

IFMCC 2023

ABSTRACT BOOK

1 - 3, March 2023
USPCASW

International Conference on
**Integrated Flood Management
Under Changing Climate Scenario**

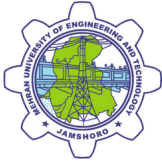


Organized by:

U.S.-Pakistan Center for Advanced Studies in Water (USPCAS-W),
Mehran University of Engineering & Technology (MUET), Jamshoro

Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences,
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Message from Prof. Dr. Rasool Bux Mahar

Director, USPCAS-W, MUET, Jamshoro

“The greatest threat to our planet is the belief that someone else will save it”

I feel pleasure to welcome all the delegates to the International Conference on the International Conference on Integrated Flood Management under Changing Climate Scenario (IFMCC-2023). We are proud to share that USPCAS-W is organizing this event with the collaboration and support of national and international organizations.

The main objective of this conference is to highlight the issues of flood management and suggest a way forward to manage floods in the context of climate change. As always, we received a record number of paper submissions. The Technical Program Committee was supported by a team from the Chinese Academy of Sciences, USPCAS-W, and technical experts from the federal and provincial departments who reviewed abstracts. Only those approved by the committee have been accepted for presentation and included in the abstract book. The Technical Committee deserves our gratitude for putting an immense amount of work into preparing a quality technical program that covers the latest advancements and research output most relevant to the conference. Besides technical sessions, several plenary speakers have accepted our invitation to talk on the floods, which will enrich your technical knowledge, update you about recent developments, and present their vision and way forward for the future.

Now allow me to say a few words about the Center established in 2014 with the financial support of USAID, Pakistan, and technical support of the University of Utah and other partnering universities of the USA. The Center is committed to focusing upon, discussing, and engaging with other stakeholders in achieving the Sustainable Development Goals (SDGs). SDG6 focuses entirely on the availability and sustainable management of water and sanitation. The Centers' agenda primarily focuses on postgraduate degree programs (HID, EE, IWRM and WASH), applied policy research, facilitation of public-private partnerships, and provision of policy advice in a range of water-related disciplines. The overall objective is to contribute solutions to Pakistan's water-related challenges by educating and training the next generation of water sustainability.

In the end, we welcome all collaborative partners' engagements focusing on SDG6. This event is an example of such a collaboration. This conference will provide a forum for researchers, academics, and practitioners actively involved in improving our understanding of flood events and our approaches to response, recovery, rehabilitation, and resilience.

We look forward to working more closely with our partners to advance mutual agenda, particularly regarding floods and other extreme events.

Concept Note

Introduction

Extreme weather events—storms, severe torrential rains, cyclones, floods, heatwaves, and droughts are happening more frequently all over the world due to climate change, putting more and more people in danger and causing structural and economic damage. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) for the Asia region noted the sensitivity of agriculture-dependent economies (such as Pakistan) towards climate change. It arises from their distinct geography, demographic trends, socioeconomic factors, and lack of adaptive capacity that, when taken together, determine the climate change vulnerability profile of the country. Pakistan is highly vulnerable to climate change and ranks in top ten countries affected by extreme rainfall events. Over the past several decades, South Asia's climate, including that of Pakistan, has changed, with significant impacts on the environment and people. A glimpse of climate change can be seen in the devastating 2022 Pakistan floods, mainly caused by increased precipitation, four times higher than the average, especially in the Sindh and Baluchistan Provinces of Pakistan. The glaciers melting fueled by climate change have destroyed around 50% of the crops of Pakistan, about a million livestock, breaching of riverbanks, soil transport and sedimentation, and destruction of critical infrastructure, including roads, bridges, schools, hospitals, and public health facilities. Besides, it has led to food shortages, displacement of rural communities, and their shifting to major cities. The fingerprints of climate change are present in these unprecedented floods in Pakistan and other countries. Taking notice of this situation and other factors impeding development on a global scale, the world body, the United Nations, agreed on the "2030 Agenda for Sustainable Development" in September 2015 and "The Paris Agreement on Climate Change". These agreements recognize the need for an effective and progressive response to the urgent threat of climate change based on the best available knowledge. It also recognizes developing countries' specific needs and special circumstances, especially those particularly vulnerable to climate change's adverse effects. To support and implement those agreements, concerted, solid, and strategic actions should be taken to enhance climate and disaster resilience and sustainability.

This conference will provide a forum for researchers, academics, and practitioners actively involved in improving our understanding of flood events and our approaches to response, recovery, rehabilitation, and resilience.

Objectives:

1. To review and learn from the recent floods, sediment disasters, and associated damages to comprehensively understand the issues.
2. To encourage participation in a broad-based discussion and development of

strategic mitigation and adaptation strategies to climate change challenges, especially flooding.

3. To deliberate on data integration, modeling, forecasting, and early warning for vulnerable regions.
4. To discuss flood prone disasters related issues from scientific, technological, social, and economic perspectives and devise strategic actions to enhance changing climate disasters' resilience and sustainability.
5. To develop policy guidelines for enhancing country-driven participatory adaptive capacity, strengthening resilience, and reducing vulnerability due to climate change impacts.
6. To provide a platform for candid discussions on the role and response of disaster and drainage management authorities in the devastating floods of 2022 in Pakistan and recommend improvements for future.

Conference Themes:

- Flood management with innovative approaches, and rehabilitation ; recovery
- Flood forecasting, vulnerability, and risk assessment
- Flood emergency preparedness and early warning system
- Flood damage and impact assessment
- Flood resilient infrastructure and mitigation works including development of major water storage reservoirs, and drainage infrastructure in low lying areas affected by water logging and salinity.
- Performance and behavior of flood defenses and management agencies.
- Flood Hazard analysis and modeling (including the effect of flooding caused by rains within the southern part of Pakistan as well as floods generated in the Indus Basin due to glacial lake outbursts and heavy monsoon rains in the northern parts of Pakistan. The models should consider all kinds of scenarios with special reference to the peculiar geographical landscape and soil characteristics of Sindh, its natural drainage capacity, and the developments done for drainage through RBOD and LBOD systems etc.)
- Hydrological and storm surge modeling
- Groundwater quality and management and the role of relevant institutions, including SIDA
- Climate change impacts: WEF Nexus; Socio-economic impacts; Sensitivity, and uncertainty analyses
- Data integration, modeling, and forecasting of extreme events (Floods, droughts, heat waves, GLOFs)

International

Prof. Dr. Chen Yaning, Director of State Key Laboratory of Desert and Oasis Ecology, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, China

Prof. Dr. Duan Weili, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, China

Prof. Dr. Sajjad Ahmad, Chairman, Civil and Environmental Engineering and Construction, UNLV, United States

Dr. Amir Motlagh, Assistant Professor (Environmental Engineering), Department of Civil Engineering, California State University, Sacramento, United States

Prof Dr. Fayyaz Ali Memon, University of Exeter, UK

Philippe De Maeyer, Ghent University

Jun Xia, Wuhan University, China

Chongyu Xu, University of Oslo, Norway

Qi Feng, Northwest Institute of Eco-Environment and Resources, CAS, China

Kaoru Takara, Kyoto University, Japan

Paul Samuels, Editor-in-Chief, Journal of Flood Risk Management

Fawu Wang, International Consortium on Geo-Disaster Reduction

Xi Chen, Xinjiang Institute of Ecology and Geography, CAS, China

Xiaohong Chen, Sun Yat-sen University, China

Yangbo Chen, Sun Yat-sen University, China

Naota Hanasaki, National Institute for Environmental Studies, Japan

Qiang Huang, Xi'an University of Technology, China

John Kimball, University of Montana, USA

Van-Thanh-Van Nguyen, McGill University, Canada

S. Geoffrey Schladow, University of California, Davis, USA

Frank W. Schwartz, Ohio State University, USA

Qiuhong Tang, Institute of Geographic Sciences and Natural Resources Research, CAS, China

Guoqing Wang, Nanjing Hydraulic Research Institute, China

Jianhua Wang, China Institute of Water Resources and Hydropower Research, China

Denghua Yan, China Institute of Water Resources and Hydropower Research, China

Satoru Oishi, Kobe University

Qingyun Duan Hohai, University

Emmanouil Anagnostou, University of Connecticut

Yuanming Zhang, Director of Xinjiang Institute of Ecology and Geography, CAS

Yaning Chen, Xinjiang Institute of Ecology and Geography, CAS, China

Fubao Sun, Vice Director of Xinjiang Institute of Ecology and Geography, CAS

Bin He, Guangdong Institute of Eco-Environmental Science & Technology,
Guangdong Academy of Sciences

Weili Duan, Xinjiang Institute of Ecology and Geography, CAS

Pingping Luo Chang'an University, School of Water and Environment

Zhi Li, Xinjiang Institute of Ecology and Geography, CAS

Zhaoxia Ye, Xinjiang Institute of Ecology and Geography, CAS

Gonghuan Fang, Xinjiang Institute of Ecology and Geography, CAS

AidiHuo Chang'an University, School of Water and Environment

YinkeYang, Chang'an University, School of Water and Environment

JiqiangLyu, Chang'an University, School of Water and Environment

Jing Ma, Xi'an Jiaotong University, Institute of Population and Development
Studies, School of Public Policy and Administration

National

Dr. M Ashraf Memon, Chairman, PCRWR, Islamabad

Prof. Dr. Muhammad Asif Kamran, Agriculture Policy, Law and Governance, University of Agriculture Faisalabad (Punjab, Pakistan)

Dr. Zia ur Rehman Hashmi, Head (Water Resources and Glaciology), GCISC, Islamabad

Dr. Zakir Hussain Dahri, Managing Director, Pakistan Agricultural Research Council (PARC)

Dr. Inayatullah Rajpar, Sindh Agricultural University, Tando Jam

Mr. Muhammad Suleman Chandio, Former MD, KWSB, Karachi, Pakistan

Engr. Zarif Iqbal Khero, Chief Engineer at Irrigation Department, Sindh

Engr. Habib Ursani, Director, Hydrology and Research, Irrigation Department, Sindh

Engr. Ghulam Mustafa Ujjan, Environment and Social Development Specialist, Sindh Irrigated Agriculture Productivity Enhancement Project (SIAPEP), Sindh

Engr. Khadim Ali Memon, Former Secretary, Irrigation Department, Sindh

Prof. Dr. Kamran Ansari, USPCAS-W, Mehran UET, Jamshoro

Prof. Dr. Zubair Ahmed, USPCAS-W, Mehran UET, Jamshoro

Prof. Dr. Abdul Latif Qureshi, USPCAS-W, Mehran UET, Jamshoro

Prof. Dr. Arjumand Zehra Zaidi, USPCAS-W, Mehran UET, Jamshoro

Dr. Naveed Qambrani, USPCAS-W, Mehran UET, Jamshoro

Dr. Tanveer Ahmed, USPCAS-W, Mehran UET, Jamshoro

Dr. Rizwan Ahmed, USPCAS-W, Mehran UET, Jamshoro

Dr. Asmatullah, USPCAS-W, Mehran UET, Jamshoro

Day 1: Wednesday, 1st March 2023

09:00 – 10:00	Registration/Assembly
10:00 – 11:00	Inaugural Session Arrival of Chief Guest Recitation from the Holy Quran National Anthem of Pakistan Welcome Address (Prof. Dr. Rasool Bux Mahar, Director, USPCAS-W, MUET, Jamshoro) Address by Guest of Honor (Prof. Dr. Tauha Hussain Ali, Vice Chancellor , MUET, Jamshoro) Address by the Chief Guest (Mr. Jam Khan Shoro, Minister for Irrigation, Government of Sindh (TBC) Vote of Thanks (Prof. Dr. Kamran Ansari, Co-Director, USPCAS-W, MUET, Jamshoro) Presentation of Souvenirs
11:00 – 11:30	Tea-Break
11:30 – 13:00	Plenary Session – I Venue: Auditorium Session Chair: Dr. Mohsin Hafeez, Country Representative, IWMI, Pakistan Facilitator: Ms. Falak Naz and Ms. Fizah Saeed Keynote Speech: Devastation of 2022 Floods in Sindh: Perspective From Sindh (Causes, Impacts and Looking Forward) – (By: Zarif Khero, Chief Engineer, Irrigation Department, Government of Sindh) Keynote Speech: TBC – (By: Dr. Muhammad Abubakr, Department Chair, Syed Babar Ali School of Science and Engineering, LUMS, Lahore) Keynote Speech: Climate change for Pakistan is a Water Menace – (By: Dr. Zia Hashmi, Section Head (Water Resources and Glaciology), GCISC, Islamabad) Keynote Speech: Attribution of a record-breaking rainfall event in summer 2018 of Hami city in Eastern Xinjiang, China – (By: Prof. Dr. Weili Duan, Professor, Water resources and climate change at Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, China) Keynote Speech: Modelling Hydrological Responses to Climate Change in Data-Scarce Mountain Basins in the Tianshan and Upper Indus – (By: Prof. Dr. Yan-Jun Shen, Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology (IGDB), Chinese Academy of Sciences (CAS), China) Keynote Speech: Impacts of Climate Change on the Runoff and its Components Across the Upper Indus River Basin – (By: Prof. Dr. Takahiro Sayama, Disaster Prevention Research Institute (DPRI), Kyoto University, Japan)
13:00 – 14:00	Lunch and Prayer Break

14:00 – 15:00	Plenary Session – II Venue: Auditorium Session Chair: Dr. Muhammad Abubakr, Department Chair, Syed Babar Ali School of Science and Engineering, LUMS, Lahore Facilitator: Ms. Falak Naz Channa and Ms. Fizah Saeed Keynote Speech: TBA (By: Dr. Mohsin Hafeez, Country Representative, IWMI, Pakistan) Keynote Speech: HANDS Response, Early recoveries Interventions, and Rehabilitation Plan for Flood 2022 with Multilaterals and Community Partnership and Lesson learned. – (By: Dr. Shaikh Tanveer Ahmed, Chief Executive of Health And Nutrition Development Society (HANDS), Pakistan) Keynote Speech: Pakistan Floods 2022: Building Back Better for A Resilience Pakistan in the Wake of Flood Damages and Loss – (By: Ali Asghar Halepo-to, Chief (Water Resources Section), Planning Commission, Ministry of Planning, Development and Special Initiatives, Government of Pakistan, Islamabad) Keynote Speech: Mechanism and Simulation of Rainfall Flooding in Dryland Watersheds and Cities in the Context of Extreme Rainstorms and Double Carbon – (By: Prof. Dr. Pingping Luo, Professor, School of Water and Environment, Chang'an University, China) Keynote Speech: TBA – (By: Dr. Zakir Hussain Dahri, Managing Director, Pakistan Agricultural Research Council, Islamabad)
15:00 – 16:00	Technical Session-I: Flood Forecasting, modeling, vulnerability and risk assessment Venue: Auditorium Chair: Zarif Khoro, Chief Engineer, Irrigation Department, Govt. of Sindh Co-Chair: Engr. Sajjad Soomro, Deputy Director, SIDA Facilitator: Ms. Falak Naz Channa and Ms. Samiya Shah 1. Changes in Flooding in the Alpine Catchments of the Tarim River Basin, Central Asia (By: Prof. Dr. Gonghuan, Fang, China) 2. Methodological Approaches for Assessing Flood Risk Management Decision at Farm Level (By: Dr. Raza Ullah, University of Agriculture, Faisalabad) 3. Analysing flood events in Pakistan using Integrated Flood Analysis System (IFAS) (By Usman Ashiq, UET Taxila) 4. Flood Risk Management and Mitigation Strategies under Climate Change (By: Muhammad Safdar, University of Agriculture, Faisalabad)\ 5. Improved Flood Mapping using Fusion of Sentinel-1, Sentinel-2 And Land-sat-9 Datasets for Data Driven Policy Design (By: Usman Nazir, LUMS, Lahore) 6. Flood Modeling, Mapping and Forecasting under Climate Change for Manchar Lake, Sindh, Pakistan (By: Aqsa Zahid, NEDUET, Karachi)

