ₂ LEVELS AND RIGOROUS VALIDATION OF SATELLITE NO ₂ VALUES WITH VARIOUS GROUND-BASED INSTRUMENTS IN ISLAMABAD, PAKISTAN
32.	*Rimsha Arshad, Salman Tariq, Zia ul Haq Remote Sensing, GIS and Climatic Research Lab (National Center of GIS and Space Applications), Centre for Remote Sensing, University of the Punjab, Lahore, Pakistan	A STUDY OF OPTICAL AND PHYSICAL PROPERTIES OF DUST AEROSOLS OVER PAKISTAN USING REMOTE SENSING
33.	*Muhammad Abid ¹ , Ijaz Hussain ¹ , Zia ul Haq ² , Munawar Iqbal ³ ¹ Department of Statistics, Quaid-i-Azam University, Islamabad, Pakistan	MODELLING THE EFFECT OF METEOROLOGICAL PARAMETERS ON TROPOSPHERIC CONCENTRATIONS IN PAKISTAN

	² Remote Sensing, GIS and Climatic Research Lab (RSGCRL), National Centre of GIS and Space Applications (NCGSA), Centre for Remote Sensing, University of the Punjab, Lahore, Pakistan ³ College of Statistical Sciences, University of the Punjab, Lahore, Pakistan	
34.	*Horeb ¹ , Salman Tariq ² ¹ Department of Space Science, University of the Punjab, Lahore ² Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore.	EVALUATION OF BLACK CARBON COLUMN MASS DENSITY IN PAKISTAN BASED ON MERRA-2 MODEL
35.	*Farwa Abdul Qadir ¹ , Salman Tariq ^{2, 3} , Sana Akhtar ¹ ¹ Kinnaird College for Women, University Punjab, Lahore ² Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ³ Department of Space Science, University of the Punjab, Lahore	TRANSBOUNDARY GEOSPATIAL ANALYSIS OF PARTICULATE MATTER (PM _{2.5}) OVER PAKISTANI AND INDIAN, PUNJAB
36.	*Fizza Nadeem ¹ , Salman Tariq ^{2, 3} , Sana Akhtar ¹ ¹ Kinnaird College for Women, University Punjab, Lahore ² Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ³ Department of Space Science, University of the Punjab, Lahore	GEOSPATIAL ANALYSIS OF VARIATION IN TEMPERATURE AND TREND ANALYSIS OF PUNJAB, PAKISTAN
37.	Uğur ÖNCEL ¹ , *Yılmaz YILDIRIM ² , Yaşar NUHOĞLU ³ , Sadullah YILDIRIM ⁴ ¹ Chemical Engineering, Graduate School of Natural and Applied Sciences, Osmangazi University, Türkiye ² Environmental Engineering, Engineering Faculty, Zonguldak Bülent Ecevit University, Türkiye ³ Environmental Engineering, Faculty of Civil Engineering, Yıldız Technical University, Türkiye ⁴ ISKI General Directorate, Planning and Investment Department, Istanbul, Türkiye	INVESTIGATION OF INDOOR AIR POLLUTION CAUSED BY PAINTS USED FOR INTERIOR PAINTING IN A BUILDING IN ISTANBUL.

2. Geohazards and Disasters

S.No	Author Name & Affiliations	Abstract Title
38.	*Asma Majeed ¹ , Syeda Aadila Batool ² , Awais Munir ¹ , Noreena Khan ³ , Farheen Nazli ¹ ¹ Institute of Agro-Industry & Environment, Faculty of Agriculture and Environment, The Islamia University of Bahawalpur, Pakistan. Email: asma.majeed@iub.edu.pk ² Remote Sensing, GIS and Climate Change Research Lab (National Center of GIS and Space Applications), Department of Space Sciences, University of the Punjab. ³ Bahawalpur Waste Management Company (BWMC), Bahawalpur	EVALUATION OF SOLID WASTE DISPOSAL STRATEGY FROM A CLIMATE CHANGE PERSPECTIVE USING MODELLING APPROACH.
39.	Muhammad Shehzad Ashraf ^{1, 2} , Muhammad Waseem ¹ , Saad Zaheer ¹ , Ayub Shah ¹ , *Muhammad Shahid ³ ¹ Center of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore 54890, Pakistan ² Department of Civil Engineering University of Central Punjab ³ Department of Civil Engineering, University of Engineering and Technology, Lahore 54890, Pakistan	INVESTIGATION OF VARIABILITY IN HYDROLOGICAL DROUGHTS OVER UPPER INDUS RIVER BASIN
40.	*Muhammad Safdar ^{1, 2} , M. Adnan Shahid ^{1, 2} , Muhammad Zaman ¹ , Fahd Rasul ³ , M. Danish Majeed ^{1, 2} , Rehan	EFFECTS OF DROUGHT ON AGRICULTURE PRODUCTION IN PAKISTAN

	Mehmood Sabir ^{1,2} , Hafsa Muzammal ^{1,2} , Aamir Raza ¹ <i>1Department of Irrigation & Drainage, University of Agriculture, Faisalabad, 38000, Punjab,</i> <i>2 Agricultural Remote Sensing Lab of National Center of GIS and Space Applications (NCGSA-ARSL), University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i> <i>3Department of Agronomy, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i>	
41.	Dr. Muhammad Farooq <i>Space Application Center for Response in Emergency and Disasters, SUPARCO, Islamabad</i>	DISASTER RISK ASSESSMENT OF PAKISTAN – AN OVERVIEW OF NATCAT MODEL PROJECT
42.	Sana Zahid Shah <i>World Food Program, Islamabad</i>	PAKISTAN INTEGRATED CONTEXT ANALYSIS (ICA) ON FOOD INSECURITY AND NATURAL HAZARDS
43.	*Letwin Pondo <i>Surveying and Geomatics, Midlands State University, Zimbabwe,</i>	FLOOD ANALYSIS THROUGH REMOTE SENSING FOR LOKOJA, NIGERIA
44.	Maryam Khalil, *Syed Umair Shahid <i>Centre for Integrated Mountain Research, University of the Punjab, Lahore</i>	FLOOD INUNDATION MAPPING AND RISK ZONATION OF KUNHAR RIVER BASIN, PAKISTAN USING HEC-GEORAS MODEL
45.	Awais Munir ¹ , *Asma Majeed ¹ , Muhammad Hussain ² , Muhammad Bachal Alias Sahib Khan ¹ , Syeda Aadila Batool ³ <i>¹Institute of Agro-Industry and Environment, Faculty of Agriculture and Environment, The Islamia University of Bahawalpur, Pakistan</i> <i>²Department of Geography, Faculty of Physical & Mathematical Sciences, The Islamia University of Bahawalpur, Pakistan</i> <i>³Remote Sensing, GIS and Climate Change Research Lab (National Center of GIS and Space Applications), Department of Space Sciences, University of the Punjab.</i>	FLOOD SUSCEPTIBILITY ASSESSMENT USING FREQUENCY RATIO MODEL: A CASE STUDY OF DISTRICT GHOTKI AND KASHMIRE
46.	Salman Ashraf ¹ , Brenda Rosser ² , Chris Massey ² , and Biljana Lukovic ¹ <i>¹Geospatial Data and Analysis Team, Data Science and Geohazards Monitoring, GNS Science, NZ</i> <i>²Engineering Geology Team, Surface Geosciences, GNS Science, New Zealand</i>	THE SIGNIFICANCE OF LANDSLIDE MAPPING AND FORECASTING IN MITIGATING NATURAL DISASTERS – A NEW ZEALAND PERSPECTIVE

3. Agriculture, Food Security, Forest, Biodiversity and Ecosystems

S.No	Author Name & Affiliations	Abstract Title
47.	*Muhammad Danish Majeed ^{1,2} , Muhammad Adnan Shahid ^{1,2} , Muhammad Zaman ² , Muhammad Tasawar ² , Muhammad Safdar ^{1,2} , Fahd Rasul ³ , Hifza Maryam ^{1,3} , Hafsa Muzammil ^{1,2} <i>¹Agricultural Remote Sensing Lab (ARSL)-NCGSA, University of Agriculture, Faisalabad, Punjab, Pakistan</i> <i>²Department of Irrigation & Drainage, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i> <i>³Department of Agronomy, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i>	HARNESSING THE POWER OF REMOTE SENSING AND MACHINE LEARNING FOR AGRICULTURAL RESOURCES MANAGEMENT IN PAKISTAN
48.	*Rumana Siddiqui, Safdar Ali Shirazi <i>Institute of Geography, University of the Punjab, Lahore, Pakistan</i>	THE EFFECTS OF CLIMATE ON HUMAN FERTILITY AND FOOD SECURITY IN PUNJAB, PAKISTAN
49.	*Ehsan Inam Ullah ¹ , Muhammad Fahim Khokhar ¹ , Shakil Ahmad ² , Umer Khayyam ³ <i>¹Institute of Environmental Sciences and Engineering (IESE), School of Civil and Environmental Engineering (SCEE), National University of Sciences and Technology (NUST), Islamabad, Pakistan.</i>	IMPACT OF GHAZI BAROTHA HYDROPOWER PROJECT ON LAND USE/ LAND COVER ALONG INDUS RIVER

	<p>²NUST Institute of Civil Engineering (NICE), School of Civil and Environmental Engineering (SCEE), National University of Sciences and Technology (NUST), Islamabad, Pakistan.</p> <p>³Department of Development Studies, School of Social Sciences and Humanities (S3H), National University of Sciences and Technology (NUST), Islamabad, Pakistan.</p>	
50.	<p>*Umar Javaid¹, Sajid Rashid Ahmad¹, Sawaid Abbas², Muhammad Usman²</p> <p>¹College of Earth and Environmental Sciences, University of the Punjab, Lahore, Pakistan.</p> <p>²Center for Geographic Information System, University of the Punjab, Lahore, Pakistan.</p>	NATURE-BASED SOLUTIONS TO ENSURE FOOD SECURITY IN THE EASTERN FOOTHILLS OF THE KIRTHAR MOUNTAIN RANGE
51.	<p>*Muhammad Iqbal</p> <p>Pakistan Space & Upper Atmosphere Research Commission Islamabad</p>	GEOSPATIAL AGRICULTURE MONITORING FOR SUSTAINABLE FOOD SECURITY IN PAKISTAN
52.	<p>*Ibrar ul Hassan Akhtar</p> <p>Space Applications and Research Wing, Pakistan Space and Upper Atmospheric Research Commission, Islamabad, 44000, Pakistan</p>	GEOSPATIAL ASSESSMENT OF FOREST COVER STATUS UNDER CHANGING CLIMATE IN KHYBER PAKHTUNKHWA DURING 2007-2018
53.	<p>*Muhammad Nabeel Khan^{1,3}, Dr Salman Tariq^{1,2}</p> <p>¹Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore</p> <p>²Centre for Remote Sensing, University of the Punjab, Lahore</p> <p>³Department of Chemistry, University of Lahore, Lahore</p>	PLDR BASED AEROSOL CLASSIFICATION OVER LAHORE CITY USING INVERSION PRODUCTS FROM VERSION 3 OF AERONET
54.	<p>*Fiza Hafeez¹, Asim Daud Rana^{1,2}, Iqra Shakeel¹, Muhammad Abdullah¹, Shahid Parvez^{1,2}, Syed Muhammad Irteza³, Sawaid Abbas⁴</p> <p>¹Remote Sensing, GIS and Climatic Research Lab National Center of GIS and Space Applications, Centre for Remote Sensing, University of the Punjab, Lahore, Pakistan</p> <p>²Department of Space Science, University of the Punjab, Lahore, Pakistan</p> <p>³The Urban Unit, Lahore</p> <p>⁴Center for GIS, Punjab University College of Information Technology (PUCIT)</p>	INDICES-BASED MAPPING OF TERRESTRIAL VEGETATIVE LANDCOVER OF KPK
55.	<p>*Prof. Nazeer Ahmed</p> <p>Faculty of Life Sciences and Informatics, Balochistan University of IT, Engineering and Management Sciences, Quetta.</p>	DNA BASED BIODIVERSITY INVENTORIES: A WAY FORWARD FOR PAKISTAN
56.	<p>Sumayya Mumtaz, Maryam Khalil, *Syed Umair Shahid</p> <p>Centre for Integrated Mountain Research, University of the Punjab, Lahore</p>	HABITAT SUITABILITY ANALYSIS FOR ENDANGERED HIMALAYAN MUSK DEER IN THE DEOSAI NATIONAL PARK, PAKISTAN
57.	<p>*Muhammad Safdar^{1,2}, M. Adnan Shahid^{1,2}, Sikandar Ali¹, Fahd Rasul³, M. Danish Majeed^{1,2}, Rehan Mehmood Sabir^{1,2}, Hafsa Muzammal^{1,2}, Aamir Raza¹</p> <p>¹Department of Irrigation & Drainage, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</p> <p>²Agricultural Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</p> <p>³Department of Agronomy, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</p>	SYNTHETIC APERTURE RADAR (SAR) REMOTE SENSING APPLICATIONS IN AGRICULTURE
58.	<p>*Muhammad Safdar^{1,2}, Muhammad Adnan Shahid^{1,2}, Abid Sarwar¹, Fahd Rasul³, Muhammad Danish Majeed^{1,2}, Hifza Marium^{2,3}, Aamir Raza¹</p> <p>¹Department of Irrigation & Drainage, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</p> <p>²Agricultural Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</p> <p>³Department of Agronomy, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</p>	CROP MODELING USING REMOTE SENSING TECHNIQUES

4. Water Resources and Water Cycle

S.No	Author Name & Affiliations	Abstract Title
59.	Iqra Basit ¹ , Ayesha Nadeem ² , *Zoha Mahmood ^{2,3} , Khalid Mahmood ² ¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ² Department of Space Science, University of the Punjab, Lahore ³ The Urban Sector Planning & Management Services Unit (Urban Unit), Lahore	SPATIO-TEMPORAL ASSESSMENT OF REMOTE SENSING BASED GROUNDWATER STORAGE VARIATION FOR PAKISTAN
60.	*Fatima Tahir ^{1,3} , Khalid Mehmood ² , Shan-e-Batool ¹ , Iqra Basit ³ ¹ Department of Chemistry, University of Lahore, Lahore, Pakistan. ² Department of Space Science, University of the Punjab, Lahore, Pakistan. ³ Remote Sensing, GIS, and Climatic Research Lab (NCGSA), University of the Punjab, Lahore	SPATIO-CHEMICAL ASSESSMENT OF GROUNDWATER CONTAMINATION BY LANDFILL LEACHATE USING INVERTED WATERSHED ANALYSIS
61.	*Shoaib Ali School of Water Conservancy & Civil Engineering, Northeast Agricultural University, Harbin 150030, China	CHARACTERIZING THE VARIATIONS IN GROUNDWATER STORAGE AT LOCAL SCALE USING DOWNSCALED GRACE/GRACE-FO DATA BASED ON A MACHINE LEARNING
62.	*Syed Waqar Hussain Shah, Mujtaba Hussan, Muhammad Zeeshan Ghani Department of Space Science, Institute of Space and Technology, Islamabad	GROUNDWATER POTENTIAL ZONES IN GWADAR USING REMOTE SENSING TECHNIQUES
63.	*Muhammad Tasawar ¹ , Muhammad Zaman ¹ , Muhammad Adnan Shahid ^{1,2} , Muhammad Danish Majeed ^{1,2} , Muhammad Safdar ^{1,2} , Aamir Raza ¹ ¹ Department of Irrigation & Drainage, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan ² Agricultural Remote Sensing Lab (ARSL)-NCGSA, University of Agriculture, Faisalabad, Punjab, Pakistan	LEVERAGING AI AND REMOTE SENSING FOR IMPROVED WATER RESOURCES MANAGEMENT
64.	*Saba Arif, Khalid Mahmood Department of Space Science, University of the Punjab, Lahore	STOCHASTIC COMPARISON OF TRADITIONAL WATER INDEXES FOR SPATIAL MONITORING OF GROUNDWATER
65.	*Nadia Jabeen ¹ , Fiza Javed ² , Shahid Parvez ^{3,4} ¹ Geospatial Research and Education lab (GREL), Department of Space Science, Institute of Space Technology, Islamabad ² Space and Astrophysics Research lab (SARL), Institute of Space Technology, Islamabad ³ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ⁴ Department of Space Science, University of the Punjab, Lahore	ANALYSING SNOW-COVER CHARACTERISTICS OF SIACHEN GLACIER USING RS&GIS TECHNIQUES
66.	*Usfa Asif ¹ , Aqsa Munir Ahmad ¹ , Muhammad Asif Javed ¹ , Sajid Rashid Ahmad ¹ College of Earth And Environmental Sciences, University Of The Punjab, Lahore, Pakistan	QUALITATIVE AND QUANTITATIVE ANALYSIS OF GROUND WATER FOR IRRIGATION PURPOSES BY USING GIS TECHNIQUES IN OKARA, SAHIWAL AND KHANEWAL DISTRICTS, LAHORE, PAKISTAN
67.	Khalid Mahmood ¹ , *Muhammad Qasim ² , Zia Mehmood ³ ¹ Department of Space Science, University of the Punjab, Lahore 54590, Pakistan ² Army Land Management Cell (ALMC), Quartering & Lands Coord, Quarter Master General (QMG) Branch, General Headquarters (GHQ), Rawalpindi, Pakistan	POTENTIAL SITES SELECTION FOR RAINWATER HARVESTING IN KOTLI, AJK, PAKISTAN

	³ Department of Forest, Project Management Unit (PMU), Ten Billion Tree Tsunami Program (TBTP), Azad Jammu & Kashmir (AJK) Unit, Pakistan	
68.	*Syed Ali Asad Naqvi, Saba Jilani Department of Geography, Government College University Faisalabad, Faisalabad 38000, Pakistan.	EVALUATING THE CHANGING RAMSAR WETLANDS IN PAKISTAN THROUGH GEOSPATIAL TECHNIQUES.
69.	*Sara Sheshangosht, Neamat Karimi, Reza Roozbehani Water Resource Department, Water Research Institute, Ministry of Energy, Tehran, Iran	INNOVATIONS IN SURFACE WATER MONITORING USING SATELLITE IMAGES, DRONES, AND ONLINE TOOLKITS
70.	*Muhammad Shahid Iqbal International Water Management Institute (IWMI) Lahore, Pakistan	UNCERTAINTIES IN HYDRO-CLIMATIC MODELING UNDER CHANGING CLIMATE
71.	*Aneeqa Arshad ¹ , Khalid Mehmood ² , Fareena Noor Malhi ³ , Iqra Basit ³ ¹ School of Economics, University of the Punjab, Lahore ² Department of Space Science, University of the Punjab, Lahore ³ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore	GEOSPATIAL BUDGETING FOR DRINKING WATER SUPPLY IN LAHORE RESIDENTIAL REGION: COST EFFECTIVE ALTERNATIVES

5. Marine and Coastal Environment Resources and Dynamics

S.No	Author Name & Affiliations	Abstract Title
72.	Syed Jamil H. Kazmi ¹ , *Maryam Khan ² , Rizwan Akhter ² , Tahreem Zafar ² , Ibrahim Zia ² , ¹ Department of Geography, University of Karachi ² National Institute of Oceanography, Pakistan	A COMPARATIVE ASSESSMENT OF SUSPENDED SEDIMENT CONCENTRATION IN INDUS DELTA REGION USING LANDSAT 8 AND SENTINEL 2

6. Urbanization, Sustainable/Smart Societies and Industrialization

S.No	Author Name & Affiliations	Abstract Title
73.	*Muhammad Sanan ² , Shahid Parvez ^{1,2} , Irfan Ashraf ² , Saad Rafiq ² ¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ² Department of Space Science, University of the Punjab, Lahore	ASSESSING POTENTIAL OF LIDAR DATA FOR 3D MODELLING
74.	*Syeda Yuman Fatima ¹ , Khalid Mehmood ^{1,2} , Iqra Basit ² , Fiza Faizi ² ¹ Department of Space Science, University of the Punjab ² Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore	SATELLITE BASED THERMAL PROFILING OF GROWING CITIES IN RELATION TO LAND TRANSFORMATION
75.	*Aiman Riaz ³ , Almas Hamid ³ , Asim Daud ^{1,2} , Syed Muhammad Irteza ^{1,2} ¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore ³ Kinnaird College for Women University, Lahore.	A SPATIOTEMPORAL ANALYSIS OF LAND USE AND LAND COVER IN PUNJAB, PAKISTAN.
76.	*Muhammad Zeeshan Ghani, Mujtaba Hussain, Syed Waqar Hussain Shah Department of Space Science, Institute of Space and Technology, Islamabad	URBAN DAMAGE DETECTION USING SENTINEL-1 DATA IN TURKEY AND SYRIA EARTHQUAKES

7. Public Health

S.No	Author Name & Affiliations	Abstract Title
77.	*Rizwan Shahid Alberta Health Services Department of Geography, University of Calgary O'Brien Institute for Public Health	LOCATION MATTERS: A SPATIAL TURN IN APPLIED HEALTH RESEARCH
78.	*Silvia Machado ^{1,3} , Shazia Ilyas ¹ , Joaquim Alonso ² , Rui Pedro Julião ³ Department of Environmental Sciences, Forman Christian College (A Chartered University), Pakistan ² College of Agriculture, Polytechnic Institute of Viana do Castelo, Portugal ³ School of Social Sciences and Humanities, NOVA University of Lisbon, Portugal.	SPATIAL MULTI-CRITERIA ANALYSIS: CASE STUDY OF LANDFILL SITING IN SHEIKHUPURA, PAKISTAN

8. Change and Adaptation in Deltaic and High Mountain Systems

S.No	Author Name & Affiliations	Abstract Title
79.	*Shahid Iqbal ¹ , Hafsa Tariq ² , Sajid Rashid Ahmad ¹ ¹ College of Earth and Environmental Sciences, University of the Punjab, Lahore ² Department of Space Science, University of the Punjab, Lahore	SPATIO-TEMPORAL ANALYSIS OF MASS BALANCE OF HUNZA BASIN GLACIERS IN RELATION WITH CLIMATIC VARIABILITY
80.	*Abdul Raouf, Sam M. Garnett Saskatchewan Polytechnic, Regina, Saskatchewan, Canada	MONITORING SURFACE WATER LEVEL CHANGES OF THE OLD WIVES LAKE USING REMOTE SENSING TECHNIQUES

9. Geological studies, mineral resources and applications

S.No	Author Name & Affiliations	Abstract Title
81.	*Mr. Naveed Iqbal Ministry of Energy (Petroleum Division)	INTEGRATED GIS-BASED MINERALS INFORMATION & SERVICES PORTAL
82.	*Hisham Azeem ¹ , Waqas A. Qazi ² ¹ Geospatial Research and Education Lab (GREL), Institute of Space Technology, Islamabad ² Geospatial Research and Education Lab (GREL), Institute of Space Technology, Islamabad	SAR DATA APPLICATIONS FOR ARCHEOLOGICAL EXPLORATION IN THE HISARA DHERAI (BALA HISAR) CHARSADDA DISTRICT
83.	*Aneeza Munir ¹ , Abdul Basit ² , Muhammad Nouman ³ ¹ Institute of Geology, University of the Punjab, Quaid-e-Azam Campus, Lahore 54590, Pakistan ² Geological Survey of Pakistan, Quetta, 87550, Pakistan ³ NCEG, University of Peshawar, Pakistan	REMOTE SENSING TECHNIQUES USING ASTER DATA FOR LITHOLOGICAL IDENTIFICATION AND MINERAL EXPLORATION OF WAZIRISTAN OPHIOLITES, NORTH WEST PAKISTAN

10. Data and Information Systems and Spatial Data Infrastructures

S.No	Author Name & Affiliations	Abstract Title
84.	*Waqas A. Qazi O.M. Offshore Monitoring Limited Limassol, Cyprus	EARTH REMOTE SENSING WITH SYNTHETIC APERTURE RADAR (SAR)
85.	*Mirza Muhammad Muzzamil, Muhammad Ali Ismail, Talha Zia, Ameer Humza National Center In Big Data & Cloud Computing (NCBC), NEDUET, Karachi	ACTIVE FIRE MONITORING IN CHILE USING GOOGLE EARTH ENGINE: AN ANALYSIS OF MODIS, GOES, AND FIRMS DATASETS
86.	*M Mukarram Muneer ^{1,2} , Khalid Mahmood ¹ , Roqya Bano Javed ³ . ¹ Department of Space Science, University of the Punjab, Lahore	GIS BASED SEVERITY INDEX ANALYSIS OF ROAD TRAFFIC CRASHES

	² Engineering Consultancy Services Punjab-ECSP, Lahore. ³ Punjab Emergency Services 1122, Lahore.	
87.	*Franz-Josef Behr Stuttgart University of Applied Sciences, Stuttgart, Germany	THE EUROPEAN INSPIRE DIRECTIVE: ITS APPROACH AND LESSONS TO LEARN
88.	*Aseer Ul Haq ¹ , Abdullah Tahir Shah ¹ , Abdul Sattar Sheikh ¹ , Tayyab Shah ² ¹ Department of Space Science, Institute of Space Technology, Islamabad ² Canadian Hub for Applied and Social Research (CHASR), University of Saskatchewan, Saskatoon, Canada	DEVELOPMENT OF PUBLIC TRANSIT ROUTES USING GEOSPATIAL TECHNOLOGIES: A CASE STUDY OF THE TWIN CITIES
89.	*Abdul Sattar Sheikh ¹ , Abdullah Tahir Shah ¹ , Aseer Ul Haq ¹ , Tayyab Shah ² ¹ Department of Space Science, Institute of Space Technology, Islamabad ² Canadian Hub for Applied and Social Research (CHASR), University of Saskatchewan, Saskatoon, Canada	GEOSPATIAL MAPPING OF SOLAR PHOTOVOLTAIC POTENTIAL AT BUILDING FOOTPRINTS IN NORTHERN TOURISM DISTRICTS ACROSS PAKISTAN
90.	*Metzi Aguilar ¹ , Felipe Carranza ² ¹ GIS Lab, University Universidad Centroamericana José Simeón Cañas, El Salvador. ² Independent data science researcher, El Salvador.	CLUSTER ANALYSIS WITH SATELLITE AND SOCIODEMOGRAPHIC DATA TO CLASSIFY THE SALVADORAN TERRITORY
91.	Ayesha Sadiqa Arif, *Munawar Iqbal College of Statistical Science, University of the Punjab, Lahore	BAYESIAN APPROACH ABC - MCMC FOR ARDL MODEL USING ECONOMIC VARIABLES OF PAKISTAN

11. Educating on Climate Change and Sustainable Development

S.No	Author Name & Affiliations	Abstract Title
92.	*Tanzeela Shahbaz, Muhammad Shahid Department of Civil Engineering, University of Engineering and Technology, Lahore 54890, Pakistan	RAINWATER HARVESTING SYSTEM AS A STRATEGY FOR URBAN STORM MANAGEMENT, A CASE STUDY OF LAHORE
93.	*Muhammad Hassan Executive Director, Nancy Thompson Learning Commons (NTLC), Kean University, Union, NJ, USA	CLIMATE CHANGE AND OPEN EDUCATIONAL RESOURCES

12. Capacity building, networking, resource sharing

S.No	Author Name & Affiliations	Abstract Title
94.	Usman Mehmood ^{1,4} , *Ali Imran ¹ , Aysha Abid ¹ , Salman Tariq ² , Zia ul Haq ¹ , Rabiya Mazhar ⁵ , Asim Daud ² , Khalid Mahmood ² , Munawar Iqbal ³ , Aadila Batool ² ¹ Remote Sensing, GIS and Climatic Research Lab (National Center of GIS and Space Applications), Center for Remote Sensing, University of the Punjab, Lahore, Pakistan. ² Remote Sensing, GIS and Climatic Research Lab (National Center of GIS and Space Applications), Department of Space Science, University of the Punjab, Lahore, Pakistan. ³ College of Statistical and actuarial sciences, University of the Punjab, Lahore ⁴ Department of Political Science, University of management and technology, Lahore, Pakistan ⁵ Department of English, Government college university, Lahore, Pakistan.	EXPLORING THE RELATIONSHIP BETWEEN GREENHOUSE GASES, ECONOMIC GROWTH, AND ENERGY USE IN SOUTH ASIA
95.	Dr Nazakat Ali FIEP	TECHNOLOGY COMMERCIALIZATION MODELS - GLOBAL PERSPECTIVE

5. Accepted Abstracts for Oral Presentations

1. Climate/Climate Change, Meteorology, and the Atmosphere

1. ASSESSMENT OF THE EFFECT OF LAND-USE ON WEATHER IN AN ARID REGION USING REMOTE SENSING

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ABSTRACT

It is well known that land-use can have an impact on the local weather, and by extension on the local climate. It has been reported that even in arid areas such as Saudi Arabia and Sudan, the presence of irrigated land affected several weather parameters such as rainfall, humidity and cloud formation. We investigated whether that was also the case for the northern Sindh region where a very large contrast exists in land-use. Irrigated and vegetated areas are situated adjacent to barren areas of the Thar desert. Remote sensing (RS) was used to investigate whether the weather was indeed different in the Thar desert compared to the vegetated areas. Various RS products were obtained from NOAA and Sentinel from which various parameters were derived for 12 locations, both the vegetated and barren areas. These RS products were supplemented with actual rainfall observations in the region. Unsurprisingly, the vegetated areas were found to have larger NDVI values while their day-time surface temperatures were lower but their night temperatures were the same. Cloud cover derived from the Sentinel product showed a consistent increase in the vegetated areas, but that was not supported by the MODIS product. Rainfall derived from RS products, after calibration with on-ground observations, did not indicate any consistent difference between the vegetated and the barren areas. When the Sindh meteorological situation is compared to those of the areas where differences were reported it was found that the weather systems responsible for the weather in Sindh are continental systems (i.e. SE & E Monsoonal). Local variations therefore in land-use, while significant, are not enough to make a difference in the weather on a local scale and therefore by extension the local climate. This should be considered when investigating urban-heat island effects on the weather or the potential for greening the desert to bring about a change in the local weather.

Keywords: MODIS, land-surface temperature, NDVI, cloud cover, rainfall.

1. Climate/Climate Change, Meteorology, and the Atmosphere

2. ENVIRONMENTAL POLLUTIONS AND REMOTE SENSING STUDIES AT ZONGULDAK REGION

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ABSTRACT

Environmental pollution occurs as a result of natural events and human activities. These problems basically consist of water and wastewater pollution, solid waste and air pollution components. In order to determine the pollutants and polluted environments, both micro and macro scale studies are carried out at worldwide. Measurement of pollutants released from a single source and determination of their composition are examples of micro-scale studies (for example, flue gas emission and its composition). Since pollutants originating from similar facilities belong to an industrial region, macro-scale studies are needed to determine the effects of these pollutants in polluted environments. Similarly, the studies of tracking and identifying transboundary pollutants are also macro-scale studies. Starting from the macro scale, tools used in earth sciences and space sciences such as remote sensing techniques are needed for pollutants monitoring studies at continental and global scale.

