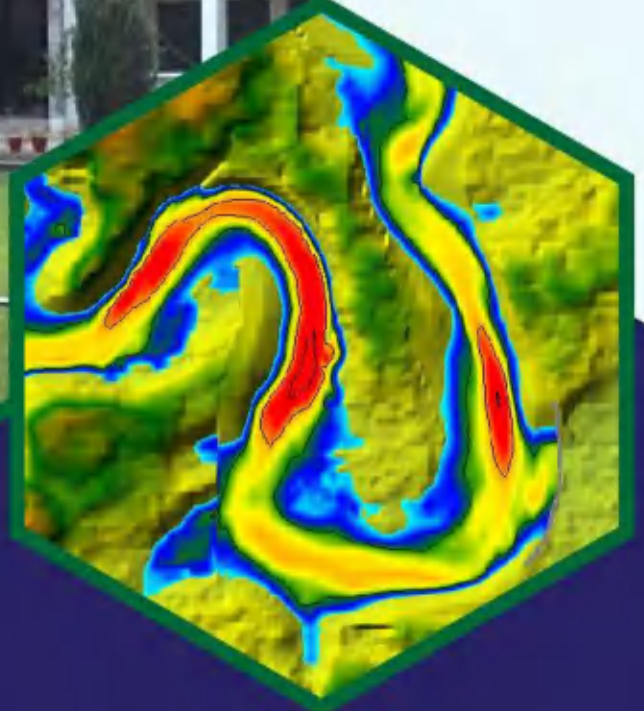


# **CEWRE ANNUAL REPORT 2021**



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Water Resources Engineering (CEWRE)  
University of Engineering and Technology (UET), Lahore**

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(CEWRE), UET, G.T. Road, Lahore 54890, Punjab.**



# CEWRE

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# Editorial Board



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**Dr. Muhammad Waseem**  
EDITOR

**Engr. Muhammad Awais Zafar**  
EDITOR





# MESSAGE FROM VICE CHANCELLOR



In the present era of water resources development in the country, it is a matter of immense honor for me to highlight the vision of Centre of Excellence in Water Resources Engineering (CEWRE). CEWRE is acting as role model towards increasing more innovative, creative, and skilled manpower to help mitigate the ever-increasing water related issues of the country. The world freshwater resources are facing stress under the rapidly changing climate, coupled with other socio-economic factors like population growth and higher living standards. To counter these challenges, focused efforts of the political leadership and research community are

required before it is too late for sustainable water resources management.

CEWRE is playing an important role in providing high-quality teaching and research in the field of water resources engineering and management since its establishment in 1976. The Board of Governors of CEWRE always welcome and appreciate innovative ideas and goal-oriented water related research projects conducted by the students and faculty of the Centre. Recent efforts of selection of regular Director, New Faculty Members and Supporting Staff are expected to strengthen the organizational setup of the Centre.

Despite of financial constrains and reduction of federal grants, the Centre has been provided with sufficient funds to carryout research and teaching activities without constraints. Merit and need based scholarships for students and approval of DRA in Centre are few recent incentives to students and faculty members.

CEWRE has to cover many challenging miles to achieve its vision of becoming a leading world class water related teaching and research institute such as IHE Delft, Colorado State University, AIT, and University of Arizona. Building active relationships with relevant institutions for coillaborative research and development is an area that the Centre needs to focus on.

I look forward to transforming the Centre to one of the finest in the world in its sphere of influence.

*Prof. Dr. Syed Mansoor Sarwar*  
Vice Chancellor/Chairman BOG

# MESSAGE FROM DEAN



*Prof. Dr. Habib-Ur-Rehman*  
*DEAN*  
*Faculty of Civil Engineering*

“

As former director, it is my great pleasure to be the part of Centre of Excellence in Water Resources Engineering (CEWRE). I have witnessed the Centre's efforts toward development of human resources that plays its part in solving water issues. Water, a vital source of life on earth is rapidly declining due to environmental changes and anthropogenic activities. Pakistan is also facing issues of water scarcity and 2.4% annual growth rate of country population intensifying the discrepancy between water supply and demand. Water right issues with neighbor country also straining relationship between communities and entire countries. According to world water vision report water scarcity is not about too little water but is a crisis of roughly managing water resources. In all this role of water research institute has increased to produce the skill professionals.

Centre of Excellence in Water Resources Engineering (CEWRE), UET Lahore is a prestigious institute of our country and effectively playing its role through human resource development and research activities to push the water professionals to come up with the possible solutions to mitigate the impacts of the looming threat to its sustainable water resources development and management. Under pursuit of CEWRE vision few efforts have been made like recharging groundwater using large diameter recharging wells under “Managing Aquifer Recharge” (MAR) project, pressurized irrigation system in Junaid Jamshed stadium and water recycling unit in main Masjid of the campus to conserve the water use. Centre has maintained its institutional integrity by strengthen the technical skills of water professionals through training workshops. CEWRE also provide training to young and mid level water professionals through its four research programs of Master and Doctoral levels. I believe that CEWRE would sustain its glory in research and development across the water sector.

”

# FOREWORD



I am obliged and pleased to share the annual report of the Centre of Excellence in Water Resources Engineering (CEWRE) for year 2021. Despite the persistent wake of COVID pandemic, the Center has been able to deliver its best performance on all domains of its assigned functions, Teaching, Research, Knowledge Dissemination, and Linkages. Thanks to support from Ministry of Federal Education, Higher Education Commission (HEC), and University of Engineering and Technology Lahore (UET) administration, Centre's faculty has been able to produce some of unique research results through student's research and

externally funded projects. Groundwater and Extreme events (Droughts and Floods) attracted much of the attention of the faculty and the students during the Year under report. In the domain of Groundwater, the performance evaluation and impact assessment of groundwater recharge interventions has been studied using numerical modeling and case study reviews. Other topic that attracted the faculty members is study of extreme events patterns and the possible change on droughts and floods in Pakistan under varying climatic change scenarios. Physical modeling-based studies have been carried out to improve the basic understanding about Rooster Tails phenomenon created downstream of Piers at Spillways. A model of subsidiary weir at Taunsa barrage was also constructed to optimize location of the weir. This year the Centre has directly conveyed its results with the relevant departments for the implementation of the new findings at CEWRE. The results of the Rooster Tail study have been shared with Wapda for possible use by the designers.

In continuation of our tradition of organizing seminars, workshops and conferences for field staff and professionals in the field of water resources, I am proud to share that two number of conferences have been conducted this year that have been attended by hundreds of the researchers across the country and were well attended by international speakers. These conferences were in addition to monthly webinars and workshops organized by the Centre's able faculty members.

Strengthening of the organization structure remained one of the top priorities, and I am happy to inform that due to persistent follow up, the Ministry has initiated the process of selection of permanent Director at most of the Centre of Excellences, including this Centre. Hope the Centre will get a regular tenured Director soon. Selection of top ranked



professionals and researchers for vacant posts of the faculty members and staff are also under process for further strengthening the human resources side of the organization.

Good progress has been made by the Centre in respect of indigenization of the water related electronic gadgets such as Water Level Sensors, Turbidity Meter, and Temperature Sensors, the details of which are given in the coming pages. Despite implementation of strict austerity measures, the Centre was able to upgrade some of very necessary infrastructure facilities, such as conference room, and lab equipment during the year.

The year 2021 also witnessed quite dynamic external factors such as revised HEC Funding Model for the Centers, and enhanced interest of the Ministries in the functioning of the Centers. In-depth reviews by the federal organizations and the BoG helped the Centre to rejuvenate its strengths and highlighted the weaknesses and the threats to the Centre on financial as well as capacity aspects. Centre will continue its efforts to improve its standing in the country and in the region too.

Centre's future is bright, however, there is need to further strengthen the facilities at Centre so that the faculty and researchers at the Centre are equipped and able to answer the call of nation in solving the ever-increasing water stress being faced by irrigation, urban supply, industrial and environment sectors of water use.

***Prof. Dr. Noor Muhammad Khan***

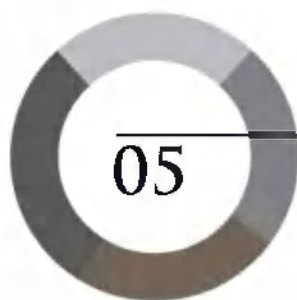
*Director*

*Centre of Excellence in Water Resources Engineering*



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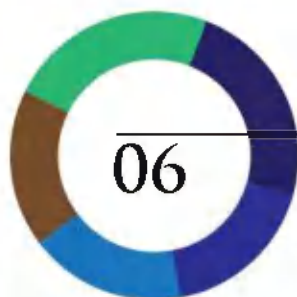
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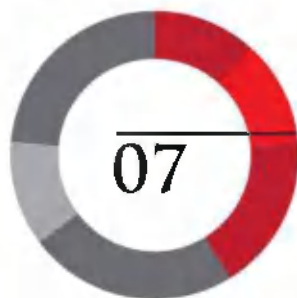
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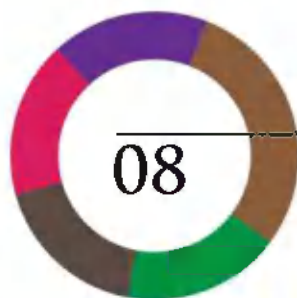
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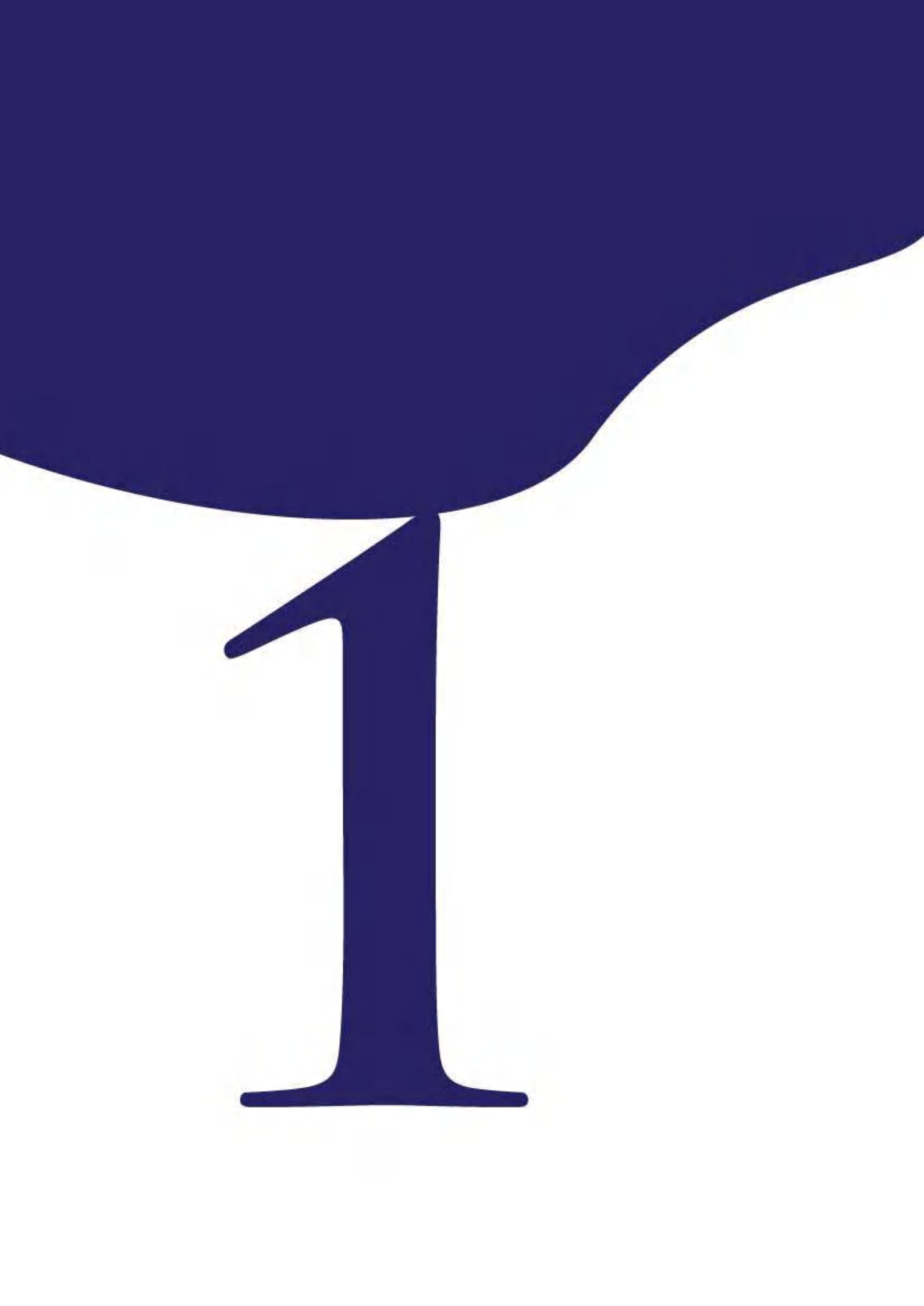


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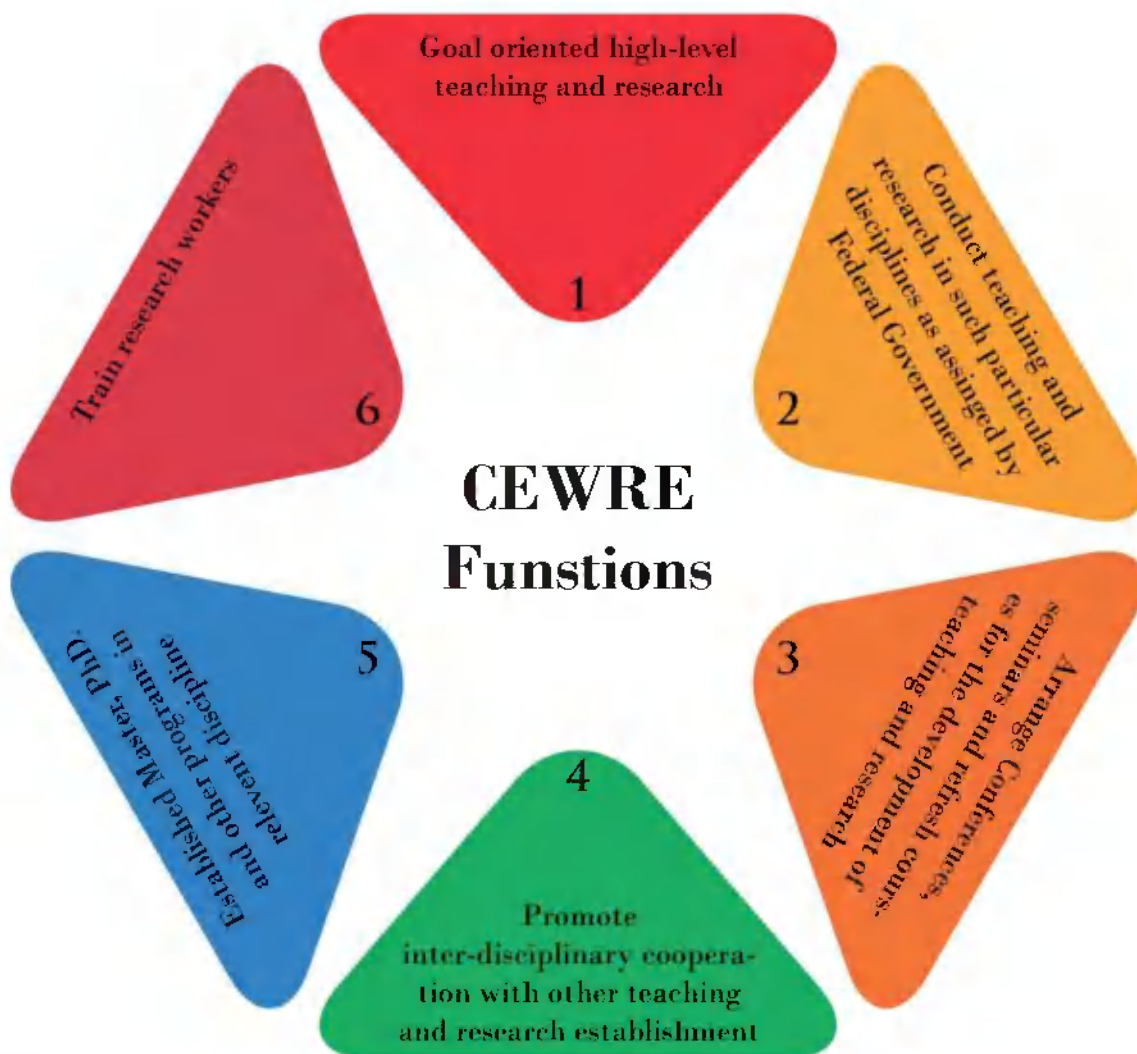
# ABOUT CEWRE





# INTRODUCTION

Centre of Excellence in Water Resources Engineering (CEWRE) was established at University of Engineering and Technology, Lahore on September 04, 1976 as an institute of high-quality goal oriented teaching and research institute of Federal Government, Pakistan. The Centre is academically affiliated with University of Engineering and Technology, Lahore, which awards degrees to Centre's graduates. The functions of Centre according to the Centre of Excellence Act of 1976 are:



## VISION

“ To generate knowledge for local and global competitive advantage and become a leading world class water related research institute. ”

The Centre of Excellence in Water Resources Engineering has had a busy year in 2021 having full of research and other activities. Following the SOP, the Centre was able to continue its education, research, and extracurricular activities. The year's goals were met successfully thanks to the combined efforts of management, faculty, and staff. In the year 2021, there was a 27 percent increase in postgraduate study applications. In total, 118 candidates applied for M.Sc. and Ph.D. programs at CEWRE, but only 33 were accepted. Under the direction of higher management, the Centre organized a series of internal and external Boards of Studies (CBS) to evaluate research studies and review new research proposals. CBS members approved forty-four (44) research proposals and accepted fourteen (14) theses of postgraduate students who successfully defended their research works. Two Board of Governors meetings were arranged throughout the year to oversee the Centre's operations and manage the institution's future direction.

The Centre of Excellence in Water Resources Engineering created numerous job opportunities for water professionals by advertising open positions to strengthen the Centre's human resources. National and international conferences, online seminars and workshops, training of other provincial professionals, various ceremonies, and an annual sports gala are among the other activities. The incoming pages of this annual report contain information about human resource development, research activities, study tours, and extra-curricular activities.

## BUDGET (2021-2022)

CEWRE's budget is supported by HEC, Government of Pakistan and is mainly used to meet salary and operational expenses. Self income is generated mainly from courses fee, hostel fee and other research activities. Budget for research comes from collaborative research and competitive research grants funded by government and non-government agencies.

### Budget of the Year 2021-2022

Description	Rs. in million
<b>Receipt-259.238</b>	
HEC/Federal Government Grant	49.506
Own Resources + Savings	209.732
<b>Expenditure-251.734</b>	
Current Expanses + Salary	120.254
Development/others	131.48
Balance	7.504

# BOARD OF GOVERNORS

The Board of Governors of the Centre is the authority for management, overall controls, and supervision of the affairs. The board is consisting of the following members: Vice-Chancellor of University, Representative of Higher Education Commission, Pakistan Science Foundation and Ministry of Education, Dean of Faculty, Three Subject Expert nominated by Federal Government, and Director of Centre. In the year 2021 three board of governor's meetings were arranged in the Centre physically coupled with online.



Chairman

**Prof. Dr. Syed Mansoor Sarwar**  
Vice Chancellor  
UET, Lahore



Secretary

**Prof. Dr. Noor Muhammad Khan**  
Director  
CEWRE, UET, Lahore

Member



**Prof. Dr. Habib ur Rehman**  
Dean, Faculty of Civil Engineering  
University of Engineering & Technology, Lahore

Member



**Dr. Amjad Hussain**  
Director General, Research & Innovation Division  
Higher Education Commission, Islamabad

Member



**Mr. Jawad Akram**  
Joint Secretary Policy, Ministry of Federal  
Education & Professional Training, Islamabad

Member



**Prof. Dr. Shahid Mahmood Baig**  
Chairman  
Pakistan Science Foundation, Islamabad

Expert



**Dr. Muhammad Ashraf**  
Chairman  
PCRWR, Lahore

Expert



**Prof. Dr. Bakhshal Khan Lashari**  
Director, US-Pakistan Centre for Advanced Studies  
in Water, Mehran University, Jamshoro

Expert



**Dr. Nasir Mahmood Khan**  
Secretary/Registrar  
Pakistan Engineering Council, Islamabad

Expert



**Engr. Shahid Hameed**  
Advisor (Hydrology & Water Management)  
WAPDA House, Lahore



# CEWRE FACULTY

As the institute's academic and executive head, the director is responsible for administrative, academic, personnel, and budget decisions under the objectives of the Centre. Faculty members provide organizational, strategic, academic, and research services to advance the teaching and research level of the Centre and provide students with the best opportunities to propel them into a successful future in the water sector. The center's faculty is consist of highly experienced individuals with diverse interests in water resources. The CEWRE faculty members are listed below:

## Director



**Prof. Dr. Noor Muhammad Khan**



**Dr. Ghulam Nabi**  
Associate Professor



**Dr. Sajid Mahmood**  
Assistant Professor



**Dr. Muhammad Masood**  
Assistant Professor



**Dr. Muhammad Kaleem Sarwar**  
Assistant Professor



**Dr. Ijaz Ahmad**  
Assistant Professor



**Dr. Muhammad Waseem**  
Assistant Professor



**Dr. Mudassar Iqbal**  
Lecturer



**Engr. Faraz Ul Haq**  
Lecturer



**Engr. Muhammad Awais Zafar**  
Lecturer



# ACADEMIC COMMITTEE

Academic Committee/Centre Board of Studies (CBS) members are the custodian of the Centre's overall academic and research programs/activities. The Chairman of the Committee conveys and submits the academic-related matters to the Board of Governors. The academic committee consists of the following members: the Director of the Centre, all of the Centre's Professors and Associate Professors, and two HEC-nominated experts. In the year 2021, the Centre arranged nine Academic Committee/CBS meetings physically coupled with online.

## Chairman



**Prof. Dr. Noor Muhammad Khan**  
Director  
CEWRE, UET, Lahore

## Member



**Prof. Dr. Shahid Ali**  
Department of Civil Engineering  
NUCES, Lahore

## Co-opted Member



**Engr. Tariq Altaf**  
Ex-Vice President, W & A Division  
NESPAK, Lahore

## Member



**Dr. Ghulam Nabi**  
Associate Professor  
CEWRE, UET, Lahore

## Member



**Dr. Mohsin Hafeez**  
Country Representative  
IWMI, Lahore

## Co-opted Member



**Dr. Sajid Mehmood**  
Assistant Professor  
CEWRE, UET, Lahore

## Co-opted Member



**Dr. Muhammad Masood**  
Assistant Professor  
CEWRE, UET, Lahore

## Co-opted Member



**Dr. M. Kaleem Sarwar**  
Assistant Professor  
CEWRE, UET, Lahore

## Secretary



**Dr. Mudassar Iqbal**  
Lecturer  
CEWRE, UET, Lahore

# ENTRY TEST

Entry test is mandatory to initially scrutinize the fresh graduates who are interested to take admission in postgraduate programs. In the year 2021, the Centre arranged entry tests for taking new intake in Fall Sessions. Overall, 118 students apply for M.Sc. in Water Resources Engineering, Water Resources Management, Engineering Hydrology, and Hydropower Engineering, as well as Ph.D. in Water Resources Engineering, Water Resources Management, and Engineering Hydrology. Among them, 82 candidates qualified for the entry test, and 33 students got enrolled in fall session 2021.