15:00 – 16:00	Technical Session-II: Flood management with innovative approaches, and rehabilitation & recovery Venue: Conference Room Chair: Dr. Zakir Hussain Dahri, Managing Director, Pakistan Agricultural Research Council, Islamabad. Co-Chair: Dr. Arjumand Zaidi, USPCAS-W, MUET, Jamshoro Facilitator: Ms. Farkhanda Noor and Mr. Tauqeer Ali 1. Mapping Flood-Affected Cropland in Sindh Using GEE and Sentinel 1 SAR Data (By: Dr. Arjumand Zaidi, USPCAS-W, MUET, Jamshoro) 2. Application of nature-based solutions to control flooding hazards in Naeen Gajj, district Dadu, Pakistan (Dr. Ziauddin, USPCAS-W, MUET, Jamshoro) 3. The Nexus Between Climate Change, Flood-2022, and Pakistan's National Security: Why does Integrated Flood Management be the best strategy? (By Zulqarnain, Quid-e-Azam University, Islamabad) 4. Managing Rivers using Satellite Radar Altimetry at Ungauged Locations: A Case Study of the Lower Indus River (By: Fizah Saeed, USPCAS-W, MUET, Jamshoro) 5. Removal of Pesticides (pops) from contaminated fresh water due to severe floodings with the help of neem decorated -TiO₂ nanoparticles (By: safina kamboh, USPCAS-W, MUET, Jamshoro) 6. Investigate the Management Structure of Drainage System to Identify the Current Problems: An Empirical Study of District Hyderabad (By: Samia Arain, MUISTD, Mehran UET, Jamshoro) 7. Accuracy Assessment of Land Use Land Cover (LULC) Derived by ESRI's Living Atlas with Ground Data in District Badin (By: Noman Irshad, USPCAS-W, MUET, Jamshoro)
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16:00 – 17:00	Technical Session-III: Flood damage and Impact Assessment Venue: Auditorium Chair: Ali Asghar Halepoto, Chief (Water Resources Section), Planning Commission, Ministry of Planning, Development and Special Initiatives, Government of Pakistan, Islamabad Co-Chair: Prof. Dr. Asmatullah, USPCAS-W, MUET, Jamshoro Facilitator: Ms. Falak Naz Channa and Ms. Samiya Shah 1. Mapping flood extent and post-flood vegetation cover using Google Earth Engine (By: Waqas Ahmad, University of Agriculture, Faisalabad) 2. Integrating Time-Series Multi-Satellite Imagery for Flood Mapping and Impact Assessment in Pakistan, 2022 (By: Sikandar Ali, University of Agriculture, Faisalabad) 3. Rapid appraisal for need assessment for rehabilitation of agriculture and livelihoods in the flood affected areas of Sindh and Punjab (By: Muhammad Asif Kamran, University of Agriculture, Faisalabad) 4. Analyzing the knock-on Impacts of 2022 Floods on Rabi 2023 Using Remote Sensing and Field Surveys (By: Usman Nazir, LUMS, Lahore) 5. Bringing the Agriculture Back to Normal: A Remote Sensing Based Analysis of Post-Flood Conditions in South Punjab and Sindh Provinces (By: Muhammad Adnan Shahid, University of Agriculture, Faisalabad) 6. Impact Analysis of 2022 Flood in Lower Indus Basin (By: Talha Khan Khoro, USPCAS-W, MUET, Jamshoro)
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16:00 – 17:00	Technical Session-IV: Climate change impacts, WEF Nexus; Socio-economic impacts; Sensitivity, and uncertainty analyses, Governance, Extreme Events (Floods, droughts, heat waves, GLOFs), Groundwater Management Venue: Conference Room Chair: Prof. Dr. Kamran Ansari, USPCAS-W, MUET, Jamshoro Co-Chair: Dr. Ghulam Hussain Dars, USPCAS-W, MUET, Jamshoro Facilitator: Ms. Farkhanda Noor and Mr. Tauqeer Ali 1. Climate Change and the Importance of Natural drains in Sindh (By: Prof. Dr. Kamran Ansari, USPCAS-W, MUET, Jamshoro) 2. Addressing Climate Change Impacts on Urban Morphology of Secondary Cities in Sindh with Planning for Flood Management (By: Dr. Ravindar Kumar Khiani, NEDUET, Karachi) 3. Sindh Flood 2022: Impacts and Challenges of Food Security (By: Dr. Abdul Ghani Soomro, PARC, Thatta) 4. Monitoring Sindh Groundwater Dynamics After 2022 Floods in Pakistan Using GRACE Satellites Data (By: Tarique Aziz, USPCAS-W, MUET, Jamshoro) 5. Measuring Urban Resilience to Natural Disasters and Climate Change for Punjab, Pakistan (By: Shareef Hussain, NUST, Islamabad) 6. Precipitation Trend Analysis Over Balochistan Pakistan (By: Abdul Wahid Mengal, USPCAS-W, MUET, Jamshoro) 7. Performance of Different Varieties of Brassica Under Variable Salinity Profiles at Malwah Distributary, District Shaheed Benazirabad, Sindh, Pakistan (By: Abdul Basit Solangi, USPCAS-W, MUET, Jamshoro)
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Day 2: Thursday, 2nd March 2023

10:00 – 11:00	Plenary Session – III Venue: Auditorium Session Chair: Dr. Zia Hashmi, Section Head (Water Resources and Glaciology), GCISC, Islamabad Facilitator: Ms. Falak Naz, Ms. Fiza Saeed and Ms. Samiya Shah Keynote Speech: Urban Storm water Management Practices to Alleviate Flood Events, Improve Water Quality and Groundwater Recharge – (By: Dr. Amir Motlagh, Assistant Professor, Department of Civil Engineering at California State University, USA) Keynote Speech: Lesons from the floods 2022 and the way forward – (By: Dr. Muhammad Ashraf, Chairman, PCRWR, Islamabad) Keynote Speech: Nanofibers Membranes for Water Purification: A Fragile Material for Robust Solution – (By: Prof. Dr. Zeeshan Khatri, Chairman, Department of Textile Engineering, Mehran UET Jamshoro) Keynote Speech: Recent Floods in Sindh: A Synergic Impact of Climate Change and Bad Governance – (By: Prof. Dr. Altaf Ali Siyal, Dean Faculty of Agricultural Engineering, Sindh Agriculture University Tando Jam) Keynote Speech: Flood Mitigation Strategies from the Perspective of a US City Government – (By: Engr. Aziz Mahar, Senior Engineer City of Alexandria, Virginia, United States)
11:00 – 11:30	Tea Break

11:30 – 12:30	Technical Session-V: Climate change impacts, WEF Nexus; Socio-economic impacts; Sensitivity, and uncertainty analyses, Governance, Extreme Events (Floods, droughts, heat waves, GLOFs), Groundwater Management Venue: Auditorium Chair: Prof. Dr. Altaf Ali Siyal, Dean Faculty of Agricultural Engineering, Sindh Agriculture University Tando Jam Co-Chair: Prof. Dr. Abdul Latif Qureshi, USPCAS-W, MUET, Jamshoro Facilitator: Ms. Falak Naz and Ms. Samiya Shah 1. Turning Threats Into Opportunities in Sindh: Above-Normal Rainfall-Induced Flood Challenges and Their Solutions (Prof. Dr. Abdul Latif Qureshi, USPCAS-W, MUET, Jamshoro) 2. Modeling of the Recent Shishper Glacier-dammed Lake and its Outburst Flood in Pakistan Using a Geospatial Integrated Approach (By: Falak Naz, USPCAS-W, MUET, Jamshoro) 3. Analysis of the Sentinel 3A radar altimetry waveform for Pakistan's recent flooding in 2022 (By: Farkhanda Noor, Institute of Physics, Sindh University, Jamshoro) 4. Effects of irrigation water regimes on young mango and jujube (ber) orchard in the Tando Allahyar (By: Raheel Raza, USPCAS-W, MUET, Jamshoro) 5. Analysis of extreme precipitation events in Sindh Province under climate change using CMIP6 climate data (By: Asad Ali, USPCAS-W, MUET, Jamshoro) 6. Impact of climate change and floods on South Asia: a review (By: Muhammad Fahad Ali, Civil Engineering, MUET, Jamshoro)
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11:30 – 12:30	Technical Session-VI: Flood management with innovative approaches, and rehabilitation & recovery Venue: Conference Room Chair: Dr. Zia-ur-Rehman Hashmi, Head (Water and Glaciology Section), GCISC, Islamabad Co-Chair: Prof. Dr. Zubair Ahmed, USPCAS-W, MUET, Jamshoro Facilitator: Ms. Fiazah Saeed and Tauqeer Ali 1. Teaching them How to Fish: Educating Flood Vulnerable Communities to Access Safe Drinking Water Using Sustainable Treatment Techniques for Prevention of Water-borne Diseases (By: Prof. Dr. Zubair Ahmed, US-PCAS-W, MUET, Jamshoro) 2. Impact Assessment of Small Dams in the Kohistan Region (By: Abdul Rafiue Memon, USPCAS-W, MUET, Jamshoro) 3. Assessment of rooftop rainwater harvesting potential in DHA Karachi (By: Sadaf Sher, USPCAS-W, MUET, Jamshoro) 4. Performance Assessment of an Irrigation Canal; A Case Study of Pir Gunio Distributary at Dadu Canal Asad Khoso (By: Prof. Dr. Zubair Ahmed, USPCAS-W, MUET, Jamshoro) 5. Flood Modeling Analysis of Lower Indus Reach to visualize the Vulnerability of Specific Districts under Threat (By: Tayyaba Suhail, USPCAS-W, MUET, Jamshoro)
12:30 – 13:30	Technical Session-VII: Climate change impacts, WEF Nexus; Socio-economic impacts; Sensitivity, and uncertainty analyses, Governance, Extreme Events (Floods, droughts, heat waves, GLOFs), Groundwater Management Venue: Auditorium Chair: Hafiz Abdul Salam, Director (DRIP), PCRWR, Tando Jam Co-Chair: Mr. Muhammad Ali, Assistant Professor, USPCAS-W, MUET, Jamshoro Facilitator: Ms. Falak Naz and Ms. Samiya Shah 1. Climate Change and Freshwater utilization for biofuels production in Pakistan (By: Dr. Muhammad Arshad, University of Veterinary and Animal Sciences Lahore, Jhang Campus) 2. Rainfall runoff modelling using artificial neural networks ANNs for flood forecasting in Pishin Lora Basin (By: Ghunwa Shah, USPCAS-W, MUET, Jamshoro) 3. Exploration of Groundwater resources for future settlement of population in northern areas of Quetta Valley through Vertical Electrical Sounding (By: Qayyum Habib, USPCAS-W, MUET, Jamshoro) 4. Assessment of Extreme Climatic Events on Darawat Dam by Using CMIP6 Climate Data (By: Mir Hassan, USPCAS-W, MUET, Jamshoro) 5. Flood Effective Drinking Water Quality Index in Qazi Ahmed, Nawabshah, Sindh (By: Touqir Raza, USPCAS-W, MUET, Jamshoro)

12:30 – 13:30	Technical Session-VIII: Flood management with innovative approaches, and rehabilitation & recovery Venue: Conference Room Chair: Prof. Dr. Ashfaqe Ahmed Memon, Civil Engineering, MUET, Jamshoro Co-Chair: Dr. Arjumand Zaidi, USPCAS-W, MUET, Jamshoro Facilitator: Ms. Fiazah Saeed and Tauqeer Ali 1. Post Flood Field Investigation for Loss Estimation and Recommendation for Structure Mitigation Using Quantitative Survey Techniques in the Gulen Gol Tehsil, District Lower Chitral, Pakistan (By: Muhammad Shahab, University of Peshawar, KPK) 2. Estimating Land Surface Temperature, NDVI, and its Correlation by Using GIS and RS Techniques (By: Naresh Kumar Guriro, USPCAS-W, MUET, Jamshoro) 3. How do Seasonal Variations from Sentinel 3 Satellite Dictate Reservoir Operations to Optimize Flood and Water Supply Releases? A Case Study of Tarbela Reservoir (By: Jasra Rehman, USPCAS-W, MUET, Jamshoro) 4. Monitoring Seasonal Water Surface Fluctuations Using Satellite Radar Altimetry Products for an Ungauged LAKE: A Case Study of the Manchar Lake (By: Shahryar Jamali, USPCAS-W, MUET, Jamshoro) 5. Assessment of Flood Hazard Zone Mapping of Sindh by Using Remote Sensing and MultiCriteria Analysis (MCA) Techniques (By: Bakhtawar Ayaz, USPCAS-W, MUET, Jamshoro) 6. Efficient agricultural practices to combat anticipated wheat shortage after 2022 Floods (By: Mumtaz Ali, USPCAS-W, MUET, Jamshoro)
13:30 – 14:30	Lunch/Prayer Break
14:30 – 15:30	Closing Ceremony Conference Report (Dr. Ghulam Hussain Dars, Assistant Professor, USPCAS-W, MUET, Jamshoro) Recommendations of the Conference (Prof. Dr. Rasool Bux Mahar, Director, USPCAS-W, MUET, Jamshoro) Address by Guest of Honor (Prof. Dr. Tauha Hussain Ali, Vice Chancellor, MUET, Jamshoro) Speech by the Chief Guest (Mr. Muhammad Mureed Rahimoon (Secretary, Universities & Boards Department, Govt. of Sindh, Karachi)) Vote of Thanks (Prof. Dr. Kamran Ansari, Co-Director, USPCAS-W, MUET, Jamshoro)

Day 3: Friday, 3rd March 2023

10:00 – 17:00	Field Visit to Keenjher Lake
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Changes in Flooding in the Alpine Catchments of the Tarim River Basin, Central Asia

Gonghuan, FANG¹ and Yaning CHEN¹

¹ State Key Laboratory of Desert and Oasis Ecology, Xinjiang Institute of Ecology and Geography

Abstract

Climate change has altered the intensity, frequency and timing of floods worldwide. Many studies have investigated change in floods caused by climate change and human activities in data-rich area, such as the US, Europe, etc., while little is known about changes in flood in mid-latitude glacierized catchments. This study examined long-term changes in flood characteristics (including magnitude, frequency, and timing) in 30 alpine headwaters of the large endorheic Tarim River Basin, Central Asia. The contributions of climatic factors to flood (magnitude and timing) changes were investigated using numerical experiments in combination with the random forest approach. The following results were obtained: (1) Annual maximum flood peaks increased at most stations (89% stations) during 1961–2015 with increased flood frequency. Earlier flood peaks were observed in spring with a rate of 1.38 day per decade; for other seasons, changes in the occurrence time of flood peaks showed strong spatial variability. (2) Precipitation was the dominant factor for the increased flood magnitude in most catchments of the southern slope of the Tianshan Mountains, and temperature played a greater role in the northern Kunlun Mountains. (3) For flood timing changes, melt level height and precipitation were the most influential factors in the alpine catchments in the Tarim River Basin. The results provide information on the spatiotemporal variations of floods and their driving factors in this alpine basin under climate change.