In this study, starting from a point source, the detection, monitoring and effects of various environmental pollutants using remote sensing techniques will be discussed. For this purpose, micro and macro scale studies on water and wastewater pollution, solid waste and air pollution in Zonguldak province and nearby areas are discussed. Ozone (O₃) and VOC related air quality measurement studies were carried out at micro scale in Zonguldak province. Air and water pollution originated from the thermal power plants in the Çatalağzı energy basin and the environmental impacts of the sanitary landfill are studies carried out on a macro scale (remote sensing) in Zonguldak region.

As a result, the benefits of interdisciplinary studies for scientists working in different fields of science, especially on environmental problems, will be discussed. In addition, a perspective on how environmental pollution and remote sensing techniques can be better combined will be presented.

Keywords: Air Pollution Monitoring, Thermal Power Plants, Landfill, Environmental Impact.

1. Climate/Climate Change, Meteorology, and the Atmosphere

3. ROLE AND CHALLENGES OF LOW-COST SENSORS IN AIR POLLUTION MONITORING

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ABSTRACT

Air pollution has emerged as one of the major environmental challenges affecting the health of the masses across the South Asia. The frequent smog episodes afflict the socio-economic activities on regular basis. Recurring air pollution events (especially “the fifth season”) periodically manifest as periods of low visibility and inflict heavy monetary losses of around 3.8 - 9.2 billion dollars and 32000-76000 estimated premature deaths in Pakistan during 2018 (Farrow et al., 2020; IQAir, 2019). These wide range of estimates is mainly because of the lack of adequate air quality monitoring and reporting throughout the country. There is a clear and definitive lack of proper monitoring infrastructure and regular monitoring methods in the region (in general) and in Pakistan (in particular) due to which the air pollution levels, and baseline conditions are unknown. Besides the scarcity, the quality of the currently available data is also questionable. Under such circumstances the efficiency of mitigation methods, characterization of pollutants, source apportionment, and assessment of adverse impacts is difficult. Sustainable national air monitoring programs and the data they provide are the bedrock for planning and implementing mitigation activities, however the current lack of monitoring infrastructure makes that impossible.

Lack of air quality monitoring infrastructure across the Pakistan is major hurdle in regulating the air quality at all levels and regional imbalance too. Conventional air quality monitoring network cost is very high and country like Pakistan is unable to afford this. Therefore, Low-cost wireless sensor network could be equally efficient in devising and monitoring the effective policy actions for the abatement of air pollution in Pakistan. There has been significant development in the field of low-cost sensors for various applications in environmental monitoring but still they face severe challenges such as accuracy and handling of huge data, acceptability, and technical capacity of regulatory authorities. Further, this study will present the glimpses of research activities going on at IESE-NUST Pakistan and areas of mutual collaboration with international scientific community.

1. Climate/Climate Change, Meteorology, and the Atmosphere

4. CONSTRAINING VARIABILITY IN LARGE ENSEMBLES OF CLIMATE MODEL SIMULATIONS TO PROVIDE SKILLFUL PREDICTIONS AND ATTRIBUTE PREDICTABILITY ON MULTI-DECADAL TIMESCALES

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ABSTRACT

Projections of near-term climate are strongly affected by the uncertainties related to internal climate variability. Here we present a novel approach to constrain variability in large ensembles of climate model simulations by phasing in variability between the model simulations and observed climate. Different approaches can be considered to implement the constraint; that focuses primarily on the phasing of climate variability or include also signatures related to the forced climate response. The constraint selects members primarily based on phasing of variability or those with (additionally) ‘more correct’ signature of a sea surface temperature (SST) warming trend (or at least more similar to observations). The constrained ensembles show significant added value over the unconstrained ensemble in predicting surface air temperature over a 20 year period after initializations. The overall skill of the constrained ensemble over the first ten forecast years is qualitatively similar to that of the initialized decadal predictions; however, the constrained ensemble provides skillful predictions over larger regions of the globe compared to the decadal predictions. In addition, the forecast times for the constrained ensemble can be as long as the projection simulations are available.

We also demonstrate the applicability of the constraint in attributing the predictability of regional and global climate variations to SST variability in different ocean regions. Furthermore, based on different approaches, as mentioned above, the constrained ensemble can be used to quantify (and attribute) the portion of predictability related to global patterns of variability alone, and variability together with the warming trend.

1. Climate/Climate Change, Meteorology, and the Atmosphere

5. SEASONAL VARIABILITY OF PARTICULATE BLACK CARBON AND IMPACT OF PLANETARY BOUNDARY LAYER IN HAZE SMOG FORMATION OVER LAHORE PAKISTAN

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ABSTRACT

Black Carbon (BC) particles result from incomplete combustion of fossil fuel and biomass burning, have strong affinity to absorb thermal radiations. BC is an important atmospheric pollutant and responsible for disturbing the atmospheric radiation balance. BC mass concentrations were measured using aethalometer (model AE 33) during January 2019 to December 2020 in Lahore, Pakistan. Continuous measurements of BC mass concentrations contained in PM 2.5 aerosols were done with temporal resolution of one-minute. Data were analyzed for daily, monthly, and seasonal trends. The daily mean BC mass concentrations were found 11.77 ± 13.54 (0.66 to 148.45), 11.17 ± 8.67 (1.55 to 50.52) $\mu\text{g}/\text{m}^3$ for 2019 and 2020, respectively. The highest monthly mean BC concentrations of 32.64 $\mu\text{g}/\text{m}^3$ were observed for January 2019 with all time high hourly value of 1042.71 $\mu\text{g}/\text{m}^3$ on 2 January at 21:00. For both years, lowest BC mass concentration values were observed in the months of August. Diurnal variations showed bimodal trend with maximum BC concentration during morning and evening to midnight. Correlation coefficient R values (-0.46 to -0.63) showed an inverse dependence of BC mass concentration levels on temperature and wind speed. Findings of the study show BC has considerable contribution in atmospheric aerosol load in Lahore. In order to study the impact of meteorological condition such as planetary boundary layer (PBL) an intensive PBL measurements were conducted over Lahore from October 2019 to March 2021 using LUFT CHM15K Ceilometer LIDAR. The impacts of PBL structure on heavy haze pollution and the relationship with PM2.5 concentrations were studied. The boundary layer height drops clearly during winter period (December 2019 and 2020, usually lower than 500m. The PM2.5 concentrations increase when the PBL drops and vice versa. Key finding in this study is that the dynamics of the Planetary Boundary Layer (PBL) change significantly during heavily polluted days during intense autumn / winter smog periods, which indicates the role of aerosols in influencing meteorological conditions, besides having other impacts in the region of study.

Keywords: Black carbon, atmospheric aerosol, Boundary Layer, Haze, Smog.

1. Climate/Climate Change, Meteorology, and the Atmosphere

6. APPLICATION OF REMOTE SENSING TO IDENTIFY CLIMATE AND LAND USE CHANGE IMPACTS ON SURFACE RUNOFF IN THE HARO RIVER BASIN

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ABSTRACT

Climate and land use changes are significant factors which influence the global hydrological cycle. The researchers are more interested to assess the impacts of these factors at regional hydrological cycle so that strategies could be adopted to mitigate these impacts. The present study is a contribution in this regard. The statistical trend analysis tests, Mann-Kendal and Pettit have been used to identify the changes in hydro-climatic variables during 1991-2019. The watershed has been delineated through Digital Elevation Model (DEM) and by ArcMap 10.8 have been used to perform remote sensing analysis. The land use changes have been analyzed by using the remote sensing techniques and the supervised classification have been performed on Landsat imageries. The Hydrological analysis have been performed on Soil and Water Assessment Tool (SWAT). The calibration of the model has been performed during 1994-2000. The results showed that significant changes have been observed in the hydro-climatic variables and a change points have been observed during 1998 and 2005. Based on these change point results Landsat images have been selected during pre-change and post-change period and supervised classification have been performed. The results of land use classification showed that there are five major land use classes in the study area i.e. forest, water bodies, agriculture, barren land and Built-up area. During the classification it has been observed that forest cover decreased significantly and a rapid increase has been observed in Built-up area. The simulation result SWAT model showed that surface runoff significantly increased after the change point which is consistent with the trend analysis results. This study conclude that remote sensing techniques have been found very useful for watershed management at regional level and similar analysis should be carried out at small watersheds along the Indus basin.

Keywords: Climate Change, Remote Sensing, Watershed Management, Surface Runoff, Supervised classification

1. Climate/Climate Change, Meteorology, and the Atmosphere

7. GREENHOUSE GAS EMISSIONS AND AEROSOL DISTRIBUTION IN THE BRICK KILN ZONES: AN APPRAISAL USING SPATIAL INFORMATION TECHNOLOGY

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ABSTRACT

Greenhouse gases (GHGs) are associated with economic growth in Punjab. Punjab has the largest market of brick making; therefore, extent of GHGs and aerosols is necessary to examine in the ambient air. In this study, spatio-temporal analysis is carried out to evaluate the extent of three GHGs namely carbon dioxide (CO₂), methane (CH₄) and ozone (O₃) including aerosol optical depth (AOD) using main seasons *i.e.* winter, spring, summer, and autumn in the brick kiln zones of Punjab during 2016-2021. 2016 is taken as base year to investigate the seasonal trends of GHGs and AOD in the province. Results of the study revealed that higher concentrations of CO₂ exhibited north-to-east and east-to-south of Punjab while highest level of carbon emission has been recorded in the winter season. Higher concentration of CH₄ and O₃ has been examined north-to-south regions of the province. Similarly, highest AOD level has been exhibited during winter season in the purple, red and orange zones of brick kilns. Spatial results of CO₂ and CH₄ have shown significant decrease in the summer season and substantial increase in the winter season. However, in the summer season, O₃ concentration has been evaluated at high level due to high amount of heat in the hot day days which leads to elevate the formation of O₃.

Keywords: Air pollution, Aerosols, CH₄, CO₂, GHGs, O₃.

1. Climate/Climate Change, Meteorology, and the Atmosphere

8. REMOTE SENSING OF ABSORBING AND SCATTERING AEROSOLS OVER PAKISTAN

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ABSTRACT

Urbanization, industrialization, economic and population growth play a key role in the increasing aerosol concentration over Pakistan. Therefore, this study examined temporal and spatial variations of satellite-based Ultraviolet Aerosol Index (UVAI) over Pakistan from July 2017 to February 2023. High UVAI values (0.54-0.90) were observed in southern, southwestern, and western Pakistan indicating the presence of absorbing aerosols probably dust and black carbon aerosols. Low values of the UVAI (-0.44- -1.20) were found over northern Pakistan suggesting the dominance of scattering aerosols and clouds. In Gilgit-Baltistan, UVAI of ~0.32 showed the presence of absorbing aerosols that can significantly contribute to snow melting in the region. Seasonally, the UVAI values were found to be highest during summer season followed by autumn, spring, and winter over southern, southwestern, and western Pakistan.

Keywords: Aerosol, UVAI, TROPOMI S5P, Remote Sensing, Pakistan

1. Climate/Climate Change, Meteorology, and the Atmosphere

9. INVESTIGATING THE RELATIONSHIP OF SOIL MOISTURE CONTENT, PRECIPITATION AND AEROSOLS WITH ENHANCED VEGETATION INDEX IN PAKISTAN

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ABSTRACT

Soil moisture content is a key element of various hydro- ecological processes at spatiotemporal scales. The soil moisture content is greatly influenced by the amount of precipitation and vegetation. Therefore, this study examined the relationship of soil moisture content (SMC), precipitation and aerosol optical depth (AOD) on enhanced vegetation index (EVI) in Pakistan during 2002-2022. The enhanced vegetation index (EVI) time series is showing/exhibiting that the rising trend 0.1 to 0.12 from 2002 to 2022. The EVI averaged map is indicating that in northern and eastern side of Pakistan is high index while on the other hand the EVI values are low on southwestern side of Pakistan. The EVI values difference is ranging between (1 to 41.44×10^{-2}). A positive correlation (0.6 to 1) of EVI with SMC in the eastern Pakistan indicating high precipitation and vegetation. In the southwestern Pakistan there is a negative correlation of (-0.2 to -0.4) because of low EVI and high AOD. A weak correlation is found between EVI and precipitation is on eastern side of Pakistan and negative correlation on northern and western side of Pakistan.

Keywords: Soil moisture content, enhanced vegetation index, Precipitation, Pakistan, Aerosols

1. Climate/Climate Change, Meteorology, and the Atmosphere

10. ROLE OF LAND USE/LAND COVER AS DETERMINANT OF LOCAL THERMAL PRINT USING GOOGLE EARTH ENGINE

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ABSTRACT

Rawalpindi city is growing at a very fast rate, due to the migration of the people from rural areas towards the urban areas. The increase in built-up area resultant from increased Land Surface Temperature (LST), due to the dense population and urban sprawl, which has inflamed the quality of life as well as the energy demand. The rise in temperature in Rawalpindi resulted in Urban Heat Islands (UHI) and the surface temperature was high when compared to nearby suburban areas. Thus, this study focused on mapping and analysis of the Land use Land cover (LULC) and LST by time-series data for the period from 1990 to 2020 through Landsat data and Google Earth Engine. The research aims at the spatial-temporal analysis of LULC change and LST dynamics and their infrastructure on socio-environmental and energy demands carried out through Landsat data. The results revealed that the urban growth of the city has increased from 7.5 to 29.7 %, resulting in an increase in LST by 3.04°C from 1990 to 2020, with an annual increase of 0.12°C. These UHI's affected areas in 2020 were large approx. 8% when compared to previous years from 1990 to 2010. The correlation of the two environmental variables built-up and vegetation with LST shows, that there is a strong relationship of built-up with LST than vegetation. Future predictions of LULC depict that, there is a linear increasing trend of built-up with a 13.8% increase from 2020 to 2030, which would increase the temperature further, and would cause an increase in energy demands, and disorder the quality of life. The result concluded that there is a need to take immediate actions to measure the mitigation of devastating effects of LST by sustainable management, encouragement of plantation, smart approaches towards vertical buildings, and the conversion of barren land to vegetation.

Keywords: UHI, Land Surface Temperature, Google Earth Engine, multi-temporal, Random Forest

1. Climate/Climate Change, Meteorology, and the Atmosphere

11. VARIATIONS IN THE AEROSOL INDEX AND ITS RELATIONSHIP WITH METEOROLOGICAL PARAMETERS OVER PAKISTAN USING REMOTE SENSING

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ABSTRACT

Particulate pollution has become a major issue in developing countries including Pakistan. To understand the effects of aerosols on the environment and human health, we must first understand their optical and physical properties. Therefore, this study analyzed the Spatio-temporal distribution, inter-annual and seasonal variations of OMI retrieved Ultraviolet Aerosol Index and their relationship with meteorological parameters (e.g., temperature, relative humidity and wind speed) from January 2004 to December 2021 over Pakistan. Therefore, this study evaluates the Spatio-temporal distribution of ultraviolet aerosol index (UVAI) over Pakistan. We also found potential sources of particulate pollution over different cities of Pakistan using HYSPLIT Model. Moreover, the natural and anthropogenic factors influencing absorbing aerosols are also discussed herein. Significant spatiotemporal changes in UVAI values were found with high values in southern and central regions and low values in northern regions of Pakistan. The mean UVAI over Pakistan showed an increasing trend of 2.89% year⁻¹. Seasonally, UVAI increases at the rate of 3.97% winter⁻¹, 3.24% autumn⁻¹, 0.81% summer⁻¹, and 0.71% spring⁻¹. UVAI shows a strong positive correlation with precipitation and temperature and a negative correlation with Normalized differential vegetation index is observed in the central and southern regions of Pakistan. A positive and negative correlation of 0.32 and -0.43 of UVAI with CO₂ emissions and primary industry is observed in Pakistan respectively. Considering the outcomes of this study different methods would be used to reduce the concentration of particulate pollution like afforestation, efficient fuel energy consumption, promotion of public transport networks, etc.

Keywords: Aerosols, Ozone Monitoring Instrument, HYSPLIT model, Aerosol Index, Enhanced Vegetation Index.

1. Climate/Climate Change, Meteorology, and the Atmosphere

12. VALIDATION AND ASSESSMENT OF PRECIPITATION FROM TROPICAL RAINFALL MEASURING MISSION AND GROUND-BASED DATA OVER PAKISTAN

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ABSTRACT

Precipitation is one of the most significant factors that determine climate change. In this study, Ground-Based Data (GBD) was used to validate satellite data from the Tropical Rainfall Measurements Mission (TRMM) during the period 1998 – 2015. For this purpose, we selected thirteen cities of Pakistan namely Balakot, Islamabad, Kalat, Jiwani, Jacobabad, Karachi, Lahore, Quetta, Nawabshah, Murree, Skardu, Dir, and Rahim Yar Khan. The highest and lowest precipitation stations were Murree (28959 mm) and Jiwani (1279 mm) respectively. Monthly, seasonal and annual trends have also been discussed in this research. In conventional seasons, winter (DJF), Spring (MAM), Summer (JJA) and Autumn (SON) the highest precipitation was recorded in summer and winter. Statistical errors i.e., Root Mean Square error (RMSE), Mean Absolute Error (MAE), Mean Error (ME) and BIAS% were also calculated. In coastal and mountainous regions, TRMM underestimated the precipitation measurements for winter season. The highest total rainfall observed is 25342.2 mm in Balakot city. The highest overestimated station is Jiwani followed by Nawabshah and then Kalat having BIAS of 42.67%, 35.04% and 31.34% respectively. The highest value of RMSE is found for Islamabad i.e., 71.13 while the lowest is for Jiwani i.e., 11.05. MAE is highest in Murree (36.65) and lowest in Karachi (6.07). There is a high correlation (R) between Karachi and Nawabshah (0.797854), Islamabad and Balakot (0.74361), and Murree and Balakot (0.73567).

Keywords: Rainfall; TRMM; Pakistan.

1. Climate/Climate Change, Meteorology, and the Atmosphere

13. USING SATELLITE REMOTE SENSING TO UNCOVER THE SPATIOTEMPORAL VARIATIONS IN METHANE EMISSIONS IN LAHORE PAKISTAN

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ABSTRACT

The atmospheric methane (CH₄) is highly potent among all greenhouse gases and rises at a record rate that plays a significant role in climate change and environmental degradation. Therefore, in the current study, we intend to analyze the spatiotemporal variation of CH₄ over Lahore using Tropospheric Monitoring Instrument-5 Precursor (TROPOMI-5P) from 2019 to 2022. The results indicate that the concentration of CH₄ increased at a growth rate of 0.4 ppb/yr during the study period. The yearly average CH₄ concentration in Lahore is 1928±7.8 ppb. Cantonment, Barki, Kamahan, and Naseer Abad are the hotspots of CH₄ emissions in Lahore. The current study also analyzed the inter, intra-annual, and seasonal variations in CH₄ emissions over the study area. The highest CH₄ concentration is observed in the Autumn season (SON) with an average concentration of 1943±9.6 ppb. Whereas, the spring season has the lowest CH₄ concentration of 1905±7.7 ppb during the study period.

Keywords: Spatiotemporal distribution; methane; TROPOMI-5P; air pollution; Lahore;

1. Climate/Climate Change, Meteorology, and the Atmosphere

14. DISTRIBUTION OF PARTICULATE MATTER IN SMOG PRONE CITY: AN ANALYSIS USING SENTINEL-5P DATA

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ABSTRACT

Globally, Lahore is one of the worst affected cities by smog where air pollutants emit from multiple sources especially transport, industrial and agriculture sectors. Therefore, the main rationale of the present study is to evaluate the extent of particulate matter (PM₁₀, PM_{2.5}) in association with metrological factors of Lahore using remote sensing data and suggest measures to overcome smog menace in the city. Results of Sentinel-5P (S5P) revealed that green infrastructure has a great influence in mitigating smog. Further, S5P results exhibited that metrological factor i.e. relative humidity has significant role in trapping the air pollutants and highlighting the highest level of PM_{2.5} in the Wagha Town of Lahore. Therefore, in the light of results of present research, suitable site will be proposed to install smog tower in the most affected smog area to mitigate the impact of air pollution. Hence, findings of the current study will provide the updated information of air quality in Lahore as well as will also help to frame long term measures to achieve the sustainable development goals (SDGs) by reducing the negative impacts of PM_{2.5} as indicated in the SDGs 11.6.2.

Keywords: Air pollution, Lahore, PM_{2.5}, PM₁₀, Smog Tower, SDG 11.6.2

1. Climate/Climate Change, Meteorology, and the Atmosphere

15. LINEAR AND WAVELET ANALYSIS OF CARBON MONOXIDE (CO) OVER PAKISTAN DURING 2019-2022 USING REMOTE SENSING

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ABSTRACT

Our atmosphere contains several gases hazardous to health, carbon monoxide (CO) being one of them. This odorless and tasteless gas has been observed to poison more than 50,000 people a year, causing clinical symptoms such as headaches, dizziness, fainting, and sometimes death. This poisonous gas has caused a great shift in the poison epidemiology of the globe and is still considered one of the most toxic gases in the atmosphere. This study attempts to portray the CO concentration in Pakistan during the years 2019 to 2022. Seasonal and averaged products at 5.5km x 3.5km were retrieved through the tropospheric monitoring instrument (TROPOMI). Time average analysis was performed to study the collective concentration of CO (2019-2022) which showed a high concentration over Punjab and Sindh, which greatly decreases over Balochistan, and is the least in the northern regions of Gilgit Baltistan (GB). The seasonal trends showed the highest mean (0.32) during DJF (2019-2022) whereas the lowest was observed during JJA (0.29), which was observed to have occurred during 2021. Yearly means showed that the highest concentration of CO was recorded in 2021 (0.031) from which peak values were observed in Lahore and Gujranwala of Punjab. Seasonal annual trends of each year were analyzed using the Mann-Kendall (MK) trend test which showed Punjab to have the highest concentration every year, from which the peak values occurred in 2019. Low to negative values were observed over Balochistan and the northern regions of Pakistan. The periodic nature was observed by applying continuous wavelet transform (CWT) on the time series of CO. Highly significant periodicities were observed in the 16 to 64 periodic band having a CWT power of 1.4. These findings can be proven useful for future CO research on a seasonal and periodic basis to reduce the hazardous amount of CO from the atmosphere.

Keywords: CO, TROPOMI, Mann Kendall, Wavelet Analysis, Time series analysis.

1. Climate/Climate Change, Meteorology, and the Atmosphere

16. TIME AVERAGED AND SEASONAL ANALYSIS OF NDVI OVER PAKISTAN DURING 2005 TO 2022 USING REMOTE SENSING

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ABSTRACT

Normalized Difference Vegetation Index (NDVI) is very efficient for observing and analyzing the vegetative features of the earth. It employs the multi-spectral remote sensing data technique to analyze the vegetation index, land cover classification, water bodies, open area, scrub area, hilly areas, agricultural area, forest types, and concrete identification by applying band combinations to see the spectral signatures of the remotely sensed data. In this study, NDVI over Pakistan was analyzed using MODIS Terra during the years 2005 to 2022. Time averaged and seasonal maps of NDVI were calculated and plotted to detect the vegetation index of different regions of Pakistan. The averaged map of NDVI (2005-2022) shows high values in Punjab whereas Khyber Pakhtunkhwa (KPK) portrays low values due to the less vegetation mass. The collective mean value of averaged NDVI throughout the years was 0.198. Annual mean values of the time series were individually calculated from which the highest mean values were observed in 2020 (0.21) and in 2022 (0.220). Seasonal variational maps were plotted to analyze the trend of NDVI from 2005 to 2022. The seasonal variational map of winter (DJF) has a mean NDVI value of 0.196, and the highest values during the season were observed over Punjab, whereas the lowest were observed over Sindh. The seasonal variation of spring (MAM) (with mean value of 0.18) also shows higher NDVI values in Punjab, whereas the regions of Azad Kashmir (AK), KPK, and Sindh have comparatively lower values. The summer (JJA) maps (having a mean value 0.20) shows that KPK and AK have the highest NDVI values whereas Punjab and Sindh have the lowest. The autumn (SON) maps with mean value of 0.21 show that AK has the highest value of NDVI, Punjab and Sindh have minimum values and rest of the regions have lower variations.

Keywords: NDVI, MODIS TERRA, time averaged analysis, seasonal variations

1. Climate/Climate Change, Meteorology, and the Atmosphere

17. PROJECTIONS OF TEMPERATURE, EVAPORATION, AND PRECIPITATION IN PAKISTAN UNDER A CHANGING CLIMATE: IMPLICATIONS FOR WATER RESOURCES MANAGEMENT AND FOOD SECURITY

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ABSTRACT

This study aims to assess the future projections of temperature, evaporation, and precipitation over Pakistan using the Coupled Model Intercomparison Project phase 6 (CMIP6) data. The CMIP6 provides a comprehensive set of climate model simulations from state-of-the-art climate models that allow us to evaluate the range of possible future climate outcomes. The study found that future projections of temperature, evaporation, and precipitation over Pakistan are complex and highly dependent on the scenarios used.

The projections indicate that the country is likely to experience a trend towards higher temperatures in the future, with the average temperature increase ranging from 1.31 to 2.33 degrees Celsius by 2060. This temperature increase is expected to impact the country's water resources and food security, as it will lead to increased evaporation and decreased precipitation patterns. The CMIP6 data projects a rise in evaporation, which could impact the water cycle and exacerbate water scarcity in the region.

On the other hand, the annual climatology projections suggest that the country will experience an increase in precipitation, with decreased evaporation for RCP 8.5 scenario. This increased precipitation could alleviate water scarcity, but also increase the risk of flooding and landslides in some areas. The highest percentage change increases for precipitation appearing in the spring and autumn seasons.

Overall, the future projections of temperature, evaporation, and precipitation over Pakistan are uncertain and complex, and more research is needed to refine the projections and to better understand the uncertainties associated with these projections. These findings have important implications for water resources management and food security in the region and highlight the need for effective adaptation strategies to address the impacts of climate change in Pakistan.

Keywords: Climate/Change, Meteorology, Atmosphere, CMIP6, GIS.

1. Climate/Climate Change, Meteorology, and the Atmosphere

18. NO₂ OVER PAKISTAN DURING 2018 TO 2023 USING TROPOMI

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ABSTRACT

Nitrogen Dioxide (NO₂) is one of a group of highly reactive gases that can cause damage to human respiratory tract and the environment by interacting with water, oxygen and other harmful chemicals in atmosphere to form acid rain. Therefore, this study analyzes temporal and spatial variations of NO₂ over Pakistan using Sentinel-5P TROPOMI (Tropospheric Monitoring Instrument) dataset from June 2018 to January 2023. The result showed significant variations of NO₂ over the study region. The mean map shows the high concentration of NO₂ (4.72×10^{-5} moles/m²) over northeast whereas the concentration of NO₂ were low (1.56×10^{-5} moles/m²) over western and southwest Pakistan. In the spatial variation, the highest concentration of NO₂ were found over eastern and northeast Pakistan in winter followed by summer, autumn and spring. NO₂ is a key indicator of air pollution, and high levels of the gas can have adverse health effects. This study can help policymakers understand the impact of air pollution on public health and inform decisions on how to reduce NO₂ emissions and improve air quality.

Keywords: TROPOMI; Nitrogen dioxide; Pakistan; Air pollutant.

1. Climate/Climate Change, Meteorology, and the Atmosphere

19. LEVERAGING OF DATA-DRIVEN MODELS AND REMOTE SENSING FOR TRANSBOUNDARY RESERVOIR OPERATION

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ABSTRACT

Water storage in reservoirs serves a variety of purposes, including regular distribution, flood control, hydropower generation, and meeting the environmental demands of downstream habitats and ecosystems. However, these objectives often conflict with one another and create complexities in reservoir operation, particularly during flood periods. To make informed decisions for downstream management, an accurate forecast of reservoir inflows and outflow is essential. This study aims to develop a method for forecasting reservoir operation to improve decision-making for reservoir management and water pre-release before a flood occurs. Here, we applied multiple Machine learning model with the aid of Remote sensing (GPM,MODIS,SAR) data to predict the reservoir inflow and outflow. The results of this study indicate that the proposed models provide a more accurate estimation of reservoir outflow compared to classical approaches, such as assuming that the outflow is equal to that of the previous day. Overall, the proposed models demonstrated good performance in estimating reservoir outflow. These findings suggest that the proposed models have the potential to improve the accuracy and reliability of reservoir outflow estimates, which can in turn improve reservoir management and decision-making. This will provide valuable information for informed decision-making and help to mitigate the impacts of flooding on downstream habitats and ecosystems.

Keywords: Machine Learning, Reservoir Operation, Remote sensing.

1. Climate/Climate Change, Meteorology, and the Atmosphere

20. SEA LEVEL VARIATIONS AND GEOMORPHOLOGICAL CHANGES IN MAKRAN COASTAL BELT AND INDUS DELTAIC REGION

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ABSTRACT

Climate change, brought on by increased temperatures around the globe, is affecting our planet and its inhabitants. Pakistan is one of five countries particularly at risk from climate change impacts like sea level rise (SLR). In recent years, numerous scientific research have focused on the country's eastern coastal belt, whereas the western coast (Makran/Baluchistan coast) has been mostly overshadowed by the geomorphological changes occurring in the eastern half. The initial step in this study is to build a sufficient correlation between satellite radar altimetry products representing Sea Level Anomaly (SLA) and existing tidal gauge datasets based in Karachi. Consequently, we define a correlation between hotspot sites (where the tide gauge dataset is unavailable) and Karachi using the same SLA product. The SLR rate is calculated using data from both tide gauges and the SLA product. Google Earth Engine, an open-source platform for cloud computing and hassle-free satellite image processing, was used for the mosaicking of images at the selected locations over the course of the study for each of the seasons that had been thoroughly researched and defined. Beginning in 1993, shorelines were delineated every five years using the Landsat dataset and MNDWI. Using the Digital Shoreline Analysis System (DSAS) technique offered by ArcGIS, the impacts of SLR on the geomorphology of the Makran coastal area are estimated. DSAS Analysis offers accretion and erosion estimates for each hotspot location (Jiwani, Gwadar, Pasni, and Damb).

Keywords: Climate change, sea level rise, tide gauges, altimetry, sea level anomaly, Landsat, MNDWI, DSAS, erosion, accretion.