Glimpses of Entry Test Conduction in Seminar Hall and Lectures Rooms

# HUMAN RESOURCE DEVELOPMENT





# رَبِّ زِدْنِي عِلْمًا

SURAH “*Ta-Ha*”  
VERSE “114”

*Oh Allah Increase me in Knowledge.*

In the digital era of information and innovation, things are evolving at a very fast pace. To meet the current challenges of the digital era human resource development training are essential for continuous learning to cultivate advanced knowledge and skills. Lifelong learning has been emphasized by our Holy Prophet Hazrat Muhammad as “seek knowledge from cradle to grave. CEWRE generated ample opportunities in the year 2021 for the capacity building of water professionals. Detail elaboration of training workshops, seminars, and conferences organized by CEWRE are provided here

## International Conference on Hydrology and Water Resources (ICHWR-21)

Centre of excellence in Water Resources Engineering, University of Engineering and Technology, Lahore held a one-day international conference on Wednesday, March 25, 2021. More than two hundred participants from different countries including Malaysia, Iran, Scotland, Hungary, and United Kingdom apart from the Pakistani experts participated in the online conference. Prof. Dr. Syed Mansoor Sarwar Vice-Chancellor, University of Engineering and Technology Lahore inaugurated the conference. While highlighting the theme of the conference Vice-Chancellor emphasized the need for innovative solutions of water conservation and its utilization to meet the future demand of the country. Vice-Chancellor also said that sustainable water resources management is only possible through concerted efforts of the political leadership and the research community. He also suggested the researcher to make their contribution to the optimal use of water resources. Earlier, Prof. Dr. Noor Muhammad Khan, Director, Centre of excellence in Water Resources Engineering welcomed the participants of the conference and highlighted the main themes. During the opening speech by the chief guest, Muhammad Mohsin Khan Leghari, Minister of Irrigation Punjab, Pakistan emphasized the role of educational institutes and utilization of modern techniques for water management along with the construction of large reservoirs. In his addresses as keynote speaker, Prof. Dr. Habib-Ur-Rehman, Dean Civil Engineering, UET, Lahore highlighted the importance of sustainable aquifer management through recharging techniques. Prof. Dr. Zahiraniza Mustafa, University Teknologi PETRONAS Malaysia provided the information regarding the importance of IoT application for the design of flood warning systems. At the end of the inaugural session, Engr. Shahid Hameed, GM, WAPDA highlighted the role of WAPDA in the efficient water resources development of Pakistan. Dr. Ali Asghar Iraqpoor, Islamic Azaad University,



Event Picture of speakers, participants and organizers

Iran; Prof. Dr. Asit K. Biswas, University of Glasgow, Scotland; Dr. Ejaz Tanveer, Federal Flood Commission, Pakistan; Dr. Raza-ul-Mustsfa, University Teknologi PETRONAS, Malaysia; Mr. Peter Kovács, Water Director, Hungary, and Dr. Mubasher Hussain, Global Hydropower & Dams Envision Digital, United Kingdom also shared the valuable knowledge and information about the role of water resources in sustainable development, flood management, and modernizing the Hydro-operations during three technical sessions. In three technical sessions, twenty technical papers were presented with the main focus on climate change, extreme event analysis, and management, hydrological modeling, optimization of water resources, and sustainable water management approaches. The participation was from various national and international organizations/institutes including the University of Lahore, Bahauddin Zakariya University, Multan, Balochistan University of Information Technology, Engineering, and Management Sciences, UET Taxila, National Engineering Services Pakistan, University of Agriculture, Faisalabad, and the University of Wollongong, Australia apart from Centre of excellence in Water Resources Engineering.



Event Picture of organizers and group photo with other faculty members



**Webinar  
on**

**River Modeling Using HEC-RAS  
1D/2D Features**

On April 26, 2021, a one-day webinar was organized by the Centre of Excellence in Water Resources Engineering (CEWRE) where 37 participants from various organizations such as National Engineering Services Pakistan (NESPAK), World Wide Fund (WWF) Pakistan, National University of Science and Technology (NUST) Islamabad, Iqra National University, Peshawar, Bahaud-din Zakariya University Multan, Highway department, Khwaja Fareed University of Engineering and Information Technology (KFUEIT) Rahim Yar Khan, Public Health Engineering Department Punjab, Pescom Engineering Pakistan, University of Agriculture Faisalabad, University of Engineering and Technology Lahore, joined this virtual event to learn the River Modeling. Dr. Mudassar Iqbal, from CEWRE and Engr. Muhammad Awais Zafar from CEWR, UET Lahore were the resource persons.



Two Dimentional Unsteady Flow Simulation with overlay on Base Map

**Special Lecture on  
Conservation Technologies for Sustainable  
Water Management in Pakistan**

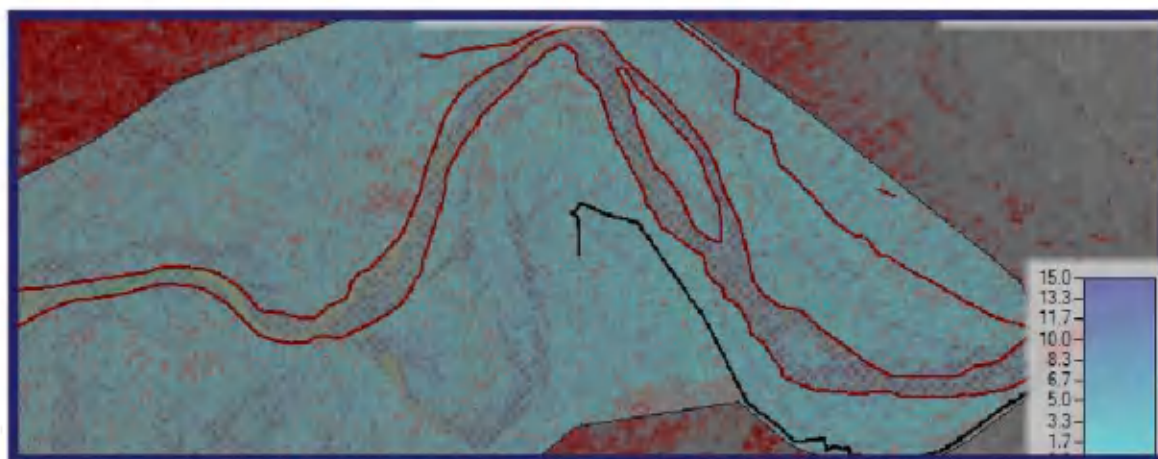
CEWRE arranged an online special lecture on July 08, 2021, titled “Conservation Technologies for Sustainable Water Management in Pakistan”. About 60 participants from various organizations joined the virtual event. The lecture focus was on modern technologies available and use in the market for sustainability and management of water resources. Prof. Dr. Rai Niaz Ahmad, Ex-Vice Chancellor, PMAS Arid Agriculture University, Rawalpindi, and Ex-Dean, Faculty of Agriculture Engineering & Technology, University of Agriculture, Faisalabad delivered his lecture as a key resource person. The organizers of the webinar were Dr. Sajid Mahmood, Assistant Professor, Dr. Ijaz Ahmad, Assistant Professor, Engr. Faraz-ul-Haq, Lecturer and Engr. Muhammad Awais Zafar, Lecturer from Centre of Excellence in Water Resources Engineering, University of Engineering and Technology, Lahore.



Glimps of Prof. Dr. Rai Niaz Ahmad presentation

## Webinar on Two Dimensional (2D) Sediment Transport Modeling

Under the series of training on water resources engineering and management, a one-day webinar titled “Two Dimensional (2D) Sediment Transport Modeling” was arranged by CEWRE on August 26, 2021. The webinar was arranged to enhance the capacity in the application of available advance hydraulic tools for post-graduate students, researchers, and professionals of water-related departments in sediment transport modeling for better management of water resources. Dr. Ghulam Nabi, Associate Professor from CEWRE was the resource person. The organizer of the event were Dr. Ghulam Nabi, Dr. Muhammad Masood, Dr. Mudassar Iqbal, and Engr. Muhammad Awais Zafar.



Glimps of Dr. Ghulam Nabi presentation



## National Conference on Sustainable Water Resources Management (SWRM-21)

Centre of excellence in Water Resources Engineering, University of Engineering and Technology, Lahore organized one day National Conference on “Sustainable Water Resources Management” dated: Thursday, September 23, 2021. The conference was graced by the Minister of Irrigation, Punjab, Pakistan Mr. Muhammad Mohsin Khan Leghari as a Chief Guest. Participants from forty-nine different institutions and organizations from Pakistan joined the conference. In the inaugural session Prof. Dr. Noor Muhammad Khan, Director, Centre of excellence in Water Resources Engineering welcomed

the chief guest, keynote speakers, and participants and highlighted the main themes. During the opening speech by the chief guest, Muhammad Mohsin Khan Leghari, Minister of Irrigation Punjab, Pakistan emphasized the role of educational institutes and the utilization of modern techniques for sustainable water management. In his addresses as keynote speaker, Prof. Dr. Habib-Ur-Rehman, Dean Civil Engineering, UET, Lahore highlighted the importance of sustainable aquifer management through recharging techniques. Engr. Shahid Hameed, Ex-General Manager, WAPDA highlighted the role of WAPDA in efficient water resources development of Pakistan and plans for Hydropower and water conservation projects. Dr. Mohsin Hafeez, Country Representative, IWMI Pakistan, discussed the issues and challenges of the Indus River and emphasis on the installation of monitoring systems. Dr. Muhammad Ashraf, Chairman, PCRWR, Pakistan, and Engr. Mushtaq Ahmad Gill, Ex-DG, Water Management expressed their views about sustainable water resources management. In three technical sessions, eighteen technical papers were



Glimps of Outline Event in Video Conferencing Room at CEWRE

presented with the main focus on climate change impact assessment, soil erosion, hydraulics, and agricultural water management. The participation was from various national organizations/institutes including the University of Lahore, Bahauddin Zakariya University, Multan, Balochistan University of Information Technology, Engineering, and Management Sciences, UET Taxila, National Engineering Services Pakistan, University of Agriculture, Faisalabad, COMSATS University, University of Punjab, Lahore apart from Centre of excellence in Water Resources Engineering. In the concluding session, Prof. Dr. Noor Muhammad Khan, Director, Centre of excellence in Water Resources Engineering appreciated the organizing team of the conference especially Dr. Kaleem Sarwar, Dr. Ijaz Ahmad, Engr. Faraz ul Haq and Engr. Muhammad Awais Zafar resolved that CEWRE will continue its struggle to train water managers and researchers in field of water resources.



Event Picture of speakers, participants and organizers



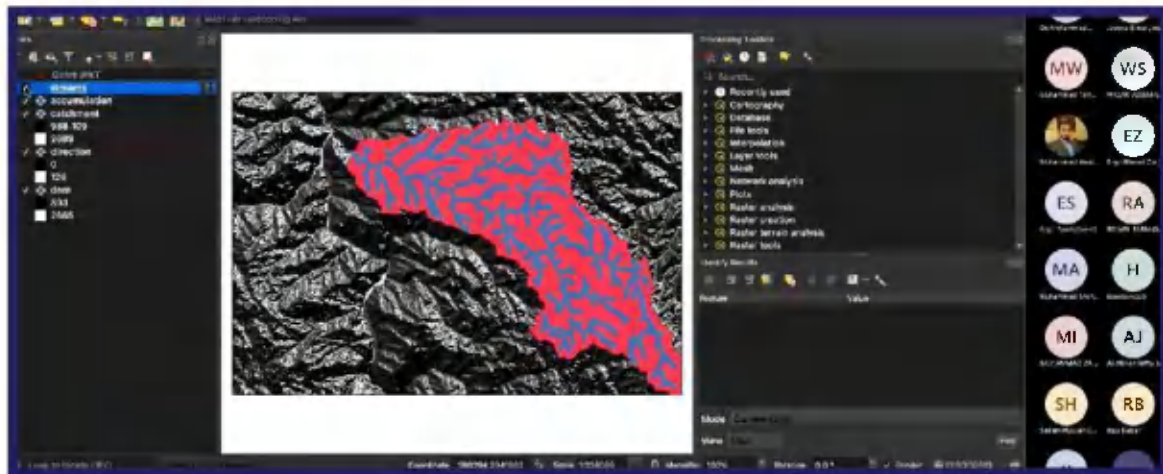
Group Photo of Organizers



Webinar  
on

## Watershed Modeling Using Python and Pyshed

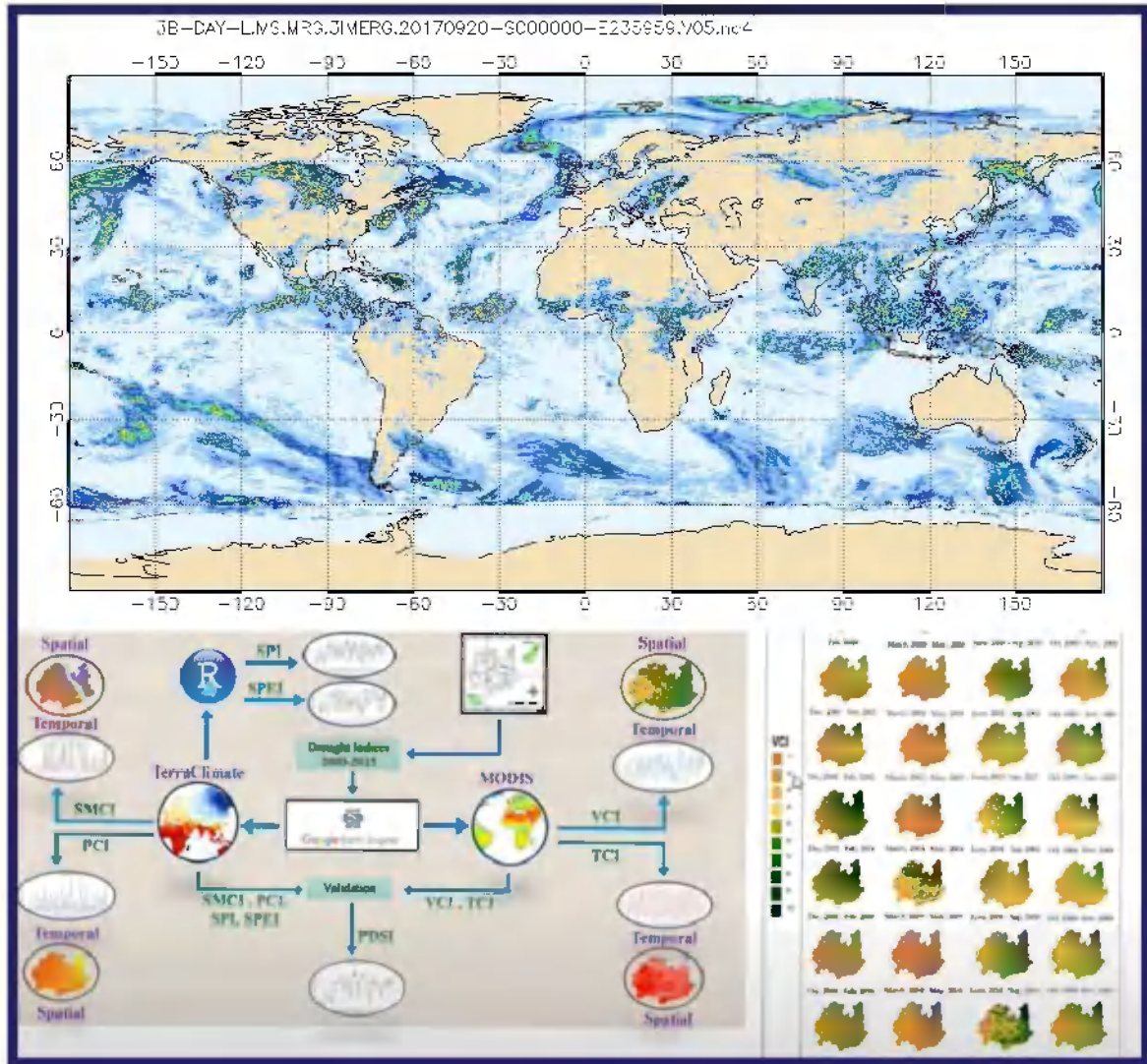
A one-day webinar titled “Watershed Modeling Using Python and Pyshed” was held on October 05, 2021. About 28 participants from various organizations including MNS University of Agriculture Multan, Khwaja Fareed University of Engineering & Information Technology (KFUEIT), UET Lahore, University of Agriculture Faisalabad, and UET, Taxila attended this event. The webinar focus was to familiarize the participants with watershed modeling using advanced computer applications including google earth engine, Python, and Pyshed. Dr. Athar Ashraf, Assistant Professor from the Department of Data Sciences, University of Punjab, and Dr. Muhammad Waseem, Assistant Professor from CEWRE were the resource persons. The organizers of the webinar were Dr. Muhammad Waseem and Engr. Faraz-ul-Haq.



Watershed Delineation using Pyshed

## Webinar on Utilization of Satellite Precipitation Data of Ungauged Catchments

CEWRE conducted a one-day webinar titled “Utilization of Satellite Precipitation Data of Ungauged Catchments” on October 27, 2021. More than 51 participants from various organizations/institutions i.e., NUST, COMSATS University, Islamabad, Mehran University of Engineering and Technology, Abasyn University Islamabad Campus, B.Z.U. Multan, NEDUET, UET Peshawar, BUISTEMS Quetta, and Integrated Consulting Services (Pvt)Ltd, joined the virtual event. The webinar's aim was to the utilization of satellite precipitation data, validation and assessment of uncertainties, satellite data mining, and application in distributed flood modeling. Dr. Ghulam Nabi, Associate Professor from CEWRE, Dr. Muhammad Masood, Assistant Professor from CEWRE, and Dr. Hammad Gilani, Assistant Professor from Institute of Space Science, Islamabad. The organizers of the webinar were Dr. Muhammad Masood, Dr. Mudassar Iqbal, and Engr. M. Awais Zafar.



Glimps of Resource Persons Presentation



Event Picture of Speakers, Participants and Organizers



## Workshop on Design Training of Projects, Schemes and Plans

CEWRE organized three weeks training workshop titled “Design Training of Projects, Schemes, and Plans” from November 22 to December. 8, 2020 under the direction of the Project Director of Balochistan Integrated Water Resources Management and Development Project (BIWRMDP). Fifteen professionals i.e., Executive Engineer and Sub-divisional Officer, from the Public Health Engineering Department, Government of Balochistan, participated in the learned workshop. Engr. Wasif Ali, Engr. Azim Farhan, Engr. Aziz ur Rehman, Mr. Ahmad Ali, Mr. Inayat Ali, Dr. Ghulam Nabi, Dr. Ejaz Ahmad, Engr. Faraz-ul-Haq and KSB team shared/bring his knowledge and experience in the training to train the participants as resource persons. The focus of the workshop was on enhancing the capacity of engineers from PHED in water supply distribution network analysis and design using state of the art software namely EPANET, WaterGEMS, Water HAMMER, and SCADA. Prof. Dr. Noor Muhammad Khan, Director of CEWRE was the head managing team as well as a resource person, and Dr. Kaleem Sarwar, Assistant Professor, CEWRE was the coordinator of the workshop as well as a resource person. Other supporting staff of



Picture of Inaugural session



the CEWRE also played their roles in successfully conducting the workshop. A closing ceremony was arranged on the last day of the Two weeks training in which Prof. Dr. Habib-ur-Rehman, DEAN, Faculty of Civill Engineering was invited as a guest honor. Post-workshop feedback was taken from training participants during the ceremony which was quite energetic. Participation certificates were distributed among the professionals of PHED and shield with certificates was presented to the resource persons of the training. Prof. Dr. Noor Muhammad Khan presented the shield to the guest of honor Prof. Dr. Habib-ur-Rehman and distributed the appreciation certificates among the supporting Centre's staff who played their role in the event to making it successful. A goodbye tea was arranged on the CEWRE lawn for informal interaction of students with the professionals of the Government of Balochistan, Pakistan.



**Group Picture of Participants, Resource Persons and Faculty Members**



**Glimps of Participants and Resource Persons at Tea Refreshment**



Picture of Resource Persons Delivering Lecture and Guiding Participant During Training



Glimpses of Field Visit of Training Participants with Resource Persons





**Glimpses of Closing Ceremony of 15 Days Training and Certificates Distribution  
Among Training Participants and Organizers**

## **Webinar on State of the Art Technology for Sustainable Tube Well Installation**

In the last month of the year 2021, on December 09, 2021, a one-day webinar titled “State of the Art Technology for Sustainable Tube Well Installation” was organized by the Centre of Excellence in Water Resources Engineering (CEWRE) where 55 participants from various organizations across the country joined this virtual event. The resource person of the webinar was Engr. Shafiq Ahmad, Ex-Director Well Drilling, Agriculture Engineering Field, Government of Pakistan. He shared his experience and delivered the lecture on the installation of tube wells to sustain the groundwater aquifer resources as well as the economic cost of installation. Dr. Ghulam Nabi, and Eng. Muhammad Awais Zafar from CEWR, UET, Lahore were the organizer of the webinar.

# RESEARCH ACTIVITIES





## National Honors/Research Competition

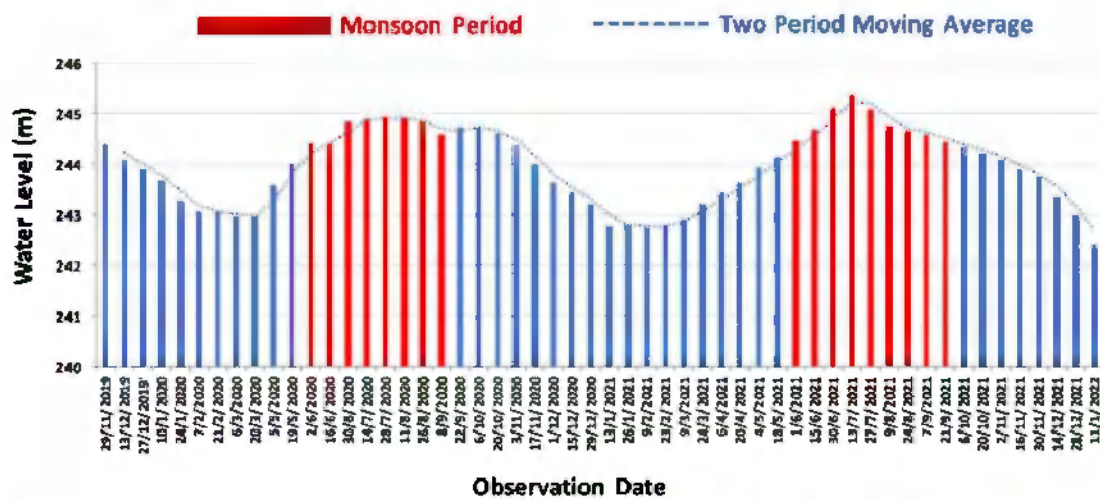
CEWRE encourage their students to take part in the compaction on national and international levels. Healthy competition inspires scholars to do their best. As team members, they motivate each other toward creativity and productivity to achieve a common goal. In the year 2021 CEWRE students take part in the national level competition arranged by the Pakistan Council of Research in Water Resources (PCRWR) with the collaboration of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for an inter-university Water Resource Mapping competition by using applications of geospatial technology. Province-wise topics were assigned by PCRWR to the universities. The topic assigned to the universities of Punjab was “Assessment of water and land resource potential for effective rainwater harvesting in Pothwar region”. A team from the Centre of Excellence in Water Resources Engineering (CEWRE), UET Lahore under the supervision of Dr. Kaleem Sarwar participated in this competition. The team members, Engr. Saleem Munawar (M. Sc. Hydropower Engineering Student) and Engr. Muhammad Muneeb Khan (Ph. D Water Resources Management Student) submitted a proposal to PCRWR and got selected among all universities of the Punjab province and awarded with souvenirs and certificates on March 15, 2021, during the event of World Water Day.



Picture of Engr. Saleem Munwar (PI of Project) Receiving Souvenir

# Managing Aquifer Recharge (MAR) Project

Under the Managing Aquifer Recharge (MAR) project, two recharging wells and piezometers were installed in 2021 at the University of Engineering and Technology, Lahore, with the mutual collaboration of PCRWR and CEWRE. One charging and monitoring unit is located at Junaid Jamshed Stadium, while the other is located at Annex Ground. CEWRE's hydrology lab manages the installed project's units and measures groundwater levels twice a month throughout the year. The plot of observed water levels is also displayed on the hydrology lab's website, where the seasonal variation in groundwater levels can be seen. A web link to the lab page is provided here.