Keywords: Climate Change, Floods, Alpine basins, Water Security.

Attribution of a record-breaking rainfall event in summer 2018 of Hami city in Eastern Xinjiang, China

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Abstract

Extreme rainfall events are rare in inland arid regions, but have exhibited an increasing trend in recent years, causing many casualties and substantial socioeconomic losses. A series of heavy rains that began on July 31th, 2018, battered the Hami prefecture of eastern Xinjiang, China for four days. These rains sparked devastating floods, caused 20 deaths, 8 missing, and the evacuation of about 5500 people. This study examines the extreme rainfall event in a historical context and explores the anthropogenic causes based on analysis of multiple datasets (i.e., the observed daily data, the global climate models (GCMs) from the Coupled Model Intercomparison Project Phase 5 (CMIP5), the NCEP/NCAR Reanalysis 1, and the satellite cloud data) and several statistical techniques. Results show that this extraordinarily heavy rainfall was due mainly to the abnormal weather system (e.g. the abnormal subtropical high) that transported abundant water vapor from the Indian Ocean and the East China Sea crossed the high mountains and formed extreme rainfall in Hami prefecture, causing the reservoir to break and form a flood event with lots of loss, which is a typical example of a comprehensive analysis of the extreme rainfall event in summer in Northwest China. Also, the fraction of attributable risk (FAR) value was 1.00 when the 2018 July-August RX1day (11.52 mm) was marked as the threshold, supporting the claim of a significant anthropogenic influence on the risk of this extreme rainfall. The results offer insights into the variability of precipitation extremes in arid areas contributing to better manage water-related disasters.

Keywords: Extreme Rainfall, CMIP5, NCAR, China, Climate Change

Impacts of Climate Change on the Runoff and its Components Across the Upper Indus River Basin

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Abstract

The runoff from the Upper Indus River Basin (UIB) is considered vital for sustainable water supply and agriculture. Climate change may alter the runoff and affect the availability of water as well as floods in the Indus River basin. This study employs a Rainfall-Runoff-Inundation (RRI) model and the climate projections of fine-resolution Meteorological Research Institute-Atmospheric General Circulation Model (MRI-AGCM) (0.1875°) to assess the impacts of climate change in the future (2075–2099) on the flows in the UIB and its sub-basins. The simulations have shown satisfactory results compared to the observed ones. Furthermore, simulated snow-cover was compared with estimated snow-cover by Moderate Resolution Imaging Spectroradiometer (MODIS). According to the results, meltwater from glaciers contributes to about two-thirds of the annual runoff from the UIB. According to the projections, the future temperature will increase by 5.3 °C and annual precipitation will increase by 17% across the UIB. Despite this increase, the annual river flows were projected to decrease by 14% in the future because of depleted glacier melt. Furthermore, the detailed hydrologic responses in selected sub-basins showed different patterns in the future depending on the climate and elevation. In an eastern sub-basin, flows will increase by 58% because of enhanced glacier melt and higher precipitation, which may lead to floods in the basin. Contrarily, two western sub-basins will experience the reduction of the flow by 30–70% because of the glacier retreat.

Keywords: Indus River Basin; Rainfall-Runoff-Inundation Model; Glacier; Snow-Melt; GCMs.

Mechanism and Simulation of Rainfall Flooding in Dryland Watersheds and Cities in the Context of Extreme Rainstorms and Double Carbon

Pingping Luo¹

¹School of Water and Environment, Chang'an University, China

Abstract

Impacted by climate change, extreme rainstorm events have occurred frequently in recent years, and floods and their associated disasters pose a major threat to regional development. As an important tool for studying watershed floods, numerical models that accurately simulate storm flood processes are essential for regional flood risk management systems. To cope with the management of floods in dry watersheds and cities under extreme rainstorms, we coupled remote sensing, machine learning, hydrology and hydrodynamics to reveal the rainfall and flood formation mechanisms and spatial-temporal patterns in typical watersheds and cities in the Yellow River dryland in China. By constructing a distributed hydrology and hydrodynamics model of watersheds and cities with dry and loess characteristics, we screen the key factors and core elements of dry watersheds and urban floods, and propose a scientific basis for the construction of distributed rainfall and floods model in dry watersheds and cities. This provides new ideas and measures for monitoring, early warning and emergency response to floods in dry watersheds and cities under the context of extreme rainstorms and double carbon.

Keywords: Extreme Rainfall, Urban Flooding, China, Climate Change

Modelling Hydrological Responses to Climate Change in Data-Scarce Mountain Basins in the Tianshan and Upper Indus

Yan-Jun Shen¹

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Abstract

Understanding the water balance, especially as it relates to the distribution of runoff components, is crucial for water resource management and coping with the impacts of climate change. However, hydrological processes are poorly known in mountainous regions due to data scarcity and the complex dynamics of snow and glaciers. Our study provides a quantitative comparison of gridded precipitation products in the Tianshan Mountains, and to further understand the mountain hydrology and distribution of runoff components in an glacierized Basin. We found that gridded precipitation products are affected by inconsistent biases and should be evaluated with caution. Although uncertainties remain in data-scarce basin, driven by field survey data and bias-corrected gridded data sets, the water balance and distribution of runoff components can be plausibly quantified based on the distributed hydrological model (J2000). We further examined parameter sensitivity and uncertainty with respect to both simulated streamflow and different runoff components based on an ensemble of simulations. Furthermore, due to the importance of precipitation, we have downscaled precipitation data in the upper Indus basin, and the non-stationary relationship between precipitation and environmental variables have been addressed. Integrating gridded products in hydrological modeling can be important for model applications and design in other data-scarce mountainous regions.

Keywords: Hydrological Modeling, Upper Indus Basin, Tianshan, Data-scarcity, Climate Change

Flood Mitigation Strategies from the Perspective of a US City Government

Aziz Mahar¹

¹Senior Engineer, City of Alexandria, Virginia, USA

Abstract

The City of Alexandria is a very old mid-size city, founded in 1779, which is a suburb of Washington DC, the US nation's capital. It sits on the west side of the Potomac river and for decades has been prone to flooding in certain areas. In recent years, the flooding problems for the city have gotten more severe and frequent rain storms due to climate change. The flooding for the city includes both coastal flooding and flash flooding.

The city's Department of Transportation and Environmental Services is enacting various mitigation strategies to combat the increasing flood hazards and prepare for future climate conditions. This presentation will provide highlights of the City of Alexandria's attempt to combat climate change induced flooding impact. It will discuss the city's Flood Action Alexandria, which is the city's comprehensive initiative to address flooding issues. This presentation will describe the different alternatives that flood mitigation projects can take, for example infrastructure upgrades, building protections to enhance the resilience of residents, water storage and nature based solutions. It will also highlight the need for future development and major retrofits to comply with flood-resilient building standards, which protect residents living in the floodplain. The city of Alexandria has made an assessment of both the stormwater runoff and hydraulics of the storm sewer system for each individual watershed within the city limits. Hydrology and Hydraulic (H&H) models were developed and utilized to generate data for different storm events. Results from this model were used to identify and prioritize flooding areas utilizing benefit cost analysis.

HANDS Response, Early Recoveries Interventions, and Rehabilitation Plan for Flood 2022 with Multilaterals and Community Partnership and Lesson learned

Prof. Dr. Altaf Ali Siyal¹

¹ Dr. Shaikh Tanveer Ahmed (MBBS, MPH, Fellow of PHI Santacruz CA)
Chief Executive HANDS Pakistan

Abstract

Pakistan has been facing an unprecedented disaster due to heavy rainfalls and flash floods since July 2022. Rains exceeding 400% of the monthly average of some regions have hit all provinces resulting in hill torrents and flash floods, which started from Balochistan province and then hit Sindh, Punjab, and Khyber Pakhtunkhwa. Over 1,700 human and 1.3 million livestock mortalities have been reported.

Thirty-three million were displaced, as per National Disaster Management Authority Report. HANDS has been at the forefront of disaster relief, response, and rehabilitation, with over 3.1 billion PKR rants spent. Our programs are designed to build the resilience of communities towards such disasters and equip them with the right tools, knowledge, and skills to bounce back and withstand such climatic shocks. Through our integrated multisectoral approach, we strive to ensure the quality of life for all, specifically focusing on marginalized groups such as the elderly, women, widows, children, persons with disabilities, etc.

HANDS having over 32 field offices and disaster risk management centers in all affected regions, immediately initiated relief and response activities. HANDS Planned to raise PKR 06 Billion in July 2021.

We are successful in raising more than 03 Billion PKR. Over 4 million affected people have been given relief by HANDS until now in response and early recovery phase in 41 districts. This includes 24 in Sindh, 10 in Balochistan, 04 in South Punjab, and 03 in Khyber Pakhtunkhwa.

We were able to ensure the provision of shelter/roofing kits, rescue through boats, provision of safedinking water, food rations, hygiene kits, dignity kits for women, Non-Food Items, medical camps, veterinary camps for livestock, and other services.

This crisis won't end as flood waters recede; the real challenge is resilient rehabilitation. We have to draw learning from our experiences. We're hoping all the stakeholders should work closely with each other, led by the Public sector, to implement a resilient rehabilitation phase.

Keywords: Rehabilitation, Early Response, Recovery, Floods-2022, Community

Recent Floods in Sindh: A Synergic Impact of Climate Change and Bad Governance

Prof. Dr. Altaf Ali Siyal¹

¹Dean, Sindh Agriculture University, Tandojam, aasiyal@sau.edu.pk

Abstract

Sindh, the southern province of Pakistan, has suffered three devastating floods within the last 15 years. Out of three, two viz. 2011 and 2022 floods were rainfall-induced, while the third 2010 flood was due to breaches in the river Indus. These floods are considered the worst in the history of Pakistan. It is a fact that these floods impacted more people in Pakistan than the South-East Asian tsunami in 2004 and more than the earthquakes in Kashmir in 2005 and Haiti in 2010. In floods in 2010, 2011, and 2022, it is reported that 1700, 5434, and 1800 respectively, lost their lives. The economic damages to the country due to floods in 2010, 2011, and 2022 are estimated as \$43 billion, \$6.8 billion, and \$17 billion, respectively. The devastation from the 2022 floods is believed to be worse than that of 2010. Despite contributing less than 1% of the world's greenhouse gas emissions, Pakistan ranks among the top 10 countries worldwide most severely impacted by climate-related extreme weather. A well-designed and operated agricultural and stormwater drainage system plays a vital role in the sustainability of agriculture in the area and mitigates the risk of urban flooding through safe disposal of the runoff during heavy rains. Sindh province of Pakistan is a low-lying area with a flat topography. In Sindh, two main drainage networks with a total drainage capacity of more than 8000 cusecs were constructed on both sides of the Indus. Thus, known as the Left Bank Outfall Drain (LBOD) and Right Bank Outfall Drain to dispose-off drainage water. People believe that if these drains had been properly maintained and operated by the concerned department, the impact of rainfall-induced floods might not have been so devastating. Some say that these floods resulted from extraordinary and above-average monsoon rainfall due to climate change which moved monsoon winds westerly towards the Indus basin. They believe that similar events of severe monsoon rainfalls, droughts, and cyclones will be witnessed frequently in the southern parts of Pakistan in the coming years. If an integrated flood management approach is not followed, future floods will be more fatal and destructive. My presentation will overview all three devastating floods, elaborating on their causes, severity, and impacts. The reasons behind the flooding of KN Shah town each time, whether the flood was rain or river-induced, will be discussed, and protective measures will be suggested. The role of the concerned departments in aggravating the severity of the floods shall also be elaborated on in the presentation. The protective measures to manage future rain and flood-induced floods in Sindh under current and future climate change scenarios will be suggested in the presentation.

Keywords: Flood, Extreme Rainfall, LBOD, Sindh, KN Shah

Nanofibers Membranes for Water Purification: a Fragile Material for Robust Solution

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Abstract

This talk discusses about nanofiber membranes development and their application in water purification. The nanofibers are believed to be delegated and fragile materials and yet a promising candidate for aqueous adsorption and filtration techniques. Despite a widely researched material on lab scale, however, the commercial development is still a challenge. This talk will gives insight into the development and challenges of nanofiber membranes from lab scale to prototyping to the mass production.

Keywords: Nanofibers, Membranes, Water, Purification, Commercialization

Urban Stormwater Management Practices to Alleviate Flood Events, Improve Water Quality and Groundwater Recharge

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Abstract

The runoff of stormwater occurs as a result of a precipitation event, and heavy storm events can overwhelm runoff drainage systems, resulting in flooding of roads and properties. Since heavy rainfall events have become more frequent and intense worldwide over the last 50 years, stormwater management practices have become increasingly important to manage and alleviate flood risks. Additionally, stormwater runoff from urban development is a major contributor to water quality degradation. Using low impact development (LID) techniques and green infrastructure practices can help manage and reduce storm water runoff. In addition to reducing runoff and protecting floodplains, green infrastructures improve water quality and reduce nutrient and toxin loadings. Furthermore, many LID practices can enhance infiltration and improve groundwater recharge. This presentation is an overview of several LIDs installed on the campus of California State University, Sacramento, and discusses about the construction, design, and operation phases, and their importance in reducing stormwater impacts on the American and Sacramento Rivers.

Keywords: Urban Stormwater Management, Groundwater Recharge, Low Impact Development, Green Infrastructure.

Climate change for Pakistan is a Water Menace

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Abstract

It has now been globally recognized that climate change is here, it is here to stay and mainly human induced. Hence, it is the biggest challenge faced by mankind right now. In developing countries, it is considered as a stress multiplier. Pakistan, one of the most climate-affected countries, has a water reliant economy. Its dwindling water resources are facing climate related challenges starting from its northern mountains to the point where the mighty Indus meets the Arabian sea. This work would endeavour to appraise the most critical issues faced by the water systems of the Indus Basin and Pakistan. Also, the opportunities and ongoing actions, to ensure sustainable development of the country by making it water secure and climate resilient, are also discussed.