1. Climate/Climate Change, Meteorology, and the Atmosphere

21. SIMULATION OF HYPERSPECTRAL INFRARED AND MICROWAVE RADIANCES FOR RETRIEVAL OF ATMOSPHERIC PROFILES IN CLEAR-SKY AND CLOUDY CONDITIONS

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ABSTRACT

Accurate and up-to-date atmospheric data have always been the prime need of Numerical Weather Prediction (NWP), climate and air quality models. With the advent of satellite technology, retrieval of atmospheric profiles including temperature, moisture, ozone, aerosol and trace gases has advanced for input in modeling and forecasting. This work focuses on the retrieval of atmospheric temperature, moisture and ozone profiles from the simulated Atmospheric Infrared Sounder (AIRS), Moderate Resolution Imaging Spectro-radiometer (MODIS) and Advanced Microwave Sounding Unit (AMSU) radiances using statistical principal component regression and Artificial Neural Network (ANN) under both the clear-sky and cloudy conditions. The clouds cover approximately 70% of the globe; therefore, making the inversion of accurate sounding parameters a challenge. Since electromagnetic radiations in the microwave region are very less affected by the clouds and aerosol, these can, therefore, be effectively complement the infrared. A fast radiative transfer model named “Community Radiative Transfer Model (CRTM)” developed at “Joint Center for Satellite Data Assimilation (JCSDA)”, “National Oceanic and Atmospheric Administration (NOAA)”, USA was used for the simulation. The radiances were simulated both for clear-sky and cloudy conditions with clouds at different cloud top pressures i.e. 206hPa, 336hPa, 506hPa and 718hPa. Sensitivity of the simulated cloudy radiances (in terms of brightness temperature) with cloud top pressure suggested that the knowledge of cloud top pressure is necessary for accurate retrieval of atmospheric profiles in the presence of cloud. Retrieval performance of ANN algorithm proved to be superior to that of the statistical principal component regression. Although its training is a time-consuming process, however, once trained, the ANN is very fast in retrieving profiles making it more suitable for operational implementation. The results show that the use of collocated microwave (AMSU), moderate spectral resolution (MODIS) and hyperspectral infrared (AIRS) radiances can greatly improve the retrieval of atmospheric profiles under cloudy conditions.

Keywords: Hyperspectral Infrared Sounding, Microwave Sounding, Atmospheric Profile Retrieval, Artificial Neural Network, ANN, CRTM, AIRS, AMSU, MODIS

1. Climate/Climate Change, Meteorology, and the Atmosphere

22. THE SPATIAL AND TEMPORAL VARIATIONS IN DUST MASS SURFACE CONCENTRATION OF PM_{2.5} IN PAKISTAN USING REMOTE SENSING

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ABSTRACT

The uprising trend of dust surface mass concentration PM_{2.5}, which is an air pollutant that is a concern for population health, the study will depict its impacts on human life and daily activities when levels in the air are high. The current study investigates the spatiotemporal variations in the surface mass concentration of PM_{2.5} in Pakistan using MERRA-2. Data sets are taken from 1980 till 2022, over all 40 years of monthly data over Pakistan describe the dust surface mass concentration PM_{2.5} and greater pollutants concentration with compressions in different areas. Over time, we observe a continuous higher trend period. We are observing a higher trend till 2000 but in a small concentration, the max level of dust surface concentrations PM_{2.5} till 2000 is $4.5 \times 10^{-8} \text{ kgm}^{-3}$. But after that era in the recent 22 years from 2000 till 2022 we have seen a huge up trend in the concentrations, with numbers crossing $5.5 \times 10^{-8} \text{ kgm}^{-3}$ in the year 2022. Our statistical study relates that we had a noticeable dip in the concentration in the year 2020 below $1 \times 10^{-8} \text{ kgm}^{-3}$ which is the lowest amount of all. Later the next we haven't seen much upward trend over the graph, which is like 1980. This drop was observed in covid-19 pandemic. Later on, in the year 2022, we had a remarkable uptrend till now which is $5.5 \times 10^{-8} \text{ kgm}^{-3}$. This is the highest up trend of dust surface concentration PM_{2.5} to date. Move over, the study also shows variations among the four seasons, the dust surface concentration PM_{2.5} have the maximum average concentration in the season June, July & August (JJA) which is $3.22 \times 10^{-8} \text{ kgm}^{-3}$. On the other hand, we have a minimum average concentration in December, January & February (DJF) recorded at $1.57 \times 10^{-8} \text{ kgm}^{-3}$.

Keywords: Dust mas surface concentration PM_{2.5}; MERRA-2; Pakistan;

1. Climate/Climate Change, Meteorology, and the Atmosphere

23. IMPACT OF DEFORESTATION ON CLIMATE CHANGE: THE CASE STUDY OF MURREE HILLS

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ABSTRACT

The shrinking of forest cover area and its ecological, environmental, and socio-economic impacts have been an issue of global concern, and extensive research has been conducted on this problem during the past few decades. The forest cover of Pakistan has been exposed to an alarming rate of degradation during the last few decades. If not controlled, the current rate of deforestation and vegetation cover degradation may lead to severe environmental and social consequences. The present study assessed temporal change in vegetation cover area and identified its impact on the weather of Murree Hills covering a period between 2000 and 2020 using Landsat images for Normalized Difference Vegetation Index (NDVI) and Land Use Land Cover (LULC). The images were processed in ArcGIS 10.8. Data was also used to establish a relationship between the fluctuations in temperature and vegetation cover dynamics through various statistical analyses using Microsoft Excel. The study revealed that forest covers considerably degraded in the study area during 2000-2010, while a significant decrease in vegetation cover can be observed during 2000-2010 and again a slight increase from 2010-2020. Due to the degradation of forest cover, the study area experienced significant variations in climatic elements. The temperature and rainfall data obtained from the Pakistan Metrological Department (PMD) was to investigate the vegetation's impact on the study area. IDW Analysis was used to find out the temperature and rainfall variations. The results showed that vegetation degradation significantly impacts temperature and rainfall.

Keywords: Deforestation, Climate Change, LULC, NDVI, IDW, Murree Hills.

1. Climate/Climate Change, Meteorology, and the Atmosphere

24. A STUDY ON AEROSOLS DISTRIBUTION OVER KARACHI USING AERONET

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ABSTRACT

In the Earth's atmosphere, aerosols are one of the most variable components that have a significant impact on climate of earth and largely vary in their types. These particles not only affect the radiative balance of earth but also affect the clouds formation.

Inter-annual variations (2007-2023) in AOD (550nm) and AE (440-870nm) indicated that highest value of AOD was observed to be 1.030 in Jun-2012 and lowest value of 0.18 was found in Jan-2014 with the mean AOD value of 0.44 throughout the study period. Meanwhile, large AE value of 1.32 was found in Jan-2014 (when lowest AOD was observed) with the lowest value of 0.15 in Aug-2018. Higher values of AOD were observed during the months of May, June and July while low AOD was found in November, December and January. Whereas, high AE values were observed in December, January and February with low AE in May, June and July. Inverse relations between AOD and AE especially in the months of autumn and winter seasons imply the presence of coarse particles. Presence of high AOD value in June, July months (with low AE) meant that aerosols were larger during this time which relates dust aerosols while high AE in December and January (with low AOD) months indicated presence of anthropogenic aerosols. 50% of AOD value lies between 0.2 to 0.3 and only 27% of AOD lies in range of 0.5 to 0.9.

Monthly mean variations also indicated that June (0.63), July (0.72) and August (0.59) are those months in which highest monthly mean AOD is recorded, meanwhile November (1.02), December (0.99) and January (1.03) are the months with highest AE has shown.

Seasonal variations in AOD have indicated that AOD was highest in summer season (0.87) of every year and lowest in spring (0.26) indicated large presence of dust aerosols, meanwhile AE was highest in Autumn (1.07) and lowest during summer (0.21) resulted in anthropogenic emissions of aerosols.

Aerosol volume size distribution (AVSD) is classified as fine mode aerosol (radius $\leq 0.6 \mu\text{m}$) and coarse mode aerosol (radius $\geq 0.6 \mu\text{m}$). Both types of aerosol have been seen in Karachi simultaneously, while significant variation was found in coarse mode particles. The peak values of AVSD for coarse mode were observed around 2.241 μm and 0.112 μm radii for fine mode, indicating largely the presence of coarse (dust) particles.

Keywords: Aerosol, Aerosol Optical Depth, Angstrom Exponent, Karachi, AERONET

1. Climate/Climate Change, Meteorology, and the Atmosphere

25. INTEGRATING REMOTE SENSING AND SOCIO-ECONOMIC DATA SETS FOR A COMPREHENSIVE ANALYSIS OF AIR POLLUTION RISK IN SOUTH ASIA.

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ABSTRACT

Three million fatalities a year can be directly attributed to bad air quality caused by smog, volcanic explosions and severe droughts are just two examples of the natural causes of air pollution; human activities like car pollutants, industrial processes, and the clearing of land and woodlands are also major contributors. Some sources of emissions release several different kinds of pollutants, each with their own unique properties and effects. It is challenging to find multi-pollutant prevention mechanisms, especially in South Asia, where air pollution travels rapidly across national boundaries, because there has been so little study on the danger of multiple air pollutants. The primary goal of this research was to use Sentinel-5P remote sensing data from 2019 and 2020 to create an index product that would measure the risk of exposure to multiple air pollutants, including carbon monoxide, nitrogen dioxide, and Sulphur dioxide. Analysis of hazards, vulnerabilities, and exposures were combined to create the risk score. Remote sensing data on air pollution is used in the hazard analysis, the air pollution sources are considered in the susceptibility analysis, and the population density is taken into account in the exposure analysis. This research contributes new knowledge by creating a multi-risk model that accounts for the relative importance of different risks based on how they relate to one another in terms of danger and susceptibility. Values for the air pollution risk index are greatest in metropolitan regions due to the high exposure index from pollution brought on by human activity. According to a study that looked at all three air contaminants together. The findings of this study can be used to identify the patterns and characteristics of the risk distribution of multiple air pollutants in South Asia, which in turn can be used to mitigate multi-pollutant sources, especially with regard to supporting the clean air targets in the Sustainable Development Goals.

Keywords: Remote Sensing, (NO₂, CO, SO₂), South Asia, Air Pollution.

1. Climate/Climate Change, Meteorology, and the Atmosphere

26. GEOSPATIAL ASSESSMENT OF SMOG PATTERNS AND ITS RELEVANT ECONOMIC VALUATION IN PUNJAB

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ABSTRACT

Punjab is suffering from a very intense form of air pollution known as “smog” which is increasing mainly due to an increase in anthropogenic activities for the past few years. Monitoring different sources of smog and tracing its origin can help mitigate this problem. Several atmospheric pollutants like nitrogen oxides, sulfur oxides, ozone, carbon monoxide and aerosols play a very crucial part in smog formation. In this study, 20 years of Moderate Resolution Imaging Spectroradiometer (MODIS) Aerosol Optical Depth (AOD) product was used to analyze its trend over 20 years. The effect of crop burning on AOD was also analyzed. Backward trajectories from the HYSPLIT model were used to trace the origin of aerosols during the days of maximum AOD. The Air Trajectories showed the vast spread of AOD from crop burning over many parts of Pakistan. An increase in AOD has been linked to climate change. AOD relationship with different meteorological parameters such as land surface temperature (LST), precipitation and relative humidity from 2002 to 2022 was also analyzed. A drastic increase in AOD was seen when relative humidity increased and temperature decreased. Furthermore, inventories data of different atmospheric pollutants were also acquired for the Punjab region over 20 years. The results of pollutants data showed that with an increase in an urban area, the concentration of gases like nitrogen oxides, sulfur oxides, ozone and carbon monoxide and aerosols increases in the atmosphere. The results will be valuable in monitoring the pattern and sources of the smog situation in Punjab along with the willingness to pay for improving the smog situation in Punjab.

Keywords: AOD, Smog, MODIS, HYSPLIT Model, Meteorological Parameter.

1. Climate/Climate Change, Meteorology, and the Atmosphere

27. A SPATIO-TEMPORAL ANALYSIS OF TRENDS IN SNOW COVER IN THE CHITRAL BASIN

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ABSTRACT

Glaciers are an important source of fresh water across the globe. In Pakistan; most of the fresh water depends upon the glacier melting. Assessing changes in snow cover is essential for understanding the impacts of climate change on fresh water resources. This study aims to analyze the spatial and temporal trends of snow cover change in the Chitral Basin using Google Earth Engine. The Chitral Basin, located in the Hindu Kush region of Pakistan, is particularly vulnerable to the effects of climate change, including changes in snow cover. The study used multiple sensors Landsat-5, Landsat-8, Sentinel-2 and MODIS satellite data over the last three decades. The study then used the Mann-Kendall trend test and Sen's slope estimator to identify significant trends in snow cover change. The results showed a decreasing trend in the snow cover extent in the Chitral Basin over the last three decades. The average annual snow cover extent decreased from 618 km² in 1988 to 492 km² in 2019, with a more pronounced decline in the last ten years (in the winter season). The snow cover duration also showed a decreasing trend, with a decline of 13 days per decade. The findings of this study can help policymakers and local communities in the Chitral Basin to develop effective strategies for climate change adaptation and sustainable water resource management.

Keywords: Temporal trends, Basin, Snow-cover extent, MODIS, Decreasing trend.

1. Climate/Climate Change, Meteorology, and the Atmosphere

28. SEASONAL AND TIME-AVERAGED ANALYSIS OF TOTAL COLUMN OZONE (TCO) OVER PAKISTAN FROM 1989 TO 2022 USING REMOTE SENSING

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ABSTRACT

Ozone plays a crucial role in the Earth's atmospheric equilibrium and significantly impacts climate change, the radiative balance, and atmospheric chemistry. Considering the importance of ozone concentration and its eminent effects on Pakistan's environment, Modern-Era Retrospective analysis for Research and Applications (MERRA) datasets are analyzed to monitor the Total Column Ozone (TCO) over the entire country. To examine the spatiotemporal distribution of atmospheric TCO over Pakistan, MERRA 2 datasets at $0.5 \times 0.625^\circ$ spatial resolution are studied. Time-averaged data for 33 years (1989 to 2022) and seasonal averaged data for the whole period is evaluated. The time series are also analyzed for their temporal trends. During 1989-2022 MERRA 2 data revealed the highest annual average TCO to be found in the northern region of Pakistan, especially in Khyber Pakhtunkhwa (KPK) while the lowest was observed in Sindh and Baluchistan; southern Pakistan. The analysis also statistically indicates the average TCO to lie within the range of 270.45 and 276.05 Dobsons. The maximum TCO value was 311.53 Dobsons in March 2001, while the minimum was 242.45 Dobsons in December 1998. Seasonal variations revealed that the higher latitudes had maximum value in winter (DJF) and spring (MAM) seasons and a minimum in summer (JJA) and Autumn (SON) seasons. In southern Pakistan, the highest concentrations recorded were found in the summer season (JJA), while the lowest were recorded in the winter (DJF) seasons. In contrast, spring (MAM) and autumn (SON) seasons show mixed trends regarding ozone concentration. Understanding the nature and ozone trends can help increase the accuracy of radiation budgets and will pave the ground for climate modeling.

Keywords: TCO, Climate Change, MERRA 2, time average, seasonal average.

1. Climate/Climate Change, Meteorology, and the Atmosphere

29. INTERVENTION OF CRITERIA AIR POLLUTANTS IN URBAN AIR: A MULTI-SECTORAL GUIDE TO COMBAT ENVIRONMENTAL SMOG

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ABSTRACT

The combination of smoke and fog ‘smog’ is one of the major environmental problems recognized globally and known as catastrophic smog in Punjab, Pakistan. Aim of the present study is to explore the key sources of air pollutants and their contributions in smog formation. For this, remote sensing derived data based on aerosol optical depth (AOD), thermal anomalies along with metrological factors *i.e.* rainfall of November 2017, 2019 and 2021 have been employed to evaluate the extent of smog and role of rainfall in the reduction of smog. Results of the study exhibited that transport sector is playing leading role in emitting pollutants into the ambient air. Spatial results indicated in the study period (2017, 2019 and 2021) that the magnitude of AOD and thermal anomalies fluctuated and noticed considerably high in the eastern and south eastern parts of Punjab. Lack of rainfall also contributed in raising the extent of smog. Findings of the study thus provide significant opportunity to adopt long term strategies as practiced in the other countries to tackle the smog catastrophe in Punjab, Pakistan.

Keywords: Air pollution, Smog, AOD, thermal anomalies, rain fall

1. Climate/Climate Change, Meteorology, and the Atmosphere

30. SPATIOTEMPORAL VARIATIONS IN TOTAL SURFACE MASS CONCENTRATION OF PM_{2.5} IN PAKISTAN USING REMOTE SENSING

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ABSTRACT

Burning of Biomass emits smoke, pollution, and haze which comes directly from vehicles. A large number of gases arising from the burning of fuels cause particulate matter (PM_{2.5}). Ineffective use of energy, increased unrestricted emissions from the industrial sector, plastic and waste burning are the major contributors to PM_{2.5} in Pakistan. The main objective of this study is to estimate the influence of the total surface mass concentration of PM_{2.5} in Pakistan. Mass concentration is also used as the system of measurement when examining and analyzing the fate and transport of conventional contaminants in the environment. This study includes monthly PM_{2.5} total surface mass concentration dataset of 42 years (1980-2022) retrieved through the Modern-Era Retrospective analysis for Research and Applications (MERRA-2) model, over Pakistan. We demonstrated time-averaged maps and statistical graphs for thorough visualization and understanding, which revealed an increasing trend over the last 42 years. The highest annual average for PM_{2.5} is found in the year 2018 (4.64E-08 kgm⁻³) in the eastern region of Pakistan, especially in Punjab and Sindh, while the lowest annual average was observed in the year 1992 (2.47E-08 kgm⁻³) in the northern region of Pakistan, especially in Gilgit Baltistan (GB). Annual and seasonal averages were also obtained. Altogether averaged value of PM_{2.5} over the last 42 years was 3.41E-08 kgm⁻³, with seasonal averages of DJF (2.57E-08 kgm⁻³), MAM (3.59E-08 kgm⁻³), JJA (4.54E-08 kgm⁻³), and SON (2.97E-08 kgm⁻³), respectively. In seasonal variation (1992-2022), DJF showed highest concentration of PM_{2.5} in the southern Baluchistan. In MAM highest concentration was recorded in the south-eastern regions especially in Punjab and Baluchistan. In JJA, it was recorded in the mid-eastern Punjab, and the SON gave the highest concentration of PM_{2.5} in the southern Baluchistan.

Keywords: PM_{2.5}, Total surface mass concentration, Emissions, Burning.

1. Climate/Climate Change, Meteorology, and the Atmosphere

31. SEASONAL AND WEEKLY NO₂ LEVELS AND RIGOROUS VALIDATION OF SATELLITE NO₂ VALUES WITH VARIOUS GROUND-BASED INSTRUMENTS IN ISLAMABAD, PAKISTAN

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ABSTRACT

Nitrogen dioxide plays an important role in earth's radiative balance by modifying its oxidizing capacity and has prime importance in tropospheric chemistry, leading to the formation of ozone. It releases primarily from anthropogenic sources and responsible for causing serious health issues. The present study, for the first time in Pakistan, presents intercomparison of various ground based (MAX-DOAS and In-situ analyzer APNA-370) and satellite instruments (OMI and TROPOMI) for retrieval of NO₂. The VCDs were converted to vertical mixing ratios (VMRs) in parts per billion by volume (ppbv) for validation purposes. The results indicate that the lowest RMSE, MAE and MAPE are found at 300m altitude i.e. 4.71 ppb, 3.59 ppb and 25.49%, respectively. Also, the paper presents validation of daily satellite observations through ground-based measurements that results in strong positive correlation of TROPOMI and OMI with In-situ analyzer i.e. 80% and 70% whereas with MAX-DOAS, it is 81% and 67%, respectively. The diurnal variation results indicate higher levels the lowest mixing ratios of NO₂ during morning (06:00 to 07:00) and noon/afternoon (11:00 to 16:00). The seasonal variability of NO₂ was investigated using In-situ analyzer and the peaks were appeared in post-monsoon whereas lowest were found in monsoon season. This kind of study are needed in time as the results will be helpful for policymakers and authorities in controlling the prime sources, as well as management and mitigation of pollution.

Keywords

Air pollution, MAX-DOAS, OMI, TROPOMI, NO₂, Validation, Satellite observation

1. Climate/Climate Change, Meteorology, and the Atmosphere

32. A STUDY OF OPTICAL AND PHYSICAL PROPERTIES OF DUST AEROSOLS OVER PAKISTAN USING REMOTE SENSING

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ABSTRACT

Millions of people suffer from health problems due to poor air quality in regions of high particulate pollution. Therefore, this paper proposes for better understanding of the impact of dust storms on both short- and long-term environmental factors that can help in a preferable formulation of warning and prediction scenarios in arid regions. By using both ground-based and satellite remote sensing techniques, we assess how dust storms affect meteorological parameters as well as aerosol optical characteristics. For this, we use AERosol RObotic NETwork (AERONET), MODerate resolution Imaging Spectroradiometer (MODIS), Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO), Ozone Monitoring Instrument (OMI), Suomi National Polar-orbiting Partnership (S-NPP) and Sentinel-5 Precursor (S5P) to retrieve aerosol optical properties from 15 May 2021 to 20 May 2021 over Karachi. At 550nm the instantaneous maximum values of aerosol optical depth (AOD) are measured to be ~0.8, and 0.59 on 16 May 2021, and the lowest values of Ångström exponent (AE) are discovered to be ~0.2, and ~0.26 by Aqua-MODIS and AERONET respectively. Such observations are attributed to dust aerosols over Karachi, these values are more than those that might be expected on an ordinary day. We also found S5P and OMI retrieved ultraviolet aerosol index (UVAI) of about 1 and ~1.9 on 17 May 2021 respectively which indicate the presence of absorbing (dust) aerosols. A HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model forward movement of air masses indicated that the winds at 500 m above the ground are to blame for the transport of dust from southern Pakistan to northern regions of the Indian state by the Arabian Sea and backward movement of air masses over the eye of TAUKTAE cyclone showed that gusty winds, from Karachi and its neighbors, are sucked by this cyclone system.

Keywords: Dust storms; Cyclones; CALIPSO; HYSPLIT model; Remote sensing

1. Climate/Climate Change, Meteorology, and the Atmosphere

33. MODELLING THE EFFECT OF METEOROLOGICAL PARAMETERS ON TROPOSPHERIC CONCENTRATIONS IN PAKISTAN

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ABSTRACT

NO₂, or nitrogen dioxide, is a combustion by product that has been associated with multiple adverse health outcomes. The focus of this study are to handling missing values and to be modelling of tropospheric NO₂ over Pakistan using data from space-borne OMI during the years 2004 to 2020. In OMI data, each observation taken at 0.25 m distance and divide into 6 zones to modelling the effect of meteorological parameters on tropospheric NO₂ concentration in Pakistan. The dataset contains lot of missing observations, to handle this problem we used different techniques to impute missing values. The work is then extending to model NO₂ concentration in Pakistan in which we used MLM, GLM, GAM and LMM for each zone. The analysis demonstrates that the estimation methods could fill time series of NO₂ concentrations when values are missing, but with a relatively low accuracy. However, prediction of NO₂ is complex since its variation is complex and affected by both meteorological parameters, on previous concentration level and on emission sources.

Keywords: NO₂; Missing Values; MLM; GLM; GAM; LMM; AIC

1. Climate/Climate Change, Meteorology, and the Atmosphere

34. EVALUATION OF BLACK CARBON COLUMN MASS DENSITY IN PAKISTAN BASED ON MERRA-2 MODEL

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ABSTRACT

One of the short-lived air pollutants that make a significant contribution to aerosol radiative forcing and global climate change is black carbon (BC). It is released by partial combustion of fossil fuels, biofuels and biomass. The use of satellite data enables us to better comprehend the dynamics of BC distribution. The current study addresses the annual, averaged and seasonal variation of BC column mass density in Pakistan from 1980-2022 that shows an increasing trend of black carbon concentration in the atmosphere with time. Time averaged map of Black Carbon column mass density shows its maximum concentration in Lahore, Sialkot, Gujranwala, and Sahiwal. Graph of the inter-annual time series shows the maximum BC column mass density in the autumn (SON) season while in averaged analysis (1980-2022) we have the maximum value in the year 2016 that is $2.05 \times 10^{-6} \text{ kgm}^{-2}$. As black carbon is a global environmental issue hence its increasing concentration in the atmosphere has adverse impacts on our climate. Moreover, BC inhalation can impose negative impacts on human health which may include cancer, respiratory and cardiovascular diseases and even birth defects.

Keywords: Black carbon, radiative forcing, Pakistan, spatial and temporal distribution.

1. Climate/Climate Change, Meteorology, and the Atmosphere

35. TRANSBOUNDARY GEOSPATIAL ANALYSIS OF PARTICULATE MATTER (PM_{2.5}) OVER PAKISTANI AND INDIAN, PUNJAB

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ABSTRACT

The main purpose of this study is to analyse the geospatial pattern of fine particulate matter in Pakistani Punjab and Indian Punjab. Exposure to fine particulate matter is a matter of great concern today as they are directly linked to human health. The data relating to the concentration of particulate matter were collected through BOX website. The spatial patterns of PM_{2.5} concentration in Pakistani Punjab and Indian Punjab from 1998 to 2019 were analysed by plotting GIS maps. The maps were developed by using ArcGIS software. Annual and monthly graphs of PM_{2.5} concentration in the study areas were plotted. The graphs showed that the concentration of fine particulate matter increased from 1998 to 2019 in an irregular pattern. The concentration of fine particulate matter was low in some cities of Pakistani Punjab and Indian Punjab during the early 20s but after 2004, their concentration went above 100µ/m³ in neighbouring states of Indian Punjab. It resulted in an increase in the concentration of fine particulate matter in the cities of Indian Punjab and Pakistani Punjab. In 2016, for the first time, the concentration of fine particulate matter went above 100µ/m³ in Amritsar and Ferozpur of Indian Punjab and Lahore which is located in Pakistani Punjab. The air current flow of fine particulate matter was also studied. According to the results, the fine particulate matter transferred from Delhi to Indian Punjab and then from Indian Punjab to Pakistani Punjab. It has been cleared from the collected data that the concentration of fine particulate matter increases during winters and decreases during summers. The graphs showed that the concentration of fine particulate matter was high during winters in Pakistani Punjab and Indian Punjab while it was low during summers. The health effects of fine particulate matter were also studied during research.

Keywords: Geospatial, Indian and Pakistani Punjab, trends, Temperature

1. Climate/Climate Change, Meteorology, and the Atmosphere

36. GEOSPATIAL ANALYSIS OF VARIATION IN TEMPERATURE AND TREND ANALYSIS OF PUNJAB, PAKISTAN

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ABSTRACT

Punjab is Pakistan's second largest province with the largest population, Punjab is also known as the agriculture hub of the country. Punjab consists of seven irrigation systems that are distributed on the basis of the flow of canal and distributaries. The main purpose of this study is to analyze the Geospatial analysis of the trends of temperature. Increasing temperatures are directly linked to human health. Graphs and maps were made through ArcGIS software. The objective of this study was to assess trends in maximum and minimum monthly temperatures and its trends in the Punjab province of Pakistan. Monthly data of maximum and minimum temperatures was obtained from Giovanni and different satellite data sets such as for the temperature data sets from MERRA model-2, Celsius with spatial resolution 0.25-0.5 degrees was used from the year 1999-2020. The results of the study are gathered through the graphs and time series trends of 20 years on the monthly basis. Overall in Punjab, maximum temperature has shown a significant upward trend in spring ($0.028^{\circ}\text{C}/\text{year}$) and downward trend in summer season ($-0.013^{\circ}\text{C}/\text{year}$). While in minimum temperature, significant increasing trends were observed in all seasons excluding summer. The results indicate that the spring season is warming and the decreasing trend in summer temperature is caused by an increasing trend of rainfall in the province whereas, The main causes of these changes in trends are due to urbanization, deforestation, overpopulation and industrialization.

Keywords: Geospatial, TRMM, Giovanni, Punjab, trends, temperature, rainfall, MERRA-2

1. Climate/Climate Change, Meteorology, and the Atmosphere

37. INVESTIGATION OF INDOOR AIR POLLUTION CAUSED BY PAINTS USED FOR INTERIOR PAINTING IN A BUILDING IN ISTANBUL.

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ABSTRACT

People spend most of their lives indoor environments. For this reason, indoor air pollution and its effect on human health are important and it is a subject of research in many parts of the world. In addition to the static structure in building constructions, the ventilation of the interior spaces, the covering of floors, ceilings and surface coatings are important both in terms of indoor air quality and aesthetics. Painting is preferred for coating the interior surfaces of many large buildings. In the composition of paints, there are many volatile organic compounds as well as different chemicals.

In this study, indoor air pollution caused by water-based and solvent-based paints used during the painting of the interior surfaces of a large building built in Istanbul was investigated. For this purpose, indoor air pollutants (i.e., VOCs) were measured as daily average values from the beginning of painting on the interior surfaces of rooms, laboratories, halls, corridors and various interior spaces using the active sampling method. In order to determine the amount of VOCs formed in the environment depending on the paint type, two different rooms with 30 m² and 60 m² dimensions were selected. In these rooms, 7 different VOCs samplings were made on the 1st, 3rd, 7th, 10th, 15th, 20th and 25th days with a 24 hours sampling time. The prepared active sampling system consists of a flow-controlled flow meter, an active carbon adsorbent tube and a pump. With the active sampling system, indoor air is passed through an absorbent containing activated carbon and volatile organic compounds are sampled by adsorbing on the activated carbon inside the tube. In the sampling and analysis processes, the international standard TS EN 13649 VOC sampling and measurement method was used. After sampling, all samples were extracted with carbon disulphide and subsequently analysed using the GC-FID system. 25 VOC species such as benzene, toluene, ethylbenzene, xylene, dichlorobenzene, 4-chlorotoluene, tetra-chloromethane, and tetra-chloroethane were analysed in the sampling air.

In all rooms painted with water-based paint, tetra-chloromethane (0.153 µg/m³) and Toluene (0.207 µg/m³) compounds are VOC compounds detected even on the seventh day of sampling. However, no detectable VOC concentration value could be reached on the 10th day. On the other hand, tetra-chloromethane (0.332 µg/m³ on the 25th day) and Toluene (1.011 µg/m³ on the 25th day) compounds were detected both on the first day and on the 25th day of the samples in all rooms painted with solvent-based paint. As a result, the choice of water-based paints is important in terms of protecting the environment and public health.

Keywords: Volatile organic compounds, solvent-based paint, water-based paint, public health.