Plot of Observed Groundwater Levels and Picture of Installed Unit at Annexe Ground

## Research Projects Submitted

- 1. Urban Rainwater Harvesting on Sustainable Basis and its Implementation through Local Stakeholders and Collaborators**  
**PI/Co.PI:** Prof. Dr. Noor Muhammad Khan
- 2. Development of Nanomaterials Based Wastewater Treatment for Water Recycling**  
**PI/Co.PI:** Dr. Ghulam Nabi
- 3. Ecosystem Based Adaptation (Wetlands Restoration, Management of Catchment Areas And Hill Torrent)**  
**PI/Co.PI:** Dr. Ghulam Nabi
- 4. Reforming agricultural policy, optimization land and water productivity for food security and future sustainability**  
**PI/Co.PI:** Dr. Ghulam Nabi
- 5. Use of Machine Learning for investigating relationships between climate change, agricultural productivity**  
**PI/Co.PI:** Dr. Ghulam Nabi
- 6. Digital & Spatial Mapping of Projects Interventions**  
**PI/Co.PI:** Dr. Ghulam Nabi
- 7. Recharge Well Performance Evaluation**  
**PI/Co.PI:** Dr. Ghulam Nabi
- 8. Optimal Filter Design for Groundwater Recharge**  
**PI/Co.PI:** Dr. Ghulam Nabi
- 9. Hydraulic Investigation and Design of Entrance Profile for High Head Orifice Spillways**  
**PI/Co.PI:** Dr. Kaleem Sarwar
- 10. Groundwater age estimation through isotopic and numerical simulations for sustainable groundwater management**  
**PI/Co.PI:** Dr. Ijaz Ahmad
- 11. Potential Impact of Climate Change with Altitude on Water Resources in Upper Indus Basin**  
**PI/Co.PI:** Dr. Muddassir Iqbal



## Patents Applied

**1. Deflecting Velocity Rod**

**By: Dr. Muhammad Masood**

**2. Development of Ultrasonic Water Level Sensor for Shallow Channels (upto 10 ft)**

**By: Prof. Dr. Noor Muhammad Khan, Dr. Muhammad Kaleem Sarwar,  
Engr. Faraz-ul-Haq, Ali Raza**



**POSTGRADUATE  
RESEARCH WORK**



## Climate Change Impacts on Crop Water Requirement, Crop Yield and Productivity



Dr. Ijaz Ahmad  
Supervisor



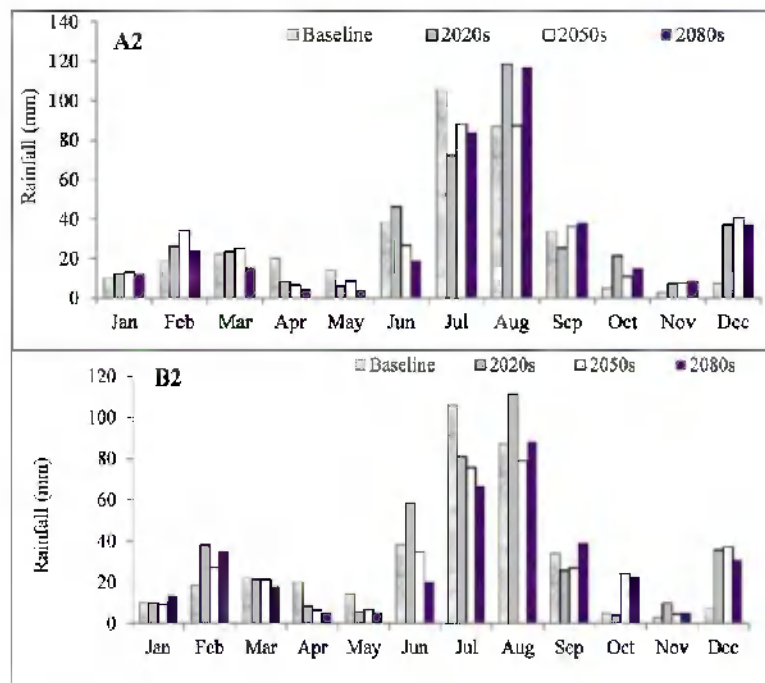
Engr. Muhammd Kashif Ali  
Student

### Abstract:

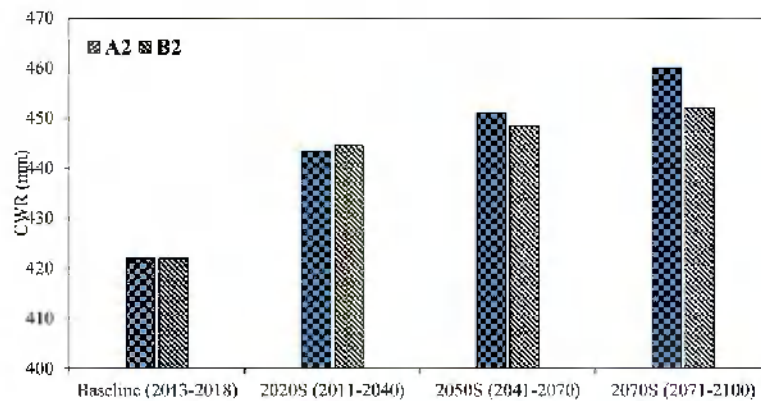
The global agricultural system is at risk of climate change. Uncertainties in temperature and rainfall regimes have a significant impact on crop growth, development and yield. Water and agriculture sectors are considered sensitive to climate change-induced impacts. Agriculture is the largest contributor in Pakistan's economy, accounting for 18.9% of gross domestic product (GDP). Due to the growing population, food and fiber requirements are increasing at an alarming rate and putting constant pressure on the water resources system. To meet the nutritional needs of the entire country and to increase agricultural water productivity, mitigation of negative impacts of climate change on agricultural crops, irrigation water requirements and crop water production should be addressed. Moreover, wheat is one of the most important crops in Pakistan, accounting approximately 40% of total cultivated area. However, its productivity is negatively affecting under changing climate and vulnerable to water stress. Therefore, present study investigates the response of wheat yield, crop water requirements and crop water productivity to climate change in Faisalabad district of Punjab.

The analysis was conducted using DSSAT crop simulation model with an ensemble of global climate model (HadCM3) under A2 and B2 scenarios with the help of statistical downscaling model (SDSM). Future climate projections indicated that maximum and minimum temperatures are expected to rise in the future for all periods, i.e., 2020s, 2050s and 2080s. Maximum temperature is expected to rise to 4.2 °C and 3.9 °C by 2080s under A2 and B2 scenarios. Similarly, minimum temperature is going to increase up to 1.8 °C and 2.0 °C by 2080s under A2 and B2 scenarios. Moreover, average annual rainfall is expected to rise under both scenarios for all three future periods. Simulation of future

wheat yield by using DSSAT crop simulation model found that a decrease is expected in the future wheat yield due to rise in temperature. Future wheat yield may reduce up to 8.96% and 7.92% cumulatively by 2080s under A2 and B2 scenarios, respectively. Although the amount of rainfall is expected to increase in the future; however, the temperature rise might be more severe. Therefore, crop water requirements will also be increased in the future due to high evapotranspiration. Average seasonal crop water requirements will increase by 38 mm and 30 mm under A2 and B2 scenarios, respectively by 2080s. Decreasing wheat yield combined with water deficit in the future would decrease the future crop water productivity (CWP) up to 17.76% and 14.95% under A2 and B2 scenarios, respectively. As, it is evident from the results that climate change is affecting the crop yield, crop water requirement and productivity, therefore, strategies should be developed to reduce the simulation uncertainties in climate change impact assessment. This study will also be helpful to formulate different adaptation strategies to address water stress and CWP issues under changing climate.



Projected trend of mean monthly rainfall under A2 and B2 scenarios



Projected Change in average CWR under A2 and B2 scenarios



## Optimal Design of Headrace Tunnel



**Dr. Kaleem Sarwar**  
Supervisor

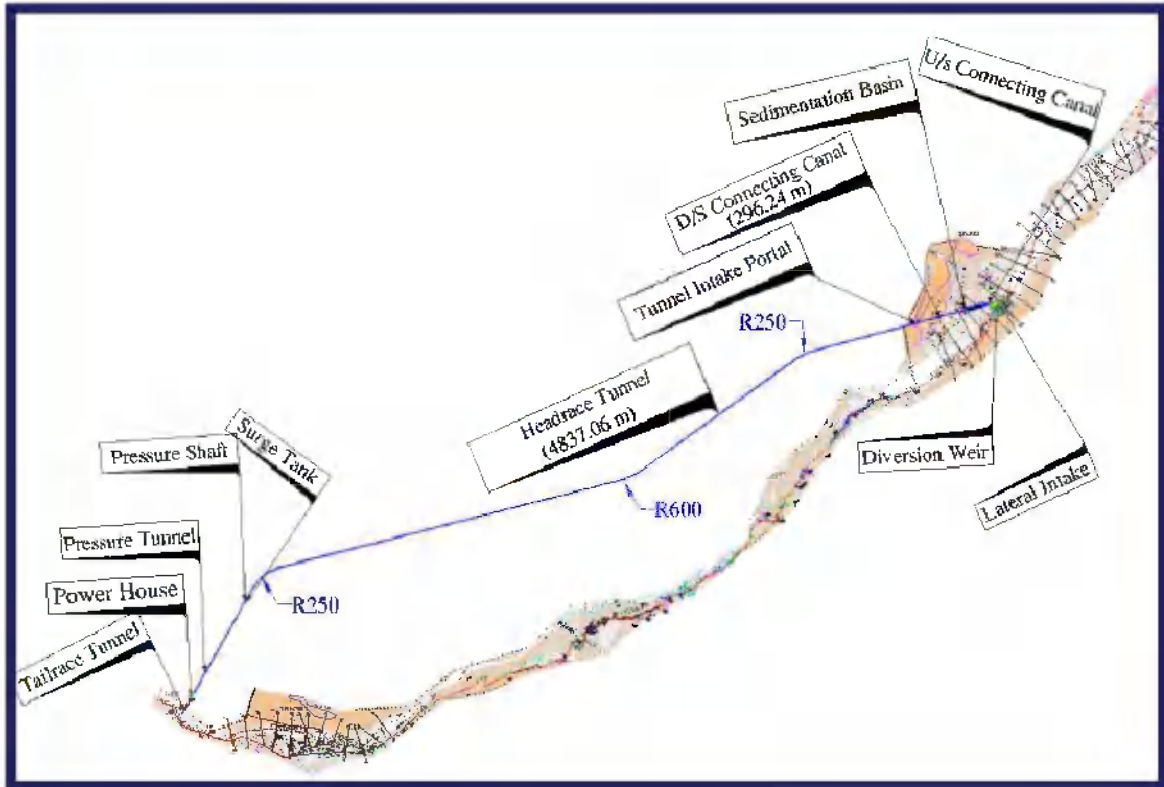


**Engr. Zain Ijaz**  
Student

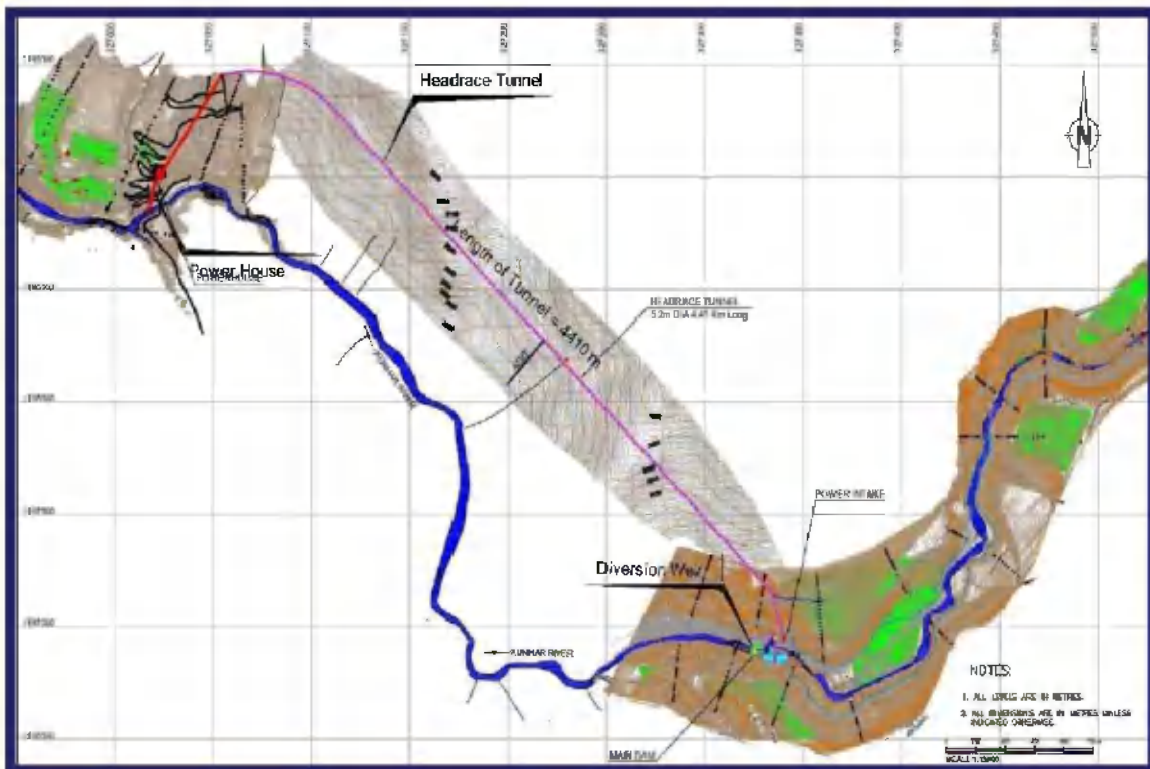
### Abstract:

Headrace tunnel is an important civil structure in any hydro-electric power project. Optimization of the headrace tunnel diameter is a challenging and complex problem due to large number of variables, its dynamic behaviour, excessive computations, and non-linearity of the objective function. Tunnel diameter greater than optimum one will be helpful in achieving more power generations due to minor hydraulic losses. However, it will result in higher construction cost. Contrary to it, tunnel diameter smaller than optimum one involves less construction cost, but it will increase hydraulic losses and as consequence less power generation. For the computation of optimal diameter of headrace tunnel many empirical relations are available in the literature. These empirical relations give different values of headrace tunnel diameter for the same site conditions.

This study has addressed many critical parameters involved in the calculation of optimal diameter of headrace tunnel. A new model was developed keeping in view the variables involved in the optimization of headrace tunnel which were not used before. The newly developed model was used to compute the diameter of headrace tunnel based on minimum cost of headrace tunnel. Newly developed model was validated using the data of various hydropower projects. The result showed that for same design discharge, diameter for an unlined tunnel is 8.75% higher as compared to the lined tunnel. The results also indicate that a minor percentage difference ranging from 1.43 to 4.26 % in diameter was found. It showed that newly developed model may be used for the optimal diameter of headrace tunnel of any hydropower project.



General Layout of Uzghor HEPP



General Layout of Batakundi HPP

## Performance Evaluation of Ground- water Recharging Arrangement in Urban Areas



**Dr. Ijaz Ahmad**  
Supervisor



**Engr. Syed Ali Husuain**  
Student

### Abstract:

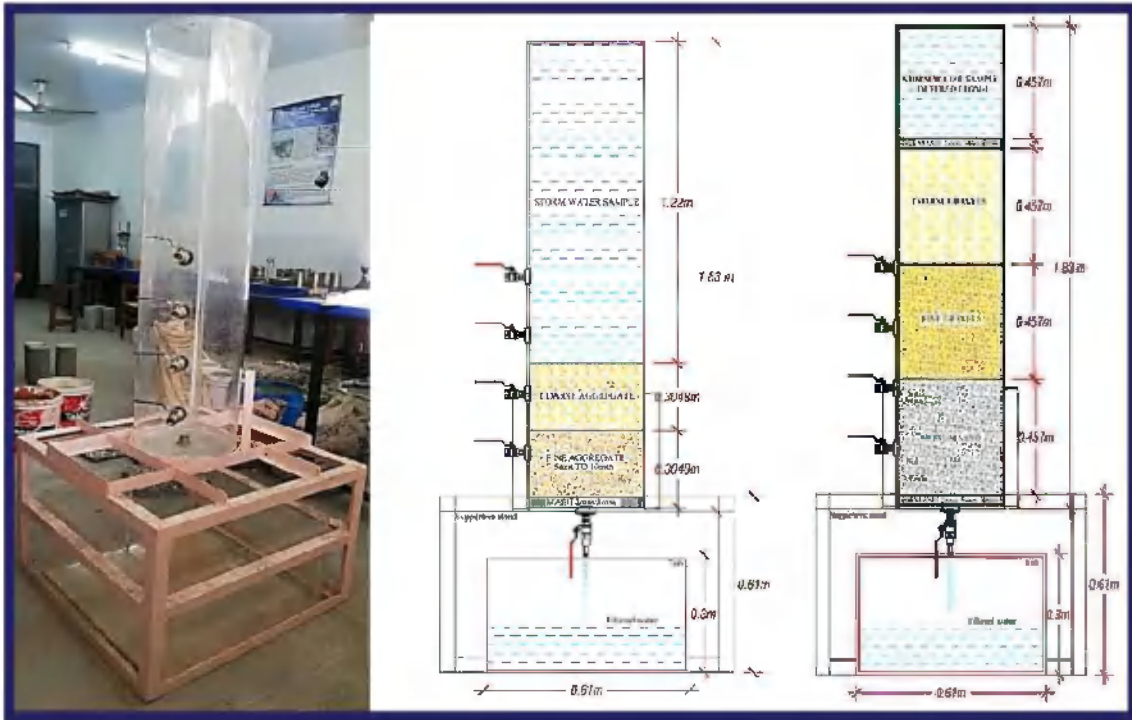
Groundwater is an important source of fresh water. In recent years, water availability in urban areas is rapidly declining due to the overexploitation of groundwater and maximum rainwater discharge in the drainage system. This water can be used to recharge the groundwater using suitable arrangements. For this purpose, present study is conducted in order to evaluate the performance of different groundwater recharging wells installed in urban areas of Lahore. The objective of present study was to investigate/ evaluate the performance of groundwater recharging well by observing groundwater levels to investigate the reasons behind the poor performance of recharging wells in order to suggest the suitable remedial measures to improve their performance.

This study was conducted on various groundwater recharging wells installed by Pakistan Council of Research in Water Resources (PCRWR) and Lahore Development Authority (LDA). Rainfall data was collected from Pakistan Meteorological Department (PMD) Lahore from Year 1991 to 2018 and analyzed. Runoff volume and peak flows were calculated using SCS Curve Number method and Rational formula. Groundwater table was observed and analyzed by using processing MODFLOW before, during and after monsoon season. In order to evaluate the performance of filters used in recharging wells, physical model study was performed. Moreover, recharge rates were measured, and water quality tests were conducted before and after the storm water was filtered through porous medium. Based on this comparison, recharge rate and water quality, final suitable design of groundwater recharging well was recommended.

The study concluded that, total maximum rechargeable volume during monsoon was 24206 m<sup>3</sup> at Gaddafi stadium, 1403 m<sup>3</sup> at irrigation colony, 3438 m<sup>3</sup> at STEDEC office



and 3587 m<sup>3</sup> at PCRWR office Lahore. It is concluded from the recharging of water can only slow down the depletion rate of groundwater table, but do not increase water table. Performance of groundwater recharging wells can be enhanced if sand traps are provided before the filter chamber in recharging wells. Recharging well at Gaddafi stadium and one of designed well having filter made of boulder and fine material along with mesh have highest recharging rates among all, also the water quality results of these wells are approximately acceptable. Recharging well at STEDEC office Lahore is found to be efficient in case of water quality although its recharging rate is less.



Physical Model of Recharging well filter (left side), Design Approach-I and Approach-II



Lab Experiment to Select best filter medium for Storm water



## Groundwater Modeling for Performance Evalu- ation of Recharging Well



Prof. Dr. Habib-ur-Rehman  
Supervisor

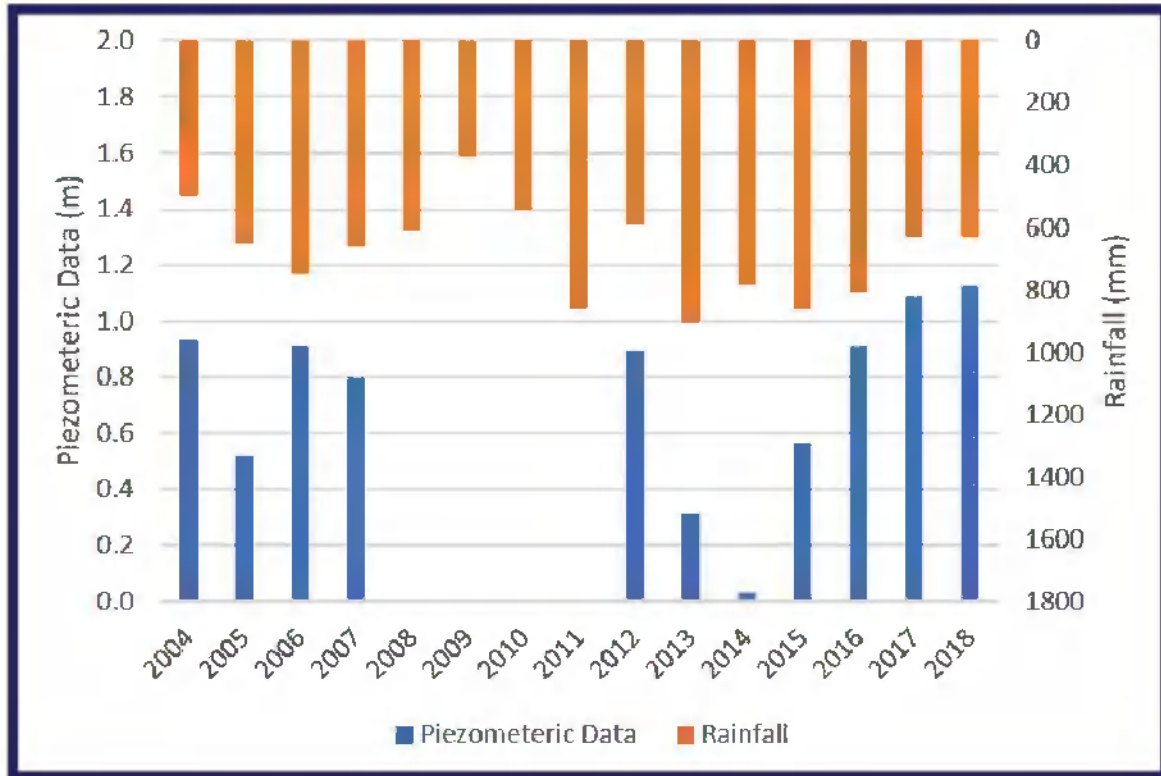


Engr. Yusra Irshad  
Student

### Abstract:

Lahore being second largest city of Pakistan solely rely on groundwater reserves for domestic, commercial & industrial purposes. Higher abstraction rates to meet increasing demands are continuously depleting the ground water table. The abstraction rate of groundwater in Lahore has increased to 784 MGD (41.23 cumecs) in 2010 from 44.6 MGD (2.35 cumecs) in 1960. Now a days many Managed Aquifer Recharge (MAR) techniques are being used to decrease the groundwater depletion rates like infiltration galleries, and recharging wells etc. Pakistan Council of Research for Water Resources (PCRWR) has recently installed one recharging well at their regional office in Lahore, whose inflows and piezometric data are collected as flowmeter and piezometer was installed by the PCRWR. This research aims assessment of groundwater recharge around the recharging well in order to predict the future trend that how much it contributes to aquifer. Setting up of groundwater flow model was carried out for the recharging well installed at PCRWR regional office Lahore using the software Visual MODFLOW. The model was calibrated for 1st January 2017 - 31st December 2017 and validated for 1st January 2018 - 31st December 2018 using observed data. It was observed that ground water table is depleted by 1.2m for the year 2017-2018 after the installation of recharging well. For long term performance evaluation hypothetical scenario modeling was carried out using 17 years rainfall data to predict groundwater levels for next five years (2018-2023). The difference in groundwater table depths with and without recharging well situation is about 2.8 m. Water table depth was found to be 192.5 m with recharging well and 195.3 m without recharging well. The study shows that if the same urban development trends prolong, it will render groundwater system unsustainable as the

groundwater recharging sources more or less remain at the same level while the abstraction rates continue to increase day by day. The gap between inflow and outflow is continuously increasing which is resulting in the depletion of groundwater storage. To overcome such rapid decline of water table, there should be rain water harvesting through recharging welis in Lahore city. The current study highlights the importance of groundwater refueling by series of recharging wells in order to minimize Lahore's water depletion rate.