Keywords: Climate Change, Extreme Events, Climate Resilient, Water Management, Indus Basin,

Devastation of 2022 Floods in Sindh: Perspective From Sindh (Causes, Impacts and Looking Forward)

Zarif Khoro¹

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Abstract

The Lower Indus presents probably the greatest flood management problem in Pakistan. Being at the downstream end of the river system, flood discharges are at their highest, flood volumes their largest and flood durations their longest. The flood mechanism in Sindh is derived from three sources that is; (1) the Indus River, (2) the entire Sindh shouldering Westerly Mountains including Marri-Bugti and Khirthar mountains whose catchments in lies in Punjab and Baluchistan, (3) the monsoon rainfall induced floods in the south-eastern plains of central and lower Sindh. The Indus River in the lower reaches had many flow courses flowing during historical times. Two distinct types of floodplains are found in the lower Indus Region, meander, and cover flood plains. The meander floodplains occupy mainly the central zone of the region and represent the present trunk river activity. Formerly the trunk river sent off distributaries and small seasonal spillway channels towards the flanks of the valley and in Indus delta. Cover floodplains are widespread along the flanking zone called western Nara from Jacobabad to Manchar Lake, and eastern Nara and the river Puran (of its own origin) in the south-east around Mirpurkhas and Umerkot, and in the delta zone. In this presentation, I will present the flood mechanism in Sindh, types of floodplains, 2022-flood, its causes, roll of Manchar Lake, and FP Bund to protect floods.

Keywords: 2022-flood, Sindh, Manchar Lake, FP Bund

Climate Change and the Importance of Natural drains in Sindh

Kamran Ansari¹

¹Professor, US-Pakistan Center for advanced studies in water (USPCAS-W)

Abstract

Climate change is causing significant changes in the rainfall pattern and with it, the occurrence of exceptionally heavy rainfall events has increased the frequency of flash floods in many parts of the world during recent years. Sindh, a province of Pakistan, faced multiple major floods in recent years. Usually in Sindh, due to synergic effect of flat topography and poor surface and subsurface natural drainage, the flood water takes months to drain out. Looking at the gravity of problem, the present study was conducted to analyze the extreme rainfall events that have caused significant floods in Sindh and ways to mitigate their effects. A comparison of the satellite images of lower Sindh after monsoon rainfall showed a significant ponding of water in many areas having a poor drainage system as compared to those areas with some kind of a drainage network in place. As much as 70% of the area was submerged under water for many days after a rainfall event. The Hydrologic Engineering Center – River Analysis System (HEC-RAS) was used to ascertain the capacity of the natural drains for the removal of the flood water. The results show that there is great potential of conveyance/disposal of flood water through the revival of natural waterways. The findings of the study are helpful for policy makers for hydrological planning as well as disaster management.

Keywords: Floods; Climate Change; Rainfall; Drainage System; Natural Drains.

Turning Threats Into Opportunities in Sindh: Above-Normal Rainfall-Induced Flood Challenges and Their Solutions

Prof. Dr. Abdul Latif Qureshi¹

¹Professor, US-Pakistan Center for advanced studies in water (USPCAS-W)

Abstract

The recent 'above-normal' rains in the Sindh province of Pakistan have resulted in widespread flooding. This condition has created pressure on the banks of the Indus River, causing breaches, flooding vast areas, displacing millions of people, and producing significant loss of life and property. Such massive destruction of crops and infrastructure made it difficult for people to access essential services. The affected areas span both sides of the Indus River, affecting food supply, shelter, medical care, and the economy. Many families lost their entire livelihoods. Moreover, the extreme rainfall-runoff has led to increased soil erosion and the spread of waterborne diseases, putting the local population's health at risk. Despite the efforts of the local authorities and international aid organizations, the situation remained dire, and the long-term recovery process became complex and challenging. This article will provide an overview of the strategies and their potential to help create a more sustainable and resilient water supply for the future. The flooded water could be stored in natural and artificial reservoirs, such as lakes, lagoons, and wetlands. Sindh province has more than 30 sites in various districts that can store flood water for future use, such as during droughts. Natural waterways, canals, and weirs can be designed to drain excess water into the storage reservoirs. New infrastructure, in addition to existing water storage systems, could also be utilized to accommodate the excess flood water. The capacities and quality of Haleji and Hadero lakes/wetlands can be enhanced/improved. Artificial wetlands can also be created/developed in areas prone to flooding to store and manage the excess water, providing important habitats for wildlife and helping reduce soil erosion. In order to effectively utilize the stored water during droughts, efficient water management practices should be implemented to ensure proper distribution to the areas in need, such as agriculture and urban areas, in a timely and effective manner. Overall, the combination of natural and artificial storage systems and effective water management practices can help mitigate the impacts of floods and droughts in the region and ensure a more sustainable and resilient water supply for the future.

Keywords: Extreme Rainfall; Floods; Surface Water Storage (SWS); Wetlands; Efficient Water Management.

Teaching them How to Fish: Educating Flood-Vulnerable Communities to Access Safe Drinking Water Using Sustainable Treatment Techniques for Prevention of Water-borne Diseases

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¹US-Pakistan Center for Advanced Studies in Water (USPCASW), Mehran UET, (MUET), Jamshoro

²Saylani Water Division, Karachi

Abstract

Millions of people in Sindh, Pakistan, were deprived of their properties during the recent flood in 2022 and lost access to safe drinking water. The spread of water-borne disease is foreseeable, with high estimated health-related costs. The need is to educate vulnerable communities to adopt simple water treatment techniques to make contaminated water potable and safe. USEPA has suggested simple techniques to make water safe to drink. In the current study, different methods for drinking water treatment are studied, which can be adopted by flood victims. Different water treatment plants installed across Pakistan with varying treatment capacities, composed of sand filtration, ultrafiltration, and Reverse Osmosis, were investigated. The associated challenges in installation and operation were identified. Also, simple methods suggested by USEPA were developed and used in flood-affected communities. Cost comparison and performance assessment were conducted at the lab-scale level. The best water treatment technique for communities with different scenarios are discussed in this paper. Furthermore, a communities-based training program is proposed during pre-flood time to enable the vulnerable communities to use different disinfection techniques suited to their situation for safe drinking water. The training sessions will cover all 29 districts of Sindh and will focus on community leaders, females, and non-governmental organizations involved in relief works. To execute the training, students from the local university can be hired, and training can be given to make them trainers. The US-Pakistan Center for Advanced Studies in Water (USPCASW) at Mehran University of Engineering and Technology (MUET), Ramshorn, Sindh, can be a hub of training/demonstration activities. Community-participatory training is expected to benefit millions of flood-vulnerable communities in Sind and Pakistan, reducing flood-related health risks and associated costs.

Keywords: Flood-Vulnerable Communities, Climate Change, Sustainable Treatment Techniques, Water-Borne Diseases;

Mapping Flood-Affected Cropland in Sindh Using GEE and Sentinel 1 SAR Data

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Abstract

Remote sensing data have been proven to be very effective in flood mapping. But flood season in Pakistan is usually the monsoon period when cloud cover is generally high. Optical images have limitations and can not work in cloud covers. Synthetic Aperture Radar (SAR) can penetrate clouds and acquire data in all weather conditions. Damage assessment and mapping are essential for adequate recovery and rehabilitation activities. Sentinel 1 multi-temporal SAR based flood mapping code in Google Earth Engine (GEE) by UN-SPIDER is utilized with some modifications to map the flooded area of the Sindh province after heavy rains of August 2022. Before and after flood images were used to separate permanent water from flooded areas. The modified code also detected the damaged/affected cropland in the province using Space and Upper Atmosphere Research Commission (SUPARCO) and Food and Agriculture Organization (FAO) developed crop masks. An Earth Engine App is developed that can be viewed through mobile devices and computers and does not have any installation or registration requirements. The flood inundation area, along with the permanent water, can be seen on the map. The flood affected kharif croplands, including cotton, rice, and sugarcane, were also delineated on the map

Keywords: Flood; SAR Data; Sentinel 1; Crop Damages; Inundated Area

Pakistan Floods 2022: Building Back Better for A Resilience Pakistan in the Wake of Flood Damages and Loss

Waqas Anwer¹, Engr. Ali Asghar Halepoto¹

¹Planning Commission, Ministry of Planning, Development & Special Initiatives, Islamabad

Abstract

Pakistan is the most flood-hit country in the south Asia in year 2022. The changing climate scenario has badly affected the country between June – August monsoon season 2022. The torrential rains and combination of riverine, urban, and flash flooding for continuous almost three months led Pakistan's 94 districts completely damaged and were declared as "Climate Hit". The assessment shows that 33 million were affected including nearly 8 million people displaced and more than 1700 people lost their lives in the wave of floods, one third of which were children. The tens of thousands houses were damaged i.e partially and completely, agriculture and livestock faced a billion rupees' loss, transport and communication sector was badly affected, infrastructure in all province is in dilapidated condition, particularly in Sindh, Balochistan and Khyber Pakhtunkhwa. It is counted that total 25 poorest districts are in the country. However, 19 districts were severely 2022.

For managing such a situation of floods in future, National Flood Protection Plan –IV (NFPP-IV) is under updating process costing to Rs. 194 billion. In response to humanitarian uplift, Pakistan's government launched Rs. 37.2 billion flood relief cash program for 1.5 million affected families. Soon after floods, the post flood need assessment report was carried out for damages, loss and need. It was reported that total flood damages were of Rs.3.202 trillion (USD 14.906 billion), loss were accounted for Rs. 3.277 trillion (USD 15.233) and Need was Rs.3.493 trillion (USD 16.261 billion). These damages, loss and need were assessed for multiple sectors includes social sector, infrastructure sector, productive sector, and cross-cutting sector in Pakistan.

Pakistan government has comprehensively framed a strategy and policy document under the title "Resilient Recovery, Rehabilitation and Reconstruction Framework" Pakistan (4RF) which is based on the post disaster need assessment document with sector wise priorities in the light of Four "Strategic Recovery Objectives" (SRO), a policy framework, a financing strategy, and implementation and monitoring arrangements with approach and Scope for governance, restore of livelihoods and economic opportunities after flood 2022.

Keywords: Floods 2022, Post Disaster Need Assessment, Resilient Recovery, Rehabilitation, and Reconstruction, NFPP-IV, Strategic Recovery Objectives.

The Nexus Between Climate Change, Flood-2022, and Pakistan's National Security: Why does Integrated Flood Management be the best strategy?

Zulqarnain¹

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Abstract

The concept of integrated flood management as a preemptive strategy in comparison to flood control as a defensive strategy is not only the paradigm shift but the acute need of Pakistan. The traditional approach based on the idea of flood control over the years had been a failed strategy in protecting the rich economic resources, social-economic well-being, and protection of the ecosystem, especially in southern Pakistan. Water scarcity is among the biggest problems of contemporary Pakistan and floods could be the biggest blessing and remedy to this problem if dealt with integrated flood management with a preemptive strategy. It has been scientifically and qualitatively observed that devastating floods as of flood-2022 and water scarcity are threat multipliers to national security owing to the adverse impacts of climate change in Pakistan. Non-traditional security threats of this age are interdisciplinary in nature and require a holistic approach of the policymakers by engaging maximum national institutions for policy analysis in the greater interest of the state. This paper qualitative studies the two primary questions why severe floods and water scarcity are the threat multiplier to the national security of Pakistan and why integrated flood management is the best strategy to curtail this threat. The paper addresses that policy feedback of the academics, water strategists, coastal management experts, environmental engineers, national institutes at all tiers, and the strategic strategist associated with the integrated risk management be made part of a grand national dialogue for the capacity building in enhancing integrated flood management in the wake of climate change.

Keywords: Climate Change, Flood-2022, Water Security, Threat Multiplier, National Security.

Addressing Climate Change Impacts on Urban Morphology of Secondary Cities in Sindh with Planning for Flood Management

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Abstract

Climate change is among the most tenacious environmental issues around globe as it leads to natural calamities, such as floods in Pakistan, especially in Sindh during the year 2022 and its aftermath that caused irreversible indemnities, and uncertainty in its socioeconomics and urban morphological structure. When natural disaster like flood occurs in any rural and urban context, its adverse paraphernalia become quite visible in the morphology of housing, urban transport, infrastructure, landuse, education, health, and economic spaces. Therefore, the objective of this paper is to address the issue of climate change and its impacts on urban morphology of secondary cities in Sindh with planning for future flood management by concerned authorities. The methodology of research includes theoretical underpinning of climate change scenario and impacts on urban morphology of secondary cities in Sindh with practical appraisal of their socioeconomics as well as uncertainty analysis of recent floods, and its associated damages to people and communities. The expected outcome of this research may be creation of different professional engineering strategies to address climate change challenges in flood prone areas from scientific, technological, social, and economic perspectives and devise strategic actions to enhance resilience and sustainability in future. It also includes candid discussions on role and responsibility of disaster and drainage management authorities in Sindh. Thus, this research would present a proper policy guideline for urban and rural contexts with appropriate professional planning and management recommendations concerning morphological planning and flood management in secondary cities of Sindh vis-à-vis devastating effects of climate change.

Keywords: Climate Change, Natural Disaster, Urban Morphology, Flood Management, Socioeconomic Sustainability.

Climate change and Freshwater utilization for Biofuels production in Pakistan

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Abstract

Biofuels have become significant fuels and will remain so for in the foreseeable future. Biofuels may substitute conventional fuels with the intentions to reduce discharges of greenhouse gases and other environmental effects. Among the potential challenges for advancement of biofuels is its impact on water resources that may not have fetch right attention yet. Fundamental questions are how fresh water use and ground water quality are at risk as the more biomass will be raised for extra production of biofuels. Water is needed to raise crops and in processing of feedstocks. Freshwater shortage is a growing concern and amplified production of biofuels may upsurge this issue. So the consumption of water sources will have become a major distress, offsetting the returns of biofuels usage with respect to climate change. Current literature does not present satisfactory solution to describe the impact. This article will be focused on the issue of water consumption in production of biofuels and water scarcity. Engagement of water in production of feedstocks and processing facilities will be examined.

Key words: Water, Bioethanol, Climate Change, Bioenergy Crops

Flood Effective Drinking Water Quality Index in Qazi Ahmed,Nawabshah, Sindh

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Abstract

Indus is the longest river in Pakistan. The river overflowed during August 2022 due heavy rainfall and releasing of water from the Indus River and destroyed almost all districts of Sindh. This resulted in flood along the bank of the river and extended to the nearby areas like badin, khairpar Nathan shah, Mirpurkhas, Nawabshah etc . Thus, it was crucial to monitor the different parameters of drinking water quality of the groundwater to ensure quality water for domestic and agricultural purposes of different Talukas of Nawabshah. The purpose of this study was to assess some physico-chemical and microbiological parameters of the groundwater and present the Water Quality data of groundwater before and after flood. We will apply the analytical result of the parameters to obtain the Water Quality Index which in turn is used to rank the river. According to the average Water Quality Index, we selected 10-15 stations that had water quality that was considered "marginal,". To maintain and improve the water quality, a regular programmed of water quality monitoring and an appropriate water safety policy are necessary.