2. Geohazards and Disasters

38. EVALUATION OF SOLID WASTE DISPOSAL STRATEGY FROM A CLIMATE CHANGE PERSPECTIVE USING MODELLING APPROACH

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Abstract

Municipal solid waste (MSW) is typically disposed of in landfills in developing economies, that has detrimental effects on the environment including its input to the climate change. The solid waste management sector being the 4th major contributor towards climate change can make a significant contribution towards the endeavor to reduce GHG emissions. The research was carried out to evaluate the climate change impacts related to the solid waste disposal strategy using modelling approach. EASETECH is a waste management model developed by Technical University of Denmark (DTU) that employs life cycle assessment (LCA) methods to present the associated environmental impacts. The open dumping scenario in a medium sized city of Pakistan (Bahawalpur) was modeled for a dumping site receiving 160 tons/day of waste with a bulk density of 1m³ and net infiltration rate of 168.6 mm/year. As per modelling outcomes under IPCC 2007 GWP (global warming potential) over 100 years, the existing waste dumping condition with zero leachate and methane collection, contributes almost 4.96E+07 kgCO₂-eq to global warming with 1.384×10⁵kg of leachate production. Major substances contributing to climate change are CH₄ (6.33×10⁶ kgCO₂-Eq), CO₂ (9.09×10³ kgCO₂-Eq) and CO in the air part (2.2E+03 kgCO₂-Eq). The existing situation was compared with two alternate scenarios with the upgradation of dumpsites to sanitary landfills along with the consideration of 50% and 75% leachate and gas collection with the adoption of technologies for leachate treatment and gas capture for energy recovery. These results indicate a significant 55% and 93% reduction in GHG emissions with an estimated value of 2.23E+07 kgCO₂-Eq and 3.32E+06 kgCO₂-Eq respectively. The overall findings imply that there is a significant need to shift from existing scenario in the country specifically in terms of measures to reduce transient gas emissions and leachate to the environment. And the LCA-based modelling approach can aid in the long-term planning while evaluating the benefits and drawbacks of different disposal options from a climate change perspective.

2. Geohazards and Disasters

39. INVESTIGATION OF VARIABILITY IN HYDROLOGICAL DROUGHTS OVER UPPER INDUS RIVER BASIN

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ABSTRACT

Understanding climate change necessitates the use of hydro-climatological time series to uncover trends. In this study, the improved innovative trend analysis (IITA) method was employed to look at trends. The results showed that hydrological drought timeseries from October to March had substantial declining tendencies on a monthly scale. From April through September, the hydrological drought timeseries showed strong upward trends. Droughts in the upper and lower sections of the UIRB have been on the rise, putting persistent pressure on water resources availability in the lower Indus plains, where agriculture supports the majority of the country's population. Furthermore, the consistency of results across all three trend analysis methods demonstrated that the innovative trend analysis (IITA) approach is a trustworthy and useful tool for investigating low, medium, and high-frequency trends. Furthermore, in comparison to other statistical methods such as MK and SR tests, which have some limiting limits such as serial independence of data, normal distribution, and length of timeseries data, the IITA approach has a universal use.

Keywords: Hydrological Drought, Upper Indus River Basin, Trend, Mann-Kendall

2. Geohazards and Disasters

40. EFFECTS OF DROUGHT ON AGRICULTURE PRODUCTION IN PAKISTAN

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ABSTRACT

Pakistan is an agricultural nation with a 79.6 million hectare (M ha) total land area and an arid to semi-arid climate. Issues such as water stress, land degradation, and crusting limit the output potential of areas under rain-fed agriculture. Climate change is putting Pakistan at risk, and extreme weather is endangering food security. The creation of high-yielding, heat- and drought-resistant cultivars is required to combat and alleviate the negative effects of climate change. Pulses, also known as grain legumes, contribute around 33% of the world's protein needs for people. Pulses are produced in Pakistan far less than what is needed, and imports make up the difference. Lack of creative crop improvement programs and a seed distribution infrastructure are factors in the low yield and production of pulses. The meteorological drought had a detrimental impact on maize production in south Punjab as a result. During the crucial growth stage of the crop, the yield was susceptible to short-term (1 and 3-month) drought. When strong spatial variability in drought effects persists over time, all the southern districts and a few districts from Central Punjab are growing more and more sensitive to drought.

Keywords: Climate Change, Drought, Agriculture, Crop Yield

3. Geohazards and Disasters

41. DISASTER RISK ASSESSMENT OF PAKISTAN – AN OVERVIEW OF NATCAT MODEL PROJECT

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ABSTRACT

In recent past, there has been a worldwide increase in the impact of natural disasters on global economies and the livelihoods of people. With every passing decade, the frequency and magnitude of these natural disasters have also seen a significant rise. Floods, droughts, Tropical Cyclones/typhoons, earthquakes, and landslides are the major natural hazards that affect infrastructure and human lives, particularly in the Asia-pacific region. Pakistan has been ranked eighth amongst the countries affected by climate change, in a recently released report by the German Watch. In the past 70 years, Pakistan has been struck by major natural disasters, especially floods and earthquakes, and has suffered huge economic losses amounting to \$38b. Kashmir Earthquake 2005, Flood 2010 and Flood 2022 were the most catastrophic events observed in Pakistan causing a cumulative loss of \$45b in addition to the loss of 90,000 precious human lives. Globally, disaster management has shifted from a reactive approach to a more proactive one i.e. focusing on hazard assessment and risk mitigation, to minimize the impact of the natural disasters on economies and livelihoods. The Geo-referenced Exposure Database for Catastrophe (NatCat Model) project will assess hazards posed by natural disasters including hydro-meteorological (flood, drought, Tropical Cyclone), to evaluate the exposure and vulnerability of elements at risk and will quantify its financial impacts at the Tehsil level. NatCat model outputs include hazards, exposure, vulnerability, and risk assessment against natural hazards (flood, drought, and Tropical Cyclone) of varying frequency and magnitude on a national level. Climate change impact on flood (peaks and frequency) and drought severity was also assessed in near, mid and far scenario under SSP245 and SSP585. NatCat Model project output will help decision-makers in the prioritization of Government funds for structure and non-structure measures to be carried out under National Disaster Management Plan (NDMP) 2012-22 (currently under revision) and National Flood Protection Plan (NFPP)-IV. Additionally, it will provide a baseline for the insurance industry entry into the Pakistan market. Finally, the NatCat model will improve institutional capacities, performance, and preparedness at key departments responsible for managing disaster risk in Pakistan.

Key words: Hazard, Modeling, Climate Change, Exposure, Vulnerability, Risk Assessment

2. Geohazards and Disasters

42. PAKISTAN INTEGRATED CONTEXT ANALYSIS (ICA) ON FOOD INSECURITY AND NATURAL HAZARDS

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ABSTRACT

Integrated Context Analysis (ICA) is a corporate programme design tool, used in over 20 countries around the globe. The study aims at applying spatial techniques and triangulation of historic recurrence of food insecurity and natural hazards (flood, drought) to categorize the districts into five different levels of vulnerability. Therefore, provides empirical evidence to support strategic planning and positioning of broad programmatic themes like social safety net, disaster risk reduction (DRR), early warning and disaster preparedness. The overlaying of additional natural hazards and contextual factors (for example degradation, soil erosion, population trend, prevalence of malnutrition etc.) helps to refine broad programmatic strategies. The findings from the study identify districts with high recurrence of food insecurity coupled with high to medium levels of natural hazards in most parts of Balochistan and southern Sindh. While in northern and central Sindh most of the districts are exposed to medium recurrence of food insecurity coupled with high to medium risks of natural shocks. The study findings provide a solid foundation to inform the geographic targeting and decision making of medium-term and long-term broad programmatic strategies.

Keywords: Food insecurity, Natural disaster, Disaster Risk Reduction

2. Geohazards and Disasters

43. FLOOD ANALYSIS THROUGH REMOTE SENSING FOR LOKOJA, NIGERIA

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ABSTRACT

With the frequent and rapid changes in climate, our seasons are always shifting from the norm by the second and unexpected circumstances occur – positive or negative. Shift of seasons is much affecting agricultural production especially in Africa. The Oxford dictionary defines a flood as an overflow of a large amount of water beyond its normal limits, especially over what is normally dry land. It is actually a matter of concern if taken from the World Health Organization's definition that defines it as the most frequent type of natural disaster which occurs when an overflow of water submerges land that is usually dry. From this angle, it becomes a matter of concern to study, monitor and analyze the natural disaster. Several cases of floods have been reported in Africa with results of injuries, death, displacement, infrastructural damages among others. Malawi, Sudan, Rwanda, Kenya, Congo, Nigeria are some of the victim countries. Some causes of floods are long lasting precipitation, snow melts and dam breaks. Flooding is now one of the major outcomes of the frequent climatic changes, when you least expect it, it can occur and it is leaving massive impacts that countries take time to heal from. This is a matter of concern especially in African countries with more less developed countries that already have shaky economies. From this, the study aims to assess flood cases in Lokoja, Nigeria (2022) using the GloFAS – a component of the Copernicus Emergency Management Service.

Keywords: Flooding, Disaster, GloFAS, Disaster Management, Prediction.

2. Geohazards and Disasters

44. FLOOD INUNDATION MAPPING AND RISK ZONATION OF KUNHAR RIVER BASIN, PAKISTAN USING HEC-GEORAS MODEL

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ABSTRACT

Floods are dreadful natural disasters that can damage infrastructure, socio-economic development and human lives. The issue of flood risk management is even more intensified in underdeveloped countries due to substandard water management, insufficient services and provision of a low budget for managing water resources. The primary objective of this study was to map flood inundation zones along the Kunhar River Basin. HEC-GeoRAS was used to create the floodplain map by organizing and interpreting geometric data from the digital elevation model. The Kunhar River's flood size was estimated using river's flood frequency analysis. The annual peak flood, watercourse bank lines, stream centerline, flow path line, XS cut lines, the river's cross-sectional profile, Manning's roughness coefficient, and Kunhar River geometry with different boundary conditions were the input parameters for flood inundation mapping in Hydrologic Engineering Center's River Analysis System (HEC-RAS). After dealing with geometric data, the model's return periods of 5, 10, 20, and 50 years of flood extensions and flow data were integrated into the HEC-RAS. The flood's inundation simulation was produced using a terrain model having 30m resolution. The flow of flood calculated using Hyfran software for different periods was used to delineate the inundation zones. The flow and stage of the Kunhar River were shown on the hydrograph as a function of time. The graph indicated that the maximum flow was 4590 cubic feet per second (cfs) while the minimum flow was 1112.97 cfs. The stage of the water was determined to be 3.8 feet deep, with an elevation range of 11113.7 feet to 11117.5 feet. The greatest water volume was 6535.54 acre feet. The proactive prediction of floods using inundation maps can facilitate in developing water management plans and rehabilitation policies to manage flood inundation and improved decision-making in flood risk protection.

Keywords: Flood risk management, HEC-RAS, TIN, hydrograph

2. Geohazards and Disasters

45. FLOOD SUSCEPTIBILITY ASSESSMENT USING FREQUENCY RATIO MODEL: A CASE STUDY OF DISTRICT GHOTKI AND KASHMORE

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ABSTRACT

Flood disasters have become more frequent in recent years as one of the byproduct of the climate change. Devastating flash floods have recently struck the Northern Punjab and Sindh region of Pakistani leaving a disastrous effect on human life and livelihood in the area. The study was intended to follow a systematic approach using a bivariate probability analysis (frequency ratio) model for the generation of a flood susceptibility map for two flood-prone districts Ghotki and Kashmore located in Sindh. A flood inventory map was prepared with a total of 120 flood locations in each district. These flood locations were randomly split into two groups, one dataset representing 70 % was used for training the models, and the remaining 30 % was used for model validation. Various flood-related factors such as slope, elevation, aspect, curvature, geology, Rainfall, Distance from Road, Distance from the river, LULC, NDVI, TWI & NDSI were included. The impact of each flood-related factor on flooding was evaluated by analyzing each factor with the historical flood inventory data. The training and validation datasets were used to evaluate the flood susceptibility maps using the success and prediction rate methods. The results of the accuracy assessment showed a success rate of 90.4 and a prediction rate of 89.6 for FR, respectively. In addition, a comparison has been made between real flood events in 2010, and 2022 and the resultant susceptibility maps. Hence, it is concluded that the FR model is an effective and reliable tool that can provide acceptable accuracy in the flood susceptibility assessment. Our findings indicate that such flood susceptibility map can assist planners and decision-makers understand the future flood trends that can facilitate in effective planning strategies leading to appropriate flood management and probable flood mitigation in the study area.

Keywords: Flood Susceptibility, Frequency Ration Modelling, Flood inventory map

2. Geohazards and Disasters

46. The significance of landslide mapping and forecasting in mitigating natural disasters – A New Zealand Perspective

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ABSTRACT

New Zealand is prone to geological hazards, and landslides are the most widespread of all, affecting people and economies more than any other natural hazard monitored by GeoNet. To ensure timely information on these hazards, GeoNet constantly monitors earthquakes, volcanoes, landslides, and tsunamis using a combination of ground-based sensors such as Global Navigation Satellite System (GNSS), seismometers, and direct observations that constantly measure and record data related to these hazards. GeoNet uses different data analysis techniques, such as machine learning and statistical modelling, to generate reports, and forecasts to enabling people to understand the associated risks and their impacts in New Zealand. Moreover, GNS Science employs a range of remotely sensed data platforms, from aerial photos to LiDAR, optical multispectral, and InSAR images, to monitor land deformation and map landslides after every significant rainfall or earthquake event.

The landslides mapping feed into provide advanced warning of landslides caused by heavy rainfall events, the Rainfall-induced Landslide (RIL) forecast tool is being developed. The tool combines rainfall data and landslide susceptibility models, developed from storm-specific landslide inventories, to predict when and where landslides are likely to occur. Rainfall and soil moisture data can be static (i.e. to represent various return interval rainfall events) or dynamic (using near-real time rainfall data). The system will assist emergency services and other stakeholders to respond to storm events, make informed decisions about potential landslide risks and take appropriate measures to help mitigate the impact of these events. This tool has the potential to save lives and minimise the damage caused by landslides triggered by heavy rainfall events.

Key words: Landslides, Remote sensing, Rainfall-induced Landslide (RIL), Forecast, New Zealand

3. Agriculture, Food Security, Forest, Biodiversity & Ecosystems

47. HARNESSING THE POWER OF REMOTE SENSING AND MACHINE LEARNING FOR AGRICULTURAL RESOURCES MANAGEMENT IN PAKISTAN

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ABSTRACT

Pakistan has a wide variety of agricultural resources including arable land, livestock, fisheries, and forestry. Agriculture is the mainstay of the economy, contributing approximately 22% to the GDP and providing employment for about 44% of the population along with over 70% of population directly or indirectly linked with agriculture. The country faces several issues in efficiently managing these resources, including inadequate irrigation infrastructure, soil degradation, climate change, and pest infestations. This research paper explores the synergy between remote sensing and machine learning for agricultural resources management in Pakistan. The paper looks at the current state of agricultural resource management in Pakistan, its challenges, and the potential of incorporating remote sensing and machine learning technologies. This includes a review of the current agricultural resource management practices, a discussion of the opportunities and potential of remote sensing and machine learning technologies, and a review of the potential applications of these technologies in managing agricultural resources in Pakistan. A review of recent studies and research efforts in the field is also conducted. The findings of the research indicate that the use of remote sensing and machine learning technologies can significantly enhance agricultural resource management in Pakistan. It can help in the identification of areas with increased crop yields, land use monitoring, crop yield prediction, and soil fertility analysis. Additionally, machine learning can be used to identify crop pests, weeds, and diseases. The research paper concludes that the integration of remote sensing and machine learning technologies into agricultural resource management in Pakistan can provide a cost-effective and efficient approach for improving crop yields and farm productivity.

Keywords: Machine Learning (ML), Precision Agriculture, Climate Change, Crop Yield, Land Use.

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48. THE EFFECTS OF CLIMATE ON HUMAN FERTILITY AND FOOD SECURITY IN PUNJAB, PAKISTAN

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ABSTRACT

The fertility rate is an important demographic phenomenon that has significant implications for sustainable development, particularly in agricultural regions such as Punjab, Pakistan. In recent years, scholars and policymakers have increasingly focused on the link between fertility transition and soil fertility, as soil fertility is an important determinant of agricultural productivity and food security. Climate change increases food insecurity and the main factor of climate change is temperature. This research article will explore the correlation among main factor of climate change fertility rate and soil fertility of Punjab, Pakistan between the year 2000 to 2020. We used Geospatial structural equation modelling (GSSEM) to perform path analysis and distinguish the direct influence of climate change on fertility and its indirect influence on fertility through food security. However, despite its agricultural productivity, Punjab is facing significant challenges related to soil fertility, which is an essential factor in determining the long-term productivity of agricultural lands. There is growing evidence that temperature change, the fertility transition and soil fertility are interrelated. Although, the relationship between fertility transition and soil fertility is complex and multifaceted and can be influenced by various social, economic, and environmental factors. The relationship between fertility transition and soil fertility can also be influenced by various social and economic factors.

Key words: Fertility rate; climate change; soil fertility; Food Security; Geospatial structural equation modelling (GSSEM).

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49. IMPACT OF GHAZI BAROTHA HYDROPOWER PROJECT ON LAND USE/ LAND COVER ALONG INDUS RIVER

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ABSTRACT

Development of run off river schemes is accelerating worldwide because of their perceived safe characteristics, but little work has been done about their impacts on downstream land use/ land cover. Present study focused on the land use/ land cover change caused after functioning of Ghazi Barotha hydropower plant in Pakistan. The study aimed at finding the impact of this project on agriculture, vegetation, bare soil and water. Villages adjoining the river downstream were selected for data collection and analysis. Landsat images from 1990 to 2020 were analyzed for this purpose. Results showed that after the project functioning, there has been major changes in land use/ land cover of the selected area, between 2000 and 2010. Agriculture lands reduced by 8.59% and 18.62% in summer and winter respectively. Consequently, bare soil and vegetation increased. However, between 2010 and 2020, governments' compensatory groundwater development schemes led to an increase in agriculture lands again. Agriculture lands increased by 15.83% and 17.75% in summer and winter respectively, whereas vegetation and bare soil reduced. Technological options and social awareness also contributed to improved state of study area during the same period.

Keywords: Run off River, Ghazi Barotha Hydropower, Indus River, Compensatory Schemes, Groundwater Development.

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50. NATURE-BASED SOLUTIONS TO ENSURE FOOD SECURITY IN THE EASTERN FOOTHILLS OF THE KIRTHAR MOUNTAIN RANGE

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ABSTRACT

Drought and flood are complex disasters affecting water resources, agriculture, livestock, and socioeconomic patterns in the eastern foothills of the Kirthar mountain range in Pakistan. The intra-seasonal variability of rainfall during the monsoon season leads to droughts and floods in this region. Recently, a drought spell during 2013-15 resulted in a large reduction in agriculture yield, on the other extreme, intense rainfall events caused flash floods in August 2022, which affected more than 100 villages and around 800 ha of agricultural land in the region. This study examines the suitability of developing water storage infrastructure to cope with water demand in season and avoid flash floods during intense rainfall events during monsoon. The study showed the strong potential of building a water storage structure to store rainwater during intense rainfall events in monsoon. Subsequently, these structures can help to increase the gross productivity of agriculture as well as enhance the socio-economic status of the local community and farmers living in nearby villages.

Keywords: Rainfall, Agriculture, Water Storage, Arid zone, Pakistan, SCS-Curve Number

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51. GEOSPATIAL AGRICULTURE MONITORING FOR SUSTAINABLE FOOD SECURITY IN PAKISTAN

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ABSTRACT

Agriculture sector in Pakistan faces multifaceted challenges of increased population, limited water resources, low productivity, poor technology use, natural disasters due to weather extremes, global warming and climate change etc. Combating these challenges require a systematic and rapid monitoring for timely decisions. Agricultural monitoring in Pakistan has been manual in character and has manifested high degrees of sampling and non-sampling errors in past leading to economic losses. Remote sensing and GIS techniques being synoptic in nature provide infinite spatial and temporal characteristics for effective and reliable agriculture monitoring over large areas. The national space agency SUPARCO has done extensive work in developing fast track and high precision Satellite Remote Sensing (SRS) and Geographic Information System (GIS) based crops statistics estimation and crops health monitoring system. The in-season crop area estimation is carried out using multi-temporal high-resolution satellite imagery based on image classification and area framing techniques. The crop yield models are developed based on the concept of harmonization and integration of historical satellite vegetation data and ground information, comprising of agro-weather systems, fertilizers and crop statistics regressed to current year's parameters. The application of satellite remote sensing /GIS technology is also being carried out for crop damages assessment due to floods/droughts, land use planning, crop growth dynamics, agro ecological zoning, digital soil mapping, erosion risk assessment and agro-climatic suitability mapping. In order to increase the farm in-put use efficiency, SUPARCO has also embarked on satellite and aerial remote sensing based precision agriculture technologies embedded with digital platforms. An integrated approach has been adopted for digitalizing agriculture using IoTs, data science, big data retrieval from satellites and UAVs equipped with multispectral, LiDAR, hyperspectral and thermal sensors. These advance RS/GIS applications in agriculture sector in Pakistan are not only supporting reliable policymaking based on authentic crops estimates but are also helping in improving crop productivity for sustaining food security in Pakistan.

Keywords: RS/GIS, Crop Estimates, Precision Agriculture, Food Security

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52. GEOSPATIAL ASSESSMENT OF FOREST COVER STATUS UNDER CHANGING CLIMATE IN KHYBER PAKHTUNKHWA DURING 2007-2018

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ABSTRACT

Forest is the major balancing natural source of earth atmosphere system and considered as lungs of life for earth. Pakistan is on high climate risk index and need measures to combat the climate change associated with natural disasters like floods, droughts. Geospatial tools of remote sensing and GIS significantly help in mapping and monitoring of forest resources in past and present scenarios. Current research study is focused on geospatial assessments of Khyber Pakhtunkhwa forest cover status during 2007-2018. Forest assessment is based on evaluation of forest land use land cover mapping, forest cover changes, phenology, density mapping and Eco-zoning. A scientific procedure has been adopted for the satellite data based forest cover assessment which include satellite data mining for availability, data cataloging and pre-processing, satellite data image processing and spatial analytics to generate the forest digital layers and associated statistics. Forest phenology is based on phenological model application on spatio-temporal SPOT vegetation images using Savitsky-Goley method. However, a new method for forest cover density estimation is proposed consisting of three components (i) pixel classification to estimate the forest tree cover (ii) horizontal forest cover density by using spatial 69m x 69m grid (0.5 ha) called spatial gridding and (iii) vertical forest cover density based on biomass index derived from forest phenology matrix. Estimated forest cover using Landsat7/8 stands at 1.466 million ha (2007), 1.509 million ha (2015), 1.546 million ha (2017-18) with 79-97% overall accuracy and 0.71-0.95 kappa. Three phenometric phenological parameters are computed i.e., season length, amplitude and peak index show suitability of climatic conditions for forest growth and biomass accumulations. Maximum estimated forest cover density is highest for 2015 with 82.1% followed by 2017-18 (77.0%) and 2007 (75.5%). Forest cover distribution across seven different eco-zones is Dry Temperature with 57.26%, followed by Moist Temperate (56.92%), Sub-Tropical (32.66%), Sub-Alpine (18.28%), Sub-Tropical Broad Leaved Evergreen (5.98%), Alpine Scrub (2.22%) and Alpine Meadows (0.14%). Overall, geospatially generated forest cover related scientific data will serve as a baseline to develop forest management information system and to address climate change at sub-national scale.

Keywords: Remote Sensing, Forest Cover Assessment, Phenology, Forest Density, Pakistan

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53. PLDR BASED AEROSOL CLASSIFICATION OVER LAHORE CITY USING INVERSION PRODUCTS FROM VERSION 3 OF AERONET

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ABSTRACT

The study aimed at the classification of aerosol types and assessing their temporal distribution in the atmosphere of Lahore. We utilized the particle linear depolarization ratio (PLDR) and the single scattering albedo (SSA) from AERONET version 3 inversion products. Aerosols were classified into pure dust (PD), Pollution aerosols (SA, MA, WA, NA), and Mixtures (PDM and DDM). The highest density of aerosols was in regions of higher angstrom values. The atmosphere of Lahore is dominated by 65 percent Pollution aerosols (33% PDM and 32 % PA) in form of pure pollution and pollution-dominated mixtures. The pure dust (PD) portion is very small only 1.5 % of dust-dominated mixtures with other pollution aerosols forming dust-dominated mixed plumes (33%). The frequency of these aerosol types varies seasonally. DDM (Dust Dominated Mixtures) prevails mostly in the summer and spring seasons, while dust or DDM is not seen but in lesser quantities in colder seasons (only in pre- and post-winter season months). The winter season months are highly polluted with 80% occurrence of pure pollution aerosol dominance. The atmosphere of Lahore is dominated by pollution aerosols with lower PLDR values associated with anthropogenic fine mode pollution.

Keywords: AERONET, Aerosol Classification, PLDR, Pollution

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54. INDICES-BASED MAPPING OF TERRESTRIAL VEGETATIVE LANDCOVER OF KPK

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ABSTRACT

Monitoring spatio-temporal trends and comparative analysis of climatic parameters and vegetation dynamics is essential to sustainable development and ecological integrity. To serve this purpose, the present study leverages cloud-computing-based Google Earth Engine (GEE) to provide spatio-temporal insights regarding LST, precipitation, and vegetation indices over the past two decades (2001-2020) in KPK. The satellite data of moderate resolution imaging spectroradiometer (MODIS) retrieved – vegetation indices (VI's) normalized difference vegetation index (NDVI), enhanced vegetation index (EVI), land surface temperature (LST) along with Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) precipitation data was used over KPK from 2001 to 2020. The correlation analysis indicated a negative correlation between NDVI and LST, indicating that as LST increases, NDVI decreases. The regression analysis showed that LST is a significant predictor of NDVI. On the other hand, the correlation analysis between NDVI and Precipitation showed a positive correlation, indicating that as Precipitation increases, NDVI also increases. The regression analysis also showed that Precipitation is a significant predictor of NDVI. In this study, the Mann-Kendall trend test and Sen's slope estimator test were used to identify the monotonic trend for these climate change parameters. As a result of this analysis, the NDVI and EVI exhibited a slightly increasing trend, with a significant increase in the northern and central regions of KPK, while LST showed a slightly decreasing trend throughout the region. The Precipitation trend showed a slightly decreasing trend in the southern region, while the northern region exhibited a slightly increasing trend. The findings of this study can be useful for better understanding the dynamics of the environment and vegetation in the KPK region and can aid in developing effective land management strategies.

Keywords:

Vegetation Indices, vegetation dynamics, land surface temperature - LST, precipitation, MODIS, GEE.

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55. DNA BASED BIODIVERSITY INVENTORIES: A WAY FORWARD FOR PAKISTAN

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ABSTRACT

Classical taxonomy has long been the cornerstone for understanding biological diversity by categorizing and naming groups of living organisms based on their shared traits. Unfortunately, taxonomic knowledge is declining worldwide, with only a fraction of land and marine species discovered despite hundreds of years of research. DNA barcoding, which allows for quick identification of species without requiring the entire organism, offers a faster and more affordable alternative to traditional taxonomy. Pakistan, a signatory to the Convention on Biological Diversity, has largely unknown biodiversity and a lack of genetic/molecular understanding of it. However, recent advancements in molecular biology offer the potential to quickly and accurately identify species and their role in the ecosystem, aiding in the development of systems to monitor invasive species and track changes in species distributions and abundances in response to climate change. The potential of DNA barcoding/metabarcoding has been highlighted here as an alternative approach for biodiversity conservation, assessment and monitoring in Pakistan, and its implications for the management of invasive species and monitoring of ecosystem changes.

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56. HABITAT SUITABILITY ANALYSIS FOR ENDANGERED HIMALAYAN MUSK DEER IN THE DEOSAI NATIONAL PARK, PAKISTAN

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ABSTRACT

The Himalayan Musk Deer (HMD) (*Moschus leucogaster*) is an endangered species, listed in the International Union for Conservation of Nature (IUCN) Red List, usually found in the highland national park territories of the Himalayan region. High rates of deforestation, overpopulation, rugged topography, human interference, climate change, and rigorous anthropogenic activities have contributed to the degradation of the environment which in turn has resulted in a habitat loss. This study was conducted to identify the habitat suitability of HMD in Deosai National Park by producing a habitat-suitability map using the integrated Habitat Suitability Model (HSM) on various environmental and anthropogenic factors. The digital elevation model derived from the Shuttle Radar Topographic Mission was used to calculate the topographic parameters including slope, aspect, and elevation. The Land use/land cover map of the area was prepared by the European Space Agency's Global Land cover having 300*300m resolution. Additionally, layers showing distance from the rivers and streams, glacial lakes and distance from the roads were also generated for the habitat suitability analysis. The aforementioned thematic layers were reclassified in ArcGIS 10.2 software. Moreover, the Habitat Suitability Index method was used to assess habitat suitability which ranked criteria from 1(unsuitable) to 4 (optimal) and included intermediate values between two adjacent values. The final habitat suitability sites of HMD specie for Deosai National Park were produced by applying the GIS-based weighted overlay technique by assigning the relevant weights and ranking the scale values of the respective classes. The generated wildlife habitat map was classified into four categories based on suitability: optimal, suitable and unsuitable zones consisting of area (1.32%), (78%), and (20.65%), respectively. The methods employed in this study might be pertinent for policymakers and government authorities to develop proactive strategies for managing, preserving, and conserving threatened species in the national park territories of Gilgit Baltistan.

Keywords: Himalayan musk deer, Endangered species, Habitat Suitability, National Parks, Habitat Suitability Model, Habitat Suitability Index

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57. SYNTHETIC APERTURE RADAR (SAR) REMOTE SENSING APPLICATIONS IN AGRICULTURE

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ABSTRACT

Because synthetic aperture radar (SAR) quality is independent of weather, it is a useful and significant technology for monitoring crops and other agricultural targets. SAR has a certain ability to penetrate some agricultural targets and is sensitive to the structural parameters and dielectric properties of the targets. Crop identification and data on crop planting areas, crop and farmland data collection, and crop productivity estimation are the three primary categories under which the competencies of SAR for agricultural applications can be divided. In light of the aforementioned ideas, this study conducts a thorough analysis of previous developments, current issues, and potential prospects in SAR agriculture remote sensing. The SAR data sources that are currently available have been substantially improved thanks to the impressive advancements in SAR remotely sensed devices in recent years. SAR data has gradually increased the accuracy of crop categorization and parameter extraction. However, the modernization of agriculture has raised the bar for SAR remotely sensed data. The authenticity of crop categorization, the monitoring of crop development status for the entire phenological period, the inversion of soil moisture under conditions of dense vegetation, the integration of SAR remotely sensed recall data to model simulations and/or crop development models, and other factors, for example, all need to be improved. Future agricultural remote sensing research will focus on the integration of optical and SAR data, the use of multi-band, multi-dimensional SAR, the accurate and highly effective modeling of electromagnetic scattered light and parametric extraction of composite scenes of crops and farmland, and the evolution of light and narrow SAR systems like those found on unmanned aerial vehicles. This study concludes that SAR remote sensing has enormous potential and will become more important in many agricultural remote sensing applications.