Annual Rainfall Amounts and Annual Piezometric Levels at PCRWR, Lahore



## Efficient Design of Tubewell by Energy and Hydranlic Approach.



Dr. Ghulam Nabi  
Supervisor



Engr. M. Sohaib Arshad  
Student

### Abstract:

Pakistan is an agricultural country, where major sources of irrigation are canal water, groundwater and rainfall. In Punjab, the canal system is a major source for irrigation but unfortunately, this system has very limited potential to meet the crop water requirements and the remaining crop water needs are met from groundwater sources through nearly (1.2 million) tubewells (Hassan et al., 2014). At present in agriculture sector; irrigation tubewells and farm tractors are large consumers of energy, so it is need of hour to make the most efficient use of available water and energy resources.

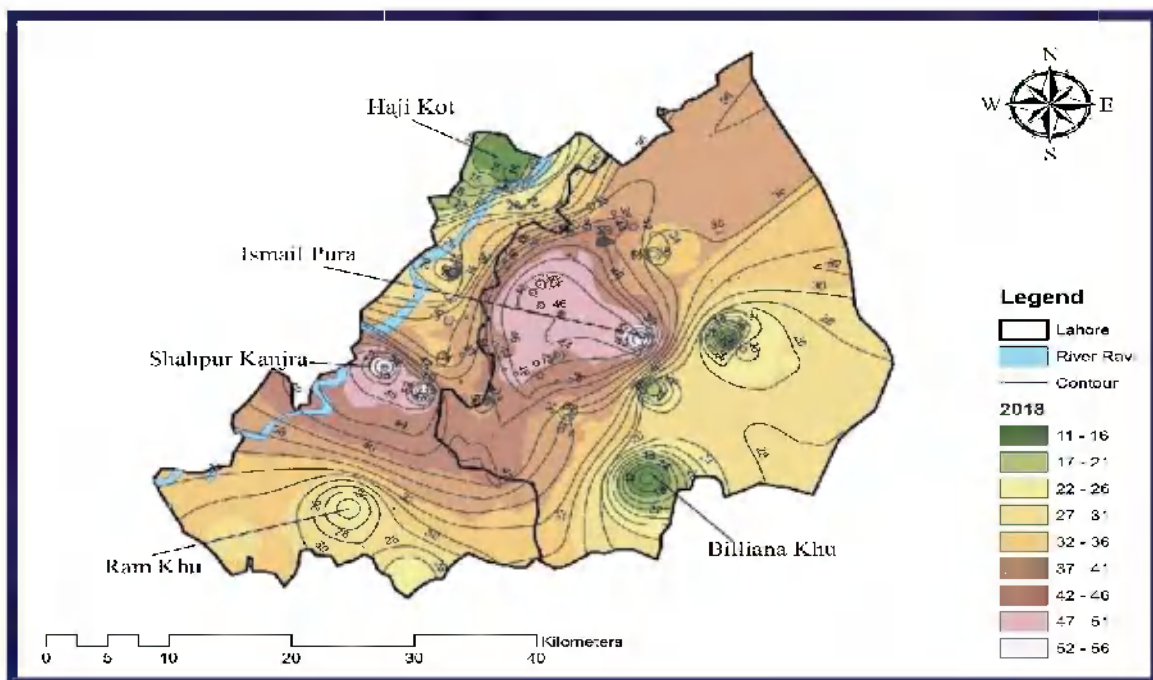
In this study, aquifer was initially analyzed by considering the recharging parameters like rainfall, river flows and canals passing through the area. Rainfall trends of (1980-2018) indicated that maximum rainfall occurs during the month of July (209.52 mm) and minimum rainfall observed was (5.72 mm) in the month of November in Lahore. Discharge data of river Ravi (1991-2018) at Shahdra showed that minimum flow observed was (569 cumec) in 2005 and maximum flow in 1995 was (4,740 cumec). The results showed that there is a continuous decrease in rainfall as well as it is found that discharge of river Ravi is also decreasing. Groundwater level maps were drawn using GIS software for year (2000-2018), which indicates that the average decline in water table depth was 1.4 meter per year.

The average seasonal crop water requirements (CWR) were estimated for the major crops in Lahore i.e. wheat and rice, their CWR's were simulated as 206 mm/dec and 667.5 mm/dec respectively. It was concluded that surface water contribution to CWR from rainfall and canal water source was 37% and remaining 63% area has to be irrigated by groundwater extraction.

Tubewell of capacity 50.9 m<sup>3</sup>/hr and 76.5 m<sup>3</sup>/hr discharges were designed for available



groundwater level of 11 m. All the calculations were performed by considering different parameters of tubewell design i.e statistical equations, pump curves and site-specific information. For discharge of 50.9 m<sup>3</sup>/hr a polyvinyl chloride (PVC) material screen was selected with an open area lies between 10-15%. The length of screen was computed as 15.3 m with a flow entrance velocity 0.030 m/sec. Total drawdown is an accumulation of aquifer and well losses which was calculated as 2.14 m. Power requirements were estimated with an ample of pump curves against discharge of 50.9 m<sup>3</sup>/hr and total head of 18.3 m. A comparison was made between different pumps to select the efficient one such that it should not be oversized or undersized pump. In comparison, it was observed that these pumps have different efficiency as varying from 81%, 78 %, 34 % and 65 % respectively. The results indicate that the selected pump model with 2900 RPM gives better performance/efficiency as compared to other three pumps with less power consumption. It was recommended that by replacing existing inefficient pump with a new pump can save energy up to 30 % to 40 %. Efficiency of existing engines and pumps was less, due to local manufacturing without patent design approved by the qualified engineers. Due to less consideration paid towards the usage of energy and water extraction, these impacts have been diagnosed long after their occurrence. To save significant amount of fuel and to improve water discharge, there is a dire need to replace conventional engines and pumps with efficient alternatives.



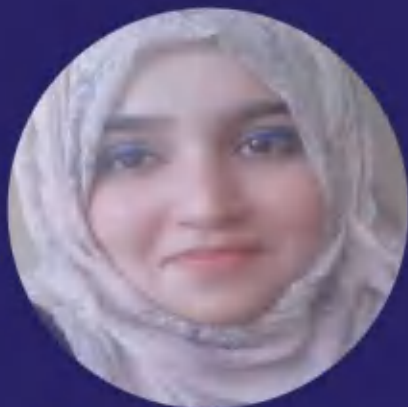
Depth to Water Table Map of Lahore for Year 2018



## Groundwater Modeling for Different Alternatives of Aquifer Recharge



**Dr. Ghulam Nabi**  
Supervisor

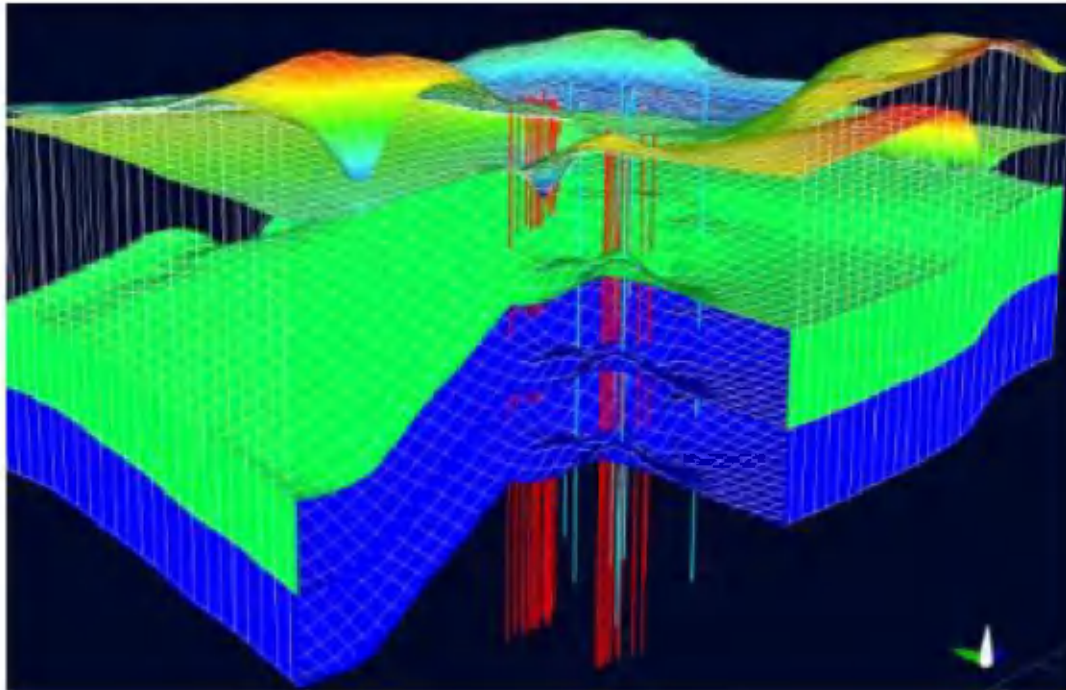


**Engr. Bisma Akmal**  
Student

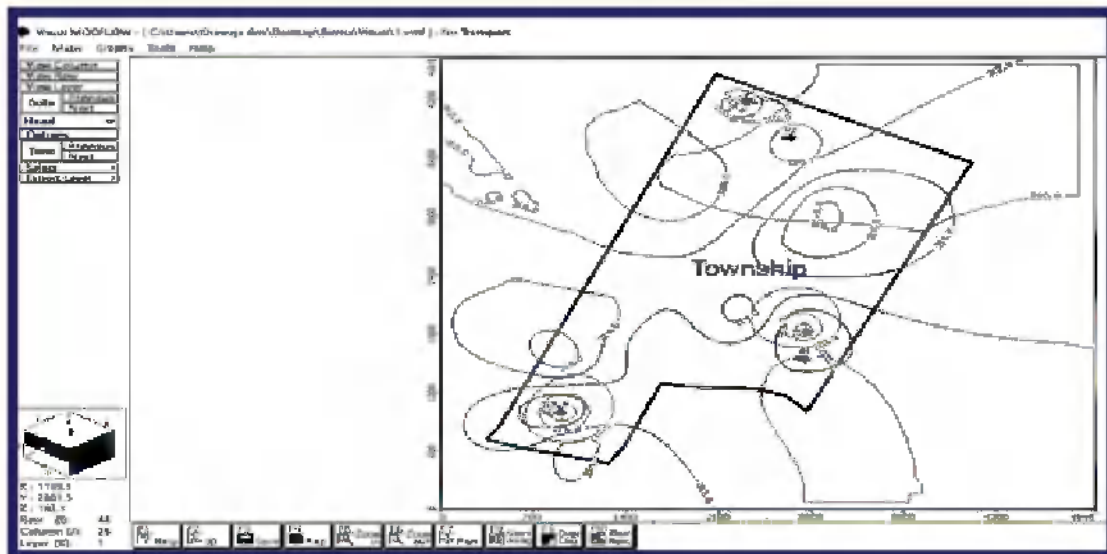
### Abstract:

Sustainability of the globe is threatened by the growing water issues. Water use has increased with the population increase which led toward water scarcity across the globe. Population in Pakistan has gone over 200 million. The country is facing water issues because of rapid increase in population, increasing industrialization and urbanization. Groundwater plays an important role to meet with the demands for domestic, agriculture, urban and industrial purpose in Lahore. Due to continuous increase in population and people moving towards the urbanized areas causes the extra groundwater extraction results in depletion of aquifer. The growing water demand in regions has resulted and demanded high water management measures to allow more effective use of the limited water supplies. The natural groundwater replenishment happens slowly. If groundwater is utilized a proportion higher than its recovery, this would result in water level loss and groundwater resource depletion in long term. In many countries, artificial recharge of groundwater is becoming necessary to optimize natural recharging of groundwater supplies. Different techniques are presented depending on specific condition. These techniques have been evaluated and compared with other recharging techniques with respect to their effectiveness and their impacts on ground water recharge. In this study rainfall runoff relationship was developed by using hydrological model. The study area and observation well shapefile was prepared by using google earth and GIS after geo-referencing observation well data was imported to Visual Modflow. Lowest elevation points were located, taken as recharging points and water being recharged through Infiltration galleries. Recharging wells were also added in model to compare results with the result of infiltration gallery. Performance of infiltration gallery was observed better

than recharging wells. Average depletion rate in study area was 0.9 m/year. The data showed groundwater levels were at 218m. The model showed ground water level was at 220m for infiltrations gallery, recharged at the rate of 2m on annual basis, whereas the groundwater level was at 219m for recharging well. This study showed if dally 0.087 m/day water is infiltrated through these infiltration gafferies then water level can be maintained. The impact of recharging techniques in groundwater was evaluated using groundwater modeling software Visual Modflow.



Mesh Layers with Pumping Wells



Visual Modflow Simulation showing Groundwater Contours

## Probabilistic Characterization of Propagation Rate and LAG Time Between Different Drought Types



Dr. Muhammad Waseem  
Supervisor



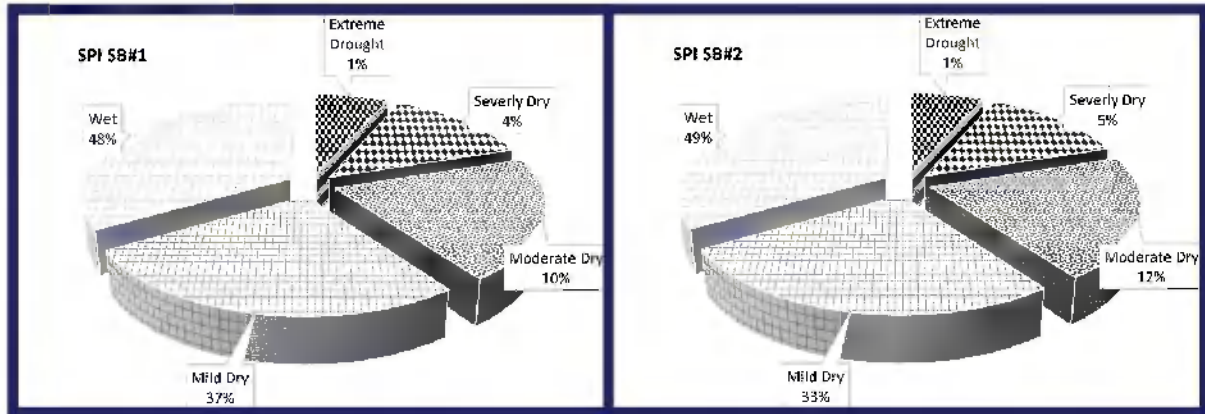
Engr. Awais Naeem Sarwar  
Student

### Abstract:

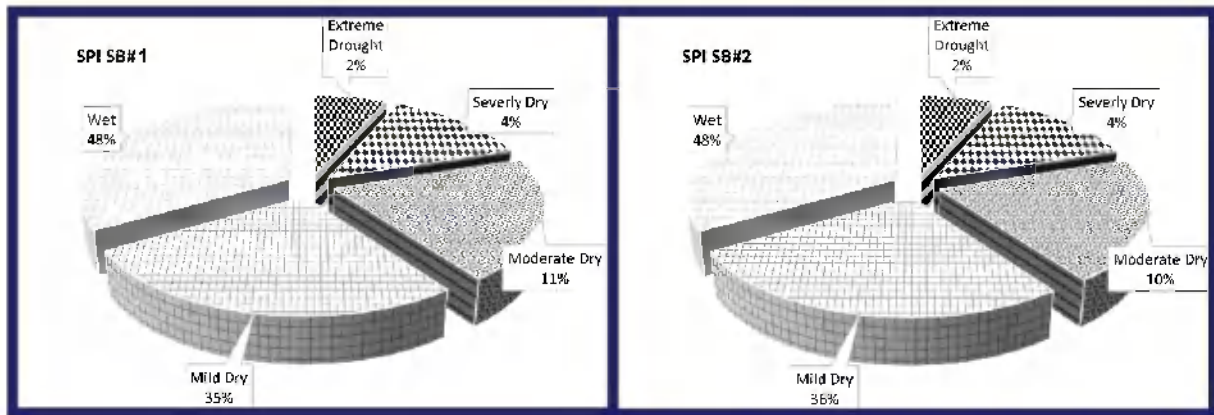
Droughts are the worst natural disasters that could affect people and the ecosystem more than any other natural disaster. It's a creeping phenomenon that is generally triggered by a severe lack of precipitation and it could prolong to hydrological, agriculture, and socio-economic droughts. Hence, the probable prediction of drought and its type's transition could play a vital role in sustainable water management and minimization of economic and human losses. Moreover, meteorological and hydrological droughts events have complex affiliations because they are influenced by watershed characteristics and climatic parameters, and meteorological events could convert into hydrological events after the lag time (L.T). The decisive calculation of the Lag time relationship between meteorological and hydrological events is very crucial for the reparation of hydrological events at a very early stage. Hence, the objective of this study is to carry out a probabilistic analysis of drought propagation between meteorological drought characterized by SPI (Standardized Precipitation Index) and hydrological drought characterized by SDI (Streamflow Drought Index) using the Bayesian network model. The results showed that during the study period (1983-2016), the Soan river basin experienced two severe droughts (i.e. 1998-2000 & 2009-2010) and a significant number of moderate and mild droughts. Both meteorological and hydrological events have a long and intense duration in sub-basin #2 (i.e. 61 meteorological events and 46 hydrological events) as compared to sub-basin #1 (i.e. 43 meteorological events and 36 hydrological events). The quantitative evaluation indicates that lag time varied with varying intensities of meteorological drought and the relationship between the duration of lag time and intensity is inversely proportional. The results also indicate that there is a higher probability of



longer lag time for meteorological droughts of medium intensity, whereas a lower probability of longer lag time for severe intensity. Furthermore, the response rate of hydrological drought to meteorological drought depicted that 65.12% and 75.41% of meteorological droughts were converted to hydrological droughts for sub-basin #1 and sub-basin #2 respectively. Conclusively this study could be a step forward to better understand drought propagation and could provide an initial indication for hydrological drought prediction and mitigation under changing climate conditions.



Characterization of Meteorological Drought (%) in Sub-Basin 1 and 2



Characterization of Hydrological drought (%) in Sub-Basin 1 and 2

## Assessment of Hydro-logical Drought in Anthropocene: A Case Study of Reservoir Effect in ARID Region



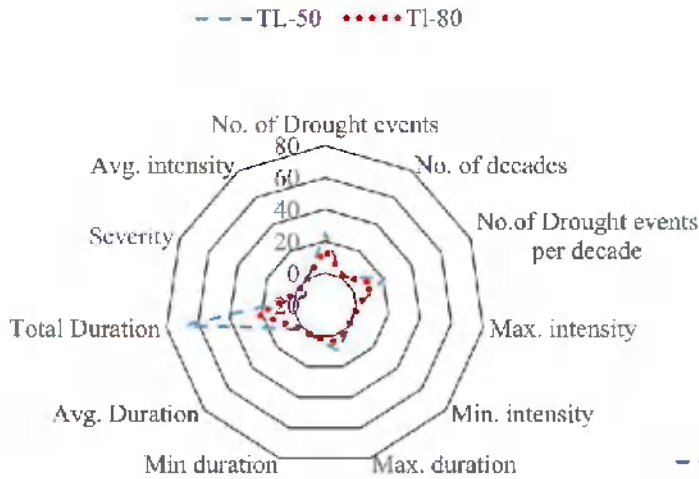
Dr. Muhammad Waseem  
Supervisor



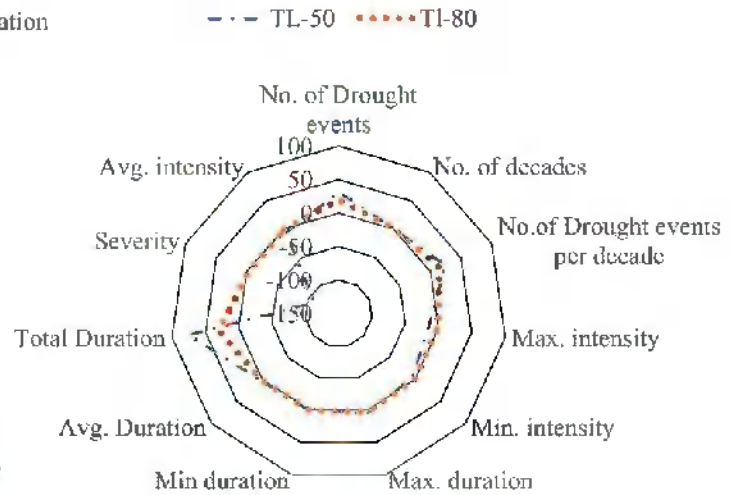
Engr. Khalil Ahmad  
Student

### Abstract:

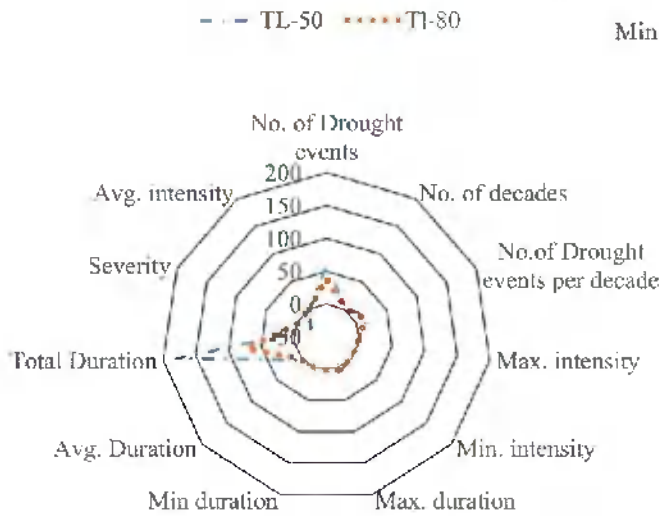
Drought is an important natural hazard that can cause severe environmental and socio-economic impact in different region of the world especially arid regions. Drought is regarded as a deficit in available water compared to the normal condition and climate variability is considered the only drives of the drought. On the other hand, pressure on water resources in arid regions has led to increase the management practices e.g., construction of dams, however the impacts of these anthropogenic activities on hydrological drought have yet to be incorporated and assessed. Moreover quantification of the human influence will improve our understanding and builds fundamental knowledge for water resource management. Hence, in current study, the impact of Simly dam on hydrological drought characteristic at downstream has been analyzed. Two drought analysis methods i.e. (a) threshold level method using 50th and 80th percentiles (TL-50 and TL-80) and (b) standardized index approach were used for hydrological drought calculation and upstream-downstream approach was used for assessment of impact of Simly dam. For upstream-downstream approach the entire data period was divided into two sub periods i.e. pre dam (1970-1982) and post dam (1983-2012). Based on the analysis, it was concluded that during post-dam period there was a decrease in total drought duration by 1.88%, frequency by 15.24% and maximum severity by 69.5% at downstream as compared to upstream. The Simly dam reservoir might have mitigated the short term drought at downstream, however, unable to reduce the impact of long-term drought. Moreover, in presence of dam a delay in drought occurrence were observed at downstream. Conclusively, this study showed an applicable way forward with quantifying the human influence on hydrologic drought.