Keywords; Water Quality Index, Indus River, Flood, Sindh, Groundwater

Estimating Land Surface Temperature, NDVI, and its Correlation by Using GIS and RS Techniques

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Abstract

Land surface temperature (LST) is defined as the temperature felt when the land surface is touched with the hands or the skin temperature of the ground. Land surface temperature is an important factor in many areas, such as global climate change, hydrological, geo-/biophysical, and urban land use/land cover. This project work was intended to estimate the LST by means of Arc GIS over district Jacobabad, Sindh, Pakistan, with the help of data obtained from LANDSAT-8. LST has been a main topic for developing methodologies to be measured from space. This present project will provide a reference for land use planning, restoration of ecological environment and sustainable development in District Jacobabad. There are two main objective of this study one is to analysis LST and NDVI trend, other is to correlate LST with NDVI, to investigate the seasonal/annual trends in LST using Land sat 08 images from 2013- 2022. Landsat-8 is one of the National Aeronautics and Space Administration (NASA) Landsat series. The Landsat-8 data is accessible in United States Geological Survey (USGS). The website Earth 4 Explorer is free of cost. The images of entire earth are taken by Landsat-8 satellite after every 16 days. In the current study, to estimate brightness temperature the TIR bands (10) were used and for the NDVI generation of the study area bands 4 and 5 were analyzed. This study only from 2013 to 2022 in every single month (May) of every year of Jacobabad city. Bands, resolution and wavelength of Landsat-8, every year from 2013 to 2022 in month of May satellite data is downloaded from USGS, presented a new LST software tool and its algorithm created in ERDAS for calculating the LST from LANDSAT 8 TIRS. The algorithm was derived using the observed thermal radiance of the TIRS Band 10 of LANDSAT 8 TIRS. As per above analysis no any regular trend is found for increasing or decreasing land surface temperature. NDVI is also decreasing and increasing no any regular trend is found.

Keywords: NASA, LST, NDVI, USGS

How do Seasonal Variations from Sentinel 3 Satellite Dictate Reservoir Operations to Optimize Flood and Water Supply Releases? A Case Study of Tarbela Reservoir

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Abstract

Tarbela is an important reservoir that ensures water availability for numerous uses in Pakistan. Changes in the reservoir's surface area and water levels over the past few years have severely impacted the energy supply. This study assessed seasonal water level fluctuations in the Tarbela reservoir using satellite radar altimetry (SRA). Sentinel-3A altimetric data in the open-loop tracing command mode were collected from the Earth Console from March 2019 to December 2020. Satellite data were compared with gauge measurements from Water And Power Development Authority(WAPDA) and the Pakistan meteorological department (PMD). The first period, from January to July, was marked by a decline in the water level, with a minimum level of 424.05 m in March 2019. In response to irrigation releases, the reservoir was lowered during this year. The reservoir continued to be drained until the minimum water level was reached, which often happens in early April or early May of the following year when the inflows are low. The second (high-level) period peaked at 472.78 m in August 2019. The cycle then repeated as the snowmelt runoff and strong flows began in late May and ended in late July. Sentinel-3's water level time series may help to understand seasonal and interannual fluctuations in Tarbela Reservoir. Seasonal fluctuations are essential to optimize releases/storages for irrigation demand and flood control. Our findings suggested lowering the reservoir to the minimum by the middle of May until June and July to capture flood water. Sentinel 3 mission missed specific extreme flows (highs and lows) due to the low temporal resolution. However, since the region's weather seasons lasts about two to five months, this temporal resolution was found to be sufficient to show how the changing seasons affect the water levels of the Tarbela Reservoir.

Keywords: Seasonal Fluctuations, Sentinel 3, Tarbela Reservoir, Water Surface Levels.

Monitoring Sindh Groundwater Dynamics After 2022 Floods in Pakistan Using GRACE Satellites Data

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Abstract

Groundwater is one of the most critical natural resources under stress globally due to high consumption rates. Developing countries like Pakistan have suffered water shortages due to increasing population, urbanization, and climate change issues. The recent floods have caused a catastrophic situation in Sindh, south Pakistan. However, every disaster has an opportunity to assess. Therefore, the impact of floods on groundwater storage has been analyzed in this study. Groundwater studies are now crucial for finding groundwater zones and monitoring and safeguarding this valuable natural resource. Geographic information system (GIS) combined with Remote sensing (RS) offers a wide range of spatial and temporal data that can quickly cover vast and inaccessible areas. This study analyzes the change in groundwater storage (GWS) after recent catastrophic rainfall-led floods in Sindh, Pakistan. Global Land Data Assimilation System version 2.2 (GLDAS-2.2) provides high-resolution (0.25°) assimilated groundwater data from gravity recovery and climate experiment (GRACE) mission. Pre (March 2022) and post (October 2022) monsoon months were selected for acquiring GRACE data. Pre- and post-monsoon temporal change assessment reveals an increasing trend in groundwater storage in Sindh after floods. On average, the storage varies from 56-137mm. Sanghar and Tharpakar districts received the maximum change in storage with an average value of 135mm, while Shikarpur and Kashmore Kandhakot districts have minimum storage changes of 56mm. The present research findings recognized the opportunities that flood events may create. The flood water, although disastrous on the earth's surface, happened to be the recharging source for groundwater. Further studies are needed to identify suitable measures to efficiently manage flood water to convert this threat into an opportunity.

Keywords: Floods, GLDAS, GRACE, Groundwater Storage (GWS), Sindh.

Flood Management with Innovative Approaches. Rehabilitation & Recovery

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Abstract

Water pollution is a serious issue nowadays in developing countries due to frequent unpredictable climate change events and lack of climate resiliency infrastructure. According to WHO, the very common risk associated with climate change impacts is the frequent flooding which leads to contamination of drinking water facilities in all over the world. According to the Pakistan economic survey 2021-22, the agriculture. It is a major contributor to the employment and foreign exchange earnings in Pakistan. Perhaps the greater role of agriculture in Pakistan economic growth, it has major role to contaminating water bodies with pesticides residual especially during severe flooding due to agriculture run-off entrance into fresh water bodies like river, lacks and streams. Water pollution due to chemical water pollutants (pesticides) has potential detrimental and devastating impacts on the survival of all living in earth including aquatic life, forest, and most vulnerable species that is human especially pregnant women by disrupting hormonal cycle and retardation of infant's growth. Pesticides are organic persistent pollutants (pops) which has capability to persist in all environment like soil, air and water for the longer period of time. Now a days, POPS are very big and challenging issue to direct extract and remove from contaminated water. To overcome this serious threatening issue, Nanotechnology is the novel, cost-effective and environmentally friendly innovative approach. To control pops from drinking water, the most convenient technology is the green decorated Titanium dioxide nanoparticle with neem herb (*Azadirachta indica*) is the green /eco-friendly solution to capture /remove pesticides residual especially atrazine herbicides effectively. The neem decorated titanium dioxide nanoparticle has effective efficiency to remove pops from contaminated water due to flooding in less time with biodegradable characteristics.

Key words: Water Treatment, Climate Change, Water Quality

Flood Risk Management and Mitigation Strategies Under Climate Change

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Abstract

Pakistan is at risk of floods as a result of social, economic, and environmental development. The nation's institutions have made a number of steps to address the issue. These precautions, however, are inadequate to ensure the protection of people and places vulnerable to disasters with a sudden onset. Therefore, it is essential to predict future flood-related risks and take the appropriate action to reduce the negative effects and losses caused by floods. The article explores flood in Pakistan, analyses how they harm people and the environment and suggest potentially sustainable solution moving forward. With several years of flood prevention strategies, the aqueduct flood analyzer pregame was used to study the effects on the gross domestic product (GDP), urban damage, and people's livelihood. The scenarios representing socioeconomic and climate change were used for each level of flood protection to adequately estimate future changes. According to the research, a 2-year flood has a 50% chance of occurring in any given area without flood protection and may not have a substantial effect on GDP, population, or urban damage. Similarly, to this, the likelihood of a flood occurring within five years is 20%, exposing the country GDO in danger, leaving 8.4 million people at risk, and causing \$1.4 billion in urban damage. To minimize the negative effects of flooding, the Pakistani government should develop proper climate change policies, enhance disaster awareness, construct new and small dams, and update relevant departments.

Keywords: Mitigation, adaptation, climate change, SSP Scenarios, Flood

Analysis of the Sentinel 3A Radar Altimetry Waveform for Pakistan's Recent Flooding in 2022

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Abstract

Continuous monitoring of water extent is necessary during a flood event. However, it is not often possible due to the unavailability of flood gauges, inaccessible locations, and other hazardous situations in flooded areas. Despite this, advanced satellite radar altimetry derived water surface elevations may be utilized to supplement in-situ data. High-resolution mode Synthetic Aperture Radar (SAR) altimetry satellites emit pulses toward the earth surface, which can penetrate clouds and operate in any weather (rain and snowfall). Some of these pulses strike on the earth surface, and received echoes show different waveform peaks at different areas. It is necessary to analyze them seasonally at land and inland waters. Specularity is a crucial factor to consider for inland altimetry (on rivers, lakes, reservoirs, and flood plains). It differentiates inland water bodies from the land because land contamination is neglected. Sentinel 3 datasets on inland water surfaces were evaluated in this study in Sindh during the 2022 flood. Echoes were found highly specular during inundation while Quasi specular during dry months. We separated waveform shapes in different months. The accuracy evaluation uses variate differences, pass-to-pass repeatability, and comparison to gauge measurements. We have proposed a straightforward rule to separate specular, quasi-specular, and non-specular echoes for floodplains. Furthermore, radar altimetry may provide information about flood water depth. This study will help to map inundation extent and depth at inaccessible locations during all weather conditions.

Keywords: Radar Altimetry; Sentinel-3A; Waveform; Inland water; Climate Change;

Impact Analysis of 2022 Flood in Lower Indus Basin

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Abstract

The 2022 flood has been very devastating to the people and the lands in Pakistan; it has marked thousand of casualties in rustic and urban areas both. These natural disasters have always brought change into natural lands and environment. Inundated areas can be seen using a good resolution satellite image i.e. sentinel image of lower Sindh area during the flood duration. The imagery is processed using ArcGIS Pro tool. Data is obtained from Sindh Irrigation Department in order to assess the function of Irrigation system and analyze the failures in irrigation system. The validation of the imagery is done using previous flood data. Further aspects observed in this study include the assessment of rainfall flooding along with the vulnerable areas that will face hazards during the floods. ArcGIS Pro is very fast processing software and helpful in findings any data from satellite images. Flood mapping include the areas that are still under flood water and those areas which have been destroyed during that time. Flood assessment is essential to analyze so to take significant measure for near future.

Key Words: Flood Assessment, ArcGIS Pro, Lower Indus Basin.

Post Flood Field Investigation for Loss Estimation and Recommendation for Structure Mitigation Using Quantitative Survey Techniques in the Gulen Gol Tehsil, District Lower Chitral, Pakistan

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Abstract

Floods are one of the most common and destructive natural disasters, causing significant damage to infrastructure and communities. Accurate and reliable flood mapping is crucial for flood risk management and disaster response. One method for mapping floods is through quantitative survey techniques, which involve measuring and analysing physical characteristics of the flood event. This study presents an overview of quantitative flood survey techniques and their applications in flood mapping and recommendation for construction of mitigation structures in the affected area. The study was carried out in the Gulen Gol, tehsil District Lower Chitral after the huge destructive flood event in August 2022. It includes various types of quantitative survey techniques, including field surveys, Google Earth images, and precipitation history of the area. To understand different parameters that triggered floods in the area and loss estimation a detail field work was carried out in the study area. Field findings reveal that the event was triggered by continuous precipitation of 9 days which is marked as high intensity, also high elevation of 6512 ft and debris played role in destruction. Statistics of the field survey reported huge destruction to infrastructure, 41 houses, 1 masjid, 5 bridges, 4 power houses, 12 electric polls, 11 fish farms, 1 link road, 2 village roads, 12-acre barren and agriculture land, 20 acres of forest, and 12 drinking water supply channels, while no fatalities were reported in the area. The estimated loss is about 200 million in PKR. Furthermore, post flood photographs of the area were compared with Google Earth images to identify highly effected areas. The annual average data of precipitation from 2005 to 2020 were acquired from Pakistan meteorological department (PMD) for understanding the average rain capacity which shows high rain intensity in 2009-10 and lowest average rain intensity in 2018 while the intensity of precipitation was higher in 2019-20. The average precipitation data of the PMD shows a rising trend in the precipitation intensity, which is alarming situation. To avoid any further loss we need check dams, retention pounds, flood walls and proper awareness about the construction of houses.

Key Word: Flood, Flood Mapping, Mitigation Structure, Lower Chitral

Monitoring Seasonal Water Surface Fluctuations Using Satellite Radar Altimetry Products for an Ungauged LAKE: A Case Study of the Manchar Lake

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Abstract

Recent floods of 2022 have exposed the vulnerability of Manchar Lake that inundated the surrounding villages, and triggered long-term infrastructure and livelihood damages. Gauge data from authentic organizations are not available for this lake which is a prerequisite for managing any water body. Satellite altimetry is a reliable substitute for this purpose at places where satellite tracks are available. Luckily, several altimetry satellites passes are present over Manchar Lake, such as Jason 3, Sentinel 3A, and ICESat 2. Some water level products are also available that provide processed surface water levels using different re-tracking algorithms. Two famous satellite radar altimetry databases provide Manchar Lake water levels— Water levels of rivers and lakes (Hydro Web – from 2008 to 2023) and Database for Hydrological Time Series of Inland Waters (DAHITI – from 2008 to 2022). This paper presents long-term seasonal variations of the Manchar lake water surface elevations using Hydro Web and DAHITI. The minimum and maximum water levels from a.m.s.l. were found to be 32.75 m (August 17, 2009) and 36.07 m (June 10, 2022), respectively, with an average value of 34.49 m. Moreover, computed water level from ICESAT2 has been validated with DAHITI database through statistical measurements in which the correlation value (R) was 0.534, an average Mean Square Error (MSE) of 0.196, and an RMSE error of 0.443 m. Similarly, ICESAT2 data will also be compared with Hydro Web to confirm the validation of ICESAT2 data. Along with it, rainfall monthly data is also available which will help us to create relationship between rainfall intensity and water level data. In conclusion, this study will assist the government organizations to improve the monitoring of Ungauged Manchar Lake to avoid the disastrous situation of flood.

Keyword: Flood, Altimetry Satellite, Manchar Lake, Water Level.

Sindh Flood 2022: Impacts and Challenges of Food Security

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Abstract

A flood investigation was carried out for the entire Sindh province in the months of October and November 2022. Four teams of scientists from the Pakistan Agricultural Research Council were assembled, and each team consisted of three scientists. During the investigation, it was found that about 3.77 million acres of cultivated crops were devastated, about Rs. 15,266 million worth of livestock died, about 1.16 million houses were partially damaged, about 0.717 million houses were completely damaged and about 12.35 million people were affected, about 4.57 million people were displaced in 24 out of 30 counties during the flood-2022 in Sindh province of Pakistan. The pattern of precipitation during the monsoon; From July to August 2022, a maximum of 1763.9 mm and a minimum of 389 mm were recorded in the Naushahro Feroze and Mithi districts respectively. In the past decade, Sindh has suffered three floods in 2010, an Indus river flood, the 2011 rain-induced urban flood, and the 2015 river flood. However, in the current decade, the 2022 flood breached Lake Hamal and Lake Manchar, and many ruptures at various locations in the Indus River caused simultaneously by urban rainfall flooding broke all historical records and damaged 85% of agricultural infrastructure in the Indus irrigated areas of Sindh Province. Most of the lands have more clay particles accumulated with salt layers, and reduced drainage ability, some districts may start farming activities in Kharif in 2023. The situation represents the worse condition for agriculture and future food insecurity in the province. Increase crop rate inflation. The government should take emergency initiatives with integrated approaches to strengthen agriculture through climate-smart agriculture, possibly provide seed and fertilizer distributions, provide farm machinery on a cheap rental basis, and provide loans at minimal interest to refurbish their agricultural infrastructure. The water infrastructures and the drainage network infrastructures can be redesigned under the flood scenario of 2022 by hydrological modeling at different return periods in connection with remote sensing and GIS.