Keywords: Cropland, Yield Estimation, Soil Moisture, Remote Sensing, Synthetic Aperture Radar (SAR)

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58. CROP MODELING USING REMOTE SENSING TECHNIQUES

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ABSTRACT

To forecast the expected yield for uses including crop management & agronomic decision-making, as well as to investigate the potential effects of climate change on food security, crop growth models are used to estimate the link between plants & the environment. The absence of datasets on the real conditions of each farm or region is a significant drawback of crop growth models. The crucial spatial information that crop models need for more accurate yield prediction can be provided through remote sensing. The most recent research on RS data and how it affects crop growth models are reviewed in this study. It examines the primary categories, uses, drawbacks, and benefits of remote sensing technology with crop models. It looks at the key approaches for integrating crop growth models with remote sensing data. The choice of the right scale is looked at in combination with its temporal resolution because the spatial resolution of the majority of remote sensing data ranges from a sub-meter to 1 km. The anticipated future trends are reviewed in light of the newly proposed remote sensing platforms, emerging crop modeling applications, and the anticipated advancement of these models to automatically incorporate the growing number of remotely sensed products.

Keywords: Crop Yield Prediction, Crop Growth models, Remote Sensing Techniques, Spatio-temporal scale

4. Water Resources and Water Cycle

59. SPATIO-TEMPORAL ASSESSMENT OF REMOTE SENSING BASED GROUNDWATER STORAGE VARIATION FOR PAKISTAN

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ABSTRACT

Groundwater is a valuable natural resource that plays a vital part for the economy of any country. It is known as one of the sources for domestic, industrial, and agricultural water usage and makes a major contributor to water storage. Pakistan is a major producer and supplier of food and crops around the world. In recent years, due to climate change and high demand of water, the computation of groundwater storage is very important. The Gravity Recovery and Climate Experiment (GRACE) satellite mission was the pioneer remote sensing satellite that assist to capture the spatio-temporal fluctuation in Terrestrial Water Storage (TWS), which is the total amount of the water masses. The variation in groundwater storage has been computed subtracting the different water variables derived from Global Land Data Assimilation System (GLDAS) NOAH. Groundwater storage variation has been observed yearly as well seasonally for Pakistan and Punjab level. The results show that the groundwater storage in Pakistan and Punjab province has decreasing continuously with alarming rate may due to increase in population, the effects of climate change and transboundary issues. This study contributes to a better knowledge of variations in groundwater storage anomaly across Pakistan and show that GRACE can be used to estimate changes in groundwater storage for developing nations where equally spaced data of in-situ observation of groundwater is not available. It can also provide authorities with the information they need to manage groundwater supplies for future use.

Keywords: Groundwater, GRACE, GLDAS

4. Water Resources and Water Cycle

60. SPATIO-CHEMICAL ASSESSMENT OF GROUNDWATER CONTAMINATION BY LANDFILL LEACHATE USING INVERTED WATERSHED ANALYSIS

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ABSTRACT

Groundwater contamination from landfill leachate is a growing concern for many cities, including Lahore. The purpose of this study was to evaluate the impact of landfill leachate on groundwater in the vicinity of dumping sites (Mehmood booti and Sagian) of Lahore. For this purpose, water samples were collected from drinking water's boreholes. The inverted watershed technique has been used to identify the groundwater in regions that are down slope and surrounding of it from municipal solid waste dumping sites. To comprehend the variations in groundwater contamination, the study was carried out before and after the monsoon seasons. Chemical parameters like pH, Electrical Conductivity (EC), Total dissolved solids (TDS), Total Hardness, Turbidity, Calcium (Ca), Magnesium (Mg), Chloride (Cl), Bicarbonate (HCO₃), Dissolved Oxygen (DO) were included in the analysis. The spatial sample points for selected regions for June (Pre-Monsoon Month) and October (Post-Monsoon Month) were interpolated using the GIS-based interpolation methods. The best interpolation method for selected parameter has been adopted based on Root Mean Square Error (RMSE). According to the findings, the groundwater was found to be more contaminated before monsoon than its counterpart because, prior to the monsoon season, lower rainfall and increased leachate production are likely to have increased the level of contaminants in the groundwater, which prevented the leachate from being diluted or dispersed. Secondly, Leachate contamination with little variation was found in both the downslope and the neighboring regions. The results of this study emphasize the importance of managing landfill sites properly and conducting routine groundwater inspections to avoid contamination.

Keyword: Landfill leachate, inverted watershed, downslope, boreholes, Groundwater Contamination

4. Water Resources and Water Cycle

61. CHARACTERIZING THE VARIATIONS IN GROUNDWATER STORAGE AT LOCAL SCALE USING DOWNSCALED GRACE/GRACE-FO DATA BASED ON A MACHINE LEARNING

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ABSTRACT

Groundwater has a significant contribution to water storage and is considered to be one of the sources for agricultural irrigation, industrial, and domestic water use. While advances through Gravity Recovery and Climate Experiment (GRACE) have facilitated estimating the groundwater storage anomaly (GWSA) in recent years, the coarse resolution of GRACE data hinders the characterization of GWSA variation hotspots. Herein, we present a spatial water balance approach to improve the distributed estimation of groundwater storage and depletion changes at a spatial scale that can detect the hotspots of GWSA variation. In this study, Random Forest Machine Learning (RFML) model was utilized to simulate fine-resolution (10 km) groundwater storage based on the coarse resolution (50 km) of GRACE observations. To this end, parameters including soil moisture, evapotranspiration, precipitation, surface runoff, surface elevation, and GRACE data were integrated into the RFML model. The results show that with a correlation of above 0.97, the RFML model is very successful in simulating the fine resolution groundwater storage over the Irrigated Indus Basin. The findings suggest that the downscaled GWSA is in harmony with the original GWSA in terms of spatial and temporal variations. The validation of the downscaled GWSA results demonstrates that the correlation is increased from 0.67 (previous study) to 0.77 over the Irrigated Indus Basin.

Keywords: GRACE, Groundwater Depletion, GWSA, Machine Learning, Downscaling

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62. GROUNDWATER POTENTIAL ZONES IN GWADAR USING REMOTE SENSING TECHNIQUES

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ABSTRACT

The Gwadar basin's demand for groundwater resources has increased due to the region's rapid population growth. In this paper, we applied scientific ideas and contemporary techniques that will enable precise quantitative evaluation, which is necessary for the sustainable management of groundwater resources. Groundwater potential zones (GWPZs) of Gwadar basins have been identified through an integrated approach that incorporates Remote Sensing (RS), a Geographic information system (GIS), and an analytical hierarchy method (AHP). Nine groundwater occurrence and movement regulating factors, including lithology, rainfall, geomorphology, slope, drainage density, soil, land use/land cover, distance to river, and lineament density, were created and converted into raster data. Nine parameters (thematic layers) were given weights in accordance with their significance. Final map was classified in 4 major classes from poor to best groundwater potential zones to identify the best suited zones in study area. This analysis will identify the area of interest in aspect of best ground water potential zones management in rapidly growing population in Gwadar.

Keywords: Remote Sensing (RS), Analytical Hierarchy Method (AHP), Drainage Density, Land Use/Land Cover, Lithology.

4. Water Resources and Water Cycle

63. LEVERAGING AI AND REMOTE SENSING FOR IMPROVED WATER RESOURCES MANAGEMENT

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ABSTRACT

Nowadays, artificial intelligence (AI) is a developing technology. Simulating human intelligence is a practice that has many uses. AI is evolving quickly in comparison to conventional methods. In a variety of fields, including agriculture, the automotive sector, banking and finance, space exploration, artificial creativity, etc., AI has demonstrated its value. Water management is one of the most important subjects covered in most international forums. The main prerequisites to meet the anticipated worldwide demand of the ongoing water crisis are water harvesting and recycling. In order to do this, we need to focus more on water management strategies that can be used in various contexts. Intelligent water management methods are urgently needed for efficient distribution, conservation, and maintaining the water quality criteria for diverse applications, keeping in mind the population density index. The assigned assignment highlights a few key application areas that are necessary for effective water management. These are current trends in artificial intelligence (AI)-based irrigation management, water distribution, rainfall harvesting, and wastewater recycling. The information gathered for these applications is entirely unique and varies by kind. A model or technique that can be used to deliver solutions across all of these applications is therefore desperately needed. Designing a smart water management system for sustainable water use from natural resources can be facilitated by artificial intelligence (AI) and deep learning (DL) techniques, as well as the Internet of things (IoT) framework. In order to provide a framework for effective water management, this work examines various water management methods and the application of AI/DL, the IoT network, case studies, and sample statistical analysis.

Keywords: Deep learning (DL), artificial intelligence (AI), internet of things (IoT), water distribution, water quality, and water conservation

4. Water Resources and Water Cycle

64. STOCHASTIC COMPARISON OF TRADITIONAL WATER INDEXES FOR SPATIAL MONITORING OF GROUNDWATER

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ABSTRACT

Groundwater is a precious resource on earth that is worst consumed by human beings. This overconsumption leads to the scarcity condition of this resource which can be seen all around the world. Therefore, a perfect management system is required to accommodate this threatened condition. This system will give detailed information about which part of the county is facing more water-scarce conditions. So that, better management and policy-making of this resource could be made. Hence research was conducted in which stochastically groundwater indexes were compared to monitor the groundwater storage of unconfined aquifers. The study is conducted on the Lahore aquifer which is a highly populated and water-scarce city. Multiple indexes were selected which were applied to groundwater depth data of April, July, and October for the period of 2014-2021, taken from (WASA). Contour analysis, pixel count under similar depth to contours, and hotspot analysis were done on the interpolated surfaces. The graphical representation of these methods gave a better understanding of which method should be opted for the estimation of groundwater storage of an aquifer and contour analysis was considered the best one. This method provides discrete variation in the storage change of groundwater. This analysis also gave detailed information about how climate change, rise in population, and change in land cover produce the worst impact on groundwater reserves. The spatial distribution map of contours tells us about the movement of the depression cone over the city. This movement predicts the rising trend of depression cone towards the eastern portion of the city where the new housing societies are formed which reduce the recharge rate of groundwater, and resultantly more abstraction will be taken place.

Keywords: Groundwater, Contour Analysis, Hotspot Analysis, Depression Cone.

4. Water Resources and Water Cycle

65. ANALYSING SNOW-COVER CHARACTERISTICS OF SIACHEN GLACIER USING RS&GIS TECHNIQUES

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ABSTRACT

Snow-cover characteristics such as snow covered areas, snow contaminations, and snow grain size are key input parameters for many hydrological models used for water resource management around the world. Using satellite remote sensing data, we calculated and analyzed these snow cover characteristics in Siachen Glacier and surrounding areas. We calculated snow characteristics using snow indices such as the Normalized Difference Snow Index (NDSI), Snow Contamination Index (SCI), and Snow Grain Size Index (SGI) on Landsat images acquired from TM, ETM+, and OLI sensors from 1989 to 2016. The results show that although the entire study area is mostly covered by snow, however, there is a decreasing trend in it. It was inferred that the least contaminated snow class with small grain size is dominant in the study area and an increasing trend has been observed in this snow class in the study area during the entire study period. The SCI and SGI results of the entire study period are found highly correlated with each other and are heavily dependent upon the precipitation data of the study area. During Pak-India conflict war in Siachen, high snow contamination and more areas having large snow grain size are observed. NDSI, SCI, and SGI results of these snow characteristics of the study area were also compared with the atmospheric data (temperature and precipitation) of this region during the study period and it showed great correlations among them. The study reveals that NDSI, SCI and SGI can effectively be applied to calculate snow-cover characteristics using Landsat sensors.

Keywords: NDSI, SGI, SCI, Landsat Data, Siachen Glacier.

4. Water Resources and Water Cycle

66. QUALITATIVE AND QUANTITATIVE ANALYSIS OF GROUND WATER FOR IRRIGATION PURPOSES BY USING GIS TECHNIQUES IN OKARA, SAHIWAL AND KHANEWAL DISTRICTS, LAHORE, PAKISTAN

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ABSTRACT

Irrigated agriculture is the major determinant of economic growth potential as it accounts for 20 % of the GDP of the country and caters to around 50 % workforce of Punjab Province. Current study focuses on qualitative and quantitatively assessment of groundwater in three districts i.e., Okara, Sahiwal and Khanewal of the Punjab province considered as highly fertile for agriculture production. The Spatio-temporal variability analysis of groundwater quality and quantity in study area were investigated by using Geographic Information System (GIS) techniques. Water quality and quantity data were acquired from Punjab Irrigation Department for last 10 years in order to assess the spatio-temporal patterns during this time span. Provided data were processed and rectified in Arc GIS 10.7 software and geodatabases were prepared from excel sheets. Subsequently, mapping of depth to the water table, electrical conductivity (EC), sodium absorption ratio (SAR), and residual sodium carbonate (RSC) were done as per the guidelines/standards of World Health Organization (WHO) and Punjab Irrigation Department (PID) using statistical approach (interpolation). Results revealed that overall water quality in study area was reported fit in accordance with WHO standards, whereas as per Punjab irrigation Department standards, quality of water observed moderately fit. Whereas, in Sahiwal, Okara, and Khanewal, districts, it was found that average depth to the water table declined from 2010 to 2015 by 2.032, 4.221, and 0.54 feet respectively, and then increased from 2016 to 2020 by 5.571, 4.665, and 2.724 feet. Although currently the quality and quantity of groundwater were not in critical condition but with continued carelessness and the release of additional water from aquifers, these conditions could deteriorate in the near future. This study advocates the significance of GIS techniques to assess groundwater quality and quantity in an efficient manner. Keywords: Groundwater Quantity, Irrigation purposes, GIS technique, Groundwater Quality, Interpolation, Geostatistical Analysis

4. Water Resources and Water Cycle

67. POTENTIAL SITES SELECTION FOR RAINWATER HARVESTING IN KOTLI, AJK, PAKISTAN

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ABSTRACT

Different geospatial techniques were applied to optimize Rainwater Harvesting (RWH) solutions. A comprehensive methodology has been implemented for the selection of potential sites for RWH in district Kotli, Azad Jammu and Kashmir, Pakistan. Various datasets i.e., soil, Digital Elevation Model (DEM), Sentinel 2 image, and rainfall were obtained from different sources. Four thematic layers i.e., Land-use/landcover, slope, drainage density, and runoff depth were prepared. These thematic layers were generated using three different datasets: Shuttle Radar Topography Mission (SRTM) DEM, Sentinel 2 satellite image, and soil data. Curve number Grid was obtained by Soil Conservation Service – Curve Number (SCS-CN) method using Hydrologic Engineering Center's Hydraulic Modelling System (HEC-HMS) extension in GIS environment from soil and land-use/landcover data. Runoff depth layer was derived from rainfall data and CN. Drainage density layer was created by using Interpolation method of Inverse Distance Weighting (IDW) from SRTM DEM data. Landuse/Landcover layer was generated using supervised classification method in GIS environment from Sentinel 2 Image. Weights were assigned to all four thematic layers according to their importance. Weighted overlay operation was applied in a GIS environment and land suitability for RWH potential sites map was generated. This suitability map was classified into three suitable regions i.e., high suitability region 616.45 km² (32.93%), medium suitability region 1122.26 km² (59.95%), and low suitability region 124.68 km² (6.66%). Accumulation points (low suitable points, high suitable points, medium suitable points) were incorporated on the down streams for estimation of artificial water capturing sites (i.e., Check Dams).

Keywords: Geospatial, GIS, Site Suitability, SCS-CN Method

4. Water Resources and Water Cycle

68. EVALUATING THE CHANGING RAMSAR WETLANDS IN PAKISTAN THROUGH GEOSPATIAL TECHNIQUES

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ABSTRACT

Wetlands have paramount importance in today's fragile nature where constant degradation and overexploitation are causing the depletion of vital ecosystems, leading toward the elimination of many vital plants as well as animal species. Therefore, continuous monitoring and assessments are inevitable as the overutilization of wetlands is being accelerated by human activities mainly through agricultural practices worldwide. Thus, we choose to study internationally—important Ramsar wetlands sites of Pakistan which were designated in the Ramsar convention. There are 19 Ramsar sites (total) located in all four provinces of Pakistan, however, Sindh holds most of them (03 in Punjab, 09 in Sindh, 05 in Balochistan, and 02 in Khyber Pakhtunkhwa (KP)). The temporal period selected was from 2013 to 2021. We used Landsat 8 imageries. We employed well-known remote sensing tools to map the Ramsar sites through supervised image classification with high-quality standards (accuracy assessed). We devised Land-use/landcover (LULC) into seven unique classes, i.e., Water, Tree-Cover, Vegetation in water, Cultivated crops, Built-Up land, Barren land, and Homogenous grasses. Results revealed that water bodies mostly increased. In Punjab, water has an increasing trend (all sites), tree-cover decreases in one, (water in vegetation decreases), crops and built-up are increasing whereas homogeneous grasses and barren land are decreasing in trend. In Sindh province, water exhibits an increasing trend in three and decreasing in five sites, trees are decreasing in five, vegetation in water is also decreasing in 6 sites, crop-land is increasing in four whereas homogeneous grasses and barren areas are also increasing in seven and two sites, respectively. In the remaining sites of KP and Balochistan, water has an increasing trend whereas other land covers also display certain variabilities. These variabilities are seemed to be associated with climate change and anthropogenic activities which necessitate further studies to advance our understanding of these vital wetlands.

Keywords: Geographical Information Systems (GIS), Land-use/Landcover (LULC), Ramsar sites, Wetlands, Ecosystems.

4. Water Resources and Water Cycle

69. INNOVATIONS IN SURFACE WATER MONITORING USING SATELLITE IMAGES, DRONES, AND ONLINE TOOLKITS

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ABSTRACT

In this era, water resources management and policies are the principal priorities for all countries. Surface water quality and quantity are highly affected by climate change. Earth observer satellites (EO) are advanced technologies that play a vital role in surface water semi-online monitoring. Additionally, EO and drones' images elevate data collection from inaccessible areas, glaciers, and remote reservoirs.

Recent innovations in satellite images, drones, and related toolkits give a more comprehensive view of surface water monitoring on global to local scales than ever before. The enhancements of spatial, spectral, and temporal resolutions of Satellite images open new ways to the evaluation of the surface water movement, altimetry, and temperature changes precisely and also for real-time inundation tracking. From this point of view, Surface Water Ocean Topography (SWOT) satellites which include a Ka-band radar interferometric, be equipped with a Ku-band altimeter and microwave radiometer to monitor the entire Earth's surface. Moreover, Gravity satellite and Gravity Recovery and Climate Experiment (GRACE) and its follow-up mission (GRACE-Fo) are satellite missions addressing Earth's water movement around the globe. Along with, EO satellites, drones are used widely as reliable, cost-effective, and rapid remote data collection tools on local scales. Drones pave the path to produce a Digital Elevation Model (DEM), measure the temperature of riverbeds and lakes and also, analyze flood disaster responses. In this case, RSS-Hydro projects use drone technology as a complementary tool to evaluate flood risk models and validate satellite-derived products.

Simultaneously with the progression of satellites, image processing online toolkits bloomed. These toolkits like Sea-level toolkits and Water Tracker allow users to process satellite data on their local steam and lakes anywhere in the world to help decision-makers to get ready for the effects of the sea rising, flood monitoring. On the other hand, Google Earth Engine (GEE), accelerates processing of big data compiled with EO Satellites, helps users to share modules.

The advancements in the new generations of satellites, drones, and toolkits help planners and managers to make better decisions about water resources management and prepare detailed operational plans combating with floods and drought.

Keywords: Surface Water Monitoring, Drones, GRACE_Fo, SWOT, Toolkits

4. Water Resources and Water Cycle

70. UNCERTAINTIES IN HYDRO-CLIMATIC MODELLING UNDER CHANGING CLIMATE

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ABSTRACT

The high climate sensitivity of hydrologic systems, the significance of these systems to society, and the imprecision of climate projections for the future all stimulate interest in defining uncertainty in the hydrologic implications of climate change. It is now widely accepted that climate change will have immediate and long-term effects on the global availability and management of water resources. All hydrological models can be classified into three fundamental categories of uncertainty: measurement, structural, and parametric. Inaccurate measurements of variables and attributes contribute to the problem of measurement uncertainty (e.g., stream flows that are typically an output and rainfall that serve as an input to hydrological models). Inaccuracies in the mathematical representation of actual hydrological processes generate structural uncertainty. Insufficient calibration data and the inherent inaccuracy of structural and measurement-based approaches add to a degree of parametric uncertainty. Despite the fact that scholars have studied measurement and parametric uncertainties, there has been a paucity of research on structural uncertainty. To be more specific, there is no known model for determining the magnitude of structural uncertainty in an unmeasured area.

4. Water Resources and Water Cycle

71. GEOSPATIAL BUDGETING FOR DRINKING WATER SUPPLY IN LAHORE RESIDENTIAL REGION: COST EFFECTIVE ALTERNATIVES

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ABSTRACT

This study is carried out to find the cost of pumping drinking water from various tubewells which is being pumped by Water and sanitation system (WASA) in different subdivisions of Lahore district, the provincial capital of the Punjab, Pakistan. It examines the depth of different tubewells and find out how cost changes with different level of depth. It discusses how with the passage of time the area having more depth is increasing and as a result, cost is increasing. Tools and methods of ArcGIS 10.3 are applied in this study. Static water level (SWL) data of 219 tube wells along with longitudinal and latitudinal data for 31 subdivisions of Lahore district for years 2015 and 2021 are taken from WASA department. Different methods of interpolations are performed but Ordinary kriging having lowest mean 0 and 0.05 and root mean square error (RMSE) 1.98 and 2.42 for dataset of 2015 and 2021 is selected for further observation of groundwater. It is found in results that in order to pump water from lowest depth that is 10 meters, 1.2×10^5 Joules of gravitational Potential energy and 3×10^{-2} kilowatt per hour of electricity is required. On the other hand, to pump water from highest depth of 52 meters, 6.3×10^5 Joules of gravitational Potential energy and 17×10^{-2} kilowatt per hour of electricity is required. So, it is recommended that by shifting the tube wells from subdivisions of Lahore district where depth is high to subdivisions where depth is low, energy usage and cost of electricity can be effectively decreased. In addition to this, shallow water is safe for drinking and in this way, cost of purifying the water can also be minimized

Keywords: Drinking water supply, Ground water, Interpolation, Ordinary Kriging, Gravitational potential energy.

5. Marine and Coastal Environment Resources and Dynamics

72. A COMPARATIVE ASSESSMENT OF SUSPENDED SEDIMENT CONCENTRATION IN INDUS DELTA REGION USING LANDSAT 8 AND SENTINEL 2

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ABSTRACT

Satellite remote sensing is now being utilized as a potential tool for computing multifarious water quality parameters over larger scales. Suspended Sediment Concentration is a key water quality constituent which influences the formation of river channels and floodplains. The in-situ SSC measurements are spatially inconsistent, time-consuming and costly in comparison to the remotely sensed SSC. This study seeks to investigate the comparison of employing Sentinel-2 and Landsat 8 in quantifying the concentration of suspended sediments in the Indus Delta Region. The radiometric performance of Sentinel 2 and Landsat 8 is assessed by utilizing in-situ and above-surface reflectance data empirically calculated using geographically weighted regression. 20 stations were used for the field measurements out of which 30% of the data is utilized for validation, with 70% of the data used for calibration between in-situ measurements and spectral band values for coefficients computation. The validation result demonstrates that the band combination of the NDSSI and the band ratio B7/B2 gives a high correlation with an R^2 value of 0.83 for Landsat while the R^2 value for Sentinel 2 was greater than 0.83. Spatial variation of SSC in wet and dry period was evaluated temporally alongside the performance of Sentinel and Landsat in SSC retrieval. Sentinel 2 outperformed Landsat in SSC estimation however the temporal limitation of Sentinel gives Landsat a step forward in long-term time-series monitoring. Better results were obtained using the Sentinel-2 spectral bands in order to estimate the SSC, with an R^2 value greater than that of Landsat and an error less than 20% in adjusted models. The results suggest that radiometric capabilities of Sentinel 2 are suitable for monitoring the spatiotemporal dynamics of Suspended Sediment Concentrations.

Keywords: Suspended Sediment Concentration, Indus Delta Region, Remote Sensing, Sentinel, Landsat.

6. Urbanization, Sustainable/Smart Societies & Industrialization

73. ASSESSING POTENTIAL OF LIDAR DATA FOR 3D MODELLING

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ABSTRACT

In the present study, LIDAR data has been exploited for various application areas including; (1) Change Detection Analysis in Wolli Creek, Australia pertaining to urban planning and tree canopy for a span of 7 years. Change analysis were performed, which inferred to urban change detection (2) Building reconstruction using point cloud data. Creating a 3D model by utilizing point cloud data accuracy. (3) Detection of elevation anomalies in Blenheim, New Zealand. Detecting temporal height profile changes using Lidar data. (4) Classification of LIDAR data, Area, New Zealand. Classifying multiple features of point cloud to measure its accuracy. (5) Terrain Profile Comparison of Lidar Dem and Nasa Dem in Khuzdar, Pakistan, and (6) Bare Earth Modelling in the Hood Canal and Mount Rainier, USA. illustrating the potential of LIDAR data in revealing the topography of the Earth Surface as compared to other elevation datasets.

The study concludes that LIDAR data has great potential for 3D surface analyses, reconstruction of 3D buildings, DEM generations, elevation analyses, bare soil analyses, and 3D terrain profiling etc.

Keywords: LIDAR, Point Cloud, 3D surfaces, DEM, 3D analyses, etc.

6. Urbanization, Sustainable/Smart Societies & Industrialization

74. SATELLITE BASED THERMAL PROFILING OF GROWING CITIES IN RELATION TO LAND TRANSFORMATION

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ABSTRACT

Mankind has been affecting the regular habitat on earth for quite a long time, bringing about various types of land use. Industrialization and urbanization both have played major roles in making the environment unsustainable by bringing about unfavorable changes in land covers and regional climate. The surprising ascent in the Land Surface Temperature (LST) is playing crucial part towards the quick and serious alterations in worldwide environment. The data from Landsat satellites having path row pairs of 149,038; 150,038 and 150,039 for the years 1989 to 2018 were used to study the cause and effect relationship between LST and some land cover classes for the two metropolitan cities of Punjab, Faisalabad and Gujranwala. Multivariate statistical methodologies of correlation coefficient and scatter charts were utilized. LSTs, built-up area and vegetative regions were processed utilizing a blend of various tools in an explicitly planned model. Univariate statistical strategies were also employed to do run time analysis of the individual variables on the basis of their trend line. Deep statistical analysis on run-charts suggests splitting up of the study timeframe into two windows on the basis of second polynomial curve. A 21-year span: 1989 to 2010 (Temporal Window-1) and an 8-year period: 2010 to 2018 (Temporal Window-2) were analyzed separately for same arguments. A terrific rise in built-up area is perceived in the developmental era (Temporal window-2) for Gujranwala and alarming decrease in vegetative area is observed for Faisalabad. It is observed that the magnitudes of the correlation coefficients are changing and so the thermal control. The maximum correlation coefficients observed for vegetative and built-up area with mean LST were -0.97 and 0.39 for Faisalabad whereas it was -0.38 and 0.55 for Gujranwala respectively. Sustainable government policies are suggested in order to provide favorable environment for living.

Keywords: LST, Thermal Controls, LULC, Correlation

6. Urbanization, Sustainable/Smart Societies & Industrialization

75. A SPATIOTEMPORAL ANALYSIS OF LAND USE AND LAND COVER IN PUNJAB, PAKISTAN

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ABSTRACT

Land use land cover (LULC) change is linked with urban land usage and vegetative loss. The normalized difference vegetation index (NDVI) is used in vegetation studies for the monitoring of vegetation status. Changes in vegetation cover can be covered using this graphical indicator. Likewise, the NDBI (normalized difference vegetation index), is used for built-up areas. The current research objectives include the identification of changes in LULC, NDVI, and NDBI in Punjab, Pakistan, during the last 18 years (2002–2020). This study targeted four major LULC classes: built-up areas, barren land, forest, and cultivated land of MODIS LULC product. The results of the study showed that significant increase in built-up area in last 18 years. Similarly, MODIS NDVI trend analysis showed a drastic decreasing trend in last 18 years in Punjab. The significant increasing trend of NDBI showed that the overall built-up of Punjab has increased. Google Earth Engine has been used for the trend analysis and the correlation between different products has been presented. The findings of this study, especially the causes and impacts of rapid LULC variations in Punjab, need immediate attention from related government departments and policymakers. There is a clear association between changes in land use and land cover classes and changes in NDVI and NDBI.

Keywords: Climate change, Land use and land cover, remote sensing, built-up index, vegetative index.

6. Urbanization, Sustainable/Smart Societies & Industrialization

76. URBAN DAMAGE DETECTION USING SENTINEL-1 DATA IN TURKEY AND SYRIA EARTHQUAKES

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ABSTRACT

Satellite based disaster management have become a substantial tool to monitor and evaluate events like earthquakes (EQ). In this paper, we analyzed the 7.8-magnitude earthquake that occurred in the middle of Turkish and Syrian region of Kahramanmaras on February 6, 2023. With almost 30,000 fatalities to date, the earthquake was one of the strongest and deadliest in the past ten years. The border province saw several fatalities, and the destruction of local emergency services, hospitals, and infrastructure made it more difficult to respond. we acquire and analyze the SAR data prior to and during the earthquake in 2023 to produce useful and actionable maps for disaster managers to use when making decisions. In this study, we generated road maps that are obstructed because of earthquakes. Furthermore, Sentinel-1 data images were utilized to detect urban areas damages through correlation between before and after images of impending EQ. This Research gives details on the damage and evaluates present conditions after the earthquake, which can aid in the analysis of sensitive situations surrounding this disaster.

Keywords: Sentinel-1, Earthquake, Change Detection, Natural Hazard, Disaster Monitoring.

7. Public Health

77. LOCATION MATTERS: A SPATIAL TURN IN APPLIED HEALTH RESEARCH

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ABSTRACT

Location plays a vital role in determining individual and population health. Geographic Information Systems and Science facilitate us to analyze and model the interaction between people, environment, health, and social aspects at the local and global scales. The results pave the way to identify gaps in health care delivery, disease management, and targeted interventions, to make informed decisions and carve evidence-based public health policy. Several applications of spatial analytical modeling from four continents are presented including Canada, Italy, Iraq, and the WHO African region. Examples include geographical variation in Hepatitis C prevalence, material and social deprivation indices and their association with health outcomes, identifying gaps in ground and air ambulance services, osteoarthritis and co-morbidities, school location and air pollution, spatiotemporal analysis of Lassa Fever and asthma-related emergency visits, excessive mortality due to Covid-19 in Italy, modernizing the primary health care system in Iraq to enhance immunization coverage, major outbreaks and related environmental and social factors in the WHO African region during the last five decades, water quality analysis, health human resources planning, and spatial dynamics modeling of childhood overweight and obesity.