Statistical Summary of monthly drought events for pre-dam upstream by TL-method

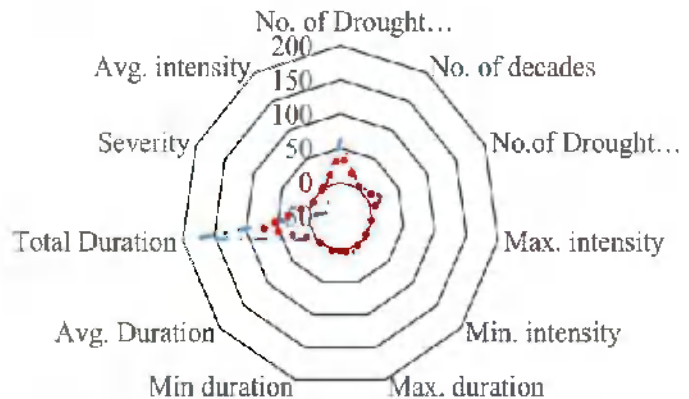


Statistical Summary of monthly drought events for pre-dam downstream by TL-method



Statistical Summary of monthly drought events for post-dam upstream by TL-method

Statistical Summary of monthly drought events for post-dam downstream by TL-method





## Statistical Modelling of Drought and Ground Water Quality NEXUS in Sargodha



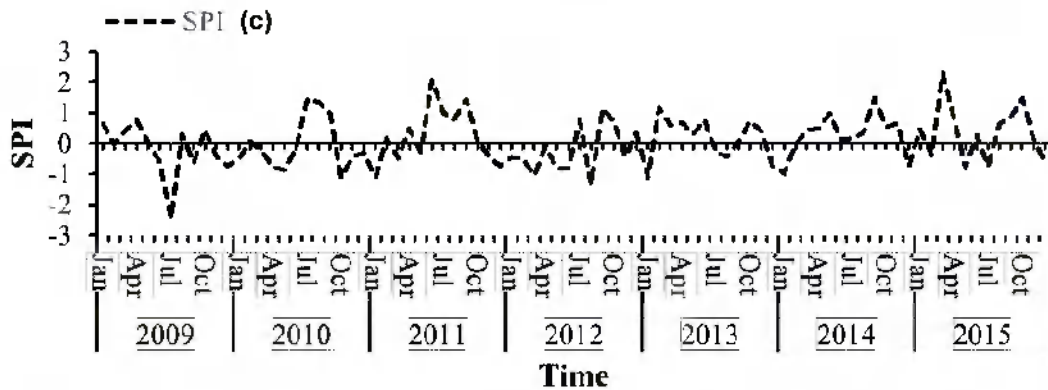
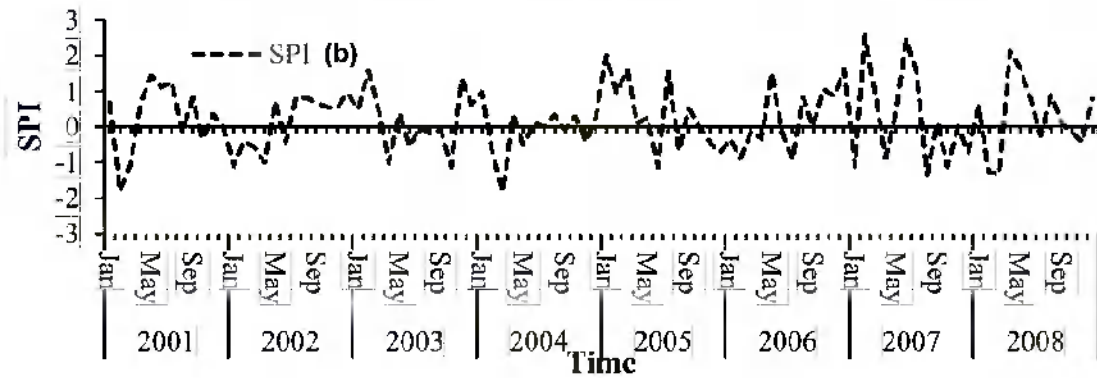
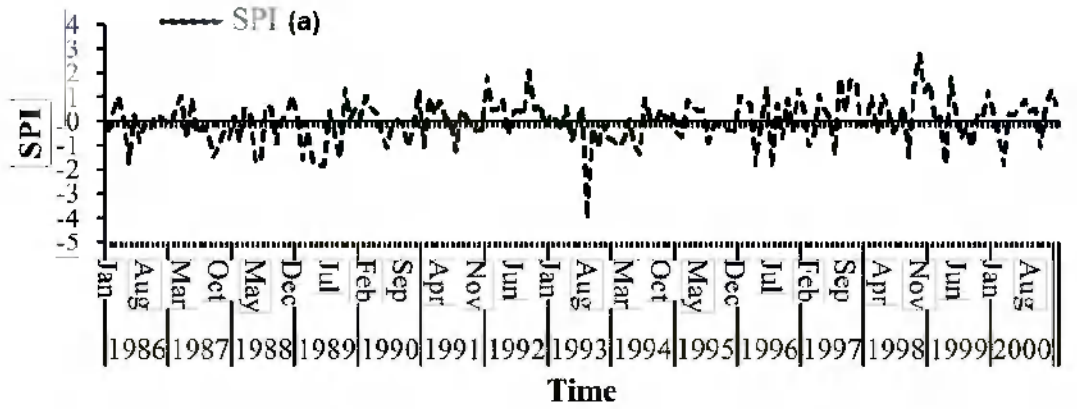
Dr. Muhammad Waseem  
Supervisor



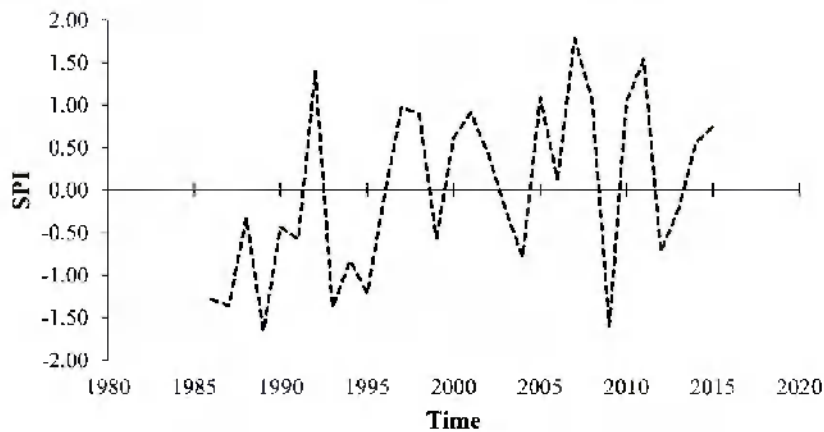
Engr. Ahsan Siddique  
Student

### Abstract:

Drought is generally categorized as metrological drought, hydrological drought, agricultural drought and socio-economic drought. The metrological drought is considered as a deficiency in rainfall over a prolonged period and can cause serious negative impacts on irrigated agriculture, catchment runoff, river flow, lake level, and ultimately the quality of water. In general drought and immediate recovery period could have profound water quality effects and these impacts can vary depending upon the characteristics of a water body and its catchments. Hence, in this study, key water quality parameters i.e. Electrical conductivity (EC), Sodium Adsorption Ratio (SAR), and Residual Sodium Carbonate (RSC) have been selected and Standard Precipitation Index (SPI) was used to compute the metrological drought at two stations i.e. Sargodha and Juharabad. Furthermore, to understand the relationship between drought and water quality, statistical modeling has been carried out based on the estimated drought index and collected water quality parameters data. Based on findings, it resulted that the study area observed 164 drought events with maximum severity of -1.62 and a maimum duration of 8 months. Moreover, a weak correlation was observed between the corresponding time series of SPI and water quality parameters. However, a better correlation ( $R^2 \geq 0.45$ ) was found in the case of lagged series. As disruption of catchment inputs and influence of interposes can increase during prolonged drought and its recovery period, hence it was expected that the lagged water quality series can have a better relationship with SPI. The overall assessment resulted that the value of EC, SAR and RSC have better agreement with prolonged metrological drought and hence it concluded that prolonged metrological drought has a significant impact on variation in water quality.



Monthly SPI Time series Analysis: (a) 1986-2000; (b) 2001-2008; (c) 2009-2015



Annually SPI Time Analysis analysis

## Spatial and Temporal Patterns of Extreme Precipitation Events Across Mangla Watershed



Dr. Ijaz Ahmad  
Supervisor



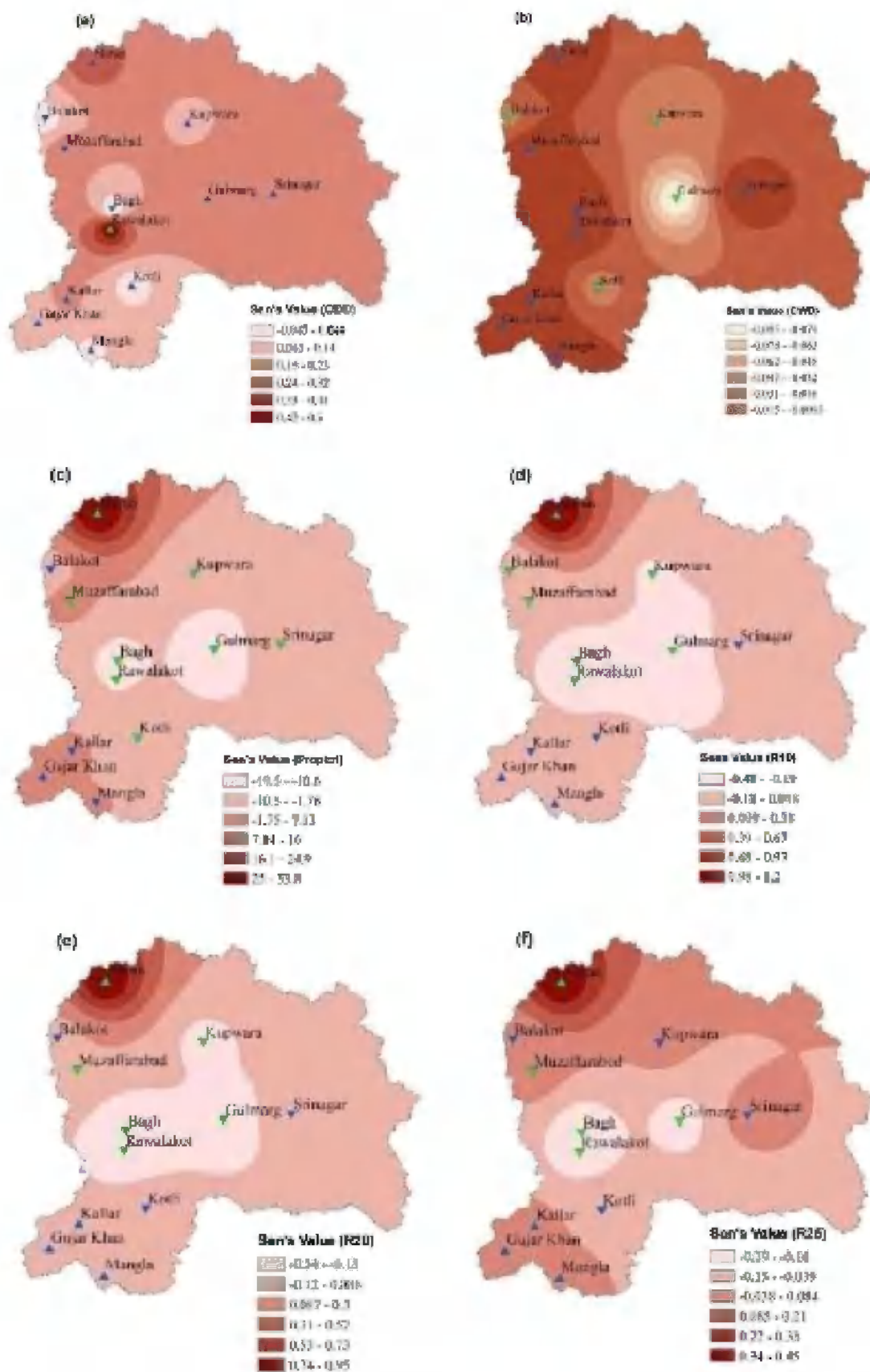
Engr. Faisal Ali  
Sullent

### Abstract:

Climate change has a wide range impacts on Pakistan's water resources system and resulting in extreme climatic events with increased magnitude, intensity and frequency. Spatial and temporal variation of extreme precipitation events is considered essential in providing the requisite assistance in the planning and management of agriculture and water conservation projects. Therefore, present study investigates the spatial and temporal patterns of extreme precipitation events across the Mangla watershed by using extreme precipitation indices (EPI) which include 11 precipitation indices as suggested by Expert Team for Climate Change Detection Monitoring and Indices, event based extreme precipitation (EEP) and time distribution pattern (TDP). Moreover, variations in extreme precipitation indices were investigated by using Mann-Kendall and innovative trend analysis method.

Results revealed that for the fixed threshold indices, decreasing trend at majority of climatic stations and consecutive dry days (CDD) exhibiting increasing trend; however, at Naran station majority of fixed threshold indices showed significant increasing trend except consecutive wet days (CWD) which exhibits decreasing trend. Station Related Threshold Indices also showed a decreasing trend at most parts of the Mangla watershed, for instance, at Naran station increasing trend was observed. The precipitation events with an amount of 40–290 mm and with a duration of 4-7 consecutive days and a concentration ratio of 0.7-0.95 were found dominant. Therefore, it is concluded that consecutive dry days are found to be increasing while consecutive wet days are decreasing. This may constitute that constant pressure on water resources availability in the Mangla reservoir. It is believed that the results of this study could help to understand the precipitation variability over Mangla watershed.





Spatial Patterns of Patterns of extreme precipitation indices in the Mangla watershed

## Subsurface Flow Stability Analysis of Punjnad Barrage



**Prof. Dr. Habib-ur-Rehman**  
Supervisor



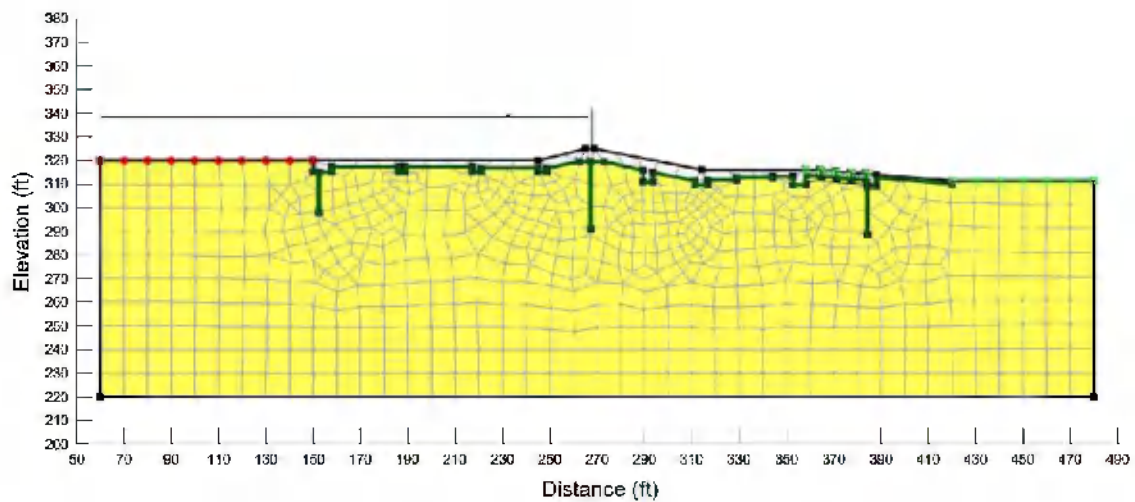
**Engr. Hasnain Jillani**  
Student

### Abstract:

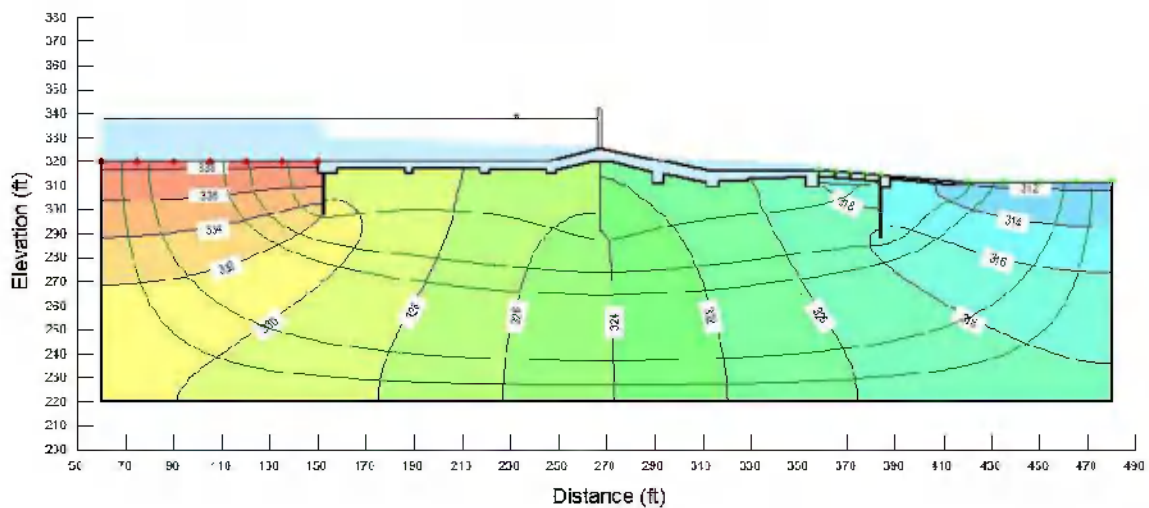
Punjnad Barrage was constructed on River Chenab, downstream of the confluence point of River Sutlej during the period 1925-1929 with design discharge of 450,000 cusecs and upstream High Flood Level (HFL) of 341.5 feet amsl. In 1957, Punjab Irrigation Department (PID) carried out major repair works and sealed the PCC blocks with provision of pressure relief holes in order to achieve adequate impervious floor length with respect to the length of jump profile. A downstream sheet pile was erected to address the unsafe Exit Gradient, however, theory of seepage flow remained unsatisfied which mainly relied upon release of uplift pressure through seep holes in downstream floor. In order to rehabilitate the Punjnad Barrage, PID engaged Consultants under the projects “Punjab Irrigated Agriculture Investment Program” (PIAIP) and “Trimmu & Punjnad Barrage Improvement Project” (TPBIP). PIAIP and TPB Consultants analysed subsurface flow using Khosla’s approach and different scenarios under different conditions were modelled on computer software SEEP/W. However, in order to have a best performing section, the final working paper proposal needs to be modeled on SEEP/W. Secondly, it was also required to check uplift pressures and floor thickness without water cushion of 3.0 feet as proposed by PIAIP Consultants and 4.0 feet as proposed by TPB Consultants due to end sill in their proposed sections. In order to evaluate the existing section of Punjnad Barrage for subsurface flow stability, it was required to analyze the existing section with pressure relief holes not fully operational & partially operational. In this study, adequacy of existing section of Punjnad Barrage for subsurface flow was checked along with proposed interventions and propose any modification for better hydraulic performance, if needed.

Existing section of Punjnad Barrage and

sections with proposed interventions of PIAIP & TPB Consultants were analyzed using classical theories; Bligh, Lane and Khosla and SEEP/W modeling. Sensitivity analysis of SEEP/W was also carried out by varying the mesh size to three different values of 2.5 ft, 5.0 ft and 10.0 ft. Six cases with varying flow conditions and proposed interventions were analyzed. First three Cases A to C results indicate that Exit Gradient & uplift pressures are not safe for the existing sections of the barrage and Case-E with proposed intervention is also unsafe in subsurface flow stability. It is found that Cases D & F are safe for subsurface flow stability with proposed water cushion on downstream floor. However, Case-F i.e. TPB Consultants Working Paper Proposal is recommended to be adopted for the rehabilitation of Punjnad Barrage. This study is useful especially for practicing hydraulic engineers who work as rehabilitation experts.



Unstructured Quad and Triangle Meshing (10 ft mesh size)



SEEP/W Simulation



## Modelling Floods and Their Damages Using GIS: A Case Study of Swat River (Munda to Charsadda Bridge )



Prof. Dr. Habib-ur-Rehman  
Supervisor



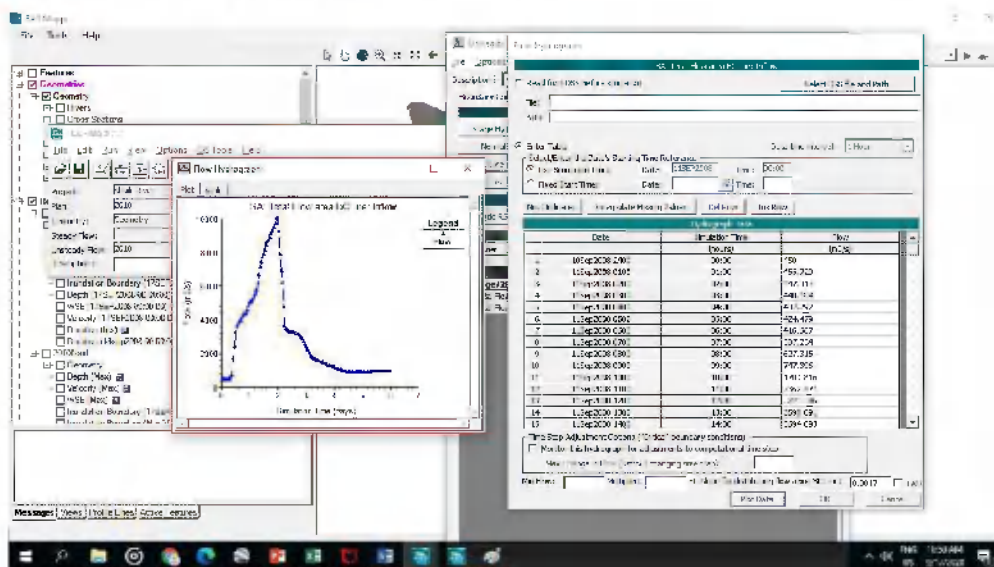
Engr. Rameez  
Student

### Abstract:

Floods are a major natural disaster world-wide. Flood control plans, risk mitigation programs, and other forms of flood management techniques require a good understanding of the flood risk situation and the possible implications for our community. The accuracy of the flood damage estimates depends on both the modeling of the phenomenon and the risk assessment of human systems exposed by the floods. This research work aimed to simulate floods and to develop a subsequent flood damage assessment model based on inundation depths, velocities, and duration mainly focusing on the impacts on agricultural land crops. The study area lies between coordinates of  $34^{\circ}-03'$  to  $34^{\circ}-38'$  latitudes and  $71^{\circ}-28'$  to  $71^{\circ}-53'$  longitudes. The soil of the study area is fertile and highly cultivated with several villages. Even the uplands are now irrigated by canals that run along the toe of Mohmand hills. The main source of irrigation for the area is the Swat River. It flows through Kalam valley up to Chakdara for 160 km and then Panjkora River joins at Qalangi. Finally, it flows through the study area (District Charsadda) for the length of about 24 km (River reach of the study area; also named as Khayali river) and outfalls into Kabul river just a few km downstream of Charsadda Bridge. In the past decades, swat valley experienced many disastrous floods e.g., in the years 1973, 1992, 1996, 2005, and 2010, etc. To strengthen efforts for flood damage assessment to crops through modeling and suggestions for mitigation activities, the availability of past flood damage data/information is very important. Even with the high magnitude of the flood, there exist no risk maps for the study area. Primarily, a conventional method was used to assess flood damage which was based on three steps: (1) elements classification (selection of culture-able field near River), (2) exposure analysis (field exposed to flooding of various

and (3) damage assessment (for selected crops).

To accomplish the research objectives, various steps were followed including flood frequency analysis, selection of best-fitted results, development of inundation maps against various return periods, and development of 1-D/2-D hydrodynamic models for estimation of flood levels. Flood modeling was carried out using ArcMap and HEC-RAS. The river geometry of the study reach was collected from the hydrology department of Khyber Pakhtunkhwa Irrigation Department coupled with DEM of 1 m grid resolutions. Initially, a simple non-linear equation was developed for historic damages incorporating all the considered parameters. A total of nine (09) years of data of historic flood damages were collected from DC Office Charsadda out of which six (06) years of data were used for developing the nonlinear regression equation and calibration of results. A statistical software named SPSS was used for developing the non-linear equation. For validation purposes, the applicability of the developed equation was checked against historic flood events of 1988, 2006, and 2010 that incurred land crop damages over areas of 14,085 acres, 22,428 acres, and 58,344 acres, respectively. The method for flood damage assessment to agriculture crops differs from that of infrastructure (roads, buildings, etc.) damages by variation of flood impacts from crop to crop. Therefore, the most cultivated crops, one from Rabi and one Kharif season, were taken into consideration in this study i.e., wheat and sugarcane, respectively. The assessment was carried out by defining flood damages to sugarcane and wheat crops by using depth damage function curves considering all the growth stages from sowing to harvesting. In comparison to all others crops, the sugarcane and rice crop was found the most less vulnerable to flood, a detail flood susceptibility analysis for all Kharif Crops planted in the study area are discussed in result and discussion chapter of the study, as we know that Rabi is dry season and did not experience any flood in the past, however we have analyzed the wheat crop for if scenario, if such kind of flood occur in Rabi then what will be the damages. This research has developed a validated flood damage estimation model and flood zoning maps for the geographical area around Khyall River in the Charsadda district with a coefficient of determination ( $R^2$ ) of 0.98. Further research may focus on flood damages to residential/non-residential areas with the incorporation of other flood influencing parameters e.g., water salinity and high sediment load etc.