Keywords: Flood 2022, Damages, Indus River, Flooding, Breaches, Precipitation, Food security Assessment of Extreme Climatic Events on Darawat Dam by Using CMIP6 Climate Data

Assessment of Extreme Climatic Events on Darawat Dam by Using CMIP6 Climate Data

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Abstract

Water is the finite resources that can be conserve only construct through dam. Climate change is the major issues of water resources. In this study, aims to determined the study to assess potential changes in the mean and extreme of across the temperature, humidity, rainfall, water inflow, sediment inflow and precipitation. The study model is EC-Earth3 download from the NEX-GDDP6-CHMIP6 under five Shared Socioeconomic Pathways (historical, SSP1-26, SSP2-4.5, SSP3-70 and SSP5-8.5). In addition, the changes are divided into two time scales, i.e., near future (2030-2060) and far future (2060-2100). It is located in district Jamshoro. In Darawat Dam main source of water is precipitation which occurs usually in the form of rainfall, and farmers dependent mainly on rainwater for irrigating their lands. Despite the uncertainties in projected future changes in runoff, these findings highlight the complexity of runoff response to climate change, promoting the need for adaptive water resource management.

Keywords: CMIP6, EC-EARTH3, Precipitation, Temperature, Humidity, Future scenarios.

Assessment of Flood Hazard Zone Mapping of Sindh by Using Remote Sensing and Multi-Criteria Analysis (MCA) Techniques

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Abstract

Flood is a common natural disaster at worldwide and it is caused serious damage to our topography, environment, and socio-economy. Flood risk occurrence is a combination of natural and anthropogenic factors, which should be understand at the spatial extent. The purpose of this study is to identify flood hazard zone mapping of Sindh. This research is based on the integrated approach of multi-criteria analysis (MCA) and remote sensing. The result is divided in different zone Very high, high, moderate, Low and very low hazard zone. This study will helpful to the decision-making bodies to understand the overall flood conditions of Sindh and to better understand the damages occurred by floods. It will also help the concerned authorities and community to identify the socioeconomic vulnerable areas.

Keywords: Flood Risk, Hazard Zone Mapping; Multi-criteria Analysis (MCA); Remote Sensing; AHP; Sindh

Assessment of Rooftop Rainwater Harvesting Potential in DHA Karachi

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Abstract

Rising populations, growing urbanization, and rural-to-urban migration pose a danger to the sustainability of cities, particularly in developing countries. Pakistan has witnessed rapid climate change in recent years, increasing the vulnerability of the country's water supplies. Lack of water is a critical issue in a majority of Pakistan's urban regions. The gap between supply and demand for water has widened rapidly and based on the current rate of population increase, a 31% water shortage is foreseen in 2025, and that shortage is projected to intensify until 2050. In many regions of the world, rainwater harvesting (RWH) is frequently utilized to control urban flooding and water scarcity. RWH can meet a sizable amount of water demand in underdeveloped nations (mostly in Asia and Africa) where household water usage is minimal. It is particularly crucial in several Asian nations where RWH enjoys official support due to its affordable implementation. To provide more drinking water and irrigation water, it is stated that more than 5.5 million water tanks have been built in China since 2001. The objective of this study was to evaluate the DHA Karachi city's rainwater potential through remote sensing and GIS. By using remote sensing and GIS, the built-up regions of DHA Karachi that could collect rainwater were located. The built-up area contributes towards rainwater collection. Remap was used to classify the region and determine how much of it was built up. The city was divided into equal grids, and each grid was given a classification. The built-up area was assessed using real-world data. The potential for collecting rainwater from roofs was calculated using appropriate runoff coefficients and the average annual rainfall of 174mm. Roofs' capacity to collect rainwater under various rainfall forecasts was calculated. The captured rooftop rainfall could significantly contribute to increasing the water supply and meeting the DHA Karachi drinking water requirements. By providing a preliminary overview of the RWH potential assessment of the study area, directing further research to determine the precise amounts of water that can be harvested and creating useful management planning, the findings are expected to be useful for decision-makers and local officials in the future planning and management of water resources.

Keywords: Rainwater Harvesting, Remote Sensing and GIS.

Impact Assessment of Small Dams in the Kohistan Region

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Abstract

Remote Sensing and Geographic Information Systems (GIS) play a vital role in monitoring and analyzing environmental changes over a particular region or the globe. Moreover, the advent of the Google Earth Engine (GEE) and Machine Learning algorithms has revolutionized and enhanced the efficiency of detecting these changes at the terrestrial level. In this study impact of small dams construction in the Kohistan region of Sindh is evaluated. Small dams are usually constructed to manage rainwater, minimize flooding, and conserve fresh water for drinking and other purposes. The study was conducted to assess the land changes one year before and one year after the construction of small dams in the study area. The satellite data of Landsat 8 at ETM delineated three land classes—water, vegetation, and soil, using supervised classification. The changes in these classes were considered the impacts of the small dams. Before and after dam construction, differences in land cover classes were observed and studied. The results show that there was no water with little vegetation and rocky soils before the dam construction. However, after the construction of dams, the water has increased to 12%, with enhanced vegetation decreasing the soil cover. Therefore, the impact of small dams in the region can be demonstrated through land cover changes. These changes will play an essential role in environmental changes in the region.

Key Words: Impact Assessment, Floods, GIS, Small Dams, Water.

Performance of Different Varieties of Brassica Under Variable Salinity Profiles at Malwah Distributary, District Shaheed Benazirabad, Sindh, Pakistan

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Abstract

Salinity is a major soil problem affecting the agricultural production of most crops. Due to genetic and physiological variations, the degree of salt tolerance varies with plant species and varieties within a species. This study investigated the comparative performance of brassica varieties planted on multiple marginally saline soils at the village of Mitha Khan Dharejo, in the command area of Malwah distributary, district Shaheed Benazirabad, Sindh, Pakistan. Three varieties of brassica, Khanpur, Sindh Raya and Mehran New, were compared with the farmers' local variety on two farm fields in Rabi 2021. Besides, the Khanpur variety alone was compared with farmers' variety on two additional farms. The planting was done on ridges 2 ft 6 in apart. Representative soil samples were collected at 0-15 cm and 15-30 cm depths from each farm field and analyzed for texture, pH and electrical conductivity. In each case, the soil texture was silty clay loam. The soil pH and EC in 1:5 soil-water extract ranged from 8.1 to 8.5, and 0.98 to 2.72 dS/m, respectively. On average, EC was 1.92 dS/m at 0-15 cm and 1.72 dS/m at 15-30 cm depths. The Khanpur and Mehran New varieties performed equally well and yielded 2.22 t/ha on a well-drained non-saline land against the yield 1.98 t/ha from Sindh Raya and farmer's variety. Grown on a slightly saline land, Khanpur yielded the highest (2.08 t/ha), followed by Mehran New with yield of 1.98 t/ha, whereas lowest yield of 1.78 t/ha was recorded for Sindh Raya and farmer's variety. On two other locations with slightly/marginally saline lands, the yield of local varieties reduced to 1.48 t/ha, whereas Khanpur yielded 1.98 t/ha. It is concluded that the Khanpur variety performed the best compared to the other varieties, even in slightly saline soil.

Keywords: Soil Salinity, Brassica Varieties, Yield, Malwah Distributary

Flood Modeling Analysis of Lower Indus Reach to visualize the Vulnerability of Specific Districts Under Threat

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Abstract

The river course of the Indus is continuously evolving and changing morphologically due to the ongoing natural and anthropogenic interventions on its riverbed and floodplains. Since 1999, several high floods have occurred that have modified the river's sand bed and vegetation status. The reach of the Indus River, which extends from Sukkur to the Kotri barrage, is selected, and the river's northern, southern, and western riparian districts were analyzed. These districts have economic significance at the provincial level due to regional industries and agricultural land, especially in Sindh. Therefore, assessing these riparian districts' flood vulnerability was felt necessary. In the past, the levee breaks accidental and deliberate events have threatened these districts' inhabitants. The 2D flood modeling approach is used in this research with HEC-RAS and ALOS Digital Elevation Model (DEM) with measurements in feet, for the study area. The spatiotemporal flood vulnerability of these districts was determined regarding flood depth and extension towards the left and right banks of the Indus River for 1999, 2010, and 2021. Historical flow data were downloaded from the irrigation department's online portal. Throughout the entire reach of the river, it has been observed that the maximum depth difference due to silt aggradation is nearly 19.9 ft, and silt removal has occurred at -2.405 ft. The study concludes that significant river migrations have occurred in the northern reach of Sukkur, Larkana, Khairpur, and Shikarpur. It is also recommended to incorporate the impacts of anthropogenic interventions along the Sukkur-Kotri Indus reach into the flood model to fully understand the river dynamics.

Keywords: Flood Modeling, River Indus, Vulnerability, Threat, District, Economic.

Modeling of the Recent Shishper Glacier-dammed Lake and its Outburst Flood in Pakistan Using a Geospatial Integrated Approach

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Abstract

Glacial-dammed lakes are important in forming the natural environment of Karakoram. As a result of changing climate, surging glaciers in the upper Shishper basin melts, and lakes form at their terminal. However, when the quantity and volume of these lakes increase, the situation deteriorates due to the ice dam lakes outbursting, resulting in calamities. The Shishper glacier's most recent glacier lake outburst flooding (GLOF) incidents happened in four consecutive years—2022, 2020, 2019, and 2018. Due to these events, buildings and hanging bridges were damaged, while agricultural regions downstream of the Shishper glacier were eroded. These events can be considerably decreased by adopting an early warning system and gradually lowering the volume of a glacial lake. Therefore, this study conducted a Spatio-temporal analysis of the ice-dammed Shishper glacier lake. This study also modeled the recent Shishper GLOF 2022 event using the HECRAS2D and its downstream impacts. The study concludes that there is a need for people living downstream of Shishper Glacier to be aware of the possible GLOF lake risk, as well as for relevant departments to develop and implement prevention and adaptation plans before a bigger disaster occurs.

Keywords: Glacier Lake Outburst Flooding (GLOF), Shishper Glacier, Ice-Dammed Lake, Climate Change; Disaster, Early Warning System.

Bringing the Agriculture Back to Normal: A Remote Sensing Based Analysis of Post- Flood Conditions in South Punjab and Sindh Provinces

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Abstract

Pakistan is one of the top-listed countries regarding vulnerability to climate change impacts. This has been significantly witnessed in the form of heatwave in March-May, 2022 followed by the intense rainy season causing above-average rains and flooding in most parts of the country. The southwestern parts of Punjab province and the Sindh province of Pakistan have suffered huge economic and life-loss due to super floods of 2022 induced by about four times the average annual rainfall. It has been estimated through the flood inundation maps developed in this study that around 300,000 ha and 350,000 ha of croplands have been affected by floods in D.G. Khan and Rajanpur districts, respectively; while the massive damage of about 3.82 million-ha croplands was done in Sindh province. While the areas of south Punjab have mostly receded due to topographical advantage, several low-lying areas in Sindh are still facing the standing water or water-logged conditions. Even the receded areas may not be having conditions fully normal for the agriculture. A remote sensing based analysis was conducted to investigate the pre and post-flood conditions by considering different parameters, imperative for the favorable agricultural environment. The multiple factors studied include the water bodies maps indicating the areas still under water about four months after the floods, soil moisture conditions, soil salinity, monitoring of soil sediments transport, etc. The maps developed for these indicators helped understanding the agricultural constraints faced by the farmers at the onset of ongoing Rabi season, which will be presented in this paper.

Keywords: Floods-2022, Agriculture, Remote Sensing, Soil Moisture, Salinity, Topography.

Rainfall runoff Modelling using artificial neural networks ANNs for flood forecasting in Pishin Lora Basin

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Abstract

This study aims at studying the precipitation effects on runoff of Pishin Lora Basin (PLB) Quetta. It is the capital and biggest city in the province of Balochistan, and 10th populous city in Pakistan (Pakistan Bureau of Statistics, 2017). PLB is one of the largest water basin in Balochistan, has around area of 18,133 km² and source of many stream networks to its sub basins so it is essential to predict its flow for flood management. ANNs is the machine learning (ML) approach which is data driven and alternative to conceptual models. Unlike conceptual models the ANNs makes relationship between input and output parameters without accounting natural physical laws and it makes the process less tedious. The objective of this study is 1) to model the seasonal rainfall runoff process using empirical model artificial neural networks ANNs, determining relationship between variables, 2) to estimate the runoff for flood forecasting and its validation. The most widely used technique for hydrological parameters feed forward multilayered perceptron (MLP) is used to train the ANN with python package. 20 years Rainfall data and meteorological data (temperature, humidity, wind, sunshine) is used as input, then processed in hidden layers and output results are provided. Nash–Sutcliffe efficiency, root mean squared error and coefficient of determination (R²) are used to evaluate the hydrological parameters (discharge and volume of runoff) and strength of model is analyzed for flood prediction.

Keywords: Machine Learning, ANN, Python, MLP, Flood Prediction, Runoff.

Impact of Climate Change and Floods on South Asia: a Review

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Abstract

The South Asia is one of the least equipped regions for climate change and flooding. Natural resource depletion, expanding population, precarious food security, and rising poverty exacerbate the effect of climate change on South Asia. This research examines the influence of climate change in relation to recurrent floods in South Asia. Further, it reviews the impact of climate change on South Asian countries such as Pakistan, Iran, India, Afghanistan, Sri Lanka, Bhutan, Maldives, Nepal, and Bangladesh. Further, it finds the unifying variable underlying the climate change and flooding. The primary variables for this research appear as follows: (i) flood frequency; (ii) flood intensity; (iii) precipitation frequency; (iv) precipitation intensity; (v) snowmelt; (vi) topography and soil characteristics; and (vii) urbanization. This research focuses on finding the links between floods and climate change based on these characteristics. Furthermore, this research exclusively includes the corpus of information from previous studies that are not older than a century. Based on the findings of the ongoing study, coastal cities in South Asia are at risk of flooding due to variations in precipitation intensity. In addition, climate change may have an adverse effect on the frequency of tropical storms and the rise of sea levels. Moreover, South Asia has experienced unprecedented warming during this century based on recent temperature estimates. Floods are becoming increasingly severe in Pakistan, India, and Bangladesh. As a matter of fact, past severe floods can be attributed to natural variability. In the near future, however, climate change may cause flooding in South Asia to increase in size, frequency, and extent.

Keywords: Climate; Floods, Precipitation, Environment, Topography, Urbanization.