8. Public Health

78. SPATIAL MULTI-CRITERIA ANALYSIS: CASE STUDY OF LANDFILL SITING IN SHEIKHUPURA, PAKISTAN

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ABSTRACT

The management of solid waste has become a complex issue in the past years due to the rapid socioeconomic development and its increase in waste production. The correct management of solid waste presupposes the reduction of solid waste, as well as its correct final destination, the most conventional being the landfill. In view of criteria and restrictions of a social, economic, environmental, and technical nature for the determination of the ideal place for the implementation of a landfill, this work carried out aptitude assessments in the Sheikhupura Tehsil, Pakistan, using multicriteria method Analytical Hierarchy Process (AHP) integrated with a Geographic Information System (GIS) for the systematization of the criteria. The study divided the criteria into environmental and socio-economic, taking into consideration the available geospatial data. The results indicated several areas with high aptitude for landfill allocation in the Tehsil. Additionally, the methodology can be reproduced and adapted to other areas, to obtain a preliminary study of the favorable and unfavorable areas for the implementation of landfills. Thus, it can help in the development of studies with the theme in question and in reducing operational costs and impacts on the environment. The biggest challenge with this study was the data availability and the difference in scales for the used data.

Keywords: Landfill siting, Multi-Criteria Decision Making, Spatial Analysis, Analytic Hierarchy Process, Spatial Data Infrastructures.

6. Change and Adaptation in Deltaic and High Mountain Systems

79. SPATIO-TEMPORAL ANALYSIS OF MASS BALANCE OF HUNZA BASIN GLACIERS IN RELATION WITH CLIMATIC VARIABILITY

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ABSTRACT

World's largest glaciers lie in Hindu Kush Himalayan (HKH) outside polar region, are the source of fresh water which accommodates the needs of millions of people living downstream. Glacier melting due to global warming at alarming rates has horrible concerns of water scarcity. Due to complex terrain of these glaciers, it is difficult to conduct field survey and lack of in-situ data, current research focuses on using geospatial tools and remote sensing to get baseline information about the glaciers of this region. The main goals of the study were to figure out mass balance of glaciers and study its relationship with climate variability in Hunza Basin. Landsat-8 datasets were used for mapping Hunza Basin glaciers (2013 - 2019). The raw data was processed and snow index (NDSI) was applied to get enhanced results. The study was distributed into two periods based on snow accumulation (December to April) and snow ablation (June to October). There was a fluctuating trend in mass balance observed for the glaciers of Hunza basin. Negative mass balance was observed due to increase in minimum temperature of winter and maximum temperature of summer. Hispar, Batura, Yazgil and Virjerab glaciers showed negative mass balance because of 0.8°C increase of minimum winter temperature and 1°C rise of maximum summer temperature from given period were -11.95, -4.11, -4.58 and -2.06 mwe, respectively. However, positive mass balance was observed for Khurdopin glacier with 5.05 mwe. This study will be helpful in understanding the behaviour of glaciers due to changing climate and their corresponding water resources downstream.

Keywords: Mass Balance, Hunza Basin, Climate variability

8. Change and Adaptation in Deltaic and High Mountain Systems

80. MONITORING SURFACE WATER LEVEL CHANGES OF THE OLD WIVES LAKE USING REMOTE SENSING TECHNIQUES.

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ABSTRACT

Old Wives Lake, situated to the southwest of Regina, is a shallow lake that serves as a migratory bird sanctuary. With an area of 26,060 hectares, it is the second largest saline lake of Canada and the fourth in North America. The temporal changes caused by atmospheric variation can affect its eco-system and thus requires continuous monitoring. Satellite images can be highly useful to record these changes. This study presents temporal changes in surface water of the old wives lake over the period of 20 years using Landsat data. Different surface water extraction techniques were evaluated to extract surface water boundaries using satellite images. Polygons representing surface water were extracted from Landsat images acquired in September of each year for the last 20 years, to compare temporal changes. This comparison revealed that surface water area had started to decrease in 2005 and was at its minimum level in 2009. When these results were compared with the annual water inflow data of creeks/rivers feeding the lake, it was discovered that annual water inflow started decreasing in 2004 and was at a minimum in 2008. This indicated that surface water contraction had a lag of one year. However, extraordinary higher annual water inflow of 2011 has fully regarded the lake and the surface water area has remained consistent after 2011.

Keywords: Remote Sensing, Temporal Changes, Water Indices, Digital Elevation Model

9. Geological studies, mineral resources and applications

81. INTEGRATED GIS-BASED MINERALS INFORMATION & SERVICES PORTAL

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ABSTRACT

The world has witnessed immense scientific and technological advancements in the modern digital era. We are heavily relying on minerals and mineral based products in almost every aspect of our modern lives. Mining and minerals-based industries can bring extensive economic benefits to Pakistan. However, Pakistan lacks development sources and is otherwise unattractive to foreign investors.

Pakistan is blessed with considerable number of mineral reserves with 66% outcrop area and ranked as one of the top ten with respect to key natural resources. During the fiscal year 2021, Pakistan's export volume of mineral products was just 4.3% of the total exports (US\$25.3 billion) whereas import volume was 30% of the total imports (US\$56.38 billion) having an export/import deficit of approximately US\$16 billion. Increasing demand for minerals and widening trade deficit requires the government's attention to industry transformational interventions.

The required ecosystem should be attractive for investment while having transparent and stable policies and should cover all critical dimensions of the mining value chain. 'Access to Geological & Minerals Data' as well as 'Ease of Doing Business' are the basic needs and direly required steps to enable a conducive and encouraging environment for investment and mineral sector growth.

The Government of Pakistan (Ministry of Energy and Ministry of Planning) is implementing a PSDP Project "Establishment of National Minerals Data Center" in close consultation with the Provincial Mines & Minerals Departments including Gilgit-Baltistan and Azad Jammu & Kashmir etc. An integrated 'GIS-based Minerals Information & Services Portal' is being developed to provide online access to basic geological, minerals and topographic data along-with provision of numerous e-services aimed at investment facilitation, encouraging & enabling business opportunities and ensuring transparency. The portal will act as One-Window operations, it is being developed on the modern lines and is expected to be launched during Nov-Dec, 2023.

9. Geological studies, mineral resources and applications

82. SAR DATA APPLICATIONS FOR ARCHEOLOGICAL EXPLORATION IN THE HISARA DHERAI (BALA HISAR) CHARASADDA DISTRICT

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ABSTRACT

Charsadda one of 35 districts in Khyber pakhtunkhwa with an ancient name Pushkalavati has great archeological importance, and believe to be the capital of Gandhara civilization according to General Alexander Cunningham. This research aims to explore and test the SAR sentinel-1 data potential in the three tehsils (Shabqadar, Tangi and Charsadda) of Charsadda district. Bala Hisar commonly known as Hisara Dherai is one the archeological site preserved by department of archeology Khyber pakhtunkhwa. Moreover, the proxy indicators visibility interconnected to the palaeo-geological and ancient archaeological features, depends on various aspects, this includes due to the presence of topographical features, variation in the presence moisture content, and seasonal changes of vegetation cover. For this purpose data collection had been carried out and data was collected from department of archeology Khyber pakhtunkhwa and through field visit for each of 132 sites to collect geographical coordinates. The time series backscatter values for both the viewing angle and polarization of year 2020 were extracted using cloud-based platform Google-Earth-Engine mostly used for analysis of satellite data. The month of June is selected to analyze and compare sentinel-1 data with sentinel-2 and Google earth imagery. Both VV and VH polarization in descending pass gives acceptable results. The features that are identified in both polarization is due to the present of soil moisture content and subtle variations in the ground surface. Compared to optical imagery SAR investigation for interpretation of archeological features are more complex and offer noise covered subtle signals. These finding demonstrate the potential of Sentinel-1 data for identification of archeological sites and provides valuable insights to use SAR data for heritage management and preservation.

Keywords: Pushkalavati, Gandhara civilization, Hisara Dherai, soil moisture, C-band.

9. Geological studies, mineral resources and applications

83. REMOTE SENSING TECHNIQUES USING ASTER DATA FOR LITHOLOGICAL IDENTIFICATION AND MINERAL EXPLORATION OF WAZIRISTAN OPHIOLITES, NORTH WEST PAKISTAN

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ABSTRACT

Remote sensing includes accretion, processing, and deciphering images and related data that memoir the interaction between matter and electromagnetic energy. Remote sensing technique requisite in mineral exploration includes: (1) map geology and the faults and fractures of ore deposits; (2) observe hydrothermally altered rocks by their spectral signatures. Remote sensing in mineral exploration aid miners locate and evaluate deposits without having to undertake massive exploration operations. The study area of this research is Waziristan Ophiolite, located in the suture zone between the Indian Plate and Afghan Block. It includes three main sheets or nappes which are: the Vezhda Sar Nappe, the Boya Nappe and the Datta Khel Nappe. The satellite image acquired for this purpose is Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), which is processed using Flaash Atmospheric Correction to cast off the radiation errors, Principal Component Analysis (PCA) to select uncorrelated linear combinations, Band Ratios (BR) to effectively extract information by enhancing the spectral signature differences, Minimum Noise Fraction (MNF) to segregate noise in the data, Decorrelation Stretch (DS) to produce a more colorful color composite image and improves the visualization and Maximum Likelihood Classification to assumes the statistics for each class in each band are normally distributed. The derived results show that BR, PCA, MNF and DS strategies discriminated the ophiolitic rocks at a regional level which consists of the ultramafic i.e., harzburgite, wehrlite and dunite, the mafic i.e., gabbro, the volcanics i.e., basalts which is covered by pelagic sediments which are limestone, chert and shale. The results of this study indicate that the unification of information unsheathe from the image processing procedures could be a widely pertinent tool for minerals prospecting and lithological mapping in hilly and inaccessible terrains such as Waziristan Ophiolitic Zones.

Keywords: Nappe, Spectral Signature, Pelagic Sediments, Electromagnetic Survey, Lithological Mapping.

10. Data and Information Systems and Spatial Data Infrastructures

84. EARTH REMOTE SENSING WITH SYNTHETIC APERTURE RADAR (SAR)

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Synthetic Aperture Radar (SAR) is a special form of active radar, which uses pulse compression and Doppler history to improve range and azimuth resolution, respectively, for high-resolution imaging. Typical spaceborne SAR spatial resolutions are on the order of a few meters. Although SAR imaging offers many advantages over optical remote sensing, such as weather and time-of-day independence, it is inherently a more difficult remote sensing process to understand with difficult visual interpretation. The data processing, interpretation, and analysis of SAR remote sensing data requires unique background knowledge and skillsets as compared to remote sensing in the optical wavelengths. This talk will introduce SAR as an imaging radar instrument, and specific applications related to oceanography and sub-surface imaging will be discussed.

10. Data and Information Systems and Spatial Data Infrastructures

85. ACTIVE FIRE MONITORING IN CHILE USING GOOGLE EARTH ENGINE: AN ANALYSIS OF MODIS, GOES, AND FIRMS DATASETS

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ABSTRACT

Wildfires have been a growing concern in many countries, including Chile, where recent wildfires have caused widespread destruction. In this study, we used Google Earth Engine based datasets, including MODIS active fire, MODIS burned area, GOES and FIRMS, to monitor the status of active fire and burned areas in Chile between 22nd December 2022 to 12th February 2023. The study area focused on the recent wildfires in the country. The data was processed and analyzed to obtain different characteristics of fire, including the extent and intensity of fire spread and the burned area. Our results show the potential of using satellite-based datasets in conjunction with Earth Engine to effectively monitor and assess the impact of wildfires on the environment. This information can be used to support informed decision-making and disaster response efforts in the future.

Keywords: Google Earth Engine, MODIS active fire, MODIS burned area, GOES, FIRMS, wildfires, Chile, active fire, burned areas, wild fires, analysis.

10. Data and Information Systems and Spatial Data Infrastructures

86. GIS BASED SEVERITY INDEX ANALYSIS OF ROAD TRAFFIC CRASHE

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ABSTRACT

This research plans to identify hotspots, hot zones, and the hazardous time intervals in the Lahore District by applying the Spatial, Non-Spatial, Temporal, and Spatio-temporal analysis on recorded Road Traffic Crashes (RTCs) data by rescue 1122. Because in the reduction of the rate of crashes and need deep information about the occurrence of crashes rather than general information. Many procedures have been invented to highlight RCs (hotspots and hot zones). Seven main strategies were chosen in this thesis for 1,172km² study area. Firstly, exploratory study that utilized the quantitative or non-spatial approach in examining RTCs data to recognize hazardous locations (Hotspots & Hot Zones). Secondly, three spatial techniques were used to find dangerous spots and zones. Furthermore, through different illustrations and visualizations tools was utilized for better understanding of RCs can be realized. A Comap method of Spatio-temporal analysis, Python, Tableau & Excel Based analysis for temporal and hotspots identification, Kernel Density Estimation (KDE), Crash Severity Index & Hot zones analysis for hotspots and hot zones determination. The hot zone methodology helped to move a step beyond hot spots by identifying hazardous towns of road that extended over continuous segments. Getis Ord & Global Moran's I Index (MI) were also applied for spatial autocorrelation, nature of data (Clustered, Random or dispersed), and hot & cold spots identifications. The results show that the most dangerous hot spots identified are predominantly located inside hot zones. In addition, these hot spots and hot zones are located in north areas and primarily in the old Lahore. The latter are the busiest zones of the district. The most densely populated towns also appear to present the highest number of hot spots and hot zones.

Keywords: Road Traffic Crashes (RTCs), rescue 1122, Hotspots, Hot Zones.

10. Data and Information Systems and Spatial Data Infrastructures

87. THE EUROPEAN INSPIRE DIRECTIVE: ITS APPROACH AND LESSONS TO LEARN

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ABSTRACT

The INSPIRE initiative, entered into force in May 2007, was initiated by the European Commission to establish an Infrastructure for Spatial Information in Europe. Its purpose is to enhance the sharing of harmonized spatial data and services between public authorities in order to assist primarily environmental policy-making and activities that may have a direct or indirect impact on the environment but goes beyond by addressing fundamental geospatial data themes which are essential to support decision making and operational activities in any country.

In the presentation main elements of the INSPIRE Directive are introduced: Metadata, Data Themes and their specifications, network based services (discovery, view, download, transform, invoke) with their architectures, Data and Service Sharing regulations, and the approach of Monitoring and Reporting.

The approaches shown can be useful for the implementation of own spatial data infrastructures and their support. The presentation ends with an outlook about the more recent developments in the European Union and its member states.

10. Data and Information Systems and Spatial Data Infrastructures

88. DEVELOPMENT OF PUBLIC TRANSIT ROUTES USING GEOSPATIAL TECHNOLOGIES: A CASE STUDY OF THE TWIN CITIES

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ABSTRACT

The use of geospatial technologies in measuring public transport accessibility is playing an important role to help resolve public transport problems in urban areas. In developing countries, the availability of up-to-date and geospatially accurate information for the urban transport system particularly public transport routes is a continuous problem. This research presents a geospatial method for developing public transport routes to measure the public transport coverage in twin cities, Islamabad, and Rawalpindi. This research can be divided into three main areas. The first step is related to conducting a GPS survey to collect detailed information about each route and assigning route waypoints to road segments (network data). Descriptive information for all public transport routes for the twin cities, Rawalpindi, and Islamabad, that includes Suzuki vans, Mini-buses, wagons, and metro bus routes, were gathered from different online sources. Using mobile GPS, a participant travels along each route (in some cases, traveling both directions where the route is different) to track the route and conduct a driver interview to get some basic information about the route. The second step is estimating the population accessibility to public routes by using spatial proximity to building footprint and 100-meter population grid datasets to measure route coverage at various walking distances. The final step is preparing static and interactive route maps for public use (riders) to plan their trips. A complete twin city transit map (in pdf and paper format), and a sample of an individual route map will be prepared. A multi-purpose interactive web map will also be prepared to disseminate route information for 1) public use to plan their trip, 2) researchers and policymakers to explore the full potential of public route data, and 3) municipal planners and decision-makers to explore the ways to extend the coverage of transport routes by adding new routes, suggesting changes to the existing routes, and deciding best detours in case of a road closure along the route.

Keywords: Transport routes, GPS survey, Public Route accessibility, Geospatial research, Web mapping.

10. Data and Information Systems and Spatial Data Infrastructures

89. GEOSPATIAL MAPPING OF SOLAR PHOTOVOLTAIC POTENTIAL AT BUILDING FOOTPRINTS IN NORTHERN TOURISM DISTRICTS ACROSS PAKISTAN

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ABSTRACT

The provision of electricity through the grid system to the northern districts of Pakistan is considered a continuous challenge due to the mountainous landscape of these areas. Installation of rooftop solar panels in these areas can help provide an alternative and cost-effective source of electricity (and energy) for reducing energy poverty, promoting economic activities including tourism, and introducing sustainable energy practices which can lead to significant environmental benefits. Installing solar panels in hilly regions is challenging due to steep terrain, extreme weather conditions, and higher operational costs. This research focuses on a geospatial approach to estimate the photovoltaic (PV) potential at a local scale in the tourism districts of Khyber Pakhtunkhwa (KPK) to identify suitable communities (and rooftops) for PV installation. In the first step using 30-meter DEM data, we estimated how much solar radiation each pixel will receive throughout the year (separated by months). The solar potential at a pixel level was estimated after considering the amount of shadow cast by the local landscape (site latitude and elevation, slope, and aspect) using an ESRI Solar Radiation Tool. In the next step to identify suitable locations for PV installation, the solar potential values were assigned to building footprints (Microsoft Bing's building footprints) and the associated population data (population by gender/age-group level estimates at a 100 m grid) using the spatial proximity approach. We analyzed the annual and monthly variation in solar radiation and PV potential. Our estimates suggest a significant number of communities across all districts where rooftop solar panels can be installed to meet the energy needs of the local population and tourism industry.

Keywords: Solar panel, Geospatial, Building footprint, Photovoltaic, Mapping.

10. Data and Information Systems and Spatial Data Infrastructures

90. CLUSTER ANALYSIS WITH SATELLITE AND SOCIODEMOGRAPHIC DATA TO CLASSIFY THE SALVADORAN TERRITORY

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ABSTRACT

This study explores whether the rural area of El Salvador can be subdivided into groups of municipalities where each group has its own characteristics in terms of variables GDP per capita, electricity consumption per capita, population density, poverty rate and night light, all from the year 2007 for being data from the last official census. The study was performed horizontally considering the spatial distribution of night lights for the year 2007. The light was obtained by processing NOAA satellite images with Geographic Information Systems software. Based on the nature of the data, it was decided to apply advanced statistical clustering techniques that, supported by the advantages of computing, would allow comparing 1000 cluster possibilities by changing the classification parameters such as the method and the distance used. The study concludes that at the exploratory level, subdivision with hierarchical cluster technique is possible only by incorporating night light and advanced techniques with t-SNE. It was found that the best model of subterritories is grouped into nine categories where two groups are mainly municipalities with urban predominance and the rest with rural predominance.

Keywords: GIS, night lights, clustering, sociodemographic indicators.

10. Data and Information Systems and Spatial Data Infrastructures

91. BAYESIAN APPROACH ABC - MCMC FOR ARDL MODEL USING ECONOMIC VARIABLES OF PAKISTAN

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ABSTRACT

Pakistan economy has many up and down. The key factors that play an important role in the economy of Pakistan are the rising in debt from foreign and prices of goods and services. Statistical model are used for the analysis of economic variable. The traditional method gives spurious regression when data is non-stationary. Now it become necessary to add lag values of variables so long run relationship can be measure. ARDL model based on GDP(dependent) ,Inflation Rate and Debt Service(Independent) shows that GDP has positive relation with GDP_{t-1} , GDP_{t-3} but negative relation with GDP_{t-2} , INF_{t-1} and DS . The model goodness of fit is check through R^2 and Durbin Watson test. MLR model just explaining 19 % variation on the other hand ARDL Model fit well and explaining 99% variation. ABC-MCMC gives full posterior distribution of unknown parameter including point estimates and credible intervals. Overall the increasing prices in Debt Service and Inflation Rate have slow down the growth of GDP in Pakistan from 1976 to 2021.

Keywords: ARDL, Bayesian

11. Educating on Climate Change and Sustainable Development

92. RAINWATER HARVESTING SYSTEM AS A STRATEGY FOR URBAN STORM MANAGEMENT, A CASE STUDY OF LAHORE

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Abstract

Pakistan requires effective management strategies because of increasing threat of urban flooding due to rapid urbanization and impervious surfaces inhibit rainwater infiltration, percolation and change the natural water flow. In many countries, Rainwater harvesting system (collection and storage of rain rather than allowing it to run off) is used as a sustainable strategy to manage urban storm water and use the rainwater as best substitute of fresh water resource. In this study rainwater harvesting areas accessed in Lahore by using, MCA integrated AHP-GIS approach. SRTM DEM data were used to find accumulated areas and for the assessment of several catchment parameters like contours, slope, stream network, aspects etc. And Landsat OLI image is used to know about land use i.e. vacant land and open green spaces, existing drainage network density, and rainfall distribution. Suitable harvesting sites in Lahore are identified by AHP analysis.

Keywords: Urban flood; rainwater harvesting system; suitability analysis ; district Lahore; Pakistan

11. Educating on Climate Change and Sustainable Development

93. CLIMATE CHANGE AND OPEN EDUCATIONAL RESOURCES

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ABSTRACT

Climate change is one of the most pressing issues of our time, and education for awareness and action are key factors in formulating and verifying sustainable responses at local, regional, national, and international levels by individuals, communities, political leaders, and the global society in aggregate. The pairing of the capabilities of real-time technologies in monitoring, defining, and demonstrating climate change impacts with expansive Open educational resources (OERs) can provide a powerful mechanism to spread knowledge, evoke and elicit action, and empower those impacted to prove cost-effectiveness of responses. OERs can inform assessments of mitigation/adaptation practices and be linked with real-time GIS/RS tools to determine, express, and report on steps taken to meet the challenges of climate change and to evaluate whether responses are timely, effective, and efficient or in accord with expectations. This linkage across scientific and societally-focused disciplines has added value as OERs reduce/eliminate costs associated with learning, teaching, and dissemination of data and information while also offering connections to environmental and social justice. The use of OERs in climate change education has grown significantly in recent years and can support advocacy, application, and legislative connections through policy and international agreements. The linkage can "level-the-field" by providing freely available resources for classroom teaching, materials for use in self-learning, research, community discussions, simulations, and transdisciplinary (and transgenerational) activities that increase awareness of climate change and its effects on the environment. Open educational resources with real-time technology can empower individuals to take action separately and with others through a richly informed and coordinated decision-making process. Applied across multiple scales the linkages provide witness to actions and procures clear real-time evidence as to the efficacy of climate change responses by people and society.

12. Capacity building, networking, resource sharing

94. EXPLORING THE RELATIONSHIP BETWEEN GREENHOUSE GASES, ECONOMIC GROWTH, AND ENERGY USE IN SOUTH ASIA

Usman Mehmood^{1,4}, *Ali Imran¹, Aysha Abid¹, Salman Tariq², Zia ul Haq¹, Rabiya Mazhar⁵, Asim Daud², Khalid Mahmood², Munawar Iqbal³, Adila Batool²

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ABSTRACT

This study examines the link between three major greenhouse gases (CO₂, N₂O, and CH₄) and their relationship with economic growth (GDP) and energy consumption across six South Asian countries. The research utilizes a panel ARDL approach covering the period from 1990 to 2017 and evaluates the Environmental Kuznets curve (EKC) hypothesis. The findings reveal a non-linear relationship between CO₂ and N₂O emissions with GDP, confirming the presence of EKC in the long run. The results also demonstrate a positive significant impact of CO₂ on both GDP and energy use in the long run, with a significant but weaker relationship observed in the short run. For CH₄, a negative relationship with energy use and a positive significant impact on GDP were detected. Meanwhile, N₂O exhibited a negative correlation with energy use, but a positive yet insignificant relationship with GDP.

Keywords: Greenhouse gases, energy use, environmental Kuznets curve, economic growth, South Asia.

6. List of Accepted Abstracts for Poster Presentations

(According to Conference Themes)

1. Climate/Climate Change, Meteorology and the Atmosphere

S.No	Author Name & Affiliations	Poster title
1.	Maria Nawaz ¹ , Salman Tariq ² ¹ Department of Space Science, University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore	INVESTIGATING THE VARIABILITY OF AEROSOL OPTICAL DEPTH IN PAKISTAN USING MAIAC DATA
2.	*Sohana Manzoor ¹ , Salman Tariq ² , Ambreena Javid ¹ ¹ Geography Department, Kinnaird college for Women, Lahore ² Remote Sensing, GIS And Climate Research lab (RSGCRL), University of the Punjab, Lahore	REMOTE SENSING OF AEROSOL OVER THE AMAZON FOREST FIRE
3.	*Syeda Haddia Abbas ¹ , Salman Tariq ² , Ambreena Javid ¹ , ¹ Geography Department, Kinnaird College for Women, Lahore ² Remote Sensing, GIS, and Climatic Research Lab (National Center of GIS and Space Applications), Centre for Remote Sensing, University of the Punjab, Lahore, Pakistan	ASSESSMENT AEROSOL OPTICAL DEPTH OF NEAR YOSEMITE USING REMOTE SENSING AND GIS
4.	*Z.M. Choudary ¹ , K. Asif ² , M.A. Shahid ¹ , H.N. Asghar ² , Z.A Saqib ³ ¹ Agriculture Remote Sensing Lab (ARSL – NCGSA), University of Agriculture, Faisalabad ² Soil Microbiology and Biochemistry Lab (SMBL), University of Agriculture, Faisalabad ³ Saline Agriculture Research Center (SARC), University of Agriculture, Faisalabad	ESTIMATION OF SOIL MOISTURE REGIMES OF PUNJAB USING JAVA NEWHALL SIMULATION MODEL IN THE CHANGING CLIMATE
5.	*Hafiza Iqra Shafi ^{1,4} , Salman Tariq ^{1,2,3} , Nimra Ehsan ⁴ ¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore ³ Department of Space Science, University of the Punjab, Lahore ⁴ The University of Lahore (UOL)	SPATIO-TEMPORAL DISTRIBUTION OF FORMALDEHYDE (HCHO) OVER PAKISTAN (2018-2022) USING REMOTE SENSING
6.	Khadija Sharaf Din, *Muhammad Fahim Khokhar Institute of environmental science and engineering (IESE), National university of science and technology, Islamabad.	EXPLORATION OF MICROPLASTIC CONCENTRATION IN AIR SAMPLES AND ATTRIBUTABLE HEALTH RISKS
7.	Talha Saeed ¹ , Muhammad Talha Zahid ¹ , Salman Tariq ² , *Muhammad Fahim Khokhar ¹ ¹ Institute of Environmental Sciences & Engineering (IESE), National University of Sciences & Technology (NUST), Islamabad ² Department of Space Science, University of the Punjab, Lahore	ANALYSIS OF ATMOSPHERIC TRACE GAS NITROGEN DIOXIDE (NO ₂) THROUGH SOUTH ASIA'S 1ST NASA PANDORA SPECTROMETER, ISLAMABAD, PAKISTAN
8.	Ahmad Furqan Hassan ^{1,2,3} ¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore ³ Department of Space Science, University of the Punjab, Lahore	STUDY OF METHANE CLIMATOLOGY OVER PAKISTAN USING RS AND GIS TECHNIQUES
9.	*Hafsa Muzammal, Muhammad Zaman, Muhammad Adnan Shahid, Muhammad Safdar, Aamir Raza Department of Irrigation and Drainage, Agriculture Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad, Pakistan	A COMPREHENSIVE REVIEW OF IMPACTS OF GLOBAL WARMING ON CLIMATE CHANGE OF RIVER INDUS OF PAKISTAN
10.	*Abeer Salman ¹ , Muhammad Fahim Khokhar ¹ , Salman Tariq ² ¹ Institute of Environmental Sciences and Engineering (IESE), NUST, Islamabad ² Department of Space Science, University of the Punjab, Lahore	MONITORING THE TEMPORAL VARIATION OF FORMALDEHYDE EMISSIONS OVER ISLAMABAD, PAKISTAN USING MAX-DOAS AND SATELLITE OBSERVATIONS

2. Geohazards and Disasters

S.No	Author Name & Affiliations	Poster Title
11.	Shees Saleem, *Dawood Ahmad, Hassan Raza, Shahid Parvez <i>Department of Space Science, University of the Punjab, Lahore</i>	DROUGHT MONITORING AND ASSESSMENT: A COMPARATIVE STUDY OF DIFFERENT INDICES AND APPROACHES
12.	*Hafiz Muhammad Tayyab Bhatti ¹ , Munazza Usmani ² , Syeda Saleha ³ ¹ <i>Department of Space Science, University of Punjab, Lahore</i> ² <i>Department of Information Engineering and Computer Science, University of Trento, Italy</i> ³ <i>Department of Space Science, Institute of Space Technology, Islamabad, Pakistan</i>	GEOSPATIAL TECHNOLOGY FOR FLOOD DISASTER MAPPING: NIGERIA-2022 FLOOD
13.	*Maryam Khalil and Syed Umair Shahid <i>Centre for Integrated Mountain Research, University of the Punjab, Lahore</i>	ASSESSMENT OF HYDRO-METEOROLOGICAL DROUGHT HAZARDS BASED ON DIFFERENT INDICES IN THE UPPER INDUS BASIN PAKISTAN
14.	*Hafsa Muzammal, Muhammad Zaman, Muhammad Adnan Shahid, Lubna Anjum, Muhammad Safdar, Aamir Raza <i>Department of Irrigation and Drainage, Agriculture Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad.</i>	APPLICATION OF DIFFERENT EXTREME LEARNING MACHINE FOR PROJECTED THE SHORT-TERM FLOOD