Unsteady Flow Simulation Using HEC-RAS for flood inundation mapping

## Study of Hydraulic Characteristics of Rooster Tail Behind Spillway Pier.



**Dr. Kaleem Sarwar**  
Supervisor



**Engr. Hafiz Kamran J. Abbasi**  
Student

### Abstract:

Rooster tail is generated behind the spillway piers due to diffusion of flow downstream of the pier. They usually occur when fluid boundaries suddenly change downstream of spillway pier. An extreme rooster tail can overtop the spillway side wall and also it can induce vibration in spillway structure. As a result, the operation during flood discharge could be affected and pose a danger to the spillway structure.

There is a lack of studies on rooster tails for spillways with flat slope chutes (5 $\sigma$  to 10 $\sigma$ ). Consequently, it is necessary to study the formation and characteristics of rooster tails on flat slope spillway chutes. For this purpose, spillway model of Mohmand dam was constructed in Model Tray Hall of CEWRE.

The objectives of the present research include, the study of hydraulic characteristics of rooster tail on flat spillway chute and development of an empirical relation for the estimation of rooster tail height.

Physical model of the spillway of Mohmand Dam Hydropower Project consisting of only two bays was designed by Froude number similarity criteria between model and prototype structure and constructed in Model Tray Hall of Center of Excellence in Water Resources Engineering.

In the design of the model, geometric similarities were observed between the model and the prototype by means of a geometrical scale ratio of 1:100. The accepted equations of hydraulic similarities, based on Froude relations, were used to express the mathematical relationship between the dimensional and hydraulic quantities of the model and those of the prototype.

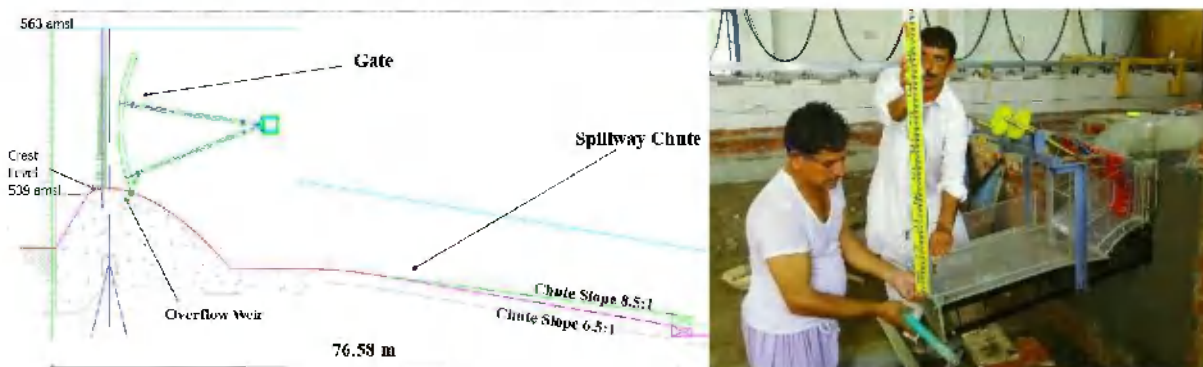
Different experiments were performed to analyze the rooster tail on flat spillway chute and to study the factor affecting the characteristics of the rooster tail. To investigate the hydraulic characteristics of rooster tail,



model was operated for free flow conditions by varying the reservoir levels from 541 m amsl to 558 m amsl (with an increment of 1m). Experiments were performed by varying the spillway chute slopes between 5o to 10o and shape of the pier. Results were plotted b/w observed rooster tail height and the reservoir levels which shows that in geometric alteration M1 & M3 the rooster tail height increased with the increase of discharge till the reservoir level 541 amsl but with further increase in discharge the rooster tail height start to decrease. Whereas, in geometric alteration M2 & M4 the rooster tail height continuously increased with the increase of discharge. The results indicated that rooster tail is significantly influenced by spillway slope ratio, pier width and type.

Rooster tail height also increased with the increase in dropping angle ( $\delta$ ), when the slope angle of the spillway and the width of the pier remain constant, which means that the rooster tail's height is markedly affected by the dropping angle and also it was observed that all the pressure peaks occur at the bottom near the tall part of the pier due to the generation of rooster tail.

It was concluded that the height of rooster tail can be minimized by installing the semi elliptical pier on tall part of main pier. Further modifications in the geometry of extended tail part of pier is recommended for elimination of the rooster tail.



Model Drawing of Spillway and Installation of Model



Model Drawing of Spillway and Installation of Model

## Flood Management Plan for Flash Floods of Pind Dadan Khan and Khewra Hill Torrents in Pakistan



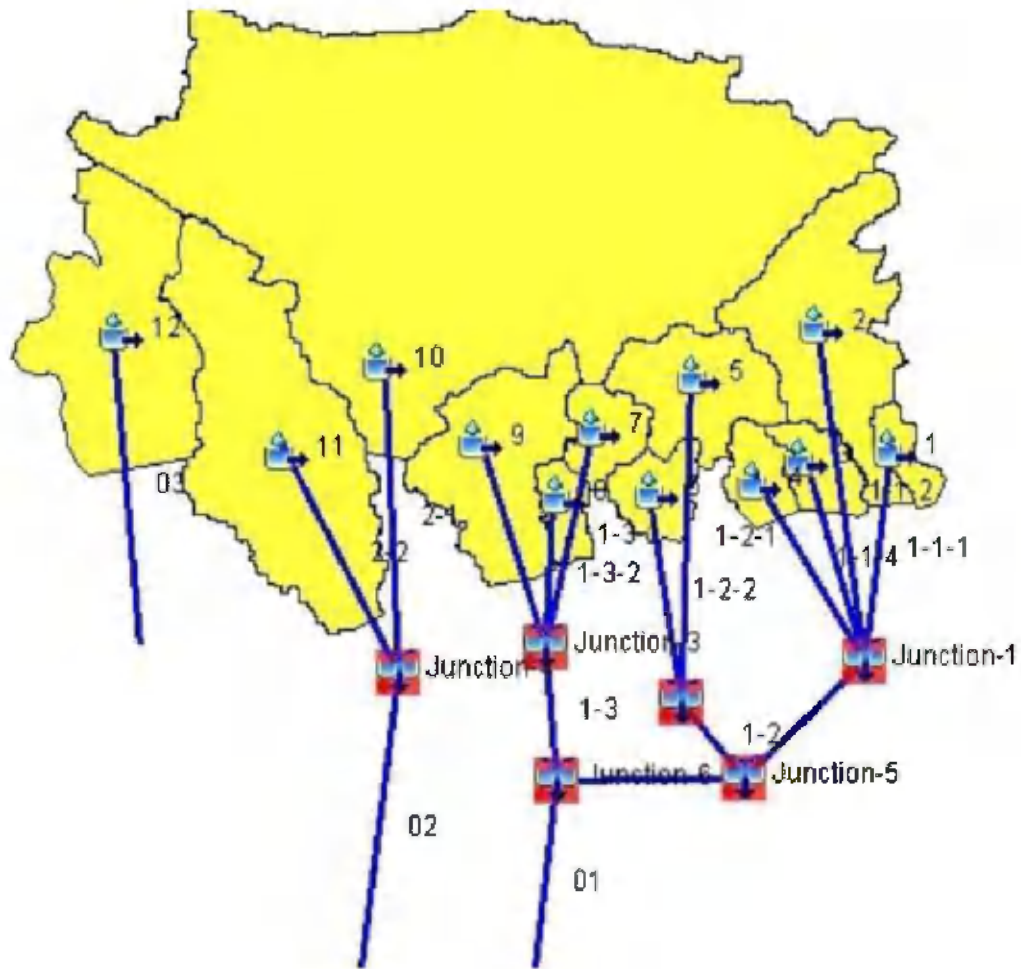
Dr. Ghulam Nabi  
Supervisor



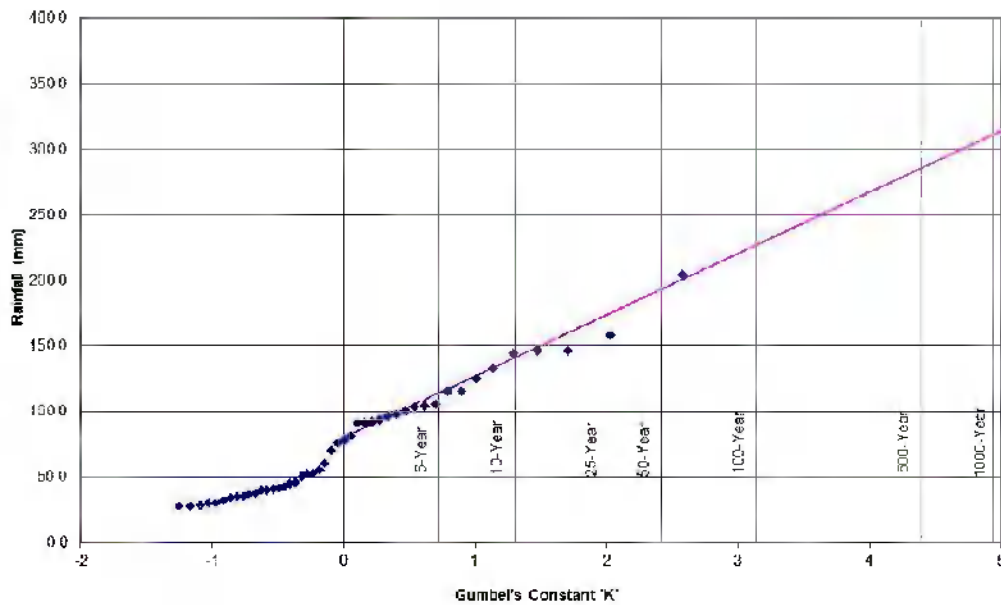
Engr. Muhammd Hamza  
Student

### Abstract:

Flash floods are described as a sudden severe increase in the flow of river/stream water within a short interval of time and are exemplified by a swift rise in water, velocities, and large amounts of debris. Flood water of Khewra Hill torrents carry a highly saline water which has made the soil highly saline, affected the human population and severely affected the agriculture of the area. Safe disposal of saline flood water is the only solution to save agriculture in the area. The purpose of the study is to evaluate the design discharges of selected catchments and propose a flood management plan for the safe disposal of the flood through flood carrier channels which would take water from catchments safely to river Jhelum. Frequency analysis of rainfall for different return periods of 50 year & 100 year were 201 and 226 mm respectively. HEC-HMS Model was used for the calculation of discharges for 50-year and 100-year return period. Discharges varied from 1,617 to 52,859 cusecs for 50-year return period whereas for 100 years return period discharges varied from 1,917 to 62,629 cusecs. Flood carrier channels were designed using Manning's Equation. The alignment of flood carrier channels was proposed using Google Earth imagery. Proposed flood carrier channels parameters have varying depth 4.72 to 9.89 ft, varying bed width (50 to 650 ft) and slope (1 in 1000 to 1 in 5,000). Flood routing of the channels were performed using the Muskingum-Cunge method and the discharges were finally used to select the sizes of the flood carrier channels. The results showed that routed discharges at selected Channel 01 & 02 for 50-year return period are 3,3450 and 56,750 cusecs respectively, whereas for 100-year return period the discharges come out as 39,431 and 67,501 cusecs respectively. The study will be useful for agricultural development, reclamation of salt affected areas, soil and water conservation structures, irrigation and economy of the country.



HEC-HMS Proposed Flood Channels Routing Model Processing



Frequency Analysis Result for Khewra Rainfall Data



## Assessment of Canal Seepage by Numerical Simulation at Trimm Sidhnai Link Canal



Dr. Ijaz Ahmad  
Supervisor

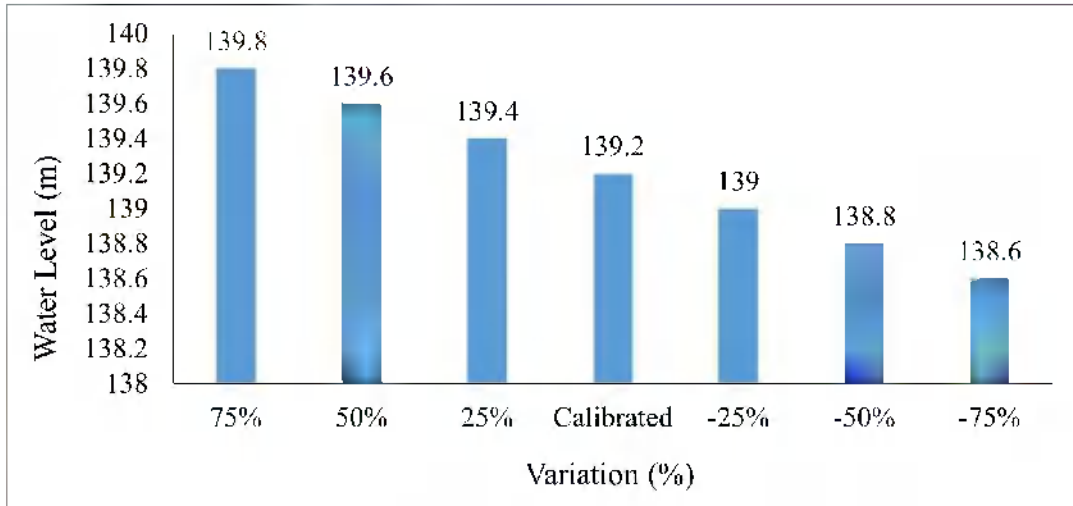


Engr. M. Umer Shehzad  
Student

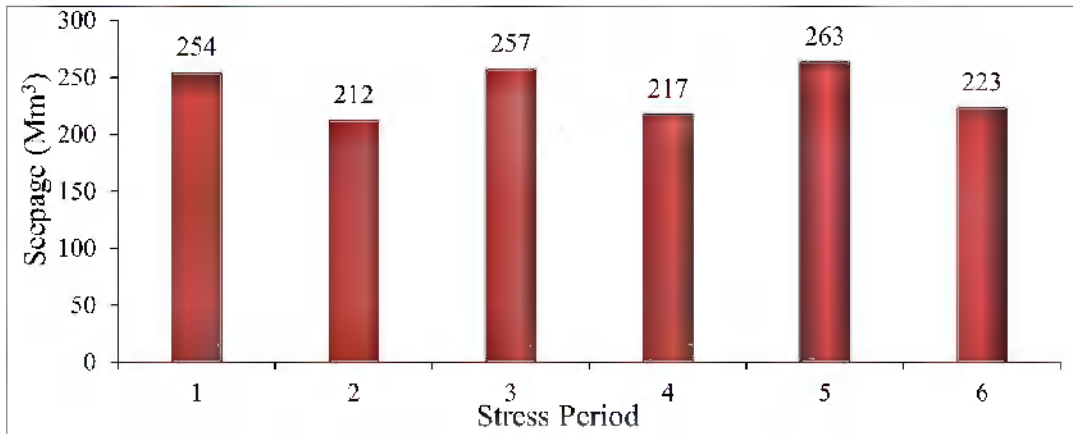
### Abstract:

Water plays an important role in the socio-economic development of any country and impacting all of its economic variables. Water availability influences the economic, agricultural and industrial growth. Groundwater is a very important component and it is second largest source of fresh water. Groundwater is an important source for agricultural growth in Pakistan, but due to excessive seepage from link canals the problem of waterlogging arises in lower regions of Punjab especially in Rechna doab which caused the loss of agricultural land and negatively affected the crop production. Same waterlogging problem have been observed due to extensive seepage from Trimmu-Sidhnai link canal.

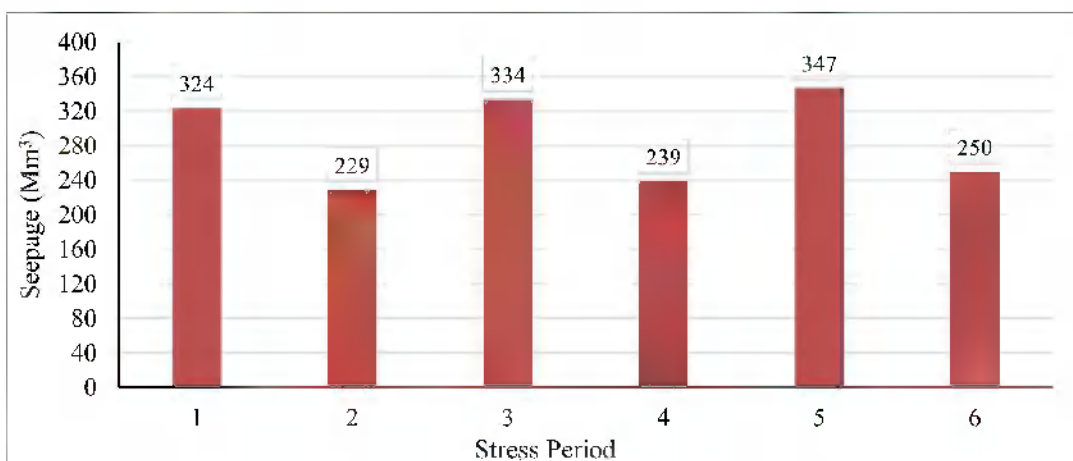
To address the issues of waterlogging, groundwater numerical model i.e. Visual MODFLOW was formulated in this study area. The model was calibrated and validated by evaluating different statistical parameters. The results indicates that the seepage rate in each successive Kharif and Rabi season is about 5 Mm<sup>3</sup> and 10 Mm<sup>3</sup> more than the previous Kharif and Rabi season in Haveli and T-S link canal respectively. Moreover, five alternatives were proposed to reduce the waterlogging problem in the study area, which includes, rehabilitation of 43 tube wells, existing drainage network working with full efficiency, a combination of rehabilitation of 43 tube wells and existing drainage network working with full efficiency, rehabilitation of lining of Haveli Main canal and rehabilitation of 43 tubewells working with full efficiency, rehabilitation of lining of Haveli Main canal rehabilitation of 43 tube wells and drainage network working with full efficiency. The results showed that fifth Alternative is found to be best to reduce the waterlogging in the study area, but in consideration of cost of the lining, third alternative is the best and economical because it involve no lining cost.



Sensitivity Analysis for Hydraulic Conductivity



Analysis of Seepage from Haveli Main Canal



Analysis of Seepage from T-S Link Canal

## Approved Research Proposals of Postgraduate Studies

- 1. Formulation of a GIS-Based Decision Support System for the Appropriate Adoption of Crops and Irrigation Techniques**

**Supervisor:** Dr. Ijaz Ahmad  
**Postgraduate:** Muhammad Naeem Zia
- 2. Development and Application of Friction Factor Model on Stage Discharge Relationship in Alluvial Streams**

**Supervisor:** Dr. Muhammad Kaleem Sarwar  
**Postgraduate:** Muhammad Awais Aslam
- 3. Hydrological Assessment of Different Slope-Adjusted Curve Number Models Under Varying Initial Abstraction Coefficient;**

**Supervisor:** Dr. Muhammad Waseem  
**Postgraduate:** Noor Ul Mateen
- 4. Simulation of Fuse Plug Operation for the Flood Management at Khanki Barrage**

**Supervisor:** Dr. Ghulam Nabi  
**Postgraduate:** Muhammad Arslan Tabassum
- 5. Modeling Glacial Lake Outburst Flood Impacts on Shogo-Sin Hydropower Project and Settled Areas**

**Supervisor:** Dr. Muhammad Kaleem Sarwar  
**Postgraduate:** Muhammad Ahsan
- 6. Evaluation of Snowmelt Contribution for Shyok River Basin**

**Supervisor:** Prof. Dr. Noor Muhammad Khan  
**Postgraduate:** Hassan Raza Mehdi
- 7. Quantification of Impacts of Combined Effluent Treatment Plant, Kasur**

**Supervisor:** Dr. Ghulam Nabi  
**Postgraduate:** Adeel Asghar
- 8. Flow Duration Curve Modeling at Ungauged Basin using Regionallzation Approaches**

**Supervisor:** Dr. Muhammad Waseem  
**Postgraduate:** Hafiz Waseem sajjad



- 9.** Simulation of Floods using Merged Satellite and Gauge Precipitation Data  
**Supervisor:** Dr. Muhammad Masood  
**Postgraduate:** Obaid Khahd
- 10.** Coupling the Land use Modeling with Climate Change to Estimate the Runoff Variability in Urban Catchment  
**Supervisor:** Dr. Muhammad Waseem  
**Postgraduate:** Muhammad Asad Hussain
- 11.** Numerical Modeling for River Morphology Analysis of Khankhwar River District Shangla  
**Supervisor:** Dr. Ghulam Nabi  
**Postgraduate:** Shehzad Iqbal
- 12.** Optimal use of Surface and Groundwater Resources for the Sustainable Agricultural Water Management  
**Supervisor:** Dr. Ijaz Ahmad  
**Postgraduate:** Faraz Saleem
- 13.** Statistical and Hydrological Assessment of Real-Time Satellite Precipitation Products for Flood Assessment  
**Supervisor:** Dr. Muhammad Masood  
**Postgraduate:** Hafiz Ahmad Hammad Abid
- 14.** Climate Change Impact on Discharge of Indus River Catchment at Khar Mong using WinSRM  
**Supervisor:** Prof. Dr. Noor Muhammad Khan  
**Postgraduate:** Muhammad Kashif
- 15.** Quantification of Groundwater Recharge Using Numerical Simulations for the Sustainable Groundwater Development  
**Supervisor:** Dr. Ijaz Ahmad  
**Postgraduate:** Abdul Reheem
- 16.** Evaluation and Modification of Empirical and Semi Empirical Approaches for Prediction of Area-storage Capacity Curve for Mangla and Tarbela Reservoirs  
**Supervisor:** Dr. Muhammad Kaleem Sarwar  
**Postgraduate:** Muhammad Asghar
- 17.** Application of SWAT Model for Integrated Water Management: A Case Study of Lower Chenab Canal  
**Supervisor:** Dr. Ghulam Nabi  
**Postgraduate:** Aon Muhammad

- 18.** Impact of Climate Change and Indian Intervention on Irrigation Supply and Hydropower of Mangla Reservoir using HEC-ResSim  
**Supervisor:** Prof. Dr. Noor Muhammad Khan  
**Postgraduate:** Zeeshan Hanif
- 19.** Study to Minimize the Rooster Tail Downstream  
**Supervisor:** Prof. Dr. Noor Muhammad Khan  
**Postgraduate:** Hafiz M. Umair
- 20.** CFD Modeling of Stilling Basin of Mohmand Dam Spillway  
**Supervisor:** Dr. Muhammad Kaleem Sarwar  
**Postgraduate:** Fareena Fatima
- 21.** Evaluation of Satellite Precipitation Products through Hydrologic Simulation under Data-Scarce Environment  
**Supervisor:** Dr. Muhammad Masood  
**Postgraduate:** Hafiz Muhammad Kashif
- 22.** Assessment of Water Quality Issues and Their Solutions for River Ravi  
**Supervisor:** Prof. Dr. Noor Muhammad Khan  
**Postgraduate:** Muhammad Taimoor Mustafa
- 23.** Impact Assessment of Proposed Chiniot Dam on Groundwater  
**Supervisor:** Dr. Muhammad Masood  
**Postgraduate:** Muhammad Jawad
- 24.** Assessment of CMIP-6 Based Climate Models for Simulation of Precipitation in Pakistan  
**Supervisor:** Dr. Muhammad Waseem  
**Postgraduate:** Muhammad Salman Munawar
- 25.** Hydrological Response under CMIP6 Climate Projection in Astor River Basin  
**Supervisor:** Dr. Mudassar Iqbal  
**Postgraduate:** Zeshan Ali
- 26.** Evaluation of Groundwater Vulnerability in the Rachna Doab using a Modified Drastic Model  
**Dr. Ijaz Ahmad**  
**Postgraduate:** Zia Ur Rehman
- 27.** Evaluation and Application of Spatial Downscaling Techniques for Satellite Precipitation Data  
**Supervisor:** Dr. Muhammad Masood  
**Postgraduate:** Syed Adeel Abrar Gillani

- 28.** Impact of Climate Change on Streamflow Using ARMA and ARMAX Model  
**Supervisor:** Dr. Muhammad Waseem  
**Postgraduate:** Raja Babar Maqbool
- 29.** The Effect of Enso on Precipitation Extremes in the Upper Indus Basin, Pakistan  
**Supervisor:** Dr. Ijaz Ahmad  
**Postgraduate:** Muhammad Usama Khan Lodhi
- 30.** Impacts of Temperature Lapse Rate Variation on Runoff in Sub-basins of Upper Indus Basin Pakistan  
**Supervisor:** Dr. Mudassar Iqbal  
**Postgraduate:** Tehseen Zulfiqar
- 31.** Modeling for Flood Management in River Chenab under Landuse Change: A Case Study of Marala - Khanki Reach  
**Supervisor:** Dr. Ghulam Nabi  
**Postgraduate:** Saman Mustafa
- 32.** Evaluation of Snow Characteristics in the Astore River Basin  
**Supervisor:** Dr. Mudassar Iqbal  
**Postgraduate:** Ihsan Ullah Khan
- 33.** Effective Management of Watershed in Response to Climate Change using GIS Based Multi-Criteria Decision Analysis (MCDA)  
**Supervisor:** Dr. Muhammad Masood  
**Postgraduate:** Abu Bakar Arshed
- 34.** Hydraulic and Structure Design of the Center-Pivot Irrigation System for Small Scale Farmers  
**Supervisor:** Dr. Gbulam Nabi  
**Postgraduate:** Muhammad Rashid
- 35.** Physical Modeling of the Hydraulic Jump in the Stilling Basin III: A case study of Mohmand Dam  
**Supervisor:** Dr. Muhammad Kaleem Sarwar  
**Postgraduate:** Hassan Raza
- 36.** Application of Machine Learning Techniques for Agriculture Drought Forecasting Using Remote Sensing Data  
**Supervisor:** Dr. Muhammad Waseem  
**Postgraduate:** Ali Hasan Jaffry



- 37.** Assessment and Management of Flood Impacts on Head Reach Infrastructure of Chiniot Dam  
**Supervisor:** Dr. Muhammad Masood  
**Postgraduate:** Shahzad Yousaf
- 38.** Hydraulic Analysis for Tailrace Culvert of Tarbela 5th Extension Hydropower (T5HP) Project using CFD Model  
**Supervisor:** Dr. Mudassar Iqbal  
**Postgraduate:** Muhammad Aizaz Ahsan
- 39.** Probabilistic Analysis for Extreme Precipitation Indices in South Punjab, Pakistan  
**Supervisor:** Dr. Mudassar Iqbal  
**Postgraduate:** Yasir Ali
- 40.** Suitability of Satellite Based Production for Spatiotemporal Analysis of Drought  
**Supervisor:** Dr. Muhammad Waseem  
**Postgraduate:** Hussain Masood Khan
- 41.** Sediment Delta and Flushing Modeling for Proposed Sindh Barrage Reservoir  
**Supervisor:** Prof. Dr. Habib ur Rehman  
**Postgraduate:** Maria Talib
- 42.** Impact Evaluation of Sediment Management Interventions for Fordwah Canal at Sulemanki Barrage  
**Supervisor:** Dr. Mudassar Iqbal  
**Postgraduate:** Amir Shehzad
- 43.** Assessment and Evaluation of Groundwater Quality Using an Integrated Water Quality Indices and Geostatistical Approach  
**Supervisor:** Dr. Ijaz Ahmad  
**Postgraduate:** Iram Naz
- 44.** Design, Manufacturing and Testing of Portable Hydro-Power Turbine  
**Supervisor:** Dr. Muhammad Kaleem Sarwar  
**Postgraduate:** Nouman Khan



# PUBLICATIONS





4

## A Bi-Level Multi-Objective Model for Optimal Allocation of Water Resources in the Punjab Province of Pakistan

Masood, M., Ahmad, I., Sarwar, M.K., Khan, N.M., Waseem, M., Nabi, G., Saleem, M.