Accuracy Assessment of Land Use Land Cover (LULC) Derived by ESRI's Living Atlas With Ground Data in District Badin

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Abstract

Land surface changes affect climate, ecology, and the services provided by these systems. Concerns regarding land use/land cover (LULC) changes have arisen worldwide. These disasters are responsible for greater surface runoff, flooding, and subsequent economic losses from flood occurrences. With time, the importance of accurately mapping LULC has increased. Esri's Living Atlas, through remote sensing, has generated a worldwide map of the land surface of 10-meter resolution on an annual average basis from 2017 to 2021 based on an advanced artificial intelligence (AI) learning model. However, it is essential to determine the accuracy of this dataset with ground data to use it with confidence for different purposes, especially for rainfall-runoff modeling. This study assessed the accuracy of the ESRI's LULC classes. For this purpose, 100 samples from the Badin District of Sindh were collected at various locations representing different LULC classes on the ground. Those locational points have been used for analysis purposes. The results show that Esri's derived LULC does not match precisely with the object class on the actual ground, which means that an object on the ground lies in one class and the LULC map shows another class at that location. This study demands the improvement of the ESRI's dataset on a regional basis through ground validation. An improved dataset will help water resources managers plan and manage flood and surface runoff in flood-prone areas.

Keywords: Esri's Living Atlas, Flood Management, Land Use and Land Cover, LULC, Remote Sensing

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Analyzing the Knock-on Impacts of 2022 Floods on Rabi 2023 Using Remote Sensing and Field Surveys

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Abstract

While the world's attention is focused on immediate relief and rescue operations for the affectees of the current floods in Pakistan, knock-on effects are expected to play further havoc with the country's economy and food security in the coming months. Significant crop yield losses had already occurred for Winter (Rabi) 2021-22 due to a heatwave earlier in the year and estimates for the Summer (Kharif) 2022 crop damage due to flood inundation have already been determined to be very high. With the next sowing season already upon the flood affectees, there is a big question mark over the resumption of agricultural activity in disaster-struck districts. This study is aimed at analyzing the range of influences of the 2022 floods on the upcoming winter (Rabi) crop. Satellite-based remote sensing data, state-of-the-art Earth system models, and field observations will be leveraged to estimate the impacts of the flood on the resumption of agricultural activity in the most impacted districts of Southern Punjab, Sindh, and Baluchistan. The field surveys are conducted during multiple visits to the study area to maximize the monitoring of on-ground conditions and provide a larger validation dataset for the satellite-based inundation and crop classification maps. The project leverages on the expertise and previous experiences of the LUMS team in performing satellite-based land/crop classification, estimation of soil moisture levels for irrigation activity, and determining changes in land-use patterns for detecting key agricultural activities. Delays in the sowing of the winter crop and its effects on crop-yield were analyzed through this study.

Keywords: Remote Sensing, Crop Classification, Inundation Maps, Soil Moisture Levels, Land Use Classification

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Rapid Appraisal for Need Assessment For Rehabilitation of Agriculture and Livelihoods in the Flood Affected Areas of Sindh and Punjab

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Abstract

Poor drainage of incidental rainfall and water from hill torrents resulted in devastating floods and inundation of cropped areas in vast tracts of Punjab and Sindh provinces. The issue was aggravated by poor drainage and largely dysfunctional floods coping institutional architecture at the grassroots level. Considering the overwhelming challenges of the farming communities in form of damage to the existing crops in the fields and rehabilitation of agriculture through cultivation in coming seasons, a rapid appraisal exercise was conducted. The objective of the exercise was to help the farming community by knowing their concerns about future of farming after the floods related disruptions of existing formal and informal channels. Data was collected using a semi-structured questionnaire. A representative sample of respondents was selected for interview from both provinces. The results about the needs of farming community for land preparation, sowing, irrigation infrastructure, agrochemicals and harvesting shows the perceived difficulty due to disrupted rural infrastructure due to floods. A risk analysis matrix was used to understand farmers; perception about the risks using a severity-incidence matrix. The findings of the study provide useful insights for policy and support interventions for the flood affected areas and also attempts to establish significance of available science-based diagnosis tools in such events in future.

Keywords: Rapid Appraisal, Agricultural Rehabilitation, Climate Change, Drainage Infrastructure, Livelihood Assets, Farming Risks

Application of Nature-Based Solutions to Control Flooding Hazards in Naeen Gajj, District Dadu, Pakistan

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Abstract

Nature-based Solutions (NbS) are based on the emerging new concept of controlling flood devastation employing green solutions. The approach to controlling rivers and hill torrents with engineering solutions has long been debated. These are not only costly but, many times in the past, have failed to manage floods. The failure / questioned efficiency / limited effectivity of "small dams" and "100 dams" projects in Sindh and Balochistan provinces are evidence of the incapability of conventional grey solutions to control floods. Hill torrents significantly contribute to the Indus River with that million tons of sediment load deposits each year. The hydraulic structures constructed in the above projects either completely washed away or silted up with sediments wasting billions of loan rupees. The watershed management in sub-basins employing NbS will effectively control the flooding hazard by revival/revamping of flood conveyance routes, water retention and detention techniques, slope stabilization and erosion control, and procedures of flood impact reduction. Hill torrent "Gajj" is developed in the foothills of the Khirthar mountain range within the border of Sindh and Balochistan provinces and eventually feeds Manchhar lake. Several conveyance structures have been washed away due to the heavy flow of the Gajj hill torrent over the last two decades. Gajj dam is also proposed on the Gajj hill torrent, which has been delayed for decades due to various reasons beyond the scope of this research. Further, the proposed dam will divide the communities into upper and lower riparian, eventually increasing the rifts on water rights and hydrological division due to recharging and non-recharging aquifers. The NbS suggested in this paper through watershed management and flood inundation modeling will reduce the risk of flood concentration, providing natural recharge to groundwater, improving the century's old practice of spate irrigation, and block plantation will support local communities and their livestock. The social and ecological benefits of NbS, areas under vegetation, green belts, and newly developed lakes contributing to the echo system are much superior than the limited benefits of grey solutions. The NbS model can effectively manage flooding hazards and improve people's livelihood in harmony with nature.

Keywords: Nature-Based Solutions, Watershed Management, Flood Hazards, Sindh, Climate Change

Methodological Approaches for Assessing Flood Risk Management Decision at Farm Level

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Abstract

Agriculture operates in an ever changing environment which makes this sector vulnerable to a number of risks and uncertainties. Among the various risks farmers face, production risks (particularly catastrophic risks including floods and droughts) presents the most dominant sources of risks and uncertainties in agriculture. Farmers use available risk management tools to mitigate/minimize the potential adverse impacts of such risks and uncertainties at farm level. The risk management decisions depend on various factors. Apart from the socio-economic and demographic factors, market access and other publically provided services including credit and information, there are some behavioral attributes that also effect farmers' risk management decisions. Farmers' risk perceptions and their attitude towards risks are significant factors affecting farmers' decisions of adopting various risk management tools. Another important aspect of the decision process is the simultaneous adoption of multiple tools at the same time i.e. adoption of one risk management tool may make it more likely to adopt other available risk management tool(s). Various methodological approaches are used to quantify these variables and fetch some meaningful results from the field data. Perceptions can be recorded using a likert scale and can be processed using a risk matrix while Equally Likely Certainty Equivalent (ELCE) and experimental gambling approach can be used to elicit risk attitude from an economic agent. Similarly the simultaneous adoption effect can be best captured using a multivariate probit/logit model. Here we highlight important factors (internal, external and behavioral factors) affecting risk management decisions at farm level and provide some methodological approaches for quantification of these variables and analyzing their effect on farmers' decisions of adopting risk management tools.

Keywords: Farm Risks, Risk Management, Risk Perceptions, Risk Attitude, Simultaneous Adoption

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Managing Rivers using Satellite Radar Altimetry at Ungauged Locations: A Case Study of the Lower Indus River

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Abstract

Mismanagement of water resources may lead to floods and droughts. Due to insufficient monitoring systems, uninformed management decisions are made, especially in developing countries with budgetary constraints. This paper investigated the utility of satellite data to augment the low-frequency gauging network of the Indus River and monitor river flows at the selected locations by developing rating equations (relating river levels with flows). Reliable estimation of discharge plays a vital role in managing water bodies. This paper proposes calibrating and validating a hydraulic model using satellite altimetry data and developing the rating curves at ungauged river locations where satellites' virtual stations (VS) are available. The rating curves may later be used to calculate discharges whenever the altimetry water surface levels (WSL) are available. WSL and discharges at selected VS of Sentinel 3A and B were estimated using a 2D GeoHECRAS model of the lower Indus River reach. Once the rating equations were derived, these equations were used to estimate discharges through past and future altimetry data. The Indus River, regardless of being the backbone of Pakistan's economy, is considered a poorly gauged river. This study's output will help bridge the data gaps at ungauged locations of the lower Indus River by estimating discharges. This information will help water engineers, decision-makers, and disaster management teams better understand and manage the river system to minimize extreme events such as floods and droughts.

Keywords: Hydraulic Modeling, Indus River, Rating Equations, River Flow, Satellite Radar Altimetry, Sentinel 3.

Analysing Flood Events in Pakistan Using Integrated Flood Analysis System (IFAS)

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Abstract

An integrated flood forecasting approach can play a dynamic role in hydrological modeling, providing the local authorities with immediate, useful information for flood mitigation and water resources management. In developing countries like Pakistan, where the major rivers of the Indus River System (IRS) and its tributaries are located, which represents the greatest hazard of flood every year, abnormal climatic behavior has resulted in heavy rains and floods that have destroyed infrastructure, properties and claimed many lives. Developed countries favor non-structural countermeasures yet they can afford structural interventions to combat flood and their damages, but Pakistan's economic condition does not support for the development of costly structural interventions. Consequently, there is a developing interest in the improvement of an early, productive flood forecasting system that can minimize the damages caused by flooding. In this study, on one of the basins of the Indus River System, an Integrated Flood Analysis System (IFAS) is used for flood forecasting. The findings lead to the conclusion that the simulated flood results are comparable to those of historical flood event which demonstrates that IFAS is capable of flood forecasting to some extent and can be used for early flood forecasting as a non-structural countermeasure. This eventually helps in the preparation of evacuation plans for communities living on floodplains or in vulnerable locations, allowing decision-makers and crisis responders to make appropriate moves and spread early awareness that can contribute progressively to the mitigation of flood disaster damages and water resource management, which is a growing need in developing countries.

Keywords: Hydrological Modeling, Indus River System, Flood Forecasting, IFAS; Integrated Flood Management, Pakistan.

Integrating Time-Series Multi-Satellite Imagery for Flood Mapping and Impact Assessment in Pakistan, 2022

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Abstract

The hill torrent and riverine floods in Pakistan, 2022, have taken a heavy toll on human lives, affected millions, devastated agricultural lands, destroyed urban areas, damaged historical sites, caused significant economic dents, instigated socio-political chaos, and fostered nutrition and food insecurity. All hands are on deck, both locally and globally, to satisfy the grievance of flood victims, and several schemes of relief efforts and programs for socioeconomic rehabilitation are currently underway throughout the country. In order to achieve this goal, it is crucial for all stakeholders to have accurate estimates of the extent and impact of floods. For this purpose, flood mapping and impact assessment are performed in this study by integrating satellite imagery from Landsat 8, Landsat 9, and Sentinel 2, along with data from the European Space Agency's WorldCover, Worldpop population data, and Global Human Settlement data, for the entire Pakistan. The findings revealed that the total area affected by floods was 1,39,826 km², the area of human settlements affected by floods was 137.1 km², and 18.36 million people were directly impacted. The Pakistan faced agricultural damage in the form of cropland, tree cover, shrubland, and grassland, with losses of 3.43, 0.05, 0.42, and 0.30 million hectares, respectively. The damage to cropland, broken down by province, was 2.06, 0.54, 0.53, and 0.3 million hectares in Sindh, Punjab, Balochistan, and Khyber Pakhtunkhwa, respectively. Furthermore, the findings revealed that there was 0.38, 0.21, and 0.08 million hectares of cultivable command area in Sindh, Punjab, and Balochistan, respectively, that remained unirrigated in 2022 compared to 2021. Conclusively, there is an imperative need to turn the tide for flood-ravaged communities through swift and decisive rehabilitation and relief efforts in priority areas highlighted in study findings to reinvigorate the nation's flagging economy.

Keywords: Floods in Pakistan, Food Insecurity, Flood Mapping, Satellite Imagery, Landsat, Sentinel.

Flood Modeling, Mapping and Forecasting under Climate Change for Manchar Lake, Sindh, Pakistan

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Abstract

Climate change is a growing global concern. One of the main consequences of it for Pakistan had been heavy downpours mainly during monsoon season. The country's hydrological cycle has been changing with an evident monsoon shift and frequent flood and drought spells. This paper models the flood events at different return periods which caused the overflow of Manchar Lake in District Dadu, Sindh, Pakistan. The inundation maps of surrounding area were generated through HecRas and validated using Landsat Imagery. The future flood predictions and possible inundation extents have been mapped using bias-corrected future climatic data from a super high resolution Global Circulation Model GCM20 (20 Km horizontal resolution) of Meteorological Research Institute, Tsukuba, Japan. Analysis of model results show more heavy downpours in coming years capable of causing severe damage to life and infrastructure. The results will help stakeholders to take necessary actions for flood resiliency through flood management.

Keywords: Climate Change, Flood, Hec-Ras, Rainfall, Landsat, Hydrological Modeling

Mapping Flood Extent and Post-Flood Vegetation Cover Using Google Earth Engine

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Abstract

Estimating flood extent through satellite images can help decision-makers manage affected regions with reliable information. With the help of satellite images, flood extent can be mapped and the damages can be assessed. Pakistan was hit by one of the worst floods in its history in the summer of 2022. Using Google Earth Engine, an effort was made to correctly map the extent of flood water in south Punjab region. Typically, Sentinel-1 SAR data is used to map flood extent due to its ability to pass through clouds but combining it with optical satellite data from the Landsat and Sentinel-2 can increase the accuracy of flood water extent. As the temporal and spatial resolution of free satellite data is low. Thus, combining them can give a reasonable estimate. Sentinel-1 images between July 2022 and August 2022 were acquired for analysis. Permanent water bodies and slopes were identified using Global Surface Water and HydroSHEDS data, respectively. Radar data was processed using backscattering filter, and a change detection technique was then applied to get the flooded pixels. Further, Sentinel-2 images were processed to calculate water and vegetation indices. Four images from July 2022 to September 2022 were used to calculate water index for flood mapping. Later, Sentinel-2 images from the year 2021 were compared with the year 2022 to estimate the vegetation cover change using change detection technique. As the temporal frequency of Sentinel-1 is 6 days and Sentinel-2 is 5 days (including both ascending and descending), it is hard to map the accurate extent of flood water, specially flash flooding from hill torrents. Although daily data from MODIS is also helpful, however, its spatial resolution is very low. So, combining both Sentinel-1 and Sentinel-2 datasets give more accurate information on flooded areas and infrastructure damages.