3. Agriculture, Food Security, Forest, Biodiversity and Ecosystems

S.No	Author Name & Affiliations	Poster Title
15.	*Hifza Mariam ^{1,2} , Sawan Chand ² , M. Danish Majeed ^{1,3} , Iftikhar Ali ² , Abdul Khaliq ² , Zia-ul-haq ² , Adnan Shahid ¹ ¹ <i>Agricultural Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad</i> ² <i>Department of Agronomy, University of Agriculture, Faisalabad</i> ³ <i>Department of Irrigation and Drainage, University of Agriculture, Faisalabad</i>	ESTIMATING BIOMASS AND YIELD OF RICE USING METRIC EVAPOTRANSPIRATION AND SIMPLE GROWTH ALOGRITHMS
16.	Qurat-Ul-Ain Raza ¹ , Muhammad Amjad Bashir ^{1,2} , Abdur Rehim [*] , Faiz-Ul-Hassan ² , Hafiz Muhammad Ali Raza ^{1,2} ¹ <i>Departemnt of Soil Science, Faculty of Agricultural Sciences and Tecnology, Bahauddin Zakariya University, Multan, 60800, Pakistan</i> ² <i>College of Agriculture, University of Layyah, Layyah, 31200,</i>	ROLE OF BIOSTIMULANTS TO MINIMIZE CLIMATE CHANGE EFFECTS ON OKRA PRODUCTION
17.	Muhammad Jawad Arshad ^{1,2} , Sikandar Ali ¹ , M. Adnan Shahid ^{1,2} , *Muhammad Safdar ^{1,2} , Zahra Batool ³ , Muhammad Khaleeq ^{1,2} , M. Danish Majeed ^{1,2} , Aamir Raza ¹ ¹ <i>Department of Irrigation & Drainage, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i> ² <i>Agricultural Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i> ³ <i>Department of Soil and Environmental Sciences, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan.</i>	CLIMATE CHANGE IMPACTS ON AGRICULTURAL PRODUCTIVITY OF MAJOR CROPS IN PUNJAB AND SINDH, PAKISTAN
18.	*Rehan Mehmood Sabir ^{1,2} , Abid Sarwar ¹ , Muhammad Adnan Shahid ^{1,2} , Syed Aftab Wajid ³ , Muhammad Safdar ^{1,2} , Nalain E Muhammad ⁴ , Aamir Raza ¹ ¹ <i>Department of Irrigation & Drainage, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i> ² <i>Agricultural Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i> ³ <i>Department of Agronomy, University of Agriculture, Faisalabad, 38000, Punjab, Pakistan</i> ⁴ <i>National University of Science and Technology, Islamabad (NUST), Punjab, Pakistan</i>	YIELD ESTIMATION OF WHEAT CROP USING REMOTE SENSING TECHNIQUES

4. Water Resources and Water Cycle

S.No	Author Name & Affiliations	Poster Title
19.	Maryam Khalil, *Syed Umair Shahid <i>Centre for Integrated Mountain Research, University of the Punjab, Lahore</i>	GEOSPATIAL ANALYSIS FOR THE IDENTIFICATION OF RAINWATER HARVESTING SITES USING THE SCS-CN TECHNIQUE IN SKARDU DISTRICT OF GILGIT BALTISTAN, PAKISTAN.
20.	*Hifza Mariam ^{1,2} , Sawan Chand ² , M. Danish Majeed ^{1,3} , Iftikhar Ali ² , Abdul Khaliq ² , Muhammad Safdar ^{1,3} , Adnan Shahid ^{1,3} , Aamir Raza ¹ ¹ <i>Agricultural Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad</i> ² <i>Department of Agronomy, University of Agriculture, Faisalabad</i> ³ <i>Department of Irrigation and Drainage, University of Agriculture, Faisalabad</i>	APPLICATIONS OF GEOSPATIAL AND MACHINE LEARNING TECHNIQUES FOR INLAND WATER QUALITY MONITORING IN PAKISTAN: A REVIEW

5. Urbanization, Sustainable/Smart Societies and Industrialization

S.No	Author Name & Affiliations	Poster Title
22.	*Usman Mehmood ¹ ¹ <i>Remote Sensing GIS and Climatic Research Lab, University of the Punjab, Lahore, Pakistan</i>	HOW ENERGY PRICES AND FOREIGN DIRECT INVESTMENT INTERACT WITH ENVIRONMENTAL SUSTAINABILITY IN SOUTH ASIAN COUNTRIES
23.	Muhammad Atif Butt ¹ , *Zaheen Fatima ^{1,2} , L. L. G. Carolina Monteiro de Carvalho ³ ¹ <i>Department of Space Science, University of the Punjab, Lahore</i> ² <i>Centre for Geographical Information System, University of the Punjab, Lahore</i>	CO-PPGIS WEB-BASED PLATFORM TO SPEEDUP GOVERNMENT POLICIES AND DEVELOPMENT IN SUSTAINABLE SMART CITIES AND INDUSTRIALIZATION
24.	*Nimra Ashraf, Ms. Rehana Ghulam Mehar Ali <i>Department of Geography, Lahore College for Women University (LCWU), Lahore</i>	GIS BASED CRIME ANALYSIS AND MAPPING OF MODEL TOWN, LAHORE PUNJAB PAKISTAN
25.	*Muneeba Shabbir, Talha Ahmed Qureshi, Fahim Khokhar <i>Institute of Environmental Sciences and Engineering, National University of Sciences and Technology, Islamabad 44000, Pakistan</i>	EXPLORING REMOTE SENSING AND GIS TECHNIQUES FOR SOURCE APPORTIONMENT OF PARTICULATE MATTER IN URBAN HUBS OF PAKISTAN
26.	Kengne Yvan D. ¹ , Ahmad Mahphood ² , *Hossein Arefi ^{1,3} ¹ <i>Faculty of Geoinformatics and Surveying, Mainz University of applied sciences, Germany</i> ² <i>Faculty of Surveying and Geomatics Engineering, Tishreen University, Latakia, Syria</i> ³ <i>i3mainz – Institute for Spatial Information and Surveying Technology, Mainz University of applied sciences</i>	AUTOMATIC POWER LINE DETECTION AND MODELING OR RECONSTRUCTION FROM LIDAR POINT CLOUD

6. Change and Adaptation in Deltaic and High Mountain Systems

S.No	Author Name & Affiliations	Poster Title
27.	*Insha Batool ¹ , Fahim Khokhar ^{1,2} , Arshad Ashraf ² , Shahid Parvez ³ ¹ <i>Institute of Environmental Science and Engineering SCEE, National University of Science and Technology, Islamabad</i> ² <i>Energy and Water Research Institute (CEWRI), NARC, Islamabad</i> ³ <i>Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore</i>	EXPLORING ANOMALOUS GLACIERS BEHAVIOR IN RESPONSE TO CLIMATIC VARIABILITY OVER KARAKORAM REGION

7. Geological studies, mineral resources and applications

S.No	Author Name & Affiliations	Poster Title
28.	*Hafsa Muzammal ¹ , Muhammad Zaman ¹ , Muhammad Adnan Shahid ¹ , Muhammad Safdar ¹ , Aamir Raza ¹ ¹ Department of Irrigation and Drainage, Agriculture Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad, Pakistan	INTEGRATED ASSESSMENT OF FLOOD INUNDATION FOR PAKISTAN UNDER CURRENT, FUTURE AND EXTREME RAINFALL CONDITIONS
29.	*Ushna Bint E Ishfaq ^{1,2} ¹ Remote Sensing, GIS and Climatic Research Lab (NCGSA), University of the Punjab, Lahore ² Centre for Remote Sensing, University of the Punjab, Lahore	FLOOD MAPPING AND DAMAGE ASSESSMENT OF FLOOD 2022 SINDH, PAKISTAN USING SENTINEL- 1 IN GOOGLE EARTH ENGINE
30.	*Aneeza Munir ¹ , Abdul Basit ² , M. Nouman ³ ¹ Institute of Geology, University of the Punjab, Quaid-e-Azam Campus, Lahore 54590, Pakistan ² Geological Survey of Pakistan, Quetta, 87550, Pakistan ³ NCEG, University of Peshawar, Pakistan	REMOTE SENSING TECHNIQUES USING ASTER AND LANDSAT 8 OLI DATA FOR LITHOLOGICAL IDENTIFICATION OF MUSLIM BAGH OPHIOLITES, WESTERN PAKISTAN

8. Data and Information Systems and Spatial Data Infrastructures

S.No	Author Name & Affiliations	Poster Title
31.	*Talha Afzal Department of Space Science, University of the Punjab, Lahore	CYBERGIS: A MODERN WAY TO GLOBAL GEOSPATIAL DATA HANDLING
32.	Umair Rasool ^{1,2} , Xinan Yin ¹ , Zongxue Xu ² ¹ State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University, No. 19 Xinjiekouwai Street, Beijing, China, 100875. ² College of Water Sciences, Beijing Normal University, Beijing Key Laboratory of Urban Hydrological Cycle and Sponge City Technology, Beijing, China, 100875	DATA-DRIVEN APPROACH FOR PREDICTING URBAN PLUVIAL FLOODING USING MACHINE LEARNING MODELS
33.	*Alina Ashraf ¹ , Sahar Zia ¹ , Muhammad Nasar-u- Minallah ² ¹ Department of Geography, Lahore College for Women University (LCWU), Lahore ² Department of Geography, Govt. Graduate College Gojra	ASSESSMENT OF ROOFTOP SOLAR POWER POTENTIAL BASED ON DIGITAL SURFACE MODEL: A CASE STUDY OF MODEL TOWN, LAHORE
34.	*Hifza Mariam ^{1,2} , Sawan Chand ² , M. Danish Majeed ^{1,3} , Iftikhar Ali ² , Abdul Khaliq ² , Zia-ul-haq ² , Adnan Shahid ^{1,3} ¹ Agricultural Remote Sensing Lab (ARSL), University of Agriculture, Faisalabad ² Dept of Agronomy, University of Agriculture, Faisalabad ³ Department of Irrigation and Drainage, University of Agriculture, Faisalabad	ESTIMATING ROLE OF DATA ASSIMILATION TECHNIQUES TO COMBINE REMOTE SENSING AND CROP MODELING FOR BETTER YIELD FORECASTING

9. Educating on Climate Change and Sustainable Development

S.No	Author Name & Affiliations	Poster Title
35.	Rimsha Azhar, *Silvia Machado Department of Environmental Sciences, Forman Christian College, Lahore	SPATIO-TEMPORAL ANALYSIS OF GREEN SPACES AND THEIR CORRELATION WITH URBAN GROWTH IN LAHORE, PAKISTAN

10. Capacity building, networking, resource sharing

S.No	Author Name & Affiliations	Poster Title
36.	*Letwin Pondo Surveying and Geomatics Department, Midlands State University, Zimbabwe	LEVERAGING THE POWER OF OPEN SOURCE GEOSPATIAL IN REMOTE SENSING, GIS AND CLIMATE CHANGE

7. Accepted Abstracts for Poster Presentations

1. Climate/Climate Change, Meteorology, and the Atmosphere

1. INVESTIGATING THE VARIABILITY OF AEROSOL OPTICAL DEPTH IN PAKISTAN USING MAIAC DATA

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ABSTRACT

Aerosols are solid or liquid particles that are suspended in the atmosphere. They have drastic impacts on the environment, and human health. To detect the pollution level in the atmosphere aerosol optical depth (AOD) is an important physical factor. In this study, we use the MAIAC AOD to quantitatively assess the intra and interannual spatial and temporal variation of AOD in Pakistan. AOD in Pakistan continuously increased from 2000 to 2022. The multi-year mean value of AOD is 3.67. The multi-year mean of AOD was high in Bahawalpur (0.73). The spatial distribution of seasonal variations in the AOD across Pakistan has significant differences. Specifically, the maximum AOD occurred in summer. AOD had the highest value in July (0.76). We believe that our results will fill existing gaps in research and help provide scientific references for future environmental governance in Pakistan.

Keywords: Aerosol optical depth; Climate change; Pakistan; Spatial and Temporal variation; Air pollution

1. Climate/Climate Change, Meteorology, and the Atmosphere

2. REMOTE SENSING OF AEROSOL OVER THE AMAZON FOREST FIRE

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ABSTRACT

Most of the forests in the Amazon River Basin are too wet to burn yet, scientist has observed and detected fire activities, especially during the driest month of the year thick plumes of smoke steaming of fire in the amazon forest. Forest fire has become extreme and has increased frequently worldwide. The dense smoke flow above the Bolivia and Santa Cruz districts. The smoke streamed from the northeast to the northwest side in various Brazilian states. In this research, the study stretches from the north state of Bolivia towards the State Of Rondonia and ends at a few regions of Brazil. An extreme level of forest fire is observed in August and September. In this research paper, these areas' air pollution will be checked before the forest fire and then during the forest fire and both values will also be compared and the AOD level will be checked e.g., On 27 august 2022 forest fire started and lasted till 17 September 2022 in some region of Bolivia And Brazil. We will be using the MODIS AQUA data set in this research.

The result shows that before the fire accusation on 20 August, the daily mean aerosol optical depth was 0.2 indicating a clear sky however, when the fire took place on August 27, the AOD level raised to 0.68. The highest AOD level was 0.87 on September 10, 2022. Maximum AOD level was observed in the northeast of Bolivia in the State of Rondonia also the result show that a high level of AOD occurred from 5 September to 14 September 2022.

Keywords: AOD, Air pollution, Forest Fire, MODIS, Bolivia, Rondonia

1. Climate/Climate Change, Meteorology, and the Atmosphere

3. ASSESSMENT AEROSOL OPTICAL DEPTH OF NEAR YOSEMITE USING REMOTE SENSING AND GIS

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ABSTRACT

Recent years have seen several major wildfires in Mariposa County, including the 2013 Rim Fire, one of the state's 20 biggest wildfires. On July 22, 2022, Yosemite National Park in California was engulfed in what is being called one of the worst wildfires in the history of Yosemite National Park. As inauspicious as it could be, the effect this wildfire had on the Aerosol Optical Depth were rather distressing. In this research paper we probed and compared the AOD during and after the Wildfire in Yosemite National Park from July 21st of July to 10th of August 2022. Because wildfires are a very common occurrence in Yosemite there was wildfire on July 22nd due to which the AOD was 0.08 a day before incident. The Recorded highest level of was AOD at 0.26 on 31st of July and the Average was 0.13.

Keywords: Air pollution · Aerosol-type · Wildfire · Remote sensing · Yosemite National Park

1. Climate/Climate Change, Meteorology, and the Atmosphere

4. ESTIMATION OF SOIL MOISTURE REGIMES OF PUNJAB USING JAVA NEWHALL SIMULATION MODEL IN THE CHANGING CLIMATE

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ABSTRACT

Climate change has a key role in the changing patterns of agriculture leading to livelihood. Global temperature has increased between 1.5 °C to 1.9 °C that is going worse day by day due to human activities and natural disasters. In the agricultural domain, soil moisture changes are affected by the changing climate while being crucial for agriculture ultimately for human beings. Acting as a living entity, the soil is a major reservoir of water and food for the inside life, being threatened by the increasing atmospheric temperature and decreasing annual rainfall. Growing population, dwindling resources, and changing climate have increased the pressure on agriculture to improve production and efficiency while maintaining or improving the sustainability of the sector. In this study, we are going to estimate the soil moisture regimes of the province of Punjab by using Java Newhall Simulation Model that uses mean monthly climatic data. The inputs of the model are mean monthly precipitation (mm) and mean monthly air temperature (°C) to estimate the monthly total evapotranspiration (mm) and monthly total water balance. The maps are made with the help of ArcGIS 10.7 by Esri which will be helpful in the changing climatic patterns and also for future policy making.

Keywords: Soil Moisture Regimes, Climate Change, Java Newhall model

1. Climate/Climate Change, Meteorology, and the Atmosphere

5. SPATIO-TEMPORAL DISTRIBUTION OF FORMALDEHYDE (HCHO) OVER PAKISTAN (2018-2022) USING REMOTE SENSING

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ABSTRACT

Formaldehyde (HCHO) is a much common carbonyl compound in both rural and urban areas of the world. It is the central component of tropospheric chemistry, as it is a byproduct of the Non-methane Volatile Organic Compounds (NMVOC) oxidation chains. Satellite measurements of formaldehyde can be used to evaluate NMVOC emissions on large three-dimensional and temporal scales, making them perfect for air quality studies and limiting emissions. Air pollution is a rapidly growing environmental issue in Pakistan. HCHO is a pollutant that is risky to both human health and the environment. HCHO normally degrades fast in the atmosphere, producing formic acid (HCOOH) and carbon monoxide (CO), both being highly toxic. In this research, we investigated the spatiotemporal trends of tropospheric HCHO columns over Pakistan using remote sensing data from the tropospheric monitoring instrument (TROPOMI) Sentinel-5 Precursor during a five-year period, from 2018 to 2022. We also analyzed HCHO's inter-annual variability as well as seasonal fluctuations. Higher HCHO emission values are observed in Punjab, followed by Islamabad, Khyber Pakhtunkhwa (KPK), Sindh, Baluchistan, and Gilgit Baltistan (GB). In this research, we observed that the highest concentration of HCHO (2018-2022) occurred in Punjab ranging between $\sim 15 \times 10^{-5}$ to 18×10^{-5} molec. cm^{-2} . In GB, the values of HCHO emissions are very low ranging between 2×10^{-5} to 3×10^{-5} molec. cm^{-2} . From time series analysis we observed four intense peaks in summer (JJA) season. After JJA we observed higher HCHO emission values in the autumn (SON) season. A moderate concentration of HCHO emissions are observed in spring (MAM). Lastly, from time series analysis we observed lowest HCHO emission peaks to have occurred are in DJF.

Keywords: HCHO, TROPOMI, Time series analysis, Seasonal analysis, Annual analysis

1. Climate/Climate Change, Meteorology, and the Atmosphere

6. EXPLORATION OF MICROPLASTIC CONCENTRATION IN AIR SAMPLES AND ATTRIBUTABLE HEALTH RISKS

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ABSTRACT

Microplastics ubiquitously exist everywhere in soil, water, and air. To date, very little attention has been given to airborne microplastics. Synthetic fibers from the air can make their way to the soil, and water bodies by various routes, from where these particles can potentially contaminate the food chain. Research on airborne microplastics is limited compared to research on aquatic and terrestrial microplastics. Their small size and synthetic nature have enhanced their persistence in the environment, which has several known and unknown health consequences for the environment and organisms. The sampling of airborne microplastics is complicated owing to their small size, instrumental limitations, and several other weather constraints. To date, no standard method is designed for sampling, identification, and chemical characterization of airborne microplastics. This research is designed for MPs in the air of the study area to assess the health risks associated with airborne MPs. Active air samplers have been used for sampling the synthetic particles and fibers from the indoor and outdoor air of the study area. Following the sample collection and preparation (organic debris removal and mineral removal), Micro-FTIR spectroscopy will be used for polymer identification of MPs in collected samples. EDX-SEM will be used in the morphological and elemental analysis of the samples. Results from both visual and spectroscopic analysis will help to characterize MPs according to their polymer type, shape, color, and abundance. Their visual analysis has revealed the presence of microplastics in all collected air samples. This data will be used to assess MPs' pollution extent in the air and explore subsequent attributable public and environmental health impacts. Microplastics constitute a significant part of particulate matter, which can cause serious respiratory issues after inhalation. This study will be helpful in the agricultural, health, and environmental protection departments.

Keywords: Airborne Microplastics, FTIR, Stereomicroscope, SEM-EDX, health risks

1. Climate/Climate Change, Meteorology, and the Atmosphere

7. ANALYSIS OF ATMOSPHERIC TRACE GAS NITROGEN DIOXIDE (NO₂) THROUGH SOUTH ASIA'S 1ST NASA PANDORA SPECTROMETER, ISLAMABAD, PAKISTAN

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ABSTRACT

Oxides of nitrogen are primary pollutants released into the atmosphere by the combustion of fossil fuels, biomass, soil microbial activity, and lightning. Nitrogen dioxide is created and destroyed during the tropospheric ozone cycle. Nitrogen dioxide is formed when nitric oxide (NO) reacts with ozone and per oxyradicals. Photolysis converts nitrogen dioxide to nitric oxide. When nitrogen oxides in the atmosphere combine with aerosols to form precipitation, acid rain is formed. The NASA Pandora Spectrometer uses solar/lunar observation and sky-scanning concepts to obtain total-column trace-gas concentrations. The nitrogen dioxide concentrations in Islamabad were determined through instrument retrieval and data analysis using OMI and TROPOMI for satellite-based validation. Excessive NO₂ levels, according to the study's findings, frequently occur in the morning and evening, when vehicle emissions are at their peak because that is when people leave for and arrive at work. The Pandora spectrometer's daily data revealed a significant positive correlation with both the OMI and the TROPOMI. Seasonal trends show that NO₂ column densities were highest in the winter and lowest during the monsoon season.

Keywords: Tropospheric NO₂, NASA Pandora Spectrometer, OMI & TROPOMI

1. Climate/Climate Change, Meteorology, and the Atmosphere

8. STUDY OF METHANE CLIMATOLOGY OVER PAKISTAN USING RS AND GIS TECHNIQUES

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ABSTRACT

In this study, the geographical and temporal fluctuations in the column averaged dry air mixing ratio of methane are examined over Pakistan using data from the TROPospheric Monitoring Instrument (TROPOMI) sensor onboard the Copernicus Sentinel-5 precursor satellite. Significant regional and temporal fluctuations in methane concentrations over the research area were found by analysing satellite data acquired over several time periods. Methane levels peaked seasonally in the autumn (2024 ppbv), followed by spring (1996 ppbv), winter (1976 ppbv), and summer (1967 ppbv). Over the years, changes in methane have also been tracked over the Eid al-Adha festival. Urban regions saw a rise in CH₄ emissions as a result of more domestic animals undergoing enteric fermentation. Industries were also listed as major human-caused CH₄ emission sources. Additionally recognised as significant point sources of CH₄ emissions in the study area were the megacities of Lahore, Sukkur, Karachi, and Dera Ghazi Khan. The highest methane levels were recorded on Eid al-Adha days in the years 2019, 2020, and 2021, with respective readings of 2031 ppbv, 2065 ppbv, and 2028 ppbv.

Keywords: Methane, Climatology, TROPOMI, Sentinel 5.

1. Climate/Climate Change, Meteorology, and the Atmosphere

9. A COMPREHENSIVE REVIEW OF IMPACTS OF GLOBAL WARMING ON CLIMATE CHANGE OF RIVER INDUS OF PAKISTAN

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ABSTRACT

River Jhelum, Chenab, Kabul, and the upper and lower reaches of the Indus are major causes of flooding in Pakistan. These rivers are major tributaries of the Indus River System, one of the most significant systems in the world and the largest system in Pakistan. The Indus River is Pakistan's longest river, with seven-gauge stations, multiple barrages and is essential to the nation's irrigation system and electricity production. This study uses historical data on maximum peak discharges to evaluate the danger of flooding in the River Indus. We determine whether dam or barrage reservoirs need to have their capacity upgraded based on our analysis, as well as whether more dams or barrages are required. Due to a high level of glacial melting, snowy mountain melting and heavy monsoon rainfall, it has been predicted that climate change may increase the frequency and intensity of floods in Pakistan. To minimize flood damages, the scenario requires efficient and long-term flood control.

Keywords:

Indus River, assessment of the risk, annual flood peak discharges.

1. Climate/Climate Change, Meteorology, and the Atmosphere

10. MONITORING THE TEMPORAL VARIATION OF FORMALDEHYDE EMISSIONS OVER ISLAMABAD, PAKISTAN USING MAX-DOAS AND SATELLITE OBSERVATIONS

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ABSTRACT

Isoprene is the most abundant biogenic volatile organic compound (BVOC). It significantly impacts atmospheric chemistry through the production of ozone, with annual global emissions estimated at 600 teragrams. While isoprene emissions have an adverse impact on both the climate and human health, its residual lifetime is less than one hour making it difficult to accurately measure emissions on a large scale. Formaldehyde (HCHO), which is a by-product of isoprene oxidation, can be used as a proxy for the analysis of the emissions of isoprene. Photolysis of formaldehyde causes a series of reactions which lead to the formation of hydroxyl radicals, consequently resulting in the formation of tropospheric ozone. It has been found that isoprene emissions increase at higher temperatures, resulting in greater formaldehyde production on warmer days. This study aims to analyze the temporal variation of formaldehyde emissions over Islamabad, Pakistan using MAX-DOAS instrument. This instrument uses the theoretical solar spectrum as a reference to determine atmospheric trace gases through differential optical absorption spectroscopy (DOAS). Data regarding formaldehyde concentrations will be obtained using the instrument and satellite observations will be used for data validation.

Keywords: Formaldehyde, MAX-DOAS, Air Quality.

2. Geohazards and Disasters

11. DROUGHT MONITORING AND ASSESSMENT: A COMPARATIVE STUDY OF DIFFERENT INDICES AND APPROACHES

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ABSTRACT

Drought monitoring and assessment is an essential aspect of water management and resource planning. Drought is a complex and multifaceted phenomenon that affects various sectors and regions differently. Thus, a comparative study of different drought indices and approaches is necessary for the analysis of Drought over any region. Land surface temperature (LST) is an important parameter for the biosphere, cryosphere, and climate change studies. In this study, we estimate LST, NDMI, and NDWI over the district of Bahawalpur, Pakistan, using Landsat-8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) data. The study develops a Google Earth Engine's image processing method by using the LANDSAT 8 band 3 (Green), band 4 (Red), band 5 (NIR), band 6 (SWIR 1), and band 10 (TIR). Also comparing this calculated value with the modeled datasets. Different Indices such as Vegetation Condition Index (VCI), Temperature Condition Index (TCI) and Rain Anomaly Index (RAI) are calculated and the results are interpreted. Furthermore, Standardized Precipitation Index (SPI) for different months is calculated using CHIRPS precipitation data, which serves as a very good indicator when it comes about Drought Analysis.

Keywords: Land surface temperature (LST), Normalized difference vegetation index (NDVI), Normalized difference moisture index (NDMI), Normalized difference water index (NDWI), Standardized Precipitation Index (SPI), Vegetation Condition Index (VCI), Temperature Condition Index (TCI), Rain Anomaly Index (RAI)

2. Geohazards and Disasters

12. GEOSPATIAL TECHNOLOGY FOR FLOOD DISASTER MAPPING: NIGERIA-2022 FLOOD

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ABSTRACT

Last year, 2022, floods caused great damage to populations and economic losses worldwide, making it one of the most catastrophic natural phenomena. Nigeria, and particularly southern Nigeria, is known for its vulnerability to flooding. Although Nigeria is regularly hit by floods, the 2022 floods were the worst since the 2012 floods. The floods in Nigeria, which began in early summer, have affected about 33 of the country's 36 states. The main objective of this study is to use a GIS environment and remote sensing data from satellites such as Sentinel and MODIS to map and identify floodplains in Nigeria. This approach was used to map and study flood hazards and their impact on the community, educational institutions, and health care in each Nigerian state. The results show that the flood inundated an area of 25,128 km² and affected 1424 schools, 6,604,122 residents, and 738 health facilities. Overall, the study showed that the proposed GIS and remote sensing approaches could be used to identify potential risk areas, protect residents, and improve disaster response in the event of natural disasters.

Keywords: GIS, Flood risk, Flood inundation, Nigeria, Remote sensing.

2. Geohazards and Disasters

13. ASSESSMENT OF HYDRO-METEOROLOGICAL DROUGHT HAZARDS BASED ON DIFFERENT INDICES IN THE UPPER INDUS BASIN PAKISTAN

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ABSTRACT

Water is an essential natural resource that plays a significant role in maintaining ecological systems, human existence and sustainability of living things all over the globe. Drought is a natural phenomenon that normally occurs when water availability is considerably below normal levels with extended years of low average humidity in an area. This study aims to estimate the hydro-meteorological drought analysis using geographical information system (GIS). The drought susceptibility mapping was carried out to display drought-prone areas of the Upper Indus Basin (UIB) catchment, Pakistan. Drought risk estimation and annual rainfall performance was calculated by using three different indices, namely, Percentage Deviation; Percent of Normal Index precipitation or precipitation anomaly and Standardized Precipitation Index (SPI) within a GIS environment. The hydro-meteorological data were obtained from WAPDA and Pakistan Meteorological Department. This data was further analyzed based on the standard range of hydro-meteorological drought indices values. Rainfall observations from specific climatic stations data of the UIB were used to establish a SPI time series baseline and identify drought between 1961 and 2014. In comparison to other approaches, the SPI index has been recognized as the most common and efficient method used throughout the world. The year with the worst drought, 1964, had an SPI value of -2.88, while the year with the highest wet conditions, 1973, had an SPI value of 2.86. Finally, the hydro-meteorological drought map was divided into the normal and wet condition based on drought indices values of the UIB. The study suggests the integrated application of GIS technique is effective for the assessment of hydrological response at the sub-basin level. However, the results of this drought simulation can be useful for decision-makers and government authorities in establishing realistic plans and strategies for better managing the water resources of the UIB, Pakistan.

Keywords: Upper Indus Basin, SPI, Drought indices, Hydrological drought analysis, GIS

2. Geohazards and Disasters

14. APPLICATION OF DIFFERENT EXTREME LEARNING MACHINE FOR PROJECTED THE SHORT-TERM FLOOD

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ABSTRACT

Future streamflow time series are essential for developing, managing, and planning the water resources system. There are several forecasting techniques, but the majority of them are very straightforward and fall short in capturing detailed correlations between factors. Challenges that come with data scarcity, soft computing technique-based models for operational flood forecasting systems are frequently more accurate and reliable than other available flood forecasting models. Extreme learning machines (ELMs) and M5 model trees have recently become well liked in hydrological forecasting as better artificial intelligence techniques that need a lot less computing time than the traditional ANN model. Different methods used for model development are compared and contrasted. The ELM and M5 model tree perform better than ANN model for 1- and 5-h lead time forecasting, however all three models perform similarly for 10-h lead flood forecasting.

Keywords

Flood forecasting, Extreme learning machines, different models and methods

3. Agriculture, Food Security, Forest, Biodiversity & Ecosystems

15. ESTIMATING BIOMASS AND YIELD OF RICE USING METRIC EVAPOTRANSPIRATION AND SIMPLE GROWTH ALOGRITHMS

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ABSTRACT

Accurate estimation of crop yield is crucial for having correct estimates of food production for burgeoning world population. Crop models have been used to predict the crop yield at both field as well as regional scale. The use of crop simulation models for analyzing performance of agricultural systems is challenging due to difficulty in characterizing spatial variability of crop, soil, weather parameters and other stress factors. The integration of remote sensing tools with crop growth models will increase certainty in estimating crop yields. Present study purposes the integrated use of mapping evapotranspiration at high resolution with internalized calibration actual evapotranspiration (E_{ta}) with simple transpiration crop growth algorithm CropSyst Model to estimate biomass and yield of rice. METRIC is satellite-based image processing model used to measure evapotranspiration as a residual of surface energy balance. It works at higher resolution, designed to prepare ET maps of the field. Landsat-8 imagery data without cloud masking will be processed to estimate E_{ta} . High resolution imagery data will be used to scale up the estimations from field level to regional level. Eddy covariance flux tower installed at each selected field will be used to make ground base E_{ta} estimations. Eddypro will be used for further processing of E_{ta} measured through eddy covariance. Ground based crop growth monitoring will be done to record E_{ta} and leaf area Index (LAI) data. Daily estimates of E_{ta} and LAI will be made via spline interpolation graph method. Estimated E_{ta} and LAI through METRIC will be compared with actual ET estimated through Eddy Covariance to ascertain its validity. This integrated approach to estimate biomass and crop yield is likely to provide more authentic insights into crop yields as compared with standalone crop growth models.

Keywords: METRIC, Eddypro, Evapotranspiration, CropSyst, Yield.

3. Agriculture, Food Security, Forest, Biodiversity & Ecosystems

16. ROLE OF BIOSTIMULANTS TO MINIMIZE CLIMATE CHANGE EFFECTS ON OKRA PRODUCTION

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ABSTRACT

Modern agriculture is facing severe environmental stresses, which is the major reason for extreme events and influencing the okra production. The anthropogenic activities are resulting drastic agricultural losses worldwide, and it is assumed that the effects will be more in the next couple of years. Biostimulants are active compounds involved in improved plant nutritional contents, health, physiological attributes, and quality. The biostimulants have capability to detoxify the hazards associated with climate change by improve the plant metabolic activities under stress environment. The current study was aimed to identify the effects of biostimulants on okra performance in comparison with chemical fertilization in hot climate of Multan. The experiment was conducted at the research area of Department of Soil Science, FAS&T, Bahauddin Zakariya University Multan. The tested treatments are:

The results obtained indicated that the application of biostimulants significantly improved the biometric, physiological, and productivity of okra crop.

The study concludes that diverse effects of climate change can be minimized, with improved crop productivity by using the biostimulants.

3. Agriculture, Food Security, Forest, Biodiversity & Ecosystems

17. CLIMATE CHANGE IMPACTS ON AGRICULTURAL PRODUCTIVITY OF MAJOR CROPS IN PUNJAB AND SINDH, PAKISTAN

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ABSTRACT

Climate change is a term used to describe the shifts in the Earth's climate patterns over an extended period. These shifts are driven by natural and human factors, with human activities playing a dominant role in recent times. Agricultural productivity is primarily influenced by climate. Climate change has a significant impact on agriculture, which is a sector that is highly vulnerable to changes in temperature, precipitation, and other weather patterns. Rising sea levels, more frequent and intense weather events, changes in precipitation patterns, and shifts in ecosystems are the effects of climate change. We are analyzing the impact of climate change on the productivity of major crops in Punjab and Sindh, Pakistan. We are using the previous Twenty-two years (2001 to 2022) data of precipitation, Temperature, and Wind pattern collected from the Pakistan Meteorological Department. Major crop data, soil data, Hydrological data, and satellite data are also used for evaluating the impact of climate change on major crop productivity.

Keywords: Climate change, Agricultural productivity, Vegetation indices, hydrometeorology.

3. Agriculture, Food Security, Forest, Biodiversity & Ecosystems

18. YIELD ESTIMATION OF WHEAT CROP USING REMOTE SENSING TECHNIQUES

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ABSTRACT

There are numerous techniques to estimate crop yields, but the optimal one relies on geospatial data as well as techniques including remote sensing. Nevertheless, because of multiple challenges, the remote sensing data necessary for forecasting crop yield are often insufficient. such as poor temporal resolution and climate circumstances (% of clouds). Using images like Modis, which have very high temporal as well as very low spatial resolution, there have been many attempts to address the lack of data issue. Even though this kind of image can make up for data gaps brought on by climate issues, it is only right for very sizable, uniform crop fields. A novel design model was developed to make up for the lack of high-resolution remote sensing images because of climate variables. The innovative model that incorporates the use of the energy balance equation optimizes and extends the precision of crop yield estimation. Information on local producers' wheat crop yields for that particular year was acquired to verify the accuracy of the crop productivity estimation using the newly developed model. The reliability of the new optimization model is proved by a comparison between predicted crop yields and actual production in various fields.

Keywords: Yield Estimation, Remote Sensing, Wheat Production

4. Water Resources and Water Cycle

19. GEOSPATIAL ANALYSIS FOR THE IDENTIFICATION OF RAINWATER HARVESTING SITES USING THE SCS-CN TECHNIQUE IN SKARDU DISTRICT OF GILGIT BALTISTAN, PAKISTAN

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ABSTRACT

In this research, an integrated approach is ascribed for identifying the optimum suitable sites for installing the rainwater harvesting systems in the Skardu District of Gilgit Baltistan, Pakistan. Subsequently, a rigorous analysis has been done to depict the most suitable locations by producing diverse characteristics of GIS layers such as surface elevation, hydrological soil groups, slope, drainage network, drainage density, surface runoff depth, and land use/land cover. Drainage streams, drainage density, and slope data were derived from the Shuttle Radar Topographic Mission's Digital Elevation Model (1-arc second). The European Space Agency's Global Land Cover was used for land use/land cover acquisition. The soil texture data was taken from the digital soil map of the world made available by the Food and Agricultural Organization. The monthly precipitation data from MERRA-2 satellite was accessed to calculate the surface runoff depth. The watershed analysis for discharge calculation was conducted using the Soil Conservation Services-Curve Numbers method. The curve numbers were computed for each watershed to identify the potential rainwater harvesting sites. The relative weights of individual layers and relative ranks of their classes were assigned by means of weighted overlay analysis in spatial analyst tools of ArcGIS 10.2 software. The final suitability map of rainwater harvesting (RWH) sites was categorized into three distinct potential zones, i.e. highly suitable (39%), moderately suitable (42%), and least suitable (19%). The integrated approach deployed in this research would certainly be prudent to identify the suitable sites in the dissemination of rainwater harvesting efficacy to not only conserve the rainwater endowment but also the socio-economic development of Skardu District. Therefore, this study can be helpful to policymakers and local watershed management authorities of the Skardu District to critically understand and implement systematic strategies to store rainwater in mountainous areas, a prerequisite for the sustainable development of urbanities.

Keywords: SCS-CN, Rainwater Harvesting, Weighted Overlay, Site suitability, Sustainable development

4. Water Resources and Water Cycle

20. APPLICATIONS OF GEOSPATIAL AND MACHINE LEARNING TECHNIQUES FOR INLAND WATER QUALITY MONITORING IN PAKISTAN: A REVIEW

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ABSTRACT

Water resource management is an emerging issue in order to resource conservation as population growth is increasing unexpectedly. Remote sensing, machine learning and cloud computing are advanced tools to evaluate the water quality and its management to aid in policy making of the country. The proposed study will provide a comprehensive review regarding recent advances in estimation of water quality using remote sensing, and current system limitations along with future perspectives of using modern technologies. For this purpose, water quality data from different selected sites will be collected which includes; blue green algae phycocyanin (BGA-PC), chlorophyll a (Chl-a), dissolved oxygen (DO), specific conductivity (SC), turbidity, fluorescent dissolved organic matter (fDOM) and pollution sediments. Hyperspectral imagery data through satellites will also be collected to estimate these parameters. RS technique provides accurate estimation in calculating those parameters. Deep learning; a data driven empirical approach explains useful applicability of RS data in water quality estimation and helps in decision making. The integration of spectral data with virtual constellation in cloud computing for data analysis will explain the more accurate results regarding detecting before time outbreaks of water such as algal blooms. Analyzing the current trends and advances in remote sensing is the main objective of the study.

Keywords: Machine learning, Water quality, Cloud Computing, Deep Learning, Data analysis

6. Urbanization, Sustainable/Smart Societies & Industrialization

21. HOW ENERGY PRICES AND FOREIGN DIRECT INVESTMENT INTERACT WITH ENVIRONMENTAL SUSTAINABILITY IN SOUTH ASIAN COUNTRIES

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ABSTRACT

Significant support from financial institutions is required for mitigation measures like enhanced technology, green energy generation, and research and development to address the growing environmental concerns faced by the developing globe. Capital can be redirected from other areas of the economy and put toward the development of green energy and advanced technology if everyone has access to credit. On the other hand, when environmental preferences aren't considered, banks may end up supporting projects that create a lot of pollution and use inefficient manufacturing methods. This research employed a panel approach to reveal the effects of financial inclusion (FI) and globalization on CO₂. These findings indicate that FI increases pollutant emissions in underdeveloped countries and that globalization further exacerbates environmental deterioration in these regions. Nonetheless, the rising cost of energy and foreign direct investment both play a role in reducing CO₂ emissions in low-income countries. Further, the emerging nations panel shows indications of the Environmental Kuznets Curve. The results were confirmed using the CS-ARDL approach. Several policy recommendations are given to improve environmental quality considering this study's findings.

Keywords: Energy prices: financial inclusion: Globalization; Environmental sustainability

6. Urbanization, Sustainable/Smart Societies & Industrialization

22. Co-PPGIS WEB-BASED PLATFORM TO SPEEDUP GOVERNMENT POLICIES AND DEVELOPMENT IN SUSTAINABLE SMART CITIES AND INDUSTRIALIZATION

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ABSTRACT

There are a number of definitions of what makes a city ‘smart,’ for example, IBM defines a smart city as “one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources.” [1] The current urbanization model is unsustainable, environmentally unjust, and excludes people socially and cognitively. Achieving sustainability and resilience requires improved social inclusion and governance structures that address multiple factors. Therefore, promoting social participation in decision-making and urban planning is essential. [2] The new platform enables e-government services for managing makers and operation supervisors in government agencies and smart city industries, including disaster management, environmental protection, transportation, and urban resource center monitoring and evaluation. The services offered are based on the practical needs of government departments. [3] This chapter discusses Collaborative Public Participatory Geographic Information Systems (Co-PPGIS) and their potential to promote social learning and participation, address sustainability and resilience issues, and combine spatial, technical, and social knowledge. Research has shown that 25% of PGIS studies are applied to urban studies and natural disasters like floods and landslides. Through mapping and social learning, Co-PPGIS promotes social engagement and has advantages over other social participation tools. It can empower citizens, improve governance, and create healthier and more resilient cities. [2]

Keywords: Sustainable, Development, Smart Cities, Resilience, Co-PPGIS.

6. Urbanization, Sustainable/Smart Societies & Industrialization

23. GIS BASED CRIME ANALYSIS AND MAPPING OF MODEL TOWN, LAHORE PUNJAB PAKISTAN

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ABSTRACT

Crime maps are quickly becoming key tools in the realm of crime and justice. New opportunities for employing digital mapping in crime prevention and control campaigns have emerged because of advances in information technology and Geographic Information Systems (GIS). Crime maps are also available that can be used to research the environment and crime's geographical characteristics. Maps can be used to locate areas of interest. Visual recognition of criminal concentrations that are unusually high or low. Visual representations of more or less intricate spatial data analysis results. Crime is a major issue in many developing or developed countries, but it has been on the rise in Pakistan over the past few years, particularly in Pakistan's major cities such as Karachi, Lahore, and Faisalabad. Because of unemployment, poverty, and a lack of education, the crime rate in Pakistan has been rising for many years, and these crimes are becoming more complicated and exceptional. Pakistani security forces lack the necessary technology and work force to combat crime and crime-related issues. However, Pakistan was able to complete or surpass these events a few years ago using Software like GIS, Crime Analysis, and Mapping. This study uses GIS, Crime Analysis, kernel density estimate tool and Crime Mapping to demonstrate where and when crime events occur, as well as the current crime rate in the model town tehsil of Lahore. Crime Mapping and Analysis in Model Town Tehsil is also such a type of research in which we pinpoint vulnerable areas and offer recommendations for reducing crime there.

Keywords: Crime Analysis, Crime Maps, GIS, KDE.

6. Urbanization, Sustainable/Smart Societies & Industrialization

24. EXPLORING REMOTE SENSING AND GIS TECHNIQUES FOR SOURCE APPORTIONMENT OF PARTICULATE MATTER IN URBAN HUBS OF PAKISTAN

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ABSTRACT

Presently, the high levels of particulate matter in urban areas of Pakistan are responsible for numerous public health implications. The gravity of the situation is such that Pakistan's annual burden of disease due to outdoor pollution accounts for 22,000 premature adult mortalities and loss of 163,432 DALYs as per the World Bank estimations. Almost 100% of the country's population is exposed to PM_{2.5} air pollution exceeding WHO guidelines with 58 μ g/m³ mean annual exposure of PM_{2.5} in 2017. According to Greenspace, world has to bear a cost of \$8 Billion/day. It is worth noticing that alleviating these repercussions of air pollution can save around 13 million lives globally. That is why, plethora of these air pollution related problems makes it imperative to hold air pollution culprits accountable and conduct source apportionment studies in the urban hubs of Pakistan. In this regard exploring such remote sensing and GIS techniques that can be efficiently employed for source apportionment of particulate matter under changing climate conditions are vital. Both PMF and CBM models are used to identify and map key PM sources and reported results indicate that the primary PM pollution culprits are vehicular emissions, industrial emissions, and biomass burning. Furthermore, the use of remote sensing and GIS techniques enables us to integrate multiple data sources, including satellite imagery, land use data, and meteorological data, to provide a comprehensive understanding of the spatial and temporal distribution of particulate matter. Also, it is notable that how changing climate conditions, such as temperature, humidity, and precipitation, can influence the concentration and distribution of particulate matter. In conclusion, these remote sensing and GIS techniques have huge potential as their findings can inform policy decisions and support the development of targeted interventions to improve air quality and protect public health in urban areas of Pakistan.

Keywords: Source Apportionment, Public Health, Positive Matrix Factorization, Remote Sensing

6. Urbanization, Sustainable/Smart Societies & Industrialization

25. AUTOMATIC POWER LINE DETECTION AND MODELING OR RECONSTRUCTION FROM LIDAR POINT CLOUD

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ABSTRACT

Power lines play an essential role in our day-to-day life activities as a transmission of power from the production sites to the users. Moreover, power line detection and modeling can also be used for many studies and is, therefore, one of the most essential applications in photogrammetry and remote sensing, and geomatics. Airborne LIDAR is a primary information source for power line detection and modeling. In the decision-making process, the automatic detection of power lines using Cloudcompare, and modeling have not yet been fully adopted. The goal of our research is to find how to detect these lines automatically and model them. This paper presents 2 major steps: firstly, to automatically detect the power line, and secondly to model them. For the first major step, the Cloth Simulation Filtering (CSF) is used to separate the ground points from the off-ground points. Secondly, Cloud-to-Cloud (C2C) distance method is applied to remove points from the off-ground points which are related to the ground points. Thirdly, vegetations, buildings, and other objects are removed using geometric features. The results obtained from the first major step are now forwarded to the second major step which is modeling. In this step some remaining objects are firstly removed based on the size of the object using the region growing method. Finally, the power lines are modeled using the algorithm RANSAC by fitting the line in the point clouds. At the end, a qualitative and quantitative evaluation of the proposed method is performed. The results show a completeness of 86.97%, correctness of 100% and quality of 86.97%.

Keywords: LiDAR Point cloud, Power line detection, Power line reconstruction, Geometric features, Segmentation

8. Change and Adaptation in Deltaic and High Mountain Systems

26. EXPLORING ANOMALOUS GLACIERS BEHAVIOR IN RESPONSE TO CLIMATIC VARIABILITY OVER KARAKORAM REGION

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ABSTRACT

The Karakoram also known as a ‘home to giant glaciers’ have increasingly attracted global attention due to its glaciological and climatological uniqueness. The ‘Karakoram Anomaly’ is termed as the stability or anomalous growth of glaciers in the central and western Karakoram, in contrast to the retreat of glaciers in other nearby mountainous ranges of Himalayas and other mountainous ranges of the world. There are several explanations given regarding causes of this anomaly but there is no clear evidence, and it is still far from complete. Therefore, this study also enlightens the causes of anomalous glaciers behaviour and its linked with possible climatic parameters. For this study, cloud free optical images of Landsat series satellite are used for spatio-temporal assessment of glaciers for the period of 2000, 2010 and 2020. This study also used RGI data through GLIMPS to update the glaciers outlines. The glaciers imageries will digitize through multiple Digital Elevation Models (DEMs) i.e., SRTM DEM and ALOS PALSAR DEM, to study the glaciers elevation changes and mass budget. Therefore, climatic field data collected from higher elevations WAPDA and PMD observational stations. In addition, gridded climate datasets of ERA5 also used to bring in comprehension on the issues of data quality over the data sparse regions of the study. Further, linear trends (based on linear regression equation) will be calculated. P-values will be then calculated for obtained trend values and statistical significance. The results of this study will support to overcome the impacts of this anomaly. It may give a better understanding of the impacts of climate change on regional ice-mass fluctuations to further deal with that issue.

Keywords: Karakoram anomaly, Glaciers, Climatic Change, Mass balance.

9. Geological studies, mineral resources and applications

27. INTEGRATED ASSESSMENT OF FLOOD INUNDATION FOR PAKISTAN UNDER CURRENT, FUTURE AND EXTREME RAINFALL CONDITIONS

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ABSTRACT

It's essential to project the characteristics of floods and droughts under climate change in order to create an integrated management plan and improve society response to these extremes. The detailed information provided by numerical flood inundation modelling is essential for managing flood risk in such conditions. This study gives an assessment of the impacts of four extreme rainfall events on water depth and inundation area in the central region of Pakistan using referenced photographs and a calibrated flood inundation model. The inundation model took four different historical and extreme rainfall forms into consideration. An R2 of 0.6 was obtained between the modelled and observed for 2008-2010 flood event with the reference stations. In terms of water flow and inundation area, the flood inundation under the predicted maximum precipitation carries the highest risk. These finding provides important information for monitoring flood risk, creating flood mitigation strategies, and properly installing pumping stations. According to the research, governmental intervention is required for the country sustainable growth through severe accountability of the resources and regulations put in place in the past for developing cutting-edge climate policy.

Key Words:

Extreme rainfall events, flood inundation modelling, flood risk, water depth

9. Geological studies, mineral resources and applications

28. FLOOD MAPPING AND DAMAGE ASSESSMENT OF FLOOD 2022 SINDH, PAKISTAN USING SENTINEL- 1 IN GOOGLE EARTH ENGINE

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ABSTRACT

Floods are one of the most common natural disasters, affecting nearly every demographic and area on Earth. They are most commonly caused by storms and torrential rain, or by overflowing lakes, rivers, or oceans. As they are wide-ranging disasters, floods leave disaster managers with a wide range of concerns. Obtaining flood inundation ranges quickly and precisely is critical for flood disaster assessment, rescue, and resource allocation. A quick flood inundation range extraction model is developed and applied to the analysis of severe floods in Sindh, in July and August 2022. The immediate concern throughout a disaster is human life and the infrastructure required to provide emergency response. Floods can wash away bridges and buildings, destroy power grids, and even cut off parts of cities or rural communities from the first responders who need to reach them. Google Earth Engine is a powerful web-platform for cloud-based processing of large-scale remote sensing data. Because processing is outsourced to Google's servers, the main advantage is its computational speed. The platform offers a wide range of constantly updated datasets that can be accessed directly from the code editor. The ESA Earth Observation Program, which includes a series of satellites known as Sentinels for operational observation of natural phenomena such as flooding, has the potential to close the gap. Sentinel-1 (SAR). Pre-flood cloud free Sentinel-2 records were used to create a land use/land cover map. This research is primarily concerned with flood mapping and damage assessment in Google Earth Engine, a cloud-based analysis platform.

Keywords: Pakistan, Google Earth Engine, Flood Mapping, Sindh, Sentinel -1, Sentinel-2

9. Geological studies, mineral resources and applications

29. REMOTE SENSING TECHNIQUES USING ASTER AND LANDSAT 8 OLI DATA FOR LITHOLOGICAL IDENTIFICATION OF MUSLIM BAGH OPHIOLITES, WESTERN PAKISTAN

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ABSTRACT

Advanced Remote Sensing (RS) techniques are appliances which expedite to map the rock units exposed on the surface in inaccessible terrains, whereas the sanctioned lithological mapping is tedious, highly cost effective, and contrived because of the practicalities of undulating terrains. The main objective of this research is to appraise the content of Landsat-8 Operational Land Imager (OLI) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite imagery to discriminate and detect the potential zone of ophiolitic complex. Lithological mapping of Muslim Bagh Ophiolites is carried out to distinguish various lithological units by using satellite-based Remote Sensing (RS) techniques. ASTER and Landsat 8 (OLI) satellite data are processed using atmospheric correction, principal component analysis (PCA), band ratios (BR), minimum noise fraction (MNF), decorrelation stretch (DS) and maximum likelihood classification. The aftermath generated by this contrivance shows that the BR, PCA, MNF and DS scenario implemented on visible and near-infrared shortwave infrared bands (NVIR-SWIR) of ASTER and Landsat 8 OLI clearly discriminate the ophiolitic rocks at a sectional scale. The results indicate the presence of various igneous and sedimentary rocks in ophiolite complex which include peridotite, gabbro-diorite and dunite, harzburgites, amphibolite. harzburgite with dunite, mélange complex including ophiolite continent, volcanic rocks, chert and pelagic limestone in association with sedimentary as well as the mafic and ultra-mafic rock unites. The hereditary results are subject to the petrographic and geochemical analysis for further confirmation which would be carried out after a detailed geological field excursion to the studied area. Moreover, in this study the comparison of both ASTER and Landsat 8 OLI is also carried out which has showed that the ASTER due to its good spatial and spectral coverage, has acquired much better results in the discrimination and identification of rock units as compared to Landsat 8 OLI results.

Keywords: Lithological Mapping, Muslim Bagh Ophiolites, Principal Component Analysis (PCA), Minimum Noise Fraction (MNF), Maximum Likelihood Classification, ASTER, Landsat 8 OLI

10. Data and Information Systems and Spatial Data Infrastructures

30. CYBERGIS: A MODERN WAY TO GLOBAL GEOSPATIAL DATA HANDLING

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ABSTRACT

The field of geospatial information science (GIS) and remote sensing has witnessed significant advancements in recent years with their applications in diverse fields such as climatology, public health, and urban planning. Geospatial data handling is a complex and challenging task, especially when dealing with large and heterogeneous data sources. With the advent of Big Data and advanced computing technologies, traditional Geographic Information Systems (GIS) are facing new challenges in handling and analyzing massive amounts of geospatial data. CyberGIS, a new paradigm for GIS, emerged as a solution to these challenges by leveraging the power of high-performance computing, advanced data management techniques, and networked collaboration.

This poster presents an overview of CyberGIS technology, its key components, and how it can be used to handle, process, and analyze geospatial data on a global scale. The poster highlights some of the most significant challenges associated with geospatial data handling and how CyberGIS can overcome them, including data volume, variety, and velocity, as well as the need for high-performance computing and parallel processing.

This poster presentation aims to highlight the importance of CyberGIS in addressing the challenges associated with geospatial data handling and analysis at a global scale. The poster will discuss the key features and benefits of CyberGIS, including its ability to enable rapid and accurate data processing, visualization, and sharing. The poster will also showcase several case studies that demonstrate the practical applications of CyberGIS in various domains, including climate modeling, urban planning, disaster management, and natural resource management.

10. Data and Information Systems and Spatial Data Infrastructures

31. DATA-DRIVEN APPROACH FOR PREDICTING URBAN PLUVIAL FLOODING USING MACHINE LEARNING MODELS

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ABSTRACT

Urban alluvial flooding (UPF) has become a serious problem in recent years, and conventional hydrologic models used for flood prediction require large amounts of data, making them computationally complex. A data-driven approach based on rainfall has been proposed to address this problem and significantly reduce computational complexity. In this study, machine learning models (ML) based on rainfall amount were used to identify flood inundated areas in Lahore, Pakistan. Five ML models were trained and validated using 300 flood inundation points with twelve flood-conditioning factors. The performance of each model was evaluated using statistical measures such as precision, recall, F1 score, and area under the Receiver Operating Characteristic Curve (AUC-ROC). The results showed that the Light Gradient Boost Machine and CatBoost Classifier models had the highest precision during training and validation, respectively. In contrast, the Decision Tree and K-Nearest Neighbor models had the lowest precision during training and validation, respectively. These models can accurately predict UPF inundation points based on rainfall, and provide valuable insights for urban planners and policy makers to develop effective flood control strategies. By using ML models, which require less data and computational resources than traditional hydrologic models, this study offers a promising approach to predicting UPF. The use of these models can help government agencies mitigate the impacts of flooding in urban areas and reduce the damages and costs associated with such natural disasters. Therefore, the results of the study are essential for policy makers, urban planners, and disaster management agencies to make informed decisions and take proactive measures to reduce the risks of UPF.

Keywords: Urban Pluvial Flooding; Machine Learning Models; Rainfall Amount; Flood Prediction; Lahore, Pakistan

10. Data and Information Systems and Spatial Data Infrastructures

32. ASSESSMENT OF ROOFTOP SOLAR POWER POTENTIAL BASED ON DIGITAL SURFACE MODEL: A CASE STUDY OF MODEL TOWN, LAHORE

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ABSTRACT

Solar energy is a sustainable and widely available energy resource among renewable energy resources for tackling the long-term issues of the energy crisis. According to the United Nations Development Program, UN Department of Economic and Social Affairs, and World Energy Council assessment, solar energy has a global potential of 1,600 to 49,800 exajoules (4.41014 to 1.41016 kWh) each year. Despite the fact, Solar PV global electricity generation is only 3.1 percent. According to media reports, either 63 percent population of Pakistan have no access to the electrical grid or they are facing daily load shedding for more than 12 hours. Our region is considered for solar insolation due to its unique geographical location and climate characteristics. With more than 300 days of sunshine per year, almost every part of the country receives high solar radiation for 8–10 hours each day. Thus, the aim of this study is to find out the solar potential of residential areas that shared 47 percent of electricity consumption. For this purpose, Model Town in District Lahore is selected as a case study. Model town is one of the core of residential areas in Lahore. For the study purpose, cadastral map is collected from the Estate man Properties International and a Surface digital model from ALOS is obtained. Solar potential is computed by performing the Area Solar Radiation analysis with the help of selected urban parameters layers such as aspect and slope by using GIS tools i.e. solar radiation and spatial analyst to calculate surface analysis. The results are showing the maximum amount of solar radiation is 4459.15 kWh/m². The minimum solar radiation, model town is receiving is 7.65 kWh/m² of current year.

Keywords: Aspect¹, Morphology², Renewable Resources³, Solar potential mapping⁴, Slope⁵, Urban parameters⁶.

10. Data and Information Systems and Spatial Data Infrastructures

33. ESTIMATING ROLE OF DATA ASSIMILATION TECHNIQUES TO COMBINE REMOTE SENSING AND CROP MODELING FOR BETTER YIELD FORECASTING

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ABSTRACT

Timely monitoring of crop growth activities is important in order to make improvements towards sustainable agriculture and to ensure food security. Earth observation (EO) tools such as satellite imagery provides spatial data at a larger range but hampered with uncertainty. Crop growth models can be used to simulate different crop physiological processes to describe developmental stages of crop. The integrated use of earth monitoring tools along with predictive abilities of crop growth simulation models yields better results under the umbrella of different data assimilation (DA) methods. The proposed study includes field data collection of a particular site of rice crop to calibrate the WOFOST model. After calibration, run the model to provide the estimates of leaf area index (LAI), evapotranspiration (ET), soil moisture (SM), above ground biomass (AGB), and development state (DVs). These parameters then also be calculated by using earth observation tools. Then the best DA technique will be used to update the uncertain model predicted parameters such as LAI, ET etc., to match with observations contain uncertainty. This all will be done to keep the probability density function (Pdf) constant with the data acquired from both sources. Finding the best data assimilation technique to integrate remote sensing and crop modelling for better forecasting is the main objective of the study.

Keywords: Data assimilation, WOFOST, Earth Observation, LAI, Remote sensing.

11. Educating on Climate Change and Sustainable Development

34. SPATIO-TEMPORAL ANALYSIS OF GREEN SPACES AND THEIR CORRELATION WITH URBAN GROWTH IN LAHORE, PAKISTAN

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ABSTRACT

Pakistan is regarded as Asia's most urbanized country. Keeping in mind the unplanned urbanization and rapid population rise, this study looks at the relationship between urban green spaces (UGSs) and urban expansion in Lahore and intends to analyze the rate of unregulated urbanization in Lahore. To evaluate the spatiotemporal patterns of land use and land cover of Lahore in context to UGSs, LANDSAT imagery of 30 m spatial resolution, Landsat 5 TM, Landsat 8 OLI and Google Earth Engine (GEE) have been used to conduct classification of image for the Lahore district for the years 1990, 2000, 2010, and 2020. As estimated by the Pakistan Bureau of Statistics, the population forecast growth rate for Lahore tehsils, population for 1990, 2000 was calculated based on the census 1998 data and for 2010 and 2020, it was based on the 2017 data. This study evaluated a considerable decline in vegetation and rapid increase in urbanization in Lahore. Between 1990 and 2000, the urban area of Lahore expanded by 24.2 square kilometers each year. Urban land grew by 12.1 square kilometers between 2000 and 2010, and by 26.4 square kilometers between 2010 and 2020 annually. The findings indicate that vegetation declined by 33.45 square kilometers between 1990 and 2000. It dropped at a rate of 20 square kilometers between 2000 and 2010. From 2010 to 2020, it grew at a 14.17 square percent annual rate. The proposed land requirements ratio for open green spaces in the Lahore Master Plan for the years 2016 to 2021 is less than WHO guidelines but results of this study show that number of green spaces available per person are enough and meet the WHO criteria. In addition to this, SDG 11 indicator 11.3.1 is calculated. This study gives fresh insight on the land cover change in Lahore from 1990 to 2020. It will provide guideline to administrators about the conservation of natural, social, and economic resources while providing direction for planned urban expansion.

Keywords: Lahore, Spatio-temporal, Land use and Land cover, Green spaces, SDGs

12. Capacity building, networking, resource sharing

35. LEVERAGING THE POWER OF OPEN SOURCE GEOSPATIAL IN REMOTE SENSING, GIS AND CLIMATE CHANGE

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ABSTRACT

With the rapid changes occurring in the world around us, there has risen a need for access to open Geospatial resources. Resources need to be ever ready to be utilized by the Geospatial community for various applications. With the frequent changes in climate, and unexpected disasters - without easy access to open sources of Geospatial data it will take ages for a solution to be reached, it will cost the world millions before analysis is made and conclusions drawn for progress and preparation. Readily available data is needed now more than ever to address the fast changing trends and for transboundary resource management. There are quite a lot of resources around us that are left idle or not used frequently. The world around us holds a lot of answers to most of our pleas. We need to leverage on the resources we have, to work on platforms around us intertwined in order to win against any upcoming abnormalities through the Geospatial technologies. Many a times the community is so exposed to one part or one software or platform or application that others are as non-existing. They focus so much on a single pathway such that ideas to explore others sound more like a waste of time. The poster seeks to address the various open Geospatial platforms, data and tools available at our disposal. It aims at educating the Geospatial community on open platforms they have and can easily access for free. It especially emphasizes on these for the future generation of Geospatial experts – the students.

Keywords: Open Geospatial, Transboundary, Open-Source, Geospatial.