### Abstract:

In this study, a simple but efficient bilevel multiobjective model (BLMOM) has been formulated for the optimal allocation of available water (AW) among competing water users. Upper-level decision makers (DMs), being the leader in the hierarchy (i.e., river authorities), allocate AW to lower-level DMs (i.e., canal authorities) based on equity and stability, whereas lower-level DMs allocate AW among competing users based on two single- and one multiobjective functions. The first objective function (OF1) maximizes the satisfaction rate (SR) of various water users, whereas the second objective function (OF2) maximizes the net economic benefits (NEB). The multiobjective function (OF12) maximizes the combined effect of the first two single objectives. The multiobjective function has been solved by using the simultaneous compromise constraint (SICCON) technique which creates a compromise between single-objective functions. The model was applied at Taunsa Barrage, Pakistan, for the optimal allocation of AW. Various scenarios were analyzed by varying priorities assigned to different objective functions and water users to evaluate the model applicability under various conditions. When OF1 was considered, maximum SR of 61% was achieved. In case of priority given to OF2, maximum NEB of 77 million USD was attained. However, in the case of OF12, both SR and NEB were maximized, whereas wheat, cotton, sugarcane, rice, onion and sunflower water users attained NEB of 14.36, 5.03, 22.96, 27.85, 1.34 and 0.13 million USD, respectively, with overall NEB of 72 million USD against satisfaction rate of 52%

## Projected Drought Pattern Under Climate Change Scenario Using Multivariate Analysis

Waseem, M., Ajmal, M., Ahmad, I., Khan, N.M., Azam, M., Sarwar, M.K.

### Abstract:

Drought is generally associated with variation in multi geomorphic-climatic variables rather than a single drought driver. Hence, it is better to consider all possible drought drivers for comprehensive spatiotemporal analysis of historical and future drought in the region with an erratic, scant, and unstable climate like the south-west agricultural region of Pakistan. This study attempted to quantify the multivariable future drought projection based on project CMIP5 climatic data under the Representative Concentration Pathway (RCP 8.5) scenario. The drought projection under the climate change scenario was performed in the historical segment (HS: 1996–2018) and two future segments (2019–2034

and 2035–2050) using trend analysis and composite drought index (CDI). The overall results indicated that temperature and evapotranspiration tend to increase with an average relative value of  $\geq 5\%$  and in the case of precipitation, the  $\geq 40\%$  (relative average) decline was observed from HS to the future, which indicated an increase in numbers of drought in near future. Moreover, drought analysis also showed that the probability of occurrence and intensity of drought would increase in the near future, especially during 2019–2034. It was observed that the sub-regions, i.e., Sindh and Balochistan, would experience more intense long-term droughts as compared to Punjab. Hence, considering the future variation of drought, substantial attention is needed for contingency planning, mitigation, and adaptation strategies to minimize the impact of probable future drought on society in drought-prone agricultural areas of Pakistan.

### Fresenius Environmental Bulletin

## Prediction And Maximization of Wheat Grain Yield in Semi-arid Environment by Using Artificial Neural Networks

Farid, H.U., Ahmad, I., Khan, Z.M., Bakhsh, A., Anjum, M.N., Shakoor, A., Farooq, A.

### Abstract:

At field level, prediction of crop yield and determination of appropriate fertilizer application rate based on soil and landscape attributes often require for better management practices finally maximizing crop yield. The present study was designed to evaluate the potential of Artificial Neural Networks (ANNs) model to predict wheat grain yield and to determine the urea fertilizer application rate for maximizing wheat grain yield. The urea fertilizer, %sand, %silt, %clay, elevation, soil nitrogen (N), soil electrical conductivity (EC), soil phosphorus (P) and soil pH were used as input parameters and wheat grain yield was used as output. The ANNs model was trained using 124 data sets collected during growing seasons of 2008-09 to 2010-11 and evaluated using randomly selected 20 data sets of 2010-11 and 48 data sets of 2011-12. The results showed that ANNs model has the potential to predict wheat grain yield under semiarid conditions, as the mean absolute error (MAE) of 6.50% was found for training and 9.48% was observed for testing the model. To determine urea fertilizer application rate for maximizing wheat grain yield, the trained model was run for 14 urea fertilizer levels ranging from 0 to 400 kgurea ha<sup>-1</sup>. It was examined that 210 kg-urea ha<sup>-1</sup> produced maximum grain wheat yield (4200 kg ha<sup>-1</sup>) and further increase of urea fertilizer rates resulted in decrease of wheat grain yield. These results also showed that ANNs model is a useful tool to estimate the wheat grain yield response to soil and landscape attributes and to determine the optimum urea fertilizer level for maximizing the wheat grain yield in semi-arid conditions of Faisalabad.

## Performance Evaluation of Micro Sprinkler Irrigation System in Tunnel Farms and Open Area Conditions

Iqbal, U., Ahmad, I., Zaman, M., Khan, N.M., Sarwar, M.K.

### Abstract:

Present study aims to analyze the performance of micro sprinkle irrigation system in tunnel farms and open area conditions. Field tests were conducted on micro sprinkle irrigation system at four different operating pressures to explore the effect on application rate (Ra), coefficient of uniformity (Cu), distribution uniformity (Du) and application efficiency (Ea) in tunnels as well as in open area. The experimental results showed that the Ra varied from 6% to 8%, Cu varied from 8% to 12%, Du from 12% to 15% and Ea from 5% to 7% higher in tunnel farms as compared to open area by changing operating pressures from 100 kPa to 220 kPa. It was also found that as the operating pressure increases Ra, Cu and Du whereas decreases Ea. The irrigation water losses were calculated in tunnel farms and open area conditions. However, evaporation losses were found slightly higher due to greenhouse effect in tunnel farms compared to open field conditions. Wind drastically affect the performance of micro sprinkle in open area and the share of wind losses were 55% to 61% to the total losses in open area whereas, wind did not affect the performance of micro sprinkle in the covered tunnel. Moreover, initial cost of micro sprinkle irrigation system decreased as the operating pressure increased. The operating cost of micro sprinkler was found at least 12% higher in the open area. Moreover, 5% to 8% water and 10% to 12% energy saved to operate the micro sprinkle in tunnel farms.

Iranian Journal of Science and Technology

## Hydraulic Analysis of Submerged Spillway Flows and Performance Evaluation of Chute Aerator Using CFD Modeling: A Case Study of Mangla Dam Spillway

Waseem, M., Ajmal, M., Ahmad, I., Khan, N.M., Azam, M., Sarwar, M.K.

### Abstract:

Submerged spillways with large capacity outlets are generally provided below the dam crest to perform the dual functions of flood disposal and sediment flushing. Flood water passing through these spillways exhibits turbulent behavior. Moreover, hydraulic analysis of such turbulent flows is a challenging task. Therefore, the present study aims to use numerical simulations to examine the hydraulic behavior of submerged spillways constructed at Mangla Dam, Pakistan. Besides, the hydraulic performance of aerator was also evaluated at different operating conditions. Computational fluid dynamics code FLOW 3D was used to numerically model the flows of Mangla Spillway. Reynolds-averaged Navier–Stokes equations are used in FLOW 3D to numerically model the turbulent flows. The study results indicated that the developed model can simulate the submerged spillway flows as it computed the flow parameters with an acceptable error of up to 6%. Moreover, air concen-



encouraging use of real time SPEs in the study area. On grid basis, at daily scale, from box plots, the median values of total bias ( $-0.5$  to  $0.5$  mm) of the used SPEs were also encouraging although some under/over estimations were noted in terms of hit bias ( $-0.15$  to  $0.05$  mm/day). Relatively higher values of missed ( $0.3$  to  $0.5$  mm/day) and false ( $0.5$  to  $0.7$  mm/day) biases were observed. The detected average dally RMSE, systematic errors, and random errors were also comparatively higher. Regional-scale spatial distribution of uncertainties revealed lower values of uncertainties in plain areas, depicting the better performance of satellite-based products in these areas. However, in areas of high altitude ( $>4000$  m), due to complex topography and climatic conditions (orographic precipitation and glaciated peaks) higher values of biases and errors were observed. Topographic barriers and point scale gauge data could also be a cause of poor performance of SPEs in these areas, where precipitation is more on ridges and less in valleys where gauge stations are usually located. Precipitation system's size and intensity can also be a reason of higher biases, because Microwave Imager underestimate precipitation in small systems ( $<200$  km<sup>2</sup>) and overestimate in large systems ( $>2000$  km<sup>2</sup>). At present, use of bias correction techniques at daily time scale is compulsory to utilize real time SPEs in estimation of floods in the study area. Inter comparison of satellite products indicated that IMERG gave better results than the others with the lowest values of systematic errors, missed and false biases.

## Journal of Water and Climate Change

### Impact of Meteorological Drought on Agriculture Production at Different Scales in Punjab, Pakistan

Waseem, M., Khurshid, T., Abbas, A., Ahmad, I., Javed, Z.

#### Abstract:

The present study aimed to quantify the impacts of the meteorological drought on the production of maize crops, using district-level observed precipitation and yield data of 21 districts across Punjab, Pakistan from 2001 to 2020. The overall analysis showed that the Standardized Precipitation Index (SPI) effectively reflects the variations in drought characteristics in Punjab on spatiotemporal scales. It also resulted that in south Punjab, the maize yield was negatively affected by the meteorological drought, and yield was sensitive to short-term (1 and 3 months) drought during the critical growth period of the crop. The overall analysis depicted that the meteorological drought was associated with about 27% of overall yield variations. Moreover, all of the southern districts and few districts from Central Punjab were becoming increasingly sensitive to meteorological drought where significant spatial variations in drought effects and sensitivity exist over time. Conclusively, this study showed a spatiotemporal pattern of drought and its impact on maize yield, indicating that the districts where variability in maize production was significantly associated with drought and recommend adoption of the management strategies and mitigation measures.

## Influence of Fly Ash, Glass Fibers, and Wastewater on Production of Recycled Aggregate Concrete

Raza, A., Ali, B., Haq, Eul., Awais, M., Iqbal, M.S.

### Abstract:

The increasing quantity of construction and demolition waste and wastewater effluents are creating various problems in their management. Furthermore, low tensile strength and high carbon footprint are the main drawbacks of plain cement concrete. Therefore, to encounter all these issues of waste materials, low tensile strength of concrete and environmental impacts of cement production, research is needed to develop a sustainable concrete. This study has endeavored to investigate the effects of using recycled coarse aggregates (RCA), various types of wastewater effluents, fly ash, and glass fibers on the mechanical behavior (compressive and tensile behavior) and durability behavior (chloride penetration, water absorption, and acid attack resistance) of recycled aggregate concrete (RAC) incorporating with fly ash and glass fibers (FG-RAC). Six different kinds of wastewater effluents for the mixing of concrete, 100% replacing the natural coarse aggregates with RCA, and 30% replacement of cement with fly ash were used for the development of concrete. A control mix with 100% RCA and potable water having fly ash and glass fibers was produced for comparison purpose. The experimental measurement portrayed that the textile factory effluent presented the highest compressive (16.8% greater than the control mix) and tensile (15.6% greater than the control mix) strengths of concrete. Fertilizer factory effluent portrayed the highest water absorption, mass loss due to acid attack, and chloride penetration to concrete. The addition of fly ash and glass fibers improved the properties of FG-RAC mixes. The statistical investigation of the experimental outputs indicated no significant difference between the properties of FG-RAC mixes made with various types of wastewater.

## Flood Frequency Analysis of River Swat Using Easy Fit Model and Statistical Approach

Sarfraz, Q., Masood, M., Shakir, A.S., Sarawar, M.K., Khan, N.M., Azhar, A.H.

### Abstract:

Pakistan has faced a tragic and massive flood in 2010. The climate change is considered a major factor for such a devastating and severe monsoon. The widespread precipitation generated very high runoff in Indus, Kabul, Swat, Chenab and Jhelum rivers. Swat River is a major tributary of the Indus Basin River system, located in between the foothills of Hindu Kush mountain range also known for its snowcapped peaks. The contribution of snowmelt, average ground water and average rainfall in the basin is 65%, 19% and 16% respec-

tively. Average annual rainfall in this region is more than 1000 mm. The dominant sources of rainfall are westerlies and monsoon which contribute 45% and 55% respectively. The sharp flow peaks are generated due to lack of surface storage capacity and non-absorption of runoff in the catchment area of River Swat. Therefore floods are common in this basin, which portrays threat both to infrastructure & humans. The unprecedented flooding in 2010 destroyed Munda & Amandara Headworks at River Swat due to much higher peak flood than the design discharge. High flow velocities and flow energy instigated erosion and also damaged infrastructure such as roads, houses and bridges. Due to undulated terrain and accessibility, there is deficiency of precipitation and discharge recording stations. Consequently measures to avert losses from such events cannot be taken well in time. In this study, flood frequency analysis of River Swat at Chakdara Station was carried out using Gumbel's Extreme Value (Type-1), Normal, Log Normal and Log Pearson Type III distributions against 2, 5, 10, 20, 25, 50, 100, 500, 1000, and 10000 year return periods to estimate the occurrence of such flood events. Significance tests, Anderson Darling, Kolmogrov Smirnov and Chi-Squared were applied in order to assess the most effective Probability Distribution for the study area. It was observed that statistical distributions helped considerably in estimation of floods at sites of homogeneous regions with less or no data. The results of the study, based on the applied significance tests i.e. Kolmogrov Smirnov, Anderson Darling and Chi-Square, exhibited that Gen Extreme Value [Type-1] ranked superior. Therefore it is the best-fit distribution among the other applied distributions for the Study area. Considering the changes in the behavior of streams and patterns of flooding, it is recommended to review the criteria and design limits for structures in urban & rural areas as well as of river training works.

## Pure and Applied Geophysics

### Temporal Analysis for Anomaly Detection in Precipitation Pattern Over the Selected Area in Indus Basin of Pakistan

Ali, A., Farid, H.U., Khan, Z.M., Ahmad, I., Anjum, M.N., Mubeen, M., Shakoor, A.

#### Abstract:

For efficient adaptation strategies, investigation of the variability in climatic data and its impact on meteorological drought is critical, particularly in semi-arid and arid regions. Innovative trend analysis (ITA), Mann-Kendall (MK) and Sen's slope estimator (SSE) tests were employed to analyze the variations in precipitation (1981-2018) on annual, seasonal and monthly scale across 12 meteorological stations over the selected areas of the lower Indus basin (LIB) of Pakistan. The reliability of the ITA method was also compared and analyzed with both MK and SSE methods for 48 seasonal precipitation times series. Annual precipitation results indicated a significant increasing trend, i.e., 2.09 mm/year, at only one station (Rahim Yar Khan (RYK)-Khanpur), with MK test statistic  $Z_{mk} = 2.09$  and Sen's slope estimator  $\beta = 2.56$ . On a monthly scale, the maximum number of positive significant trends were noted during June, with  $Z_{mk}$  values of 2.01 to 3.24 and  $\beta$  values of 1.06-3.06, while the maximum number of negative trends was found during January, February, November and December. On a seasonal scale, ITA methods showed significant increasing trends during the summer at 12 selected meteorological stations, with trend indicator (B)



values ranging from 0.22 to 2.46. Moreover, performance of the ITA method was found to be consistent with both MK and SSE test results at a verified significance level. The results of the study can help to increase our understanding of the annual, seasonal and monthly precipitation variability in the LIB that may be helpful in developing strategies for the proper management of water resources over the area.

## **Impact of Urbanization on Groundwater Levels in Rawalpindi City, Pakistan**

Haq, F.ul., Aaeem, U.A., Gabriel, H.F., Khan, N.M., Ahmad, I., Rehman, H.ur., Zafar, M.A.

### **Abstract:**

Variations in the rate of urbanization directly impact groundwater levels and quality. Therefore, the present study examines the relationship between changes in land-use and land-cover (LULC) and groundwater drawdown in Rawalpindi, Paklstan. Landsat images, i.e., Operational Land Imager (OLI), Thematic Mapper (TM), and Enhanced Thematic Mapper Plus (ETM+), were downloaded for the years 1991, 1997, 2007, 2010, and 2017. The study area was classified using the normalized difference vegetation index (NDVI) and normalized difference built-up index (NDBI) to create three classes, i.e., urban area, vegetation, and barren land. The groundwater level in the study area for the year 2017 was obtained using an electrical resistivity survey (ERS) with a Schlumberger configuration. The data obtained were interpreted using IX1D iteration software. The results of NDBI and NDVI showed that the urban area increased by 37.89% during the period 1991–2017, at the expense of vegetation. Similarly, the groundwater level was found to decrease at a rate of 1.38 m per annum. If the same trend prevails, the groundwater level will decrease to approximately 160 m from the natural ground surface by the end of this century. The results of the present study may be used for the formulation of policy and proper planning prior to any major developmental project to control the impact of LULC changes on water resources in the future.

### **Structures**

## **Performance Evaluation of Hybrid Fiber Reinforced Low Strength Concrete Cylinders Confined with CFRP Wraps**

Raza, a., Rafique, U., Masood, B., Ali, B., Haq, F.ul., Nawaz, M.A.

### **Abstract:**

The improvement in the compressive strength (CS) and ductility of plain concrete always remained an active area for advanced research. The present study aims to enhance the strength of low strength hybrid fiber reinforced concrete (HFRC) cylinders confined with different number of carbon fiber reinforced polymer (CFRP) sheets by examining the axial CS, axial compressive strain, and compressive stress–strain behavior of low strength HFRC



cylinders confined with CFRP sheets. The HFRC consisted of steel fibers and polypropylene fibers. Two groups of low strength HFRC specimens (12.5 MPa and 16.5 MPa) were fabricated to investigate the effect of CFRP confinement on the different CS of HFRC. The experimental outcomes depicted that the lateral CFRP confinement of concrete significantly improved the CS, axial compressive strain, and axial stiffness of low strength HFRC specimens. The improvements of 115.7% and 130.7% occurred in the CS of 12.5 MPa group for single and double CFRP layers, respectively. Similarly, the improvements of 37.4% and 112.6% occurred in the CS of 16.5 MPa group for single and double CFRP layers, respectively. Therefore, the CFRP confinement is more effective for low strength HFRC as compared with high strength HFRC in terms of axial CS and axial compressive strain.

## Sustainability

### Towards Sustainable Farm Production System: A Case Study of Corn Farming

Abbas, A., Zhao, C., Ullah, W., Ahmad, R., Waseem, M., Zhu, J.

#### Abstract:

Many recent studies show that most of the crop production systems in developing countries are not environmentally sustainable. This study uses the life cycle assessment (LCA) to investigate the potential impacts of corn production in Pakistan on global warming and human health damages and also suggests mitigation strategies to reduce environmental impacts towards sustainable crop production based on the results. Land-based, mass-based, and energy-based functional units were used. IMPACT 2002+ methodology—a combination of IMPACT 2002, Eco-Indicator 99, CML, and intergovernmental panel on climate change (IPCC)—is used for the impact assessment. The results demonstrated that the global warming potential of one-ton production of corn, one-hectare corn farm, and production of 1000 MJ energy were 354.18, 34,569.90, and 1275.13 kg CO<sub>2</sub> equivalents, respectively. The off-farm and on-farm emissions of nitrogen-based chemical fertilizers were the hotspots in the most impact categories. Moreover, human health damages followed by global warming as environmental externalities were also associated with corn production. We also highlighted the production areas with light, medium and extreme environmental externalities with Toba Tek Singh and Okara districts in the Punjab province of Pakistan being the most and least contributing districts towards global warming, respectively. Results further indicated that a 5 to 100% reduction of chemical fertilizers would mitigate the environmental impacts of corn production by 4.38 to 87.58% and 2.16 to 43.30% in terms of aquatic acidification and global warming, respectively. Modern farming systems and conservation technologies were suggested to reduce emissions and improve the environmental performance of corn production. Furthermore, agricultural extension and the ministry of agriculture should pay more attention to farmers' education on emissions from farming inputs and their impact on climate.

## Validation of Selected Roughness Coefficient in a Lined Distributary and Its Effect on Water Equity

Masood, M.

### Abstract:

In the present study design value of the roughness coefficient for a lined distributary (Chena distributary district Kasur) was validated and its effect on the water drawing capacity of outlets was assessed. Chena distributary, off takes from the left bank of Depalpur canal, at RD 359020. The total length of the distributary is 25.46 km. More than 50 percent of its length has been lined. In this study, a reach from RD 0.00 to 7590 having a trapezoidal lined section was used. The total numbers of outlets being fed by the distributary were 62. The first 17 outlets were included in the study. A comparison was made between design and field measurements of the hydraulic parameters of the canal and the outlets. Simulations of canal and outlet flows were made using the (Simulation Irrigation Canal) SIC model. A considerable difference was observed between the design and the prevailing water surface profiles and resultantly water drawing capacity of the outlets. The results showed that the prevailing value of the roughness coefficient was 0.02 instead of 0.016, the design value. Because of increased roughness coefficient value, due to sedimentation or due to some tempering, the depth of flow increased in the head reaches. Therefore outlets at the head were drawing more than allocated share. In the tail reaches due to reduced discharges, tailenders were deprived of their due share. Not only cleaning and maintenance of lined portion of canal at regular intervals but also strict regulations to avoid tampering are required for sustainable operation of an irrigation system as per design.