Keywords: Sentinel-1, Sentinel-2, Flood Mapping, Satellite Image Analysis, Google Earth Engine, Change Detection

Improved Flood Mapping Using Fusion Of Sentinel-1, Sentinel-2 And Landsat-9 Datasets For Data Driven Policy Design

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Abstract

The estimation of flood water levels is required for the design of flood defence structures. The application of optical and radar synthetic aperture radar (SAR) imagery in tandem provides a means of extended availability and enhanced reliability of flood mapping. We propose a methodology to merge these two datasets into a common data space. The merging of optical and SAR data allows for increased observations in cloud prone regions that can be used to gain additional insights into flood mapping applications. We validated this methodology quantitatively and qualitatively for the districts affected by 2022 floods in Pakistan. We use Google Earth Engine to evaluate the performance of the proposed architecture on all union councils of Sindh and Punjab province, Pakistan. In the proposed approach, we define pre- and post-flood time periods for both radar (Sentinel-1) and optical (Sentinel-2 and Landsat-9) based satellites. By setting periods, rather than individual dates, we allow the selection of enough tiles to cover the area of interest. In optical based satellites, we calculated the flood mapping using NDWI thresholding on the difference layer between dry image and wet image. While in radar based satellites we first apply speckle filtering to remove noise, then we take the difference between before and after flood mosaics and then we apply some post-processing filtering to get the flood mapping. We increase the reliability of flood area mapping using the intersection of results of radar and optical based satellites. Similarly, we increase the availability of flood mapping by computing the flood areas of different districts using different satellites as optical and radar based satellites provide imagery for different dates. The proposed methodology increases the availability and reliability of flood mapping for effective and efficient policy design and implementation using cloud based processing that requires no specific hardware.

Keywords: Flood Mapping, Sentinel-1, Sentinel-2, Landsat-9, Data Driven Policy Design.

Effects of Irrigation Water Regimes on Young Mango and Jujube (ber) Orchard in the Tando Allahyar

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Abstract

A research study was carried out at the experimental site of Dr. Nasir farm in Chambur, Tando Allahyar, Sindh, Pakistan, to determine the effect of different irrigation water regimes levels on mango and jujube (ber) growth and soil salinity status. The design of the research study was based on complete randomized design with including 3-Treatments i.e. T1 = 40% soil water depletion, T2 = 50% soil water depletion and T3 = 60% soil water depletion under ring basin irrigation method with 3 replicates. During experimental total 108 young mangos and jujube (ber) plants were selected. The soil has an average bulk density of 1.38 g cm⁻³ and retains about 38% moisture content at field capacity. Whereas, the ground water used for irrigation has EC values ranging between 0.22 to 0.28 dS m⁻¹ and pH values between 8.1-8.2, and is suitable for irrigation. The data on plant growth show no-significant differences among the treatments, however, it was affected under T3 treatment and it recorded the smallest plant whereas, highest plants were recorded at T1 and T2 treatments. The results reveal that T1 treatment received the maximum amount of water but produced the lowest yield as compared to T2 and T3 treatments. The total water consumed under T1, T2, and T3 treatments was 189 mm, 157.3 mm, and 125.8 mm, respectively. The saved water under T3 could be used to irrigate additional land this would provide an extra yield. The data on different soil chemical properties show no significant difference among treatments. No remarkable change in salinity status was observed after experiment under any treatment. The values of pH and EC observed were within safe limits and would not affect the plant growth and development under T2.

Keywords: Irrigation Water Regime, Young Mango, Jujube, Basin Irrigation Method, Tando Allahyar

Measuring Urban Resilience to Natural Disasters and Climate Change for Punjab, Pakistan

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Abstract

Global warming and increase in disaster events are posing threats to world population, especially people living in urban areas. The growth of urban population is increasing alarmingly, and according to United Nations Development Programme the half of world population will be in urban areas by 2030. It means that human beings will be susceptible to various natural, man-made hazards and severe climatic conditions. The concept of resilience is gaining popularity in urban, rural areas, and international organizations such as UNISDR, United Nations-Habitat, Asian Development Bank and World Bank are also inclined to measure urban resilience to address future impacts of various disasters. Scholars and researchers are encouraged to investigate and develop frameworks to measure resilience of urban systems components i.e. socio-economic, institutional, and governance. This research is one of such initiatives that will address sustainable development goals (SDGs) priority area number 9 and 11. The aim of these goals is to build settlements, cities, and infrastructures that are resilient and sustainable. In 2015 Sara Meerow included terms disaster and climate change while defining urban resilience. Previous research encourages to integrate disaster risk reduction and climate change adaptation in urban resilience to empower community living in urban areas. This integration will enable the urban system to achieve millennium development goals and sustainable development goals. The methodology to conduct this research consists of three parts i.e. conceptualization, data collection, and modeling. In conceptualization, literature from the year 2000 to 2016 was reviewed to investigate key dimensions and indicators. Secondly, data collection from field experts in the context of Punjab, Pakistan was done. In the last step, the data gathered was screened and analysis was conducted. Multivariate techniques (exploratory factor analysis and regression analysis) were used to model the dimensions of urban resilience. The regression model for urban resilience revealed that there are six dimensions playing a vital role in making urban area resilient against natural hazards and climate change. These are institutions, infrastructures, community awareness, Hazards, Vulnerability & Risk Assessment (HVRA), social, and economic dimensions.

Keywords: Urban Resilience, Disaster Risk Reduction, Flood, Climate

Performance Assessment of an Irrigation Canal: A Case Study of Pir Gunio Distributary at Dadu Canal

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Abstract

Performance evaluation is the key factor to check the physical conditions, maintenance and water delivery services of the system. This study determines the hardware conditions (e.g. cross regulator, turnouts, gauges, bed level, longitudinal section and communication) and water delivery services to assess the performance of the Pir-Gunio distributary and its two minors Kharro and Baghban off-taking from Dadu canal. Hardware conditions were observed by using framework of rapid appraisal proceedings (RAP) and the required designed data were obtained from Irrigation office Dadu, RAP sheets were developed and filled according to the available conditions of the system. Current meter is used to measure the discharge by area velocity method. Performance indicators such as Delivery Performance Ratio (DPR), Co-efficient of variance (CV) and Tail End Supply Ratio (TSR) were evaluated for the study period of three months June 2022 to August 2022 for Kharif season. Based on the collected/observed data, performance of the system was assessed. Based on the assessment in RAP sheet it is clear that the actual water delivery service is 0.25 in ranking, which is less than stated water delivery services (1.8) by irrigation officials. Other internal performance indicators which have low ranking value (i.e. less than 2) are considered in poor condition. Baghban Minor has 0 ranking value in cross-regulators, turnouts and operation because of non availability of gate and section, while Pir-Gunio seems poor except turnout indicator. Kharro minor seems to be good because all indicators values are greater than 2 except canal communication. Pir Gunio distributary, Pir Gunio 2nd mile regulator and Kharro comes under poor (DPR <0.7), however Baghban minor has good value of (DPR >0.9) which shows poor and good performance of the irrigation department. The Co-efficient of variance (CV) of Pir Gunio distributary and Kharro minor was fair (CV 0.7 to 0.9), while Pir Gunio at 2nd mile regulator and Baghban minor was good having (CV > 0.9). The water availability at tail by TSR is observed for Pir Gunio and Kharro Minor having 87% and 70% which shows good performance of the concerned department, while Pir Gunio at 2nd mile regulator and Baghban minor with 51.25% and 51.42% respectively which shows poor performance of the concerned department. There is the need to improve the hardware conditions; proper maintenance is required to the irrigation system and for water delivery services proper monitoring is required to distribute the water equally in order to meet the targeted performance of the system.

Keywords: Hardware Survey, Water Delivery Performance, Pir Gunio, Baghban, Kharro Minor, Dadu Canal.

Analysis of Extreme Precipitation Events in Sindh Province Under Climate Change Using CMIP6 Climate Data

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Abstract

This study aims to estimate potential changes in the extreme events of precipitation in Sindh because extreme rainfall is the main source of the flood, soil erosion, and the impact on human resources. So it needs to understand spatio-temporal changes in the future rainfall extreme events. We selected EC-EARTH3 climate model from the Coupled Model Intercomparison Project Phase 6 (CMIP6) data archive based on the literature review. Three SSP (Shared Socioeconomic Pathways) future scenarios (SSP245, SSP585, SPP370) are selected in this study. In addition, the changes are divided into two time scales, i.e., near future (2030-2060) and far future (2060-2100). Estimating index value by using generalized extreme value (GEV) was applied to quantify extreme events of precipitation. This technique was used to observe simulated precipitation data to estimate extreme events. The result show overall a significantly increasing tendency in mean and maximum rainfall events in Sindh under all three scenarios.

Keywords: CMIP6, EC-EARTH3, Precipitation, Future scenarios, Sindh

Investigate the Management Structure of Drainage System to Identify the Current Problems: An Empirical Study of District Hyderabad

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Abstract

The aim of this research was to investigate the causes of deteriorated drainage system in three tehsils (Qasimabad, Latifabad and City) of district Hyderabad. Due to poor drainage system the citizens face a lot of problems, there are dozens of news and literature regarding deteriorated drainage system, several incidents happened with people like no cover on open manholes due to this it has made it common for children to fall into gutters. Many other problems were written in numerous literature and news but there is less focus on the causes of deteriorated drainage system that municipal administration face in terms of better service delivery of drainage system. The research approach was qualitative in nature. Secondary data were drawn from desk research and primary data were conducted through twenty-seven (in-depth, open-ended) semi-structured interviews from the employees and officers of municipal institutes in three tehsils of district Hyderabad. Snowball (Non-probability) sample technique were used to collect primary data. The data were analyzed using thematic analysis. After analysis several themes emerged from the data. The findings shows that municipal administration of district Hyderabad in three taluka have several issues in terms of better service provision of drainage system. Furthermore, findings revealed the outcome of this research is that it presented the identified barriers that are important and exists at the management level are (Shortage of human resource, lack of qualified personnel, lack of training, lack of accountability), functional level (Inadequate physical resources, encroachment, inaccessibility, corruption, electricity issue and Political issues) and at the institutional level (Lack of effective communication/liaison between institutes, blame game, lack of appropriate sources of finance), underlying issues that municipal administration faces are the main barriers to the successful implementation. This situation finally effected in increasing the ineffectiveness and inefficiency of service provision of drainage system.

Keywords: Municipal Administration, Deteriorated, Drainage System, Hyderabad.

Efficient Agricultural Practices To Combat Anticipated Wheat Shortage After 2022 Floods

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Abstract

This study advocated efficient agricultural practices such as Zero Tillage (ZT) for the farmers of the flood-hit areas in Sindh. The recent flood has affected many fertile land parcels damaging their crops and impairing their wheat cultivation. Farmers of the flood-hit areas had economic losses due to these damages and were left with limited resources and land to grow Rabi crops, especially wheat. Through this study economic benefits of ZT were demonstrated to convince the farmers to adopt ZT on conventional tillage methods. Farmers were surveyed to encourage them to adopt ZT over Conventional Tillage (CT). The study highlighted the benefits of ZT over conventional, including timely plantation of the wheat crop, saving of machine cost and human labor, retention of irrigation water in the soil for a longer duration, and increased soil fertility. This study compared wheat crops' economics under ZT and CT methods. The study found that the total production cost of wheat crops under CT was Rs.60120/acre, and under ZT was Rs.55644/acre. The study showed that the cost of production under the conventional technique was approximately Rs.4476 higher than that of the zero-tillage technique. Similarly, the wheat crop yield under the conventional technique was 40 Maund/acre. It was around 44 Maund/acre, which shows a notable increase of 4 Maund/acre in zero-tillage than conventional tillage. Likewise, the net income observed under CT was Rs.40470, and under zero-tillage was Rs.58985. Thus, the study showed that the net saving of Rs.18515 was achieved under zero-tillage than conventional tillage. Likewise, the benefit-cost ratio under zero-tillage and CT were 2.06 and 1.67. The study results presented cost savings, and an increase in the wheat crop yield was also observed. The main outputs of this study were an increase in net income and a higher benefit-cost ratio of wheat crops under zero-tillage technology than conventional methods.

Keywords: Floods; Food shortage; Efficient agriculture; Wheat; Zero-Tillage.

Precipitation Trend Analysis Over Balochistan Pakistan

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Abstract

Climate change is a major concern for researchers and policymakers all around the globe as it is affecting every aspect of life. Pakistan is most vulnerable hotspot due to climate change, especially Balochistan province; so it is important to analyze the likely impacts of climate change and authentic climatic data play vital role to carry out the analysis. This research study focus on historical precipitation trend analysis and comparison of various available datasets with the observed data; for that purpose multiple statistics' equations have been used i.e. Nash–Sutcliffe Efficiency, Percent bias (PBIAS), and Pearson Correlation Coefficient. There is almost no change in precipitation in Balochistan. However, individual stations show changes in precipitation. Four stations Barkhan , Kalat, Khuzdar and Lasbella show increasing trend in precipitation over time. Seven stations Zhob, Quetta, Dalbandin, Panjgur , Uthal , Turbat and Pasni stations show decreasing trend in precipitation over time Only Nokundi station show almost no change in precipitation over time. The results show that GPCC, TRMM, and CRU datasets performed quite well and could be used in other studies such as hydrological modeling and crop water modeling. However, GPCC outperformed and is ranked at number 1, TRMM and CRU at number 2. This research study will assist researcher to carry out research studies related to climatic analysis and hydrological processes and also to policymakers to draw sustainable plan to mitigate with impacts hasten by climate change in Balochistan province of Pakistan.

Keywords: Extreme Precipitation, Climate Change, Balochistan

Exploration of Groundwater resources for future settlement of population in northern areas of Quetta Valley through Vertical Electrical Sounding

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Abstract

Since groundwater is the most accessible source of water for human consumption, it is typically chosen as a source of drinking water. Baluchistan is suffering from a groundwater problem as a result of ongoing droughts, excessive groundwater use, urbanization, and a lack of knowledge of hydrogeological conditions. In this study, northern areas of Quetta valley have been explored using electric resistivity method for deeper understanding of hydro geophysical conditions. The field data has been processed and layer modeling through IPI2win software, which displays the layers of each survey point in the form of 1D sections and pseudo-section which shows the apparent resistivity thickness and depth. Total 06 VES were conducted at Quetta North from Pishin Bypass area in five different profile lines up to the depth of 500 m. The distance between each VES point is 2km. In profile 1 aquifer bearing limestone lithology were encountered at average depth of 250m, in profile 2 aquifers were explored in silty sand lithology at the shallow depth of 100 m. Due to presence of silt in aquifer these are also low pressure and low potential aquifer considered. It is recommended that find other sources of water in area only groundwater will not bear the burden of shifted population and Plans for groundwater monitoring in the area must be developed by concerned departments.

Keywords: Groundwater, aquifers, vertical electrical sounding (VES), resistivity, lithology.

Endnotes

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WE'RE WORKING TOWARDS
GLOBAL GOAL NO.



CLEAN WATER
AND SANITATION

BY 2030 EVERYONE WILL HAVE
SAFE WATER TO DRINK

SDG-6: Targets to be achieved by 2030

- 6.1: Achieve universal and equitable access to safe and affordable drinking water for all
- 6.2: Achieve access to adequate and equitable sanitation and hygiene for all
- 6.3: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials
- 6.4: Substantially increase water-use efficiency across all sectors
- 6.5: Implement integrated water resources management at all levels
- 6.6: Protect and restore water-related ecosystems
- 6.a: Expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs
- 6.b: Support and strengthen the participation of local communities in improving water and sanitation management

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