## Utilization of Reverse Slope to Increase Full Supply Level in Small Irrigation Channels

Masood, M., Amin, M.S., Nabi, G., Azhar, A.H., Babur, M.

### Abstract:

In this study optimal limit of the reverse slope, downstream of an irrigation outlet, where flow is supercritical was studied to create sufficient working head required to irrigate elevated fields in the command area of a watercourse. Three different types of outlets (AOSM, Pipe and Open flume) were designed and constructed in the lab. Various values of reverse slopes were incorporated in one-meter and two-meter length of the watercourse bed downstream of the selected outlets at a constant value of canal Full Supply Level (FSL). It was observed that FSL of watercourse increased with increase in reverse slope. Reverse slopes -0.10 and -0.15 incorporated in a length of one meter were found most suitable for an outlet of one-cusec discharge. FSL of watercourse increased with increase in reverse slope value up to -0.15 and then started decreasing gradually at -0.20. The outlet discharge

decreased slightly (3%) from -0.10 to -0.15 reverse slopes and significantly (26%) at -0.20 reverse slope by submerging the outlets. Reverse slope incorporated in one-meter length of the channel bed was more useful than incorporated in the two-meter length of the channel bed. The results obtained for AOSM and pipe outlets were identical. Open Flume outlets found not to be fit for reverse slope. The best hydraulic section for the reverse slope was with upstream width equal to the Bt of the outlet and then expanded in the direction of flow to join the designed width of the channel.

## Water

### Spatiotemporal Analysis of Meteorological and Hydrological Droughts and their Propagations

Abbas, A., Waseem, M., Ullah, W., Zhao, C., Zbu, J.

#### Abstract:

The quantitative description of relationships and propagation between different forms of drought at multiple spatiotemporal scales in various geographical locations is informative for early drought warning systems. This study intends to evaluate the historical hydrometeorological drought from 1984–2015 in the Soan River Basin, which is a critical water source for the Pothwar region of Pakistan. The reconnaissance drought index (RDI) and standardized runoff index (SRI) are used to characterize meteorological and hydrological droughts, respectively. The spatiotemporal variations of the RDI and SRI demonstrated that 2000 and 2010 were extremely dry and wet years, respectively. The results further reveal that the frequency of hydrometeorological drought events was higher in a shorter time scale (3 and 6 months), while durations featured longer timescales (9 and 12 months). The RDI and SRI time series showed a significant decreasing trend in terms of the Mann–Kendal and Sen slope estimator (SSE) results. Cross-correlation analysis for RDI and SRI with a time lag acknowledged the existence of a sequence between the RDI and SRI and a positive relationship between the two indices. The findings of this study could be helpful for better understanding drought variability and water resource management.

## Water Resources Management

### Streamflow Variations in Monthly, Seasonal, Annual and Extreme Values using Mann-Kendall, Spearman's Rho and Innovative Trend Analysis

Ashraf, M.S., Ahmad, I., Khan, N.M., Zhang, E., Bllal, A., Guo, J.

#### Abstract:

The present study investigates the variations in the monthly, seasonal and annual streamflow timeseries at twenty (20) stations over the upper Indus river basin (UIRB) by using

Mann-Kendali (MK), Spearman's rho (SR) and innovative trend analysis (ITA) methods. Moreover, variations in extreme flows were investigated by dividing the daily streamflow timeseries into two categories; extremely low ( 90th percentile) flows. At monthly time scale, 240 timeseries were investigated, out of which 134, 138 and 159 timeseries manifested significant trends by using MK, SR and ITA methods, respectively. Whereas, seasonal and annual flows showed significant trends over 57, 62 and 75 timeseries based on MK, SR and ITA methods, respectively. Extremely low flows exhibited significant increasing trends over seven (07) stations and significantly decreasing trends over three (03) stations whereas, four (04) stations exhibited significantly decreasing trends in extremely high flows. Therefore, it may be concluded that the variations in the extremely low flows will be more pronounced compared to extremely high flows in the future. This may constitute constant pressure on water resources availability in the lower Indus plains where most of the country's population is dependent on agricultural activities.





TOURS  
&  
MEETINGS



## Study Tour of Nandipur Irrigation Research Institute

Study tours are very essential for practical exposure toward a better understanding of the subjects. Centre of Excellence in Water Resources Engineering (CEWRE) arranged the study tour to Nandipur Irrigation Research Institute for postgraduate students on December 03, 2021. Fifteen students from Water Resources Engineering Discipline joined the study tour. Deputy Director and Senior Research Officers at Nandipur explained the importance and main features of existing physical models during the visit.



Senior Research Officer Describing the Participants about the existing Physical Model



Group Picture of Students with Dr. Ghulam Nabi



## Visit of Nandipur Irrigation Research Institute under NRPU Project

Principle investigator and Co-principal investigator of research project title “Performance Evaluation of Multiple Aerators Installed in Series at High Head overflow Spillway: Case Study of Mohmand Dam” funded by HEC under NRPU visited Nandipur on December 23, 2021. Students of postgraduate program from Civil Engineering Department, UET also join the team for practical exposure toward the better understanding of subject. Six students from the Hydraulic class joined the study tour.



Scale Down Physical Model of Mohmand Dam Spillway



Group Picture of Students with PI & Co-PI (from left # 4 & # 6)

## Outreach Activities of Faculty

Participation of the Centre in various water challenges at the national level is not old. Since its inception Centre's played its part either in human resource development or addressing water issues by conducting solution-oriented research. In the year 2021, the Centre's faculty actively participated in various platforms at international and national levels. Outreach activities of faculty are listed below.

- 1.** Launching of "National Water Quality Monitoring Report 2020-21 (Punjab Chapter) invited by PCRWR, Islamabad, on December 23, 2021.
- 2.** Sri Katas Raj holy Pond Case, Choa Saiden Shah, Chakwal Case invited by Environmental Protection Agency, GoP, on December 20, 2021.
- 3.** Think Tank on Water Resources Development, constituted by Pakistan Engineering Council, Islamabad on December 15, 2021
- 4.** Pakistan Water Week 2021 and the International Conference, by IWMI-PCRWR-ICARDA, December 6-7, 2021, Islamabad
- 5.** Launching event of FCDO funded Water Resource Accountability in Pakistan (WRAP) Programme, Lahore, on November 30th, 2021.
- 6.** Attended 51 meeting of Pakistan National Commission on Irrigation and Drainage (PANCID) held in Islamabad on November 24, 2021
- 7.** Participated in training on Flood and Hydrology Forecasting and Warning for Development Countries arranged by Ministry of Commerce, People's Republic of China, from October 13 to November 02, 2021.
- 8.** Participated in training organized by FFC, MoWR on Flood and Drought Management Under Hungary Pakistan Water Management MOU, 28 Oct 2021
- 9.** Attended BoS Meeting of Civil Engineering Deptt. University of Management and Technology, Lahore. 11 Oct 2021
- 10.** Participated in Pakistan National Committee on Intergovernmental Hydrological Program (PNC-IHP) of UNESCO, in Islamabad on September 30, 2021

- 11.** Coliaboration initiative meeting with Center of Excellence for Water, The American University in Cairo, Egypt, on September 09, 2021.
- 12.** Participated ad Speaker at 3rd Conference on Sustainability in Civil Engineering held on August 11, 2021, CUST Islamabad
- 13.** Joint Experts Group on Hungary-Pak Water Management MoU, 9 June 2021 (3rd meeting, 29 July 2021 4th meeting)
- 14.** Visit to IGIS NUST for accreditation of GIS program 1-2 July 2021
- 15.** Member of Selection Board at University of Management and Technology, Lahore on 26 April 2021
- 16.** Attended IWMI Pakistan's 2nd Webinar on Technological Innovations: 29th March 2021
- 17.** Attended meeting on CARE Program invided by Asian Disaster Preparedness Centre (ADPC) on 8 March 2021
- 18.** Member of PhD Comprehensive exam at UET Taxila, March 2021

# FACILITIES UPGRADATIONS





To provide better research environment to postgraduate students and researchers CEWRE has upgraded its facilities in year 2021. Major Facilities upgraded include:

## Hydraulic Laboratory

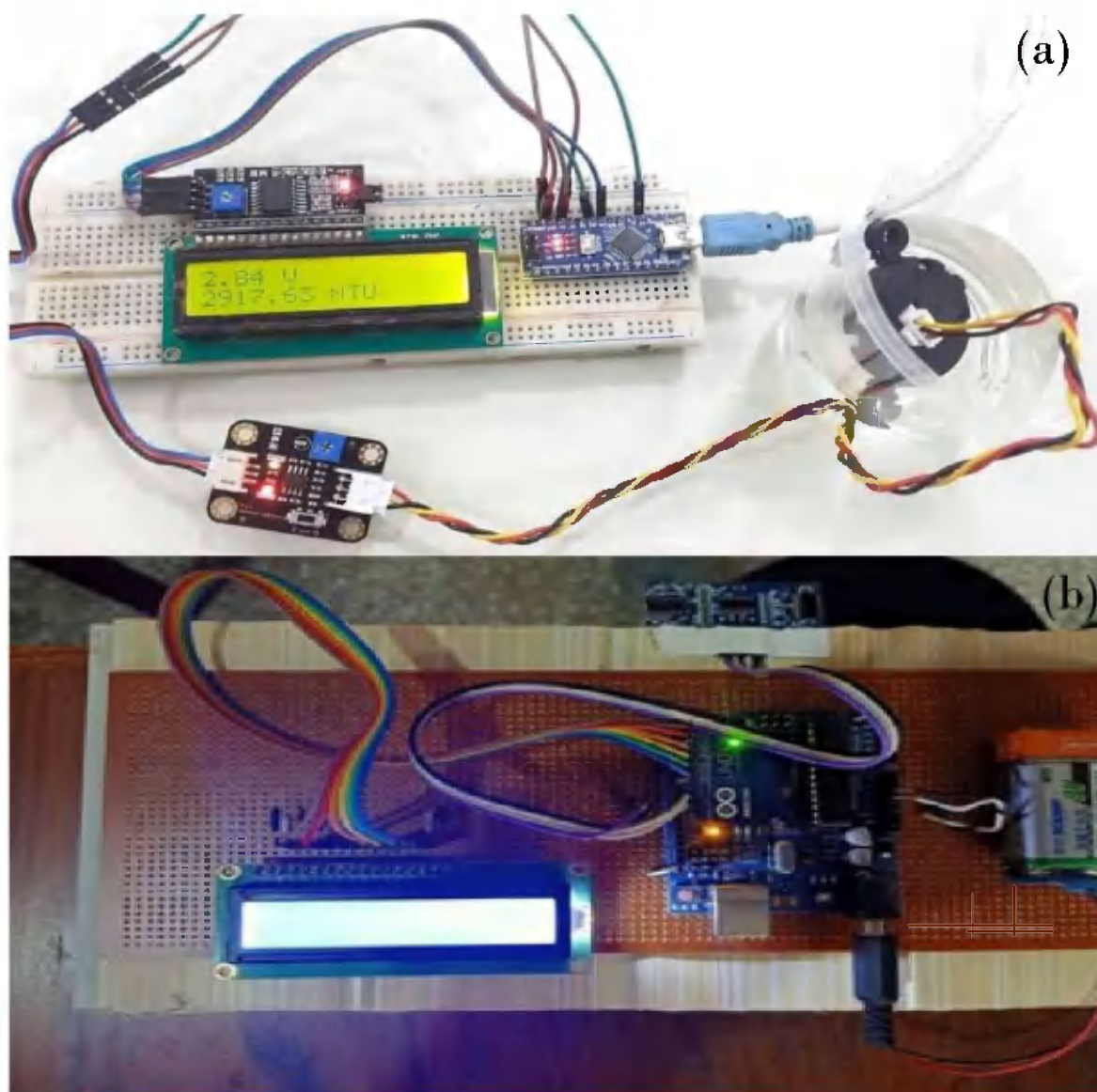
The need of the hour is digitally empowering the labs and using state of the art research to make them globally connected. . Keeping in view the digital era, CEWRE has also upgraded its Hydraulic Laboratory with a water depth sensor and a Boat for large and small streams surveys to provide research students with cutting-edge equipment.



Picture of Boat and Depth Sensor

## Model Tray Hall

In the present digital era, no field is intact without computer applications and electronic instruments. To modernize the model tray hall lab and provides low-cost indigenous instruments, the Centre has developed the low and high range ultrasonic sensor, and turbidity meter and temperature Sensor. The ultrasonic sensor with a low range was firstly developed at the Centre in 2020 using locally available instruments. In the year 2021 high range, ultrasonic sensor, and turbidity meter and temperature Sensor are developed to provide and familiarized the young students and researchers with modern instruments.



Picture of (a) Turbidity Meter and Temperature Sensors (b) Ultrasonic Sensor



## Committee Room

The committee room in the Centre is the well-known room where the Board of Governors (BOG), Centre's Board of Studies (CBS), and Academic Committee Meetings are held. The room is refurbished with a modern interior design with new furniture. A smart screen is also installed to experience the high-definition display of presentation and videotelephony during BOG and CBS meetings. Prof. Dr. Syed Mansoor Sarwar, Vice-Chancellor/Chairman BOG with other members inaugurated the committee room to chair the 74th BOG meeting. Vice-Chancellor with other BOG members cutting the inauguration ribbon of the committee room



Glimpse of VC, UET with Other BOG Members Cutting the Inauguration Ribbon



## CEWRE Library

More than 15000 collections of books, thesis, documents, reports, research papers, and a conducive environment of sitting for 15-20 persons make the CEWRE's library a unique feature of the Centre. Continuing CEWRE Vision to share the knowledge with national and global water professionals. With the tremendous efforts of library staff, CEWRE has digitized the existing collection in the library for knowledge seekers. Online Public Access Catalogue for users is available on the library webpage and leverages this opportunity to cultivate desired knowledge.

### Library Webpage Link:

<http://cewre.edu.pk/web/library/>

CEWRE has also purchased the new books on various topics to provide and familiarize the researchers with new and advanced knowledge. New arrivals at the library during the year 2021 are:

1. Remote sensing application for the urban environment. 2019  
**Author: Xian**
2. The Global positioning system and ARCGIS 3rd ed. 2017  
**Author: Kennedy**
3. Groundwater science. 2nd ed.2012  
**Author: Fitts**
4. Handbook of engineering hydrology: modeling, climate change, and variability.2014  
**Author: Eslamian**
5. Indus water treaty: political and legal dimensions.2017  
**Author: Hussain**
6. Glacier science and environmental change.2009  
**Author: Knight**
7. A textbook of waterpower engineering. 2016  
**Author: Sharma**
8. Hydraulic structures.2015  
**Author: Chen**

9. Kalabagh dam sifting fact from fiction.2016  
**Author: Mahmood**
10. Weirs and harrages across alluvial rivers.2007  
**Author: Siddiqui**
11. Water resources engineering.2019  
**Author: Wurbs**
12. Hydrology and hydro cllmatology principles and application. 2013  
**Author: Karamouz**
13. Transboundary water resources management. 1996  
**Author: Ganoulis, J.**
14. Transboundary water management principles and practice. 2010  
**Author: Anton Earle**
15. Trans-boundary water issues in south Asia.  
**Author: Tauhidul Anwar Khan**
16. Water issues in Himalayan south Asia: internal challenges, disputes and transboundary tensions. 2020  
**Author: Amit Ranjan**
17. Hydro diplomacy: preventing water war between nuclear-armed Pakistan and India. 2018  
**Author: Ashfaq Mahmood**
18. Climate change and social ecology a new perspective on the cllmate challenge. 2012  
**Author: Wheeler**
19. Ecology: Person new international edition. 2013  
**Author: Charlas**
20. Agricultural development and environmental degradation.  
**Author: Solhi**
21. Hydrology and Soil conservation engineering including watershed management. 2nd ed. 2016  
**Author: Das**
22. Python programming for beginners, quick start guide. 2020  
**Author: Ray Yao**



# EXTRA-ACADEMIC ACTIVITIES





To build a healthy mind and promote resilience about daily life events, extra-academic activities are one of the ways to take a break from routine acts. The Centre arranged various activities around the year to provide the postgraduate students an opportunity to expand their interests, build a better connection with their fellows and learn teamwork. The extra-academic activities arranged by CEWRE are following.

## Kashmir Solidarity Day

Each year on February 05 Pakistan observes a national holiday as Kashmir Solidarity Day to show Pakistan's support and unity with the people of Indian-administered Jammu and Kashmir. CEWRE also arranged the gathering of faculty, staff, and postgraduate students in the seminar hall to pay homage to the Kashmiris who died in the conflict. On solidarity day pictorials presentation was displayed about the history of illegally Kashmir occupation and violation of human rights by the Indian Government and maintained one Silent with the whole Nation.



Glimpses of Kashmir Solidarity Day Gathering

## Welcome Ceremony

CEWRE organized a ceremony in the seminar hall to welcome newly admitted postgraduate students. Such a ceremony gave the newly admitted student a chance to adjust physically and emotionally to the new learning environment, as well as become acquainted with the faculty and staff. Prof. Dr. Noor Muhammad Khan, Director CEWRE, officially welcomed the admitted students to the Centre in his opening remarks. Every faculty member introduced himself and greeted the students. The ceremony was concluded with refreshments.



Glimpses of Welcome Ceremony

## Sports Gala 2021

Each year CEWRE arranges sports week in which different games are played. Faculty members, staff, and postgraduate students take part in the games. In the year 2021, the Centre conducted the sports gala on December 13-17, 2021. Dr. Muhammad Waseem, Assistant Professor was the sports coordinator who played a key role in the successful conduction of sports week with the support of other faculty members. The inaugural ceremony of the sports gala took place on the lawn of CEWRE in the evening time. Opening remarks were delivered by Director, CEWRE then followed by cricket and football teams appearances, and cultural dances were performed by the indigenous students of KPK and Punjab province. Faculty members also participated in the event to make it memorable. In the end, students and faculty members joined the table for refreshment. The games played in gala 2021 were:



Cricket



Badminton



Football



Table Tennis



Chess



Carrom board



Ludo

## 2021 Sports Teams



Media Partner of  
Sport Gala 2021



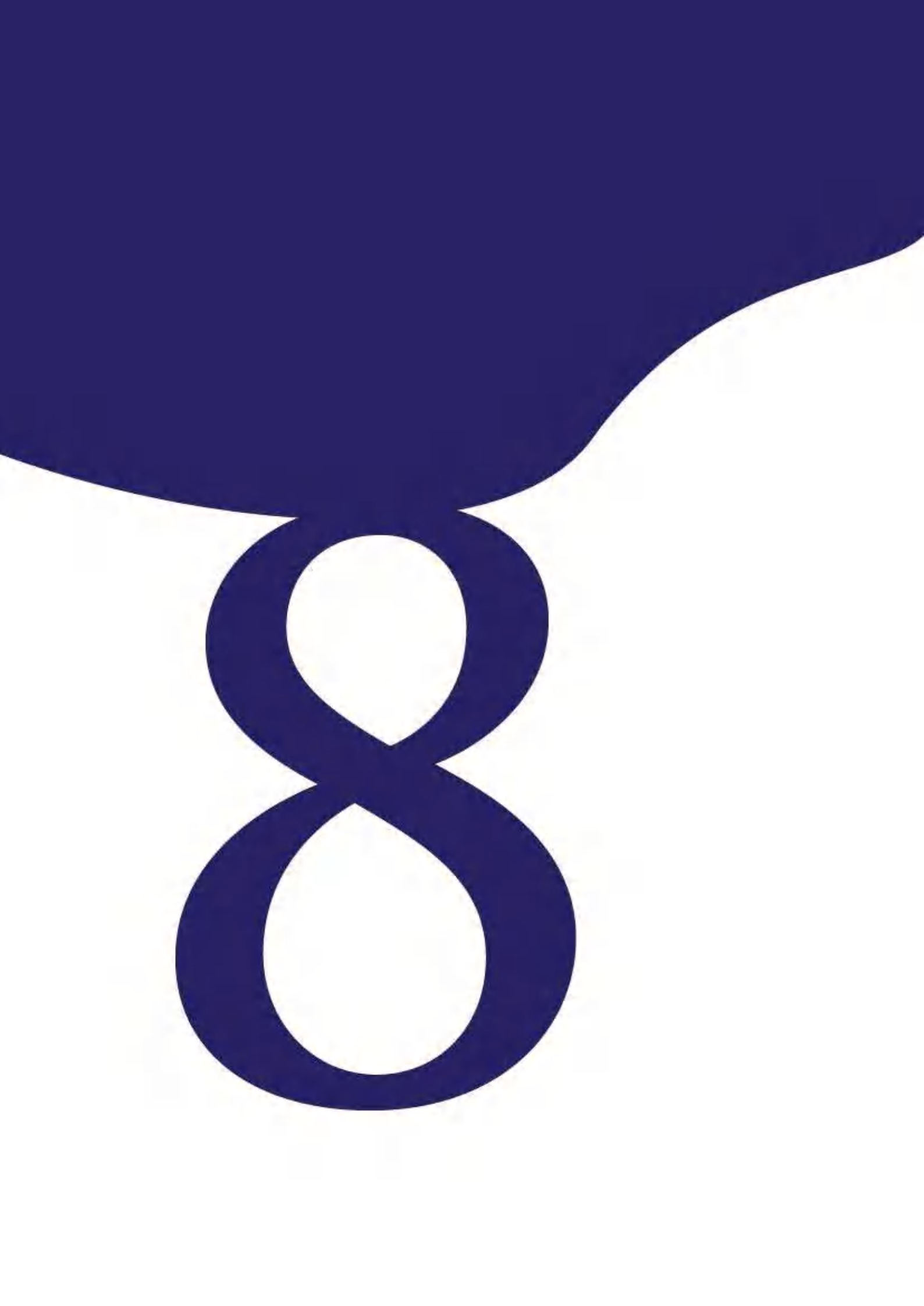


Pictures of Playing Games



Glimpses of Prize Distribution Ceremony, Sport Gala 2021

OTHER ACTIVITIES  
&  
SERVICES



CEWRE supports its faculty and staff under the direction of the Centre's rules. Director, CEWRE as manager of the institute put their best efforts to facilitate their faculty and staff to promote a conducive working environment.

## Scholarship Cheque Distribution

Centre offers scholarships to their students in three categories; need base and merit base initially for one year and position holding in each semester, to support and nurture the research capabilities in postgraduates. A committee is existing that consists of three faculty members. The members interview the students and provide recommendations to Director for final approval. In the year 2021, scholarship cheques were distributed among students.



Director CEWRE and Faculty Members Distributing Scholarship Cheques to Students



## Benevolent Cheque Distribution

Benevolent funds for welfare, marriage, study, and in case of emergencies (as defined by rules) are available for staff members of the Centre. A committee consisting of the Director as head and one member each from faculty and staff is established for authentication of the cases and disbursement of the approved cheque. In the year 2021, the committee approved cheques of various amounts as per case and distributed them.



Director CEWRE Distributing Benevolent Cheques to Mr. Umer, Mr. Binyameen and Mr. Aslam Butt

## Retirement

Mr. Bari retired from CEWRE on December 22, 2021, after 35 years of service. During the service, he served as a peon. Maintaining the Centre tradition, a farewell ceremony was arranged on the day of his retirement. All faculty members including the Director CEWRE and staff had joined the ceremony, shared remembrance, and wished him a happy life.



Glimpses of Mr. Abdul Bari Farewell Ceremony



## Services

CEWRE provides consultancy and testing services to public and private water-related institutes. In the year 2021, the Centre provide testing services to the International Sedimentation Research Institute Pakistan (ISRIP) and Glacier Monitoring Research Centre (GMRC), WAPDA. They hire the Centre's Model Tray (MT) Hall services to test and calibrate the AA-type current meters. MT Hall provides services for modeling of scale-down physical models and calibration of current meters and acoustic doppler current profiler (ADCP).



Glimpses of Testing and Calibrating the AA Type Current Meters Using Tow Trolley